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FOREWORD

The four independent reviewers estimated each paper and recommended 89 articles for publishing at the proceedings consisted of 2 volumes, which started life as presentations at the Annual 21st International Scientific Conference "Research for Rural Development 2015" held at the Latvia University of Agriculture, in Jelgava, on 13 to 15 May 2015.

In the retrospect of four months later, we can count the Conference as a great success. The theme – Research for Rural Development - attracted participation more than 185 researchers with very different backgrounds. There were 147 presentations from different universities of Lithuania, Estonia, Poland, Turkey, Greece, Slovakia, Nepal, Russia, Czech Republic, Kazakhstan and Latvia.

Thank you for your participation! I'm sure that you have learned from the presentations and discussions during the conference and you can use the outcomes in the future.

The cross disciplinary proceedings of the Annual 21st International Scientific Conference "Research for Rural Development 2015" (2 volume since 2010) are intended for academics, students and professionals. The subjects covered by those issues are crop production, animal breeding, agricultural engineering, agrarian and regional economics, food sciences, veterinary medicine, forestry, wood processing, water management, environmental engineering, landscape architecture, information and communication technologies. The papers are grouped according to the sessions in which they have been presented.

Finally, I wish to thank Organizing and Scientific Committee and the sponsors for their great support to the conference and proceedings.

On behalf of the Organizing Committee

of Annual 21st International Scientific Conference

"Research for Rural Development 2015"

Ausma Markevica
Latvia University of Agriculture

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ASSESSMENT OF HYPERSPECTRAL DATA ANALYSIS METHODS TO CLASSIFY TREE SPECIES

Gints Priedītis, Ingus Šmits, Salvis Daģis, Līga Paura, Jānis Krūmiņš, Dagnis Dubrovskis
Latvia University of Agriculture
gints.prieditis@llu.lv

Abstract
One of the most challenging issues in forest inventory based on remote sensing data is identification of tree species. Hyperspectral remote sensing data provides information which considerably facilitates tree species recognition. The objective of the research is to evaluate different hyperspectral data analysis methods to classify tree species in Latvian forest conditions. The study site is a forest in the central part of Latvia, Jelgava district (56º39' N, 23º47' E). The area consists of a mixed coniferous and deciduous forest. During research 598 trees were analyzed in 70 sample plots. Remote sensing data are 64 hyperspectral bands in the 400 - 970 nm spectral range. Two different classification techniques: linear discriminant analysis (LDA) and artificial neural networks (ANNs) were used. In LDA species classification was done by stepwise and using principal components of hyperspectral bands. In stepwise LDA 18 hyperspectral bands were used. LDA using principal components and ANNs used all 64 hyperspectral bands. The best results show stepwise LDA where 82.4% of the data were correctly classified. Scots pine was classified 94.8%, Norway spruce 83.5%, Silver birch 77%, European aspen 71.4% and Black alder 56.3%. Classification with ANN's best results showed for Scots pine, Norway spruce and Silver birch – respectively 81%, 84%, 86%. With LDA using principal components Scots pine's classification showed best results with 85.1% correctly classified trees.
Key words: Forest inventory, hyperspectral remote sensing, tree species identification, linear discriminant analysis.

Introduction

The objective of forest inventory is to provide forest owners with the necessary information dealing with forest management planning, documentation of economic activities and for stating the value. The quality of the information is very topical in forestry industry because it leads to a precision of evaluating the condition of forest resources and helps to take the most effective forest management planning decisions.

Forest inventory methods that are based on remote sensing data are economic and less time consuming (Hyyppä et al., 2008). Up until now, the studies in Latvia and in the world show that separate stand characteristics can be identified with a high precision. At the same time it has been pointed out that results are substantially influenced by the structures of remote sensing data, additional information about the stand, and data processing methods being used (Korpela et al., 2006).

Main problems impeding the development of this technology in the conditions of Latvia are related to the fact that data processing methods cannot fully evaluate and automatically identify all economically important tree species (Priedītis et al., 2013).

Promising results in identification of tree species are obtained with the help of hyperspectral remote sensing that allows to analyse hundreds of spectral bands. Hyperspectral remote sensing data provides information of many spectral bands. Most frequently, to obtain optimal results, only a part of proposed spectral bands is used (Ghiyamat and Shafri, 2008; Thenkabail et al., 2004). Several scientists consider that approximately 90% of hypesrspectral remote sensing data are unnecessary and can even interfere with the identification of tree species (Thenkabail et al., 2004). Latest scientific improvements in hyperspectral image acquisition have allowed to improve the spectral and spatial resolution, which allows to obtain even larger amount of information, and as a result, it allows to separate and analyze very narrow spectral bands (Thenkabail et al., 2014).

Various statistical approaches are used in most of data processing methods when analysing separate spectral bands (Masaitis and Mozgeris, 2013; Thenkabail et al., 2004), their combinations (Agapiou et al., 2012; Agapiou et al., 2012; Blackburn, 2007; Thenkabail et al., 2004; Thenkabail et al., 2014), or indices (Adam et al., 2010; Haboudane et al., 2004; Thenkabail et al., 2004; Thenkabail et al., 2014). Different formulas are used to calculate indices, using information only from approximately 30 spectral bands (Blackburn, 2002; Thenkabail et al., 2002), the used spectral bands in various studies are observed as different. Classification methods that reduce the high range of data and process only that part which is characterized by tree species, are also frequently used (Dinuls et al., 2011; Dinuls et al., 2012; Waser et al., 2010). Reflection intensity, which is analysed in various spectral bands, can be dependent on many internal and external factors (Adam et al., 2010) on a species level, thus influencing identification and classification results of the tree species. Different studies have shown that, despite the large number of spectra, spectral measurements tend to be very similar for different tree species (Waser et al., 2010; Wen et al., 2008).

The use of hyperspectral remote sensing data in forest inventory for classification of tree species is

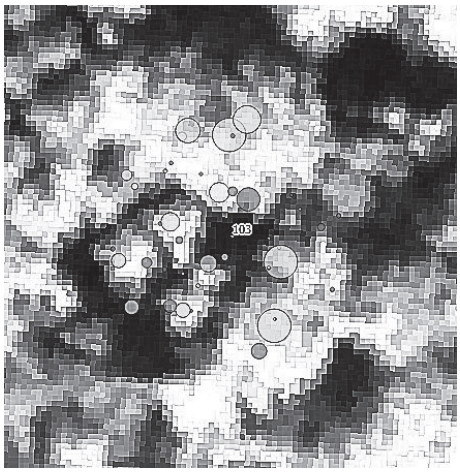

Figure 1. Aerial photography with actual on-site situation of the sample plot.

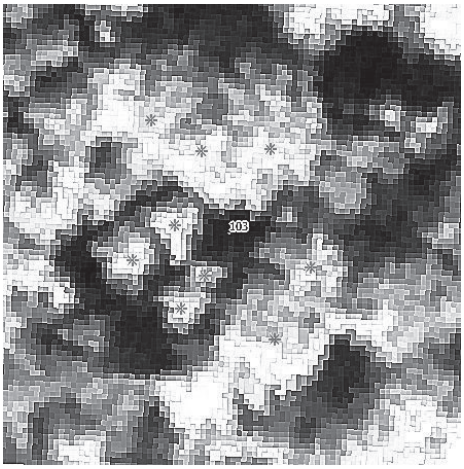

Figure 2. Aerial photography with adjusted situation of the sample plot and marked sample trees.

extensively researched in various types of forests. The structural characteristics of a stand is one of the reasons which determine the precision level of results, applicable data processing methods, and also most suitable spectral bands. When hyperspectral remote sensing data is analysed, it is possible to obtain information about biochemical (Curran et al., 2001) and biophysical (Darvishdaeh, 2008; Zhang et al., 2013) characteristics of a plant, which in several cases can help to identify the tree species.

The objective of the research is to evaluate different hyperspectral data analysis methods to classify tree species in Latvian forest conditions.

Materials and Methods

The study site was a forest in the central part of Latvia, Jelgava district (56º39' N, 23º47' E). Totally 70 sample plots (0.05 ha) were established. The area consists of a mixed coniferous and deciduous forest of different age, high density, complex structure, various components, composition and soil conditions. Represented species are Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) H.Karst), Silver birch (*Betula pendula* Roth), Black alder (*Alnus glutinos* L.), and European aspen (*Populus trémula* L.).

All trees with a diameter at breast height DBH of more than 5 cm were measured and for each tree coordinates, its species, height, DBH, crown width and length were recorded. Differentially corrected Global Positioning System measurements were used to determine the position of each plot centre. The accuracy of the positioning was less than 1 meter.

Individual trees from the sample plots were used in the study. Data processing consisted of manually selecting trees with recognizable tree crowns in the images. Tree centres were adjusted by putting them in the accurate position according to the situation in aerial photography (Figure 1 and Figure 2).

It was performed with an aim to exclude miscalculations that could appear when inaccurate tree centres would be determined by using automated approach. Study includes sample plot measurements for 598 trees - Scots pine (209 trees), Norway spruce (133 trees), Silver birch (147 trees), Black alder (47 trees), and European aspen (62 trees).

Remote sensing data were obtained using a specialized aircraft (Pilatus PC-6), which is equipped with a high-performance airborne VNIR pushbroom hyperspectral system (AisaEAGLE). System acquires full, high quality hyperspectral data up to 488 spectral channels with 1024 swath pixels and high image rates. The study area was flown at 1000 m altitude. Data was recorded in 64 hyperspectral bands in the 400 - 970 nm spectral range, spectral resolution was 3.3 nm, ground resolution 0.5 m, a field of view from 17.36° to - 18.68°. Flight was done on 27 October, 2014.

Two different classification techniques were used in the paper: linear discriminant analysis (LDA) and artificial neural networks (ANNs). Data of 64 hyperspectral bands was analysed to classify and predict five trees species: Scots pine, Norway spruce, Silver birch, Black alder and European aspen. Before the tests, the outliers were excluded from the data set and each predictor variable was normally distributed. Most of hyperspectral bands are correlated with each other, therefore for the LDA application from the large number of bands were selected uncorrelated bands. The number of hyperspectral bands was reduced by stepwise LDA and factor analysis (PCA). According to stepwise LDA, 18 hyperspectral bands contributed to the difference between the groups and these bands were included in the discriminant function. According to PCA, 64 hyperspectral bands were combined to

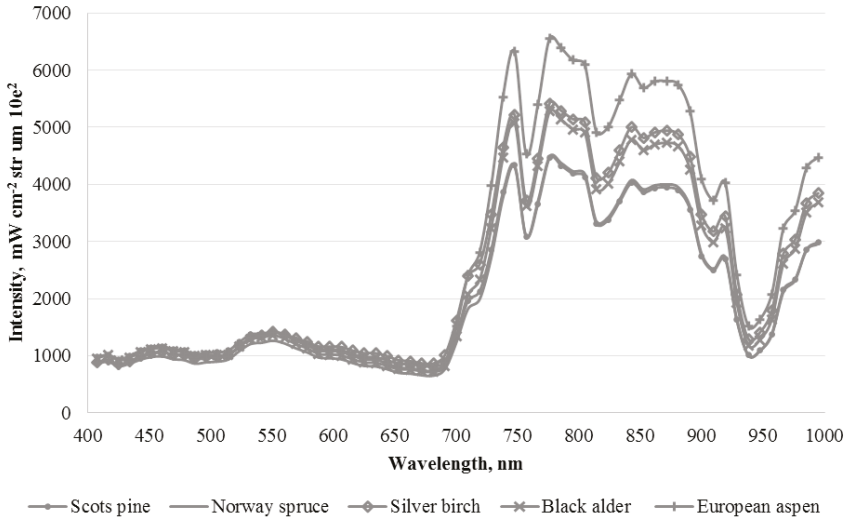

Figure 3. Average reflection intensity in different spectral bands according to the tree species.

four factors (PC) and new factors (PC) were used in LDA to classify tree species.

ANNs training was performed with 100 Scots pine, silver birch and Norway spruce trees, but for European aspen ANNs training was done with 42 trees and for black alder with 27 trees. For the test data, 20 trees of each species, which would not overlap with the training set of data, were selected. For each test, the set of data was randomised and only the specified tree count was selected. Tree identification test was repeated 4 times. For the ANNs, 64 spectra were used in the input, and 5 species in the output.

Results and Discussion

Differences between trees species means were analysed by ANOVA and differences were observed for all predictor variables or 64 hyperspectral bands. Mean differences between interested tree species in red and near infrared hyperspectral bands are larger and these bands may be good discriminators for separation of groups (Figure 3).

Literature analysis shows that spectral features of tree species during the year vary by seasons (Masaitis and Mozgeris, 2013). Our research results about spectral ranges with largest differences between tree species are similar to the findings in the studies of other scientists.

Species classification by stepwise LDA

According to stepwise LDA, the 18 hyperspectral bands were significant and were used to classify five tree species. The intracorrelations between blue and red, and between violet and red infrared hyperspectral bands are low. The 18 bands discriminate functions revealed significant associations between groups and predictors. Four canonical discriminant functions were used in the analysis (Table 1) and the three models explain 95.4% of the variation in the grouping variable – tree species. The first discriminant function explains 49.8% of the possible differences among the five tree species groups; whereas bands more than 700 nm were the stronger predictors and 400-600nm bands were with less predictor with smaller standardized canonical discriminant function coefficients.

The second discriminant function explains 29.4% of the possible differences among the species. 8 hyperspectral bands in range 400-600nm have a higher loading on the second discriminant function and can be labelled “visible light spectres”. The first discriminant function is statistically significant and with this function it is possible to classify two groups’ – differences among the Scots pine, Norway spruce and Silver birch, Black alder, European aspen (Figure 4). The second discriminant function can be used to classify Scots pine from Norway spruce and the 3rd Silver birch from European aspen.

Table 1

Eigenvalues, variance and canonical correlation of 18 bands discriminant functions

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.2	49.8	49.8	0.830
2	1.3	29.4	79.2	0.753
3	0.7	16.2	95.4	0.647
4	0.2	4.6	100.0	0.412

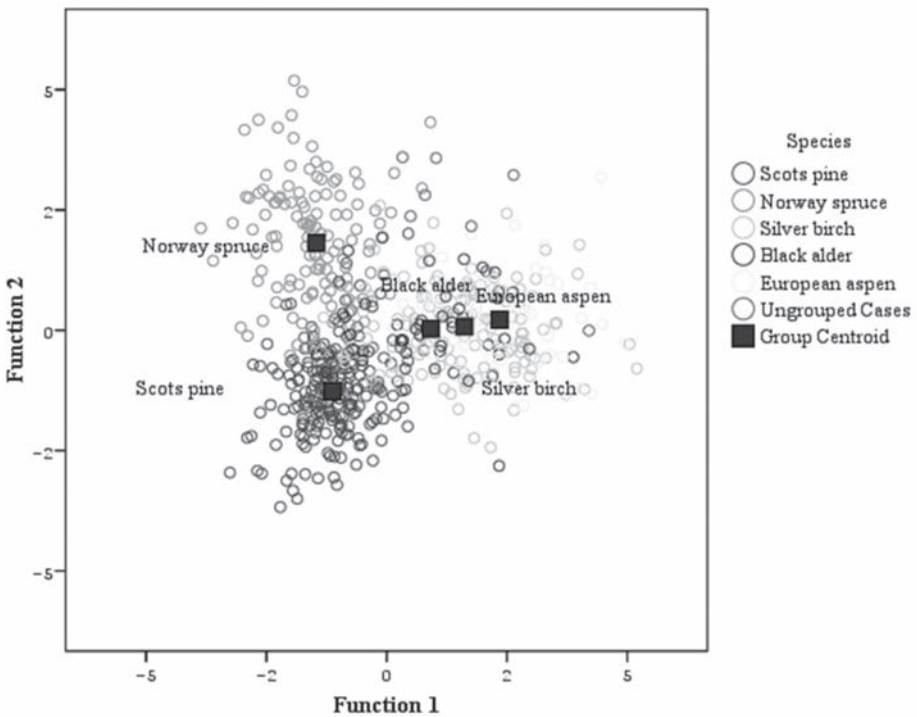

Figure 4. Plot of five tree species groups in discriminant space.

The classification results of tree species are shown in Table 2 and Figure 3. 82.4% of the data (trees) were correctly classified. Scots pine and Norway spruce were classified with a slightly better accuracy 94.8% and 83.5%, respectively, than other tree species. 14.3% of Norway spruce and 14.6% of Black alder were classified as Scots pine. 15.9% of European aspen were classified as Silver birch. The cross validated classification showed that 81.1% of trees were correctly classified.

Species classification by stepwise LDA is used for identification of tree species in varied structure forest stands. Literature analysis shows that even if 15 tree species are classified, this method can produce an overall classification accuracy of 86% for dense crowns (Alonzo et al., 2013).

Species classification by LDA using principal components of hyperspectral bands

The hardest part of hyperspectral data evaluation process is to decide which bands are the most valuable for given task. One of the common solutions for such a problem is to use the principal component analysis, which investigates if it is possible to represent variation between data samples using a smaller number of variables (usually called principal components). Principal components show the amount of variance described by each of principal components which is

Table 2

Tree species classification results of the total number of cases obtained with 18 hyperspectral bands, %

	Tree species	Scots pine	Norway spruce	Silver birch	Black alder	European aspen
Original	Scots pine	**94.8**	3.3	1.9	-	-
	Norway spruce	14.3	**83.5**	2.3	-	-
	Silver birch	10.1	2.7	**77.0**	6.1	4.1
	Black alder	14.6	6.3	8.3	**56.3**	14.6
	European aspen	3.2	1.6	15.9	7.9	**71.4**
Cross validation	Scots pine	**94.3**	3.3	1.9	.5	-
	Norway spruce	14.3	**83.5**	2.3	-	-
	Silver birch	10.1	4.1	**75.0**	6.8	4.1
	Black alder	14.6	8.3	10.4	**52.1**	14.6
	European aspen	3.2	1.6	15.9	11.1	**68.3**

Table 3

Tree species classification results of the total number of cases obtained with PC of hyperspectral bands, %

Tree species	European aspen	Silver birch	Norway spruce	Black alder	Scots pine
European aspen	**54.1**	24.3	8.1	5.4	8.1
Silver birch	6.7	**72.7**	4.6	-	16.4
Norway spruce	1.1	5.3	**50.5**	5.3	37.9
Black alder	10.5	21.1	-	**15.8**	52.6
Scots pine	0.6	4.6	9.7	-	**85.1**

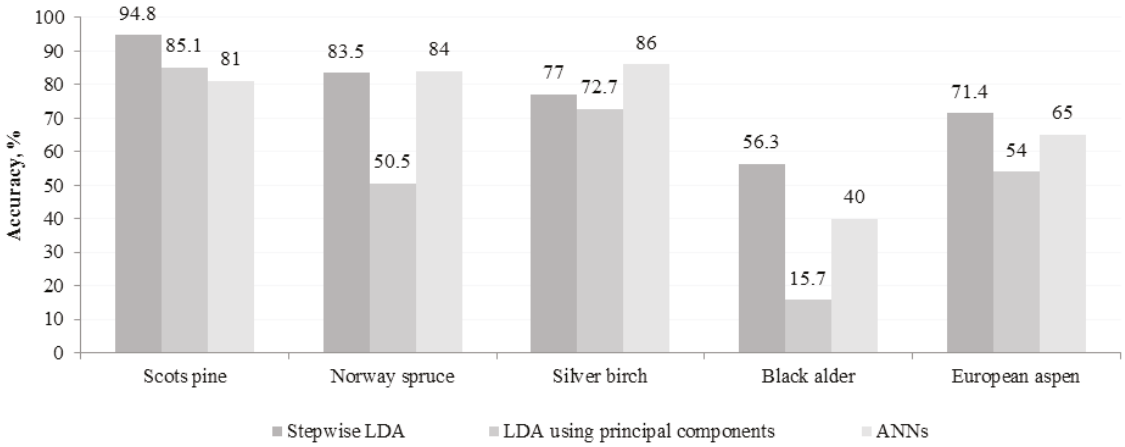

Figure 5. Summary of tree species classification methods.

acquired by transforming all 64 bands of hyperspectral data. The biggest amount of variances is described by the first component and four components describe in total 0.9961% of data variance. LDA model which uses transformed data of spectral bands to classify tree species were created. Tree species classification results obtained with PC are shown in Table 3 and Figure 5.

Scots pine and Silver birch were classified with accuracy of 85.1% and 72.7%. Black alder was classified with accuracy of 15.8%.

The PC has been used as a method for best band selection in many studies and is a widely used method (Agapiou et al., 2012; Ghiyamat and Shafri, 2008; Masaitis and Mozgeris, 2013). The use of this method in our research shows poor results, which could be due to the use of all available bands in the data processing. In scientific literature, some authors suggest using a smaller set of selected bands which could generate more accurate results than the whole set of spectral bands (Adam et al., 2010; Krahwinkler and Rossmann, 2010).

Species classification by ANNs

Results of tree species classification with ANNs in the studies of different authors are controversial, because precision of the results depends on many parameters and in most cases these parameters are unique within the certain trial. Precision of this method is basically influenced by the amount of input and training data.

In the research best results of tree species classification with ANNs were achieved for Scots pine, Norway spruce and Silver birch – respectively 81%, 84%, 86% of trees were classified correctly. But for Black alder and European aspen only 40% and 65% of trees were classified correctly (Figure 5), which could be explained due to the small number of training data – 27 for Black alder and 42 for European aspen.

Summary of Tree species classification methods

In the research of different authors the tree species identification using hyperspectral remote sensing data is performed with the precision from 50 till even 97%, which depends on tree species and used data processing methods (Adam et al., 2010; Chan and Paelinckx, 2008). Several studies show a 90% precision for separate tree species (Agapiou et al., 2012; Boschetti et al., 2007; Clark et al., 2012). In the ideal conditions, tree species can be identified with precision, which is higher than 95 % (Dinuls et al., 2011; Dinuls et al., 2012). Hyperspectral remote sensing data in combination with Lidar data is used to

increase and obtain more precise results (Blackburn, 2002; Dinuls et al., 2012).

Conclusions

1. The presented classification methods LDA and ANNs in Latvian forest conditions are providing classification accuracy in range of 40-95%.
2. LDA using 18 hyperspectral bands show the highest tree species classification, where on average 82.4% of the trees were correctly classified. The Scot pine and Norway spruce species had higher classification results.
3. ANNs classifier provided similar classification results as LDA. The Scot pine, Norway spruce and Silver birch species had higher classification results. Only 40% of Norway spruce was correctly classified.
4. LDA classification using principal component produced very weak results and the number of classification trees had decreased.
5. The wavebands which showed the largest spectral differences about interested species in autumn are red and near infrared spectral zones.
6. Combinations with other remote sensing data sources could improve tree species classification results, as well as the combinations of data processing methods.
7. Latvian forest conditions are difficult for all remote sensing methods used mainly for mixed deciduous and coniferous spaces with high density and homogeneous crown.

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References

1. Adam E., Mutanga O., Rugege D. (2010) Multispectral and hyperspectral remote sensing for identification and mapping of wetland vegetation. *Wetlands Ecology and Management*, 18(3), pp. 281-296.
2. Agapiou A., Hadjimitsis D.G., Alexakis D.D. (2012) Evaluation of Broadband and Narrowband Vegetation Indices for the Identification of Archaeological Crop Marks. *Remote sensing,* 4(12), pp. 3892-3919.
3. Alonzo M., Roth K., Dar R. (2013) Identifying Santa Barbara's urban tree species from AVIRIS imagery using canonical discriminant analysis. *Remote Sensing Letters*, Vol. 4, No. 5, pp. 513-521.
4. Blackburn G.A. (2002) Remote sensing of forest pigments using airborne imaging spectometer and LIDAR imagery. *Remote Sensing of Environment*, 82, pp. 311-321.
5. Blackburn G.A. (2007) Hyperspectral remote sensing of plant pigments. *Journal of Experimental Botany,* 58(4), pp. 855-867.
6. Boschetti M., Boschetti L., Oliver S., Casati L., Canova I. (2007) Tree species mapping with Airborne hyper-spectral MIVIS data. *International Journal of Remote Sensing*, 28(6), pp. 1251-1261.
7. Chan J.C.W., Paelinckx D. (2008) Evaluation of Random Forest and Adaboost tree-based ensemble classification andspectral band selection for ecotope mapping using airborne hyperspectral imagery. *Remote Sensing of Environment*, 112, pp. 2999-3011.
8. Clark M.L., Roberts D.A. (2012) Species-Level Differences in Hyperspectral Metrics among Tropical Rainforest Trees as Determined by a Tree-Based Classifier. *Remote Sensing*, 4(6), pp. 1820-1855.
9. Curran P.J., Dungan J.L., Peterson D.L. (2001) Estimating the foliar biochemical concentration of leaves with reflectance spectrometry: Testing the Kokaly and Clark methodologies, *Remote Sensing of Enivironment*, 76, pp. 349-359.
10. Darvishzadeh R. (2008). Hyperspectral remote sensing of vegitation parameters using statistical and physical models. *ITC Dissertation*. International Institute for Geo-information Science & Earth Observation, Enschede, the Netherlands, 169 p.
11. Dinuls R., Erins G., Lorencs A., Mednieks I., Sinica-Sinavskis J. (2012) Tree species identification in mixed Baltic forest using lidar and multispectral data. *Selected Topics in Applied Earth Observations and Remote Sensing.* Vol.5, pp. 594-603.
12. Dinuls R., Lorencs A., Mednieks I. (2011) Performance Comparison of Methods for Tree Species Classification in Multispectral Images. *Electronics and Electrical Engineering*, 111(5), pp. 119-122.
13. Ghiyamat A., Shafri H.Z.M. (2008) A review on hyperspectral remote sensing for homogeneous and heterogeneous forest biodiversity assessment. *International Journal of Remote Sensing,* 31(7), pp. 1837-1856.
14. Haboudane D., Miller J.R., Pattey E., Zarco-Tejada P.J., Strachan I. B. (2004) Hyperspectral vegetation indices and novel algorithms for predicting green LAI of crop canopies: Modeling and validation in the context of precision agriculture. *Remote Sensing of Environment*, 90, pp. 337-352.

15. Hyyppä J., Hyyppä H., Leckie D. (2008) Review of Methods of Small-footprint Airborne Laser Scanning for Extracting Forest Inventory Data in Boreal Forests. *International Journal of Remote Sensing*, 29, pp. 339-366.
16. Korpela I. (2006) Incorporation of Allometry into Single-tree Remote Sensing with LIDAR and Multiple Areal Images. Department of Forest Resource Management. University of Helsinki, Finland. p. 6.
17. Krahwinkler P., Rossmann J. (2010) Tree Species Classification Based on the Analysis of Hyperspectral Remote Sensing Data. In: *Remote Sensing for Science, Education, and Natural and Cultural Heritage.* Proceedings of the 30th EARSeL symposium, University of Oldenburg, Oldenburg, Germany, pp. 321-328.
18. Masaitis G., Mozgeris G. (2013) The influence of the growing season on the spectral reflectance properties of forest tree species. In: Treja S. and Skujniece S. (eds) Research for Rural Development. *Annual 19th ISC proceedings Vol. 2*, Latvia University of Agriculture, Lielā ielā 2, Jelgava, Latvia, pp. 20-25.
19. Priedītis G., Šmits I., Daģis S., Dubrovskis D. (2013) Treee species identification using Lidar and optical imagery. In: Treja S. and Skujniece S. (eds) Research for Rural Development. *Annual 19th ISC proceedings Vol. 2*, Latvia University of Agriculture, Lielā ielā 2, Jelgava, Latvia, pp. 34-42.
20. Thenkabail P.S., Gumma M.K., Teluguntla P., Mohammed I.A. (2014) Hyperspectral remote sensing of vegetation and agricultural crops. Photogrammetric Engineering & Remote Sensing, 80(8), pp. 697-709.
21. Thenkabail P.S., Enclona E.A., Ashton M.S., Van Der Meer B. (2004) Accuracy assessments of hyperspectral waveband performance for vegetation analysis applications. *Remote Sensing of Environment*, vol. 91, pp. 354-376.
22. Thenkabail P.S., Smith R.B., De-Pauw E. (2002) Evaluation of Narrowband and Broadband Vegetation Indices for Determining Optimal Hyperspectral Wavebands for Agricultural Crop Characterization. *Photogrammetric Engineering and Remote Sensing*, 68(6), pp. 607-621.
23. Waser L.T., Baltsavias E., Ginzler C., Küchler M. (2010) Semiautomatic classification of tree species by means of multi-temporal airborne digital sensor data ADS40. In: *ISPRS Technical Commission VII Symposium*. Vol. 38 - Part 7B, pp. 633-638.
24. Wen Z., Baoxin H., Linhai J., Woods M., Courville P. (2008) Automatic Forest Species Classification using Combined LIDAR Data and Optical Imagery. In: Geoscience and Remote Sensing Symposium. Vol 5 – Part 5, pp.134-137.
25. Zhang C., Kovacs J. M., Wachowiak M.P., Flores-Verdugo F. (2013) Relationship between Hyperspectral Measurements and Mangrove Leaf Nitrogen Concentrations. Remote Sensing, 5(2), pp. 891-908.

METHODS AND INDICATORS FOR EVALUATION OF FOREST ECOSYSTEM SERVICES IN RIPARIAN BUFFER STRIPS

Mārcis Saklaurs, Jānis Krūmiņš
Latvia University of Agriculture
marcis.saklaurs@llu.lv

Abstract
In the research evaluation of the ecosystem services provided by riparian forests in Latvia has been studied. The aim of this research is to investigate the methods and indicators for assessing the value of ecosystem services of riparian forests and to establish the most appropriate methods of ecosystem service valuation in the case of Latvia. The study is based on analysis of scientific publications, special literature and reports of international organizations, studying results of previously performed qualitative and quantitative research methods in the field of ecosystem service evaluation. The results of this study revealed several methods that could be applied for evaluation of ecosystem services provided by riparian forests, taking into account that the set of available data may be limited and considering the costs and span of time that may be necessary to collect the missing data. The results also show that the majority of ecosystem service evaluation indicators can be applied if appropriate earlier studies have been performed and feasible data for similar territories or conditions are available. The knowledge of the methods and indicators for evaluation of ecosystem services is a crucial factor in the decision making process, when decisions on economic development or sustainable management of ecosystem services are made.
Key words: forest value, riparian forests, ecosystem services.

Introduction

Natural capital is one of four capital types that have been generally recognized by the economic theory (Gómez-Baggethun et al., 2010; Wittmer and Gundimenta, 2012). Evaluation of ecosystem services (natural capital) allows explaining its importance and the significance of its sustainable management (Soulard et al., 2012). As ecosystem services are a common resource that belongs to and is used by everyone by default, the incentive of a sustainable use of these services is very little (Chee, 2004). Value is given to ecosystem services from the human perspective, evaluating services that people perceive as important (various types of goods, services and intangible benefits) (MA, 2005; SEEA, 2012). If this value is not known, it can not be given a proper weight in the decision-making process, when decisions on economic development or sustainable management of ecosystem services are made (Mazza et al., 2013; Soulard et al., 2012).

The importance of ecosystem service evaluation has also been emphasized on the EU level, requiring all member states to set the economic value of their ecosystem services by 2020 (EC, 2013). To this day, however, the valuation of ecosystem services has not been implemented in Latvia.

Riparian forest buffer strips provide several ecosystem services and products, composing a large part of forest landscapes as a whole (Kuglerová et al., 2014; SEEA-Water, 2012; Soulard et al., 2012). Recent studies have confirmed that small multiform riparian forests also have a significant role in the functioning of ecosystems and biodiversity conservation.

Riparian forests are the transition zone between water and terrestrial ecosystems, which are important in biodiversity conservation. With an increasing extent of intense human activities in economically profitable lands the pressure on natural ecosystems has grown and they have been transformed in the course of time. A relatively compact river network with the average density of 0.6 km km^{-2} is characteristic to Latvia. Nearly all freshwater ecosystems and their adjacent areas are subjected to anthropogenic pressure and their functionality can be reduced or even lost due to pollution.

There is a variety of reasons for a continued reduction of environmental quality, including freshwater. A series of anthropogenic activities have increased river eutrophication (SEEA-Water, 2012), resulting in a negative impact on formerly abundant plant and animal species (Urtāns, 2008). Increased concentrations of phosphorus and nitrogen that originate from point sources in watercourses (SEEA-Water, 2012), diffuse nutrient runoff from the catchment area and other types of pollution and runoff have been identified as the main reasons of eutrophication (Russi et al., 2013). The degradation of river functions in relation to a reduction of extensive anthropogenic activities in riparian forests has been evaluated to a lesser extent (Urtāns, 2008). This urges to find ways to halt or control the biogenic pollution. One of the main solutions for vitalizing freshwater habitats in this case study is a sustainable management of riparian forest buffer strips (Kuglerová et al., 2014; SEEA-Water, 2012). A methodology that would allow assessing the impact of natural processes in riparian forest buffer strips is necessary to help decision makers express the benefit of the ecosystem services provided by riparian forests in a monetary value (De Groot et al., 2012). In order to estimate their value, it is important to assess the methods of ecosystem service valuation and the indicators that are included in them.

The aim of this research is to analyze methods and indicators for assessing the value of ecosystem services of riparian forests and to establish the most appropriate methods of ecosystem service valuation in the case of Latvia.

To achieve the aim, the following objectives were defined:

- To characterize the functions, services and goods which are provided by riparian forest ecosystems;
- To investigate indicators of riparian forest ecosystem service valuation;
- To analyze common, internationally recognized methods of ecosystem service valuation;
- To describe methods that can be applicable in assessing ecosystem services of riparian forests in Latvia.

Materials and Methods

To meet the objectives of this study, the following written materials were used: scientific publications, scientific and specialized literature, reports of international organizations, online materials, publications in press. Articles and reports that focus on the case of Latvia and cases in northern Europe were a priority, when selecting information for analysis. Data and information from the above mentioned materials was analyzed, synthesized and grouped, and, by applying logical and abstract constructive methods, the conclusions of this study were drawn. Characteristics of the methods for valuation of ecosystem services and the corresponding indicators were studied in scientific literature and periodicals of Latvian and foreign authors. This research is based on the author`s theoretical and practical knowledge and a series of studies that are performed in relation to the doctoral thesis.

Results and Discussion

The assessment of riparian forests and the ecosystem services that are provided by them has been performed in several studies. A great part of research that has been performed in Latvia is indirect in relation to riparian forests (e.g. research on forest stands, vegetation, water quality, protected species and habitats). Research has also been performed in watercourses that run through forest stands, studying the dynamics of eutrophication and sedimentation.

However, there is a significant lack of knowledge in the fields related to ecosystem services that are provided by riparian forests. Several studies have used various cost approaches, such as replacement costs, costs for an environmental damage and market prices that are assimilated to the assessment of ecosystem services. In ecosystem service studies the main focus has been on the identification of ecosystem services as values of cultural history (Estonia-Latvia, 2011). It should be noted that the majority of research is not directly aimed at assessing the ecosystem services of riparian forest stands, but forest stands altogether. It is a gain, as the existing methods and the gathered data can be used in further research that is related to forest stands of particular areas. It should be emphasized that ecosystem services, which are related to diversity and habitats, should be set as priority topics for future research (EC, 2013; MA, 2005).

There is still a number of blank fields in research on the services of landscape, aesthetics, cultural heritage and recreation. Complete knowledge on economic benefits, such as food, medicinal products and wood of riparian forests is also missing. It is important to gain information on the impact of forest stands on a wider scale, e.g. on water quality in catchment area and the Baltic Sea, the impact on eutrophication and sedimentation in watercourses as well as fish resources.

It should be recognized that research is frequently adapted to specific situations and separate localities but is not aligned to general quantitative conclusions on the forest environment on river banks. This, however, is extremely important for it to be used interlinked to the aims of existing policies. It should also be noted that the existing quantitative data of a broad scope does not always represent the real situation in life – out-dated information should be stressed, as it highlights the necessity for large-scale research, which would clarify the true situation in riparian forests and their ability to provide ecosystem services.

The main threats that have been addressed by scholars in their previous research, and are indirectly related to riparian forests, are processes of eutrophication and sedimentation that take place in watercourses (SEEA-Water, 2012; Urtāns, 2008). The attention is also put on the catchment areas that are directly related to the Baltic Sea, have an impact on its condition and regeneration of fish resources and, unfortunately, contribute to eutrophication of the Baltic Sea (BalticSTERN, 2013).

1. Integrated assessment and valuation of ecosystem functions, goods and services

The field of ecological economics has witnessed a spectacular rise of concern with the valuation of ecosystem functions, goods and services (De Groot et al., 2002).

A principal scheme has been developed to identify the areas of ecosystem services, goods and services within the decision-making process. Ecosystem functions and ecological values are directly influenced by the structure of a specific ecosystem and the processes that take place within. Ecological, social an economical values form a total economic value that, in case of their total identification, could be used in the decision-making process to set the development strategies of territories.

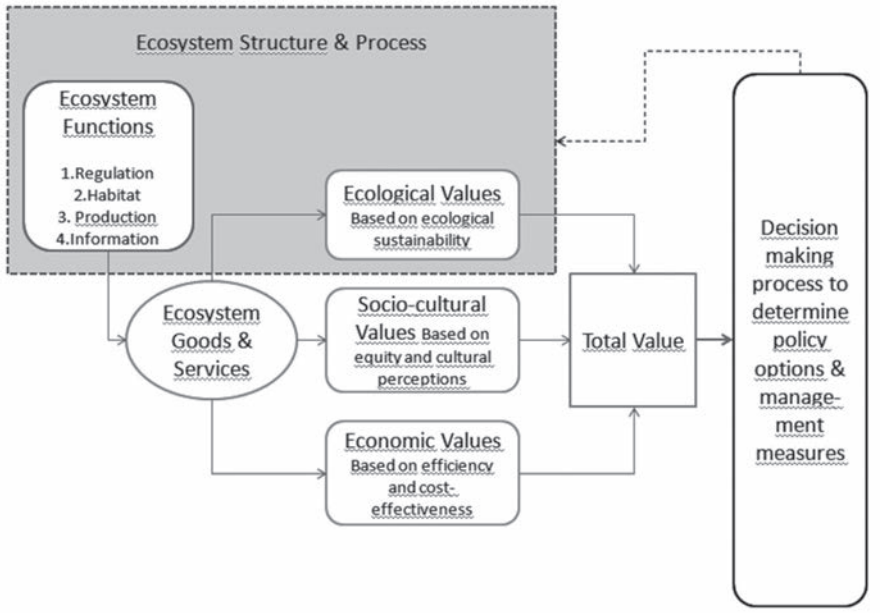

Figure 1. Framework for integrated assessment and valuation of ecosystem functions, goods and services. (Adapted from De Groot et al., 2002).

Ecosystem functions.

All ecosystem functions are divided into four larger groups that allow to assess the ecosystem value to human society. Goods and services that result from services of **regulation** (natural bio-geochemical cycles and biospheric processes) and **habitat** (providing diversity and evolution) create the necessary prerequisites for services of **production** (creation of living biomass) and **information** (mental and recreational value). The direct and indirect benefits that result from the above mentioned ecosystem functions are crucial for human well-being and are, therefore, highly valuable (Groot et al., 2002).

Ecosystem goods and services.

Within the context of a sustainable development, riparian forests hold a special importance. In addition, they also provide ecosystem services and benefits to the social sphere, nature protection and economy. The above mentioned services are divided into several groups (Chee, 2004; Daily, 1999).

Ecosystem services (or the goods that arise as a result of these services) can be expressed as values that can be used to set a total economic value. A system of values and indicators is used in assessment. Values are mostly expressed by qualitative features that can be valued, classified and analysed. Setting of values is mostly based on indicator marks – these indicators reflect the condition of an object as well as the changes that are taking place. Indicators are means for setting value. The measurement of an indicator is quantitative, while in separate cases it is possible to identify descriptive or qualitative indicators (Table 1).

In order to assess the value of ecosystem services, the values to be assessed can be applied, such as: land cover, forest productivity, flora and fauna richness, local and introduced tree species, game mammals and birds, successional stages, ecotones, deadwood, forest productivity, forest stand age, forest stand structure, habitats, forest habitat conservation and protection, forest stand continuity, fragmentation, natural and anthropogenic elements of forest lands, forest renewal.

Riparian forests are fully related to values of their functions, they perform processes that fully influence their values. Regardless of the importance of function values and their application they can be greatly influenced by unified factors that are evaluated jointly – e.g. natural disturbances (fire, wind, snow, water, biological disturbances), factors that limit the natural disturbances, anthropogenic factors (forest cuts, disturbances, forest sinantropisation and eutrophication, grazing). Accordingly, indicators are used for their evaluation: a) the number of forest fires – (pcs.), areas damaged by windfall – (ha), areas damaged by snowbreaks – (ha), forest areas that have been invaded by meadow grasses , ruderal plants, alien trees – (ha), length of riverbank with signs of eutrophication – (km), grazing in forest – (ha).

2. Valuing ecosystem functions, goods and services

A number of valuation methods exist that allow to aggregate different values that are included in the total economic value (TEV). As a great part of ecosystem services is of a non-market nature, the valuation can not be direct, while majority of valuation methods are applicable to specific use-values, creating a challenge

Table 1

The system of values and indicators for ecosystem services that are provided by riparian forests (Modified from Chee, 2004; Daily, 1999; Hattam et al., 2015)

Services	Values	Indicators and measurememt units (examples)
Economic benefits	Food: terrestrial animal and plant products, forage, food, spices	Extracted food and forage, including berries, mushrooms, game ($t*ha^{-2}$)
	Medicinal products	Extracted amount ($kg*ha^{-2}$)
	Materials (natural fibre, timber)	Extracted amount of timber (m^3*ha^{-2}), extracted amount of natural fibre ($t*km^{-2}$)
	Energy (biomass fuels, low-sediment water for hydropower)	Extracted amount of timber (m^3*ha^{-2}) Amount of purified water (m^3*ha^{-2})
	Industrial products (waxes, oils, fragrances, dyes, precursors to synthetic products)	Amount of extracted products ($kg*km^{-2}$)
	Genetic resources	Specially protected nature territories (ha), habitat types (pcs.), habitat area (ha), deadwood (m^3*ha^{-2}), species composition (pcs.), species diversity index s
Regeneration services	Circulation of substances in nature (detoxification, decomposition of waste, renewal of soil fertility, purification of air and water)	Permanence of carbon sequestration (annual carbon turnover, t), Increase of forest stand stock (m^3*ha^{-2})
	Dispersal of seeds necessary for revegetation and pollination of crops	Species composition (pcs.)
Stabilizing services	Partial stabilization of climate, moderation of weather extremes (e.g., temperature and wind)	Areas damaged by windfalls (ha)
	Regulation of the hydrological cycle (reduction of flooding and drought)	Assessment of water level alterations (cm)
	Maintenance of coasts and waterways	Number of trees in a waterway ($pcs.*km^{-2}$), Extent of errosion (m^3 or number of indentified locations)
	Compensation and substitution of one species for another when environments vary	Species composition (pcs.), deadwood (m^3), species diversity index s
	Control of the majority of potential pest species	Area of forest stands invaded by pests (m^3)
Life-fulfilling services	Provision of cultural, intellectual and spiritual inspiration	Public assessment (quality)
	Provision of aesthetic beauty	Public assessment (quality)
Conservation services	Maintenance of ecological components and systems needed for the future	Specially protected nature territories (ha), habitat types (pcs.), habitat area (ha), deadwood (m^3*ha^{-2}), species composition (pcs.), species diversity index s
	Supply of goods and services awaiting discovery	Number of introduced goods and services (pcs.)

for setting the non-use values. There are, however, few methods for assessing the non-use values (Turner et al., 2010; Wittmer and Gundimeda, 2012).

Methods to assess ecosystem services and goods – each with their benefits and drawbacks – can be divided into three groups:

Pricing approaches – a widely used method that usually allows to assess a part of the benefits provided by ecosystem services. Nevertheless, it is applicable to gain an estimate of the monetary value that may be difficult to assess otherwise. Methods where market prices are used are usually based on turnover, while methods where the direct costs are used, are based on clean-up costs (including costs that should be covered in case of an environmental damage, necessity to replace ecosystem services with man-made systems or provide precautions in providing ecosystem services) (Turner et al., 2010).

Revealed preference methods use the relation between ecosystem services and one or several market goods, grounding this method on information of the behaviour of individuals and businesses in market where ecosystem services can be indirectly purchased (Turner et al., 2010). The most important estimation methods are: production function method (assumes that conservation of good environmental quality is an investment in the future production of goods and services), travel cost method (studies the amount of financial and time-consuming travel costs that arise in order to use ecosystem services for recreation), *hedonic price method* (assessing the prices that people pay for goods that are related to ecosystem services, analysing information on prices in the housing market) and *defensive expenditure method* (focuses on data on human behaviour).

Stated preference method is used when a weak relation exists between ecosystem services and market goods that are insufficient to perform a monetary assessment. This method is especially useful when an impact on non-market values that are related to important non-use values must be evaluated and revealed preference methods can not be used (Turner et al., 2010). Willingness to pay (WTP) and willingness to accept (WTA) are used to create a hypothetical market situation to assess people's willingness to pay for non-use value provision, using the contingent valuation - CV (social surveys that include hypothetical scenarios with descriptions of alternatives such as WTP to improve an existing situation in order to enjoy wider benefits from ecosystem services) and *choice experiments* - CE (Turner et al., 2010).

Indirect market valuation methods, such as *avoided cost* (when ecosystem services allow costs that would have been incurred in absence of these services to be avoided) and factor income method (when the ecosystem services enhance income) also exist, but are not studied in detail in this research.

Ecological functions and services can overlap, leading to the possibility of economic 'double counting'. To avoid double counting and enhance data comparability has been addressed in different papers (Fisher et al., 2008).

3. Methods for ecosystem service valuation of the riparian forests in the case of Latvia

While analysing evaluation methods and indicators of ecosystem service valuation, prerequisites that are important for the specific situation of Latvia (which, above all, would allow cost-effective collection of data that is of high demand but currently lacking), were identified. They are as follow: 1) existing and available data that can be used in valuation or 2) data sets that can be gathered as a part of the valuation and whose collection is not resource-demanding. Considering the above mentioned prerequisites, to assess the ecosystem services that are provided by riparian forests, the following approaches are recommendable for Latvia:

First approach: Forest surveying is performed, which determines the characteristic elements of the forest stand, the amount and condition of the dead wood, species diversity nearby the stream in a 10-30 m zone and 60-80 m zone by setting sample plots with size of 20 x 20 m (400 m^2). The sample plot size (20 x 20 m) is typical in forest-related research, as it describes the tree stand, as well as bush and herbaceous stand. It is the most representative sample plot size, which is often used in research, as it is small enough to describe the typical condition of the forest and keep within a single forest type and, simultaneously, large enough to create a full impression of the forest.

Transects are placed accordingly, perpendicularly to the stream bank and reached further into the forest interior. Transects that are located nearby the stream describe the interaction between the forest and river, also describing the impact of disturbances (that are created by flooding, for example), while transects that are placed further away from streams, describe the typical forest situation. For every stream three transects are established with the distance between transects of 1 km (Liepa et al., 2015). The gained data was then analyzed by the substitute-cost method, which allows assessing the monetary value of the "substitute" resource. To set the value for the dead wood, the market price for firewood is applied, while the market price of industrial wood is applied to living trees. Therefore, the forest stand information, which is further transformed into monetary assessment, is used, providing a theoretical monetary value of the forest stand. This method is also used to assess the total monetary value of biodiversity. Its main principle is to set the total costs for a situation when damage would be done to the biodiversity of a certain area that should be replaced, or it was necessary to provide precautions to provide these ecosystem services in the future (ten Brink et al., 2012). In order to gain results, data and measurements from field work are used, allowing forest stands with their specific vegetation and dead wood to be assessed in monetary terms.

Second approach: Surveys are used in ecosystem service assessment, using the above mentioned methods – CV and CE. During a survey the public attitude on environment (i.e. riparian forests) is established. To deal with issues that are related to riparian forests and evaluate the associated risks, the public attitude on the various obligations that would promote improvement of environmental condition and means to fund the necessary improvement measures must be clarified. Telephone interviews as well as face-to-face interviews can be used in such a survey. When performing a survey, its objective should first be explained to the interviewee, followed by clarification of the main connections of respondents to the specific area as well as their attitude to the processes that occur there. The questions of the survey must be mainly aimed at the potential issues of riparian forests and solutions to these issues, including potential costs that could occur to handle environmental problems and the amount of costs that each household is ready to bear in exchange for specific ecosystem services. Each questionnaire should be designed accurately and include background information and existing problems of riparian forests and their effects on ecosystem services. Background information (age, sex, income) is requested to

provide comparability to the Latvian population and possible corrections that may be necessary later. The questionnaire should include different development scenarios and their costs per household, as it would facilitate in-depth understanding of the issue and provide better and more focused answers. It is extremely important to provide cost distributions for different development scenarios.

By using the methodology for gathering vegetation data that has been described under the first approach, basic information is gained that allows to model the use of CV and CE methods, thereby offering potential development scenarios and possible future alternatives in riparian forests. A question on a potential implementation of a payment system should also be included. The CV method is used in this research, determining the costs that the society is ready to pay in order to reduce the negative processes in riparian forests. During the research both – the use (forest resources) and non-use values (aesthetics) of riparian forests - should also be viewed. Studies that are based on CV method are mostly applicable to valuation situations where coherent hypothetical alternatives of environmental change are valued. CE method, however, provides good results when the values of individual attributes are assessed. When constructing the questionnaire, a number of potential impacts for a specific future scenario can be described, defining the quality and costs of each of these.

To establish the value of recreation services of riparian forests, the applicability of travel cost method was analyzed. This method is based on surveys that focus on recreation activities that are appealing to interviewees (hikes, orienteering, bird watching etc.), travel time, distance, duration and costs that occur to reach these activities as well as the number of travels to the specific location in a set period of time. This allows creating a demand curve of a specific location, which is defined by the travel costs. The method is based on evaluation of a specific place that is used for recreation, e.g. nature trail, bird watching tower etc. If this method was used, the analysis would not return results on the whole territory – all riparian forests, but specific places instead. Accordingly, to determine the recreation services provided by riparian forests and the value of the quality of this specific place, the above mentioned CV and CE methods should be used. It should be noted that the question on the place of residence of respondents and whether they own a riparian forest should be definitely included in the background information of the survey, so that proper respondent groups could be divided in data analysis.

Third approach: Riparian forests are a fundamental solution in reduction of river pollution. Research shows that biologically diverse and productive riparian forest stands can retain and accumulate pollutants and nutrients (SEEA-Water, 2012; Soulard et al., 2012). Riparian forests can stabilize or reduce nutrient runoff. This ecosystem service of riparian forests can be assessed using the pricing approach method of replacement costs, as forest stands provide a clean-up service. The value of this clean-up service can be assessed by comparing the costs of expensive and energy intensive man–made water treatment plants to the water treatment services that are provided by riparian forests.

Fourth approach: The benefit-transfer method, which is based on existing research, can be used to assess ecosystem services of riparian forests. It allows using piloted indicators - the data derived from these indicators can be compared to the situation in riparian forest stands. Successful application of this method depends on the quality of existing research and their applicability. For example, the data on research of non-timber values can be used to set these values in riparian forests (Account Latvia, 2010).

Conclusions

1. When assessing ecosystem services it is suggested to use methods and indicators that simultaneously define ecological, social and economic factors, thereby assessing the total economic value of ecosystem services and their components.
2. It is possible to assess the ecosystem services of riparian forests in Latvia, using the methodology that has been described in this research, taking into account the fact that up-to-date scientific research on riparian forests is very little or absent altogether.
3. Methods and indicators must be used according to the available data and data whose collection is limited in time and costs.
4. Consequent research will address the issue of specific data availability in Latvia; however preliminary signals show that lack of relevant field data could threaten the performance of a fluent research.

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References

1. Chee Y.E. (2004) An ecological perspective on the valuation of ecosystem services. *Biological conservation* 120, 4, pp. 549-565.

2. Gómez-Baggethun E., De Groot R., Lomas P.L., Montes C. (2010) The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. *Ecological Economics,* 69, (6), pp. 1209-1218.
3. Daily G.C. (1999) Developing a scientific basis for managing Earth's life support systems. *Conservation Ecology,* 3, (2), pp. 14.
4. De Groot R.S., Brander L., van der Ploeg S., Costanza R., Bernard F., Braat L., Christie M., Crossman N., Ghermandi A., Hein L., Hussain S., Kumar P., McVittie A., Portela R., Rodriguez L.C., ten Brink P., van Beukering P. (2012) Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services,* 1, pp. 50-61.
5. De Groot R.S., Wilson M.A., Boumans R.M.J. (2002) A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological economics,* 41, (3) pp. 393-408.
6. European Commission (EC) (2013) Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Discussion paper. Technical Report - 2013 – 067. Available at: http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf, 3 March 2015.
7. Fisher B., Turner K., Zylstra M., Brouwer M., de Groot R., Farber S., Ferraro P., Green R., Hadley H., Harlow J., Jefferiss P., Kirkby C., Morling P., Mowatt S., Naidoo R., Paavola J., Strassburg B., Yu D., Balmford A. (2008) Ecosystem services and economic theory: integration for policy-relevant research. *Ecological applications,* 18, (8), pp. 2050-2067.
8. Hattam C., Atkins J.P., Beaumont N., Börger T., Böhnke-Henrichs A., Burdon D., De Groot R., Hoefnagel E., Nunes P.A.L.D., Piwowarczyk J., Sastre S., Austen M.C. (2015) Marine ecosystem services: linking indicators to their classification. *Ecological Indicators,* 49, pp. 61-75.
9. Integrated enviromental and economical account system in forestry sector in Latvia (AccountLatvia) (2010) The ministry of Agriculture, Forest and Wood Products Research and Development Institute, company ''Ernst&Young Baltic''. Available at: http://old.e-koks.lv/files/Gada_parskats_2010.pdf, 12 November 2014.
10. Kuglerová L., Ågren A., Jansson R., Laudon H. (2014) Towards optimizing riparian buffer zones: Ecological and biogeochemical implications for forest management. *Forest Ecology and Management,* 334, pp. 74-84.
11. Liepa L., Saklaurs M., Straupe I., Krūmiņš J. (2015) The evaluation of vegetation in riparian forest buffer strips in Latvia. Submitted to - *iForest - Biogeosciences and Forestry*, ID: ms14/1549, 20 p.
12. Mazza L., Bröckl M., Ahvenharju S., ten Brink P., Pursula T. (2013) Nordic capital in a Nordic context – Status and Challenges in the Decade of Biodiversity. the Nordic Council of Ministers, Copenhagen. Available at: http://www.norden.org/en/publications/publikationer/2013-526, 3 March 2015.
13. Millennium Ecosystem Assessment (MA) (2005) *Ecosystems and Human Well-Being: Wetlands and Water Synthesis*. World Resources Institute, Washington, DC, 80 p.
14. Russi D., ten Brink P., Farmer A., Badura T., Coates D., Förster J., Kumar R., Davidson N. (2013) *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. IEEP, London and Brussels; Ramsar Secretariat, Gland, 118 p.
15. Soulard F., Filoso G., Gagnon G., Bemrose R., Henry M., Adams P., Bordt M. (2012) M.E.G.S. Building Experimental Ecosystem Accounts. Presentation at the London Group, Ottawa, October 2012. Available at: http://unstats.un.org/unsd/envaccounting/londongroup/meeting18/LG18_p11_MEGS%20Building%20Experimental%20Ecosystem%20Accounts.pdf, 3 March 2015.
16. System of Environmental-Economic Accounting (SEEA) (2012) Central Framework. European Commission, FAO, IMF, OECD, UN, World Bank. Available at: http://unstats.un.org/unsd/envaccounting/White_cover.pdf, 3 March 2015.
17. System of Environmental-Economic Accounting for Water. (SEEA-Water) (2012) United Nations. Available at: http://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf, 3 March 2015.
18. Systems Tools and Ecological; economic evaluation; a Research Network, (BalticSTERN). (2013) *Benefits of mitigating eutrophication*. Background Paper, Stockholm Resilience Centre, 34 p.
19. Ten Brink P., Mazza L., Badura T., Kettunen M., Withana S. (2012) Nature and its Role in the Transition to a Green Economy. Available at: http://www.ieep.eu/publications/2012/10/nature-and-its-role-in-the-transition-to-a-green-economy-1157, 3 March 2015.
20. Turner R.K., Hadley D., Luisetti T., Lam V.W.Y., Cheung W.W.L. (2010) Anintroduction to socio-economic assessment within a marine strategy framework. Department for Environment, Food and Rural Affairs: London. Available at: www.defra.gov.uk, 3 March 2015.

21. Unknown cultural heritage values in common natural and cultural space (Estonia - Latvia) (2011) State Forest Management Centre. Available at: http://www.estlat.eu/supported-projects/?project=15, 2 March 2015.
22. Urtāns A. (2008) Upju biotopu apsaimniekošana: Salacas un Jaunupes rekultivācijas pieredze (The experience of river habitat management in recultivation of Salaca and Jaunupe). In: Auniņš A (Ed.). *Aktuālā savvaļas sugu un biotopu apsaimniekošanas problemātika Latvijā*. Latvijas Universitāte, 131.-141. lpp. (in Latvian).
23. Wittmer H., Gundimeda H. (2012) *The Economics of Ecosystems and Biodiversity in Local and Regional Policy and Managemen* (TEEB). Earthscan, London, 210 p.

EVALUATION OF BARK VOLUME OF FOUR TREE SPECIES IN LATVIA

Jānis Liepiņš[1,2], Kaspars Liepiņš[1]
[1]Latvian State Forest Research Institute 'Silava'
[2]Latvia University of Agriculture
janis.liepins@silava.lv; kaspars.liepins@silava.lv

Abstract
The objective of this study is to elaborate the mathematical model describing the bark proportion (BP) in stems of Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* [L.] Karst), silver birch (*Betula pendula* Roth.) and aspen (*Populus tremula* L.), as well as to analyze the vertical variation of the BP for the aforementioned species. The study material consists of data of 372 sample trees sampled in three regions of Latvia – Western (Kurzeme), Eastern (Latgale) and North-eastern (Vidzeme) during the years 2011 – 2014. The BP for each tree was calculated as a difference between the under-bark and over-bark stem volume. In this study, we compared the performance of three power regression models in predicting of BP using breast height diameter (DBH), tree height (H) and total volume (TV) as independent variables. The best fit to data was achieved by using tree height for the prediction of BP. Our results confirm that the highest proportion of the bark is at the upper part of the stem (relative height 95%) for all trees species. Pine stems have a lower BP of up to 30% relative height comparing to other species, while the spruce has the lowest bark percentage at the stem base relative to other tested species There were no significant differences found in BP among the stands from different regions for all studied species, indicating no need for derivation of separate equations for each region and ascertaining the possibility of use of the average BP values for the whole country.
Key words: bark proportion, bark volume, Scots pine, Norway spruce, silver birch, common aspen.

Introduction

The necessity of the assessment of forest stand, individual tree and its components' biomass has been highlighted internationally during the last decades since the mitigation of climate change became a highest priority worldwide. The Kyoto Protocol determines that carbon pools in forest above – and below – ground biomass and other carbon sources should be reported by countries which have ratified this protocol. According to the general guidelines defined by Intergovernmental Panel on Climate Change, the carbon is calculated by multiplying the dry biomass by 0.5 default value, which is based on a very overall assumption about carbon content in wood biomass (Good practice guidance for land use …, 2003). In fact, the carbon concentration is different among tree species and tree components, particularly in stem wood and bark (Chauhan et al., 2009). Elaboration of the mathematical functions for calculation of the bark proportion in the total stemwood volume will provide the possibility to improve the accuracy of the national reporting of the carbon balance.

Besides the improvement of national reporting of carbon stock, the reliable methods for calculation of bark content are demanded for the estimation of under-bark volume of roundwood assortments and the bark content of energy wood. The ratio of bark and wood is among qualities influencing the heating value of biomass feedstock (Kenney et al., 1990). The influence of bark content on energy wood quality becomes particularly important in harvesting of small dimensions trees (Adler, 2007). In a two-year poplar short-rotation coppice bark proportion in the extracted whole-stem biomass ranged from 33.9–31.4% in small dimensions stems to 15.1–12.5% in largest stems, depending on their moisture content (Guidi et al., 2008).

The average heating value of bark from the coniferous species is about 7% higher than the average of the deciduous species (Corder, 1976) indicating that bark content is increasing the calorific value of the energy wood. However, a potential problem of using bark in the heating is that the bark of many wood species has higher ash contents than the stem wood (Passialis et al., 2008). High ash content also tends to lower the heating value (Corder, 1976). In Sweden, the estimation of tree ash content showed that the ash content of Scots pine (*Pinus sylvestris* L.) stem with bark is clearly under the limit (0.7%), as well as in almost all cases of silver birch (*Betula pendula* Roth.) (Lestander et al., 2012). Authors found that Norway spruce (*Picea abies* [L.] Karst) stems seem to be problematic for producing pellets of the highest quality because of their high bark ash content (the average ash content in spruce bark is 3.27%, for pine bark – 1.97%, for birch bark – 2.20%) and relatively high bark percentages. The average ash content in pine, spruce and birch stem wood is 0.35%, 0.36% and 0.32%, respectively. Wood ash is a by-product of wood burning, causing problems when making a deposition on heat transfer surfaces in boilers and on internal surfaces in gasifiers (Misra et al., 1993).

The bark can comprise a remarkable amount of the total stem volume and its relative proportion of total stem volume is depending on trees species, tree diameter, tree height and bark thickness (Wehenkel et al., 2012). Bark can reach from 6 to 20% of the total volume of the stems (Heath et al., 2009; Cellini et al.,

2012; Wehenkel et al., 2012). Bark thickness is also affected by the climatic zone, stem form, site quality, tree age and other aspects (Laasasenaho et al., 2005; Sonmez et al., 2007; Cellini et al., 2012). R. Li and A.R. Weiskittel (2011) emphasize the importance of the tree bark that plays a critical role in the life of a tree when it is standing, while the harvested bark can be used as a source of energy or mulching, as well as applied in the production of some special products like in the pharmacy.

Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* [L.] Karst), silver birch (*Betula pendula* Roth.) and aspen (*Populus tremula* L.) are economically most important tree species in Latvia. According to data from the National Forest Inventory, in 2014 these four tree species covered 81.3% of the total forest area and 85.8% of the total forest volume (http://www.csb.gov.lv/en/dati/koku-sugas-latvijas-mezos-30236.html). The proportion of the bark and bark thickness has been studied previously in Latvia. The existing average bark volume values for tree species in Latvia are very general disregarding the tree age while the available equations for calculation of the bark proportions are applicable only for the estimation of under-bark volume of roundwood assortments (Līpiņš and Liepa, 2007) and cannot be used in calculation of bark proportion of standing trees. Bark thickness of spruce and pine depending on the vertical location in the stem has been studied by A. Drēska et al. (2002), however, the authors have not provided the mathematical equation for predicting the bark thickness. Z. Sarmulis et al. (2005) recommended to use the fourth-degree polynomial equation for predicting the bark thickness for spruce. The study material of the aforementioned research is based on sample trees obtained only on pre-matured and matured spruce stands restricting the use of model for prediction of bark thickness of young trees.

Several studies have been carried out abroad on the bark thickness modelling (Laasasenaho et al., 2005; Li and Weiskittel, 2011; Cellini et al., 2012). The proportion of bark biomass for pine, spruce and birch has been studied previously in Sweden (Lestander et al., 2012). For further studies authors suggested to clarify the information about the ash content in different tree parts, especially in bark biomass and to investigate the variation of bark structure along the stem. C. Wehenkel et al. (2012) estimated bark volumes for 16 native tree species in Mexico and recommend using power regression models to evaluate the proportion of bark in tree stems.

The objective of this study is to elaborate the mathematical model describing the proportion of bark volume in the stems of Scots pine, Norway spruce, silver birch and aspen, as well as to analyze the vertical variation of the bark proportion for the aforementioned species.

Materials and Methods

The study material consists of 27 Norway spruce, 34 Scots pine, 35 silver birch, and 28 common aspen stands. These stands are located mainly on mineral and drained soils representing a largest part of forest stand types in Latvia and covering all age classes starting from young stands to matured forest. The selected stands were located in three regions of Latvia – Western (Kurzeme), Eastern (Latgale) and North-eastern (Vidzeme), representing different climatic regions and tree populations. The temporary plots were laid in all selected stands placing them subjectively in the spots most accurately representing the whole stands. All the sample plots were circular plots with an area of 500 m^2. In each of the established sample plots three sample trees representing the range of dimensions of the dominant stand were felled down. The measurements for all tree species were based on data of 372 sample trees carried out during the years 2011 – 2014 (Table 1).

The sample trees were felled and the stem length was measured with the measuring tape. Felling height (stump height) was defined to be 1% of the tree height being measured before the felling. The stems were cross-cut into 1 m or 2 m sections towards the top depending on the stem length (1 m sections for stems with a length below 20 m, 2 m sections for stems with length over 20 m). The bark thickness was measured at the end of each section to the nearest millimetre using a metric tape at two perpendicular directions. The measurements were made also at the stump height, 1.3 m height and at the midpoint of the first section.

Table 1

Sample tree characteristics by tree species

	Scots pine			Norway spruce			Silver birch			Common aspen		
	DBH, cm	L, m	T, year	DBH, cm	L, m	T, year	DBH, cm	L, m	T, year	DBH, cm	L, m	T, year
Mean	19.0	17.3	54.0	17.5	16.6	41.0	14.7	18.1	35.0	13.8	16.6	23.0
Std	9.4	9.2	39.1	9.0	8.9	26.9	7.5	8.1	23.6	8.3	8.5	18.2
Min	1.5	1.9	6.0	2.3	2.8	9.0	2.7	4.8	8.0	2.7	3.7	5.0
Max	45.2	34.5	141.0	36.3	30.8	97.0	37.1	32.3	92.0	34.0	29.9	76.0

DBH = mean diameter at breast height, L = stem length, T = stand age.

Bark thickness values were determined by averaging the two measurements.

The bark volume for each tree was calculated as the difference between the under-bark and over-bark stem volume and expressed as a percentage. Stem volume with and without bark was calculated using cone formula for top section of the tree and using truncated cone formula for the rest of stem sections summing the obtained volumes of each separate section. The vertical variation of the bark proportion was calculated as the ratio of cross sectional basal area with and without bark.

The power regression models proposed by C. Wehenkel et al. (2012) were chosen to determine the relationship between the dependent variable and specific tree characteristics as independent variables. The general forms of the models are as follows:

$$BP = \beta_1 \times DBH^{\beta 2} \quad (1)$$
$$BP = \beta_1 \times H^{\beta 2} \quad (2)$$
$$BP = \beta_1 \times TV^{\beta 2} \quad (3)$$

Where BP is the bark proportion, DBH is breast height diameter, H is tree height and TV is the total volume of tree stem with bark. β_1 and β_2 are the coefficients.

The DBH and H are easily measurable variables and also used in the forest inventory, but TV is possible to calculate from the two previous variables using the tree stem volume equations. Statistic evaluation of the models was made by R^2 which reflects the total variability that is explained by the model and RMSE – root mean square error which measures the precision of the estimates. The best fit of regression is indicated by smaller RMSE value. The RMSE is calculated using the following equation:

$$RMSE = \sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{n}} \quad (4)$$

Where y_i and $\hat{y}_i$ are observed and predicted values of BP for *i*th tree and *n* is the total number of BP observations for the particular tree species.

The influence of different tree growing regions on BP was assessed using covariance analysis marking growing region as fixed factor, but DBH and H separately as covariants. Regression, correlation, covariance analyses and descriptive statistics were carried out with the SPSS Statistics 20.0 statistical software package.

Results and Discussion

The vertical variation of BP is the combined effect between bark thickness and stem diameter at examined height. For all studied tree species the bark was thickest at the base of the tree that is reflecting as the higher BP values. In the middle part of the stem, which is usually utilized for roundwood production, the BP is rather constant, thereafter sharply increasing towards the top part of the tree. This indicates that energy wood produced form logging residues mainly consisting from branches and tree tops has a tendency to have a bigger bark content. Disregarding the particular bark percentage values, the general form of bark curves at different tree size is similar for all tree species (Fig. 1).

The general tendency is that BP is decreasing from the base towards the middle part of the stem. However, the lower-most values of BP for every particular tree species are reached at different height. For Scots pine the smallest BP is in the middle of the stem at 50% relative height while for Norway spruce, silver birch and common aspen the smallest BP is in the lowest third of the stem at 20 – 30% relative height (Table 2). Similar results are reported by J. Laasasenaho et al. (2005) who stated that the lowest proportion of bark for Norway spruce in Finland is detected at 20% relative tree height. The vertical variation of pine and spruce bark thickness along the stem in Latvia has been studied by A. Drēska et al. (2002). In the study it was reported that at 20% relative height the bark of Scots pine becomes thinner than that for Norway spruce while at the base of tree the bark of Scots pine

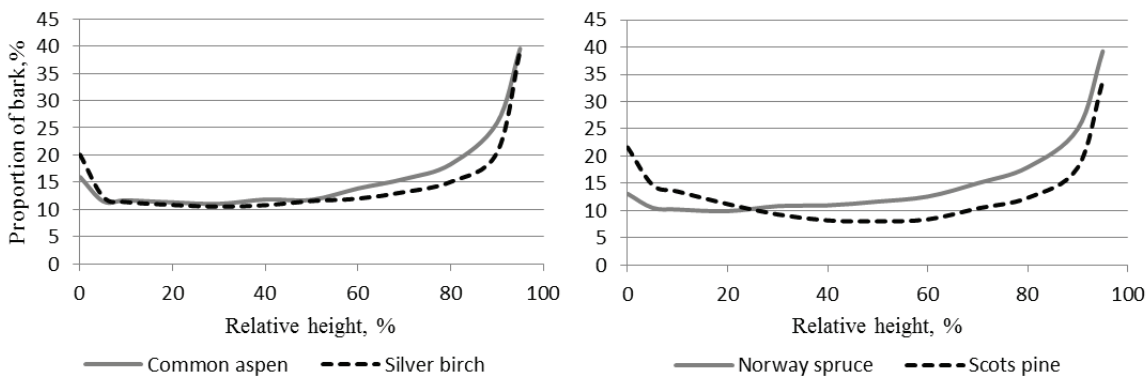

Figure 1. Average values of BP of stem basal area as a function of relative height.

Table 2

Bark proportion as a percentage of stem basal area at different relative heights, %

Relative height, %	Scots pine		Norway spruce		Silver birch		Common aspen	
	mean*	range**	mean	range	mean	range	mean	range
1	21.6±0.6	9.5-40.6	13.1±0.6	4.6-30.0	20.1±0.6	9.7-36.5	16.0±0.5	7.9-29.8
5	14.7±0.5	8.3-37.6	10.5±0.4	4.5-30.9	12.3±0.7	6.5-31.5	11.5±0.4	6.6-25.8
10	13.5±0.4	4.8-34.4	10.2±0.3	5.1-24.8	11.4±0.2	3.8-26.0	11.7±0.2	5.1-23.1
20	11.2±0.6	2.5-32.4	9.9±0.5	5.5-31.8	10.8±0.2	6.5-23.7	11.3±0.4	6.1-23.7
30	9.3±0.6	1.7-36.0	10.8±0.5	5.3-30.2	10.5±0.2	5.8-19.5	11.0±0.4	5.3-24.3
40	8.2±0.5	2.7-27.3	11.0±0.4	5.2-26.5	10.8±0.2	6.5-20.3	11.8±0.4	5.8-24.4
50	8.0±0.5	3.0-26.5	11.6±0.5	5.5-35.4	11.6±0.2	5.6-22.1	11.8±0.3	6.9-26.5
60	8.4±0.5	2.9-30.6	12.6±0.5	6.1-29.6	12.0±0.2	5.6-24.7	13.9±0.4	7.9-26.5
70	10.4±0.7	2.9-37.9	15.0±0.6	6.3-32.8	13.2±0.3	7.7-31.8	15.6±0.5	7.6-30.6
80	12.3±0.8	3.6-53.4	18.0±0.8	5.4-49.0	15.1±0.4	8.1-36.0	18.3±0.6	7.9-40.8
90	17.9±0.9	5.1-50.2	25.0±1.0	8.0-59.5	20.4±0.5	9.8-43.8	25.9±0.9	9.1-49.0
95	33.8±1.7	10.5-67.3	39.3±2.2	8.9-64.0	39.2±1.8	19.0-88.9	39.5±1.6	23.4-71.0

*Average value of bark percentage ± SE; **minimum and maximum values.

is approximately two times thicker than for Norway spruce.

The vertical variation of the BP of studied deciduous trees is similar, showing the differences only in the upper part of the stem where the bark of the birch is slightly thinner than for aspen.

The average BP along the stem ranges from 8.0% to 39.5% depending on the tree species and relative height. Our results confirm that the greatest proportion of the bark is at the upper part of the stem (relative height 95%) for all trees species. Pine stems have a lower BP up to 30% relative height comparing to other species while the spruce has the lowest bark percentage at the stem base relatively to other tested species (Figure 1, Table 2).

The influence of geographic location of the studied stands on average BP of the stems was studied using covariance analysis excluding the effect of breast height diameter and tree height. We found no significant differences in BP among the stands from different regions that BP for all studied species ($p>0.05$) indicating no need for derivation of separate equations for each region and ascertaining the possibility of use of the average BP values for the whole country. These results are in consistency with those presented by L. Līpiņš and I. Liepa (2007). The effect of the climatic zones and forest type on bark thickness of spruce is studied in Finland (Laasasenaho et al., 2005). The study confirmed that the length of growing period is a very significant factor that affects the bark thickness – the bark is thicker in the northern parts of the country while the dependency of bark thickness on forest type was not found. The contradictory results of our study (no regional differences were found among the stands from different locations), can be explained by the small geographic variation of sampled stands all being close to 56th and 57th parallels.

All independent variables (DBH, H and TV) displayed a negative, statistically significant ($p<0.05$) correlation (correlation coefficients -0.73, -0.78 and -0.57, respectively) with the BP indicating that BP values decrease with the increase of the tree size. The

Table 3

Summary of fit statistics and parameter estimates of the model of BP estimated by the Equations 1-3

Species	Equation 1				Equation 2				Equation 3			
	R^2	RMSE	b_1^*	b_2^*	R^2	RMSE	β_1	β_2	R^2	RMSE	β_1	β_2
Scots pine	0.85	2.562	75.492	-0.654	0.90	2.075	57.943	-0.597	0.89	2.215	38.189	-0.227
Norway spruce	0.86	1.891	47.272	-0.516	0.89	1.691	47.051	-0.531	0.88	1.754	29.972	-0.194
Silver birch	0.51	2.153	25.502	-0.289	0.56	2.032	31.020	-0.335	0.53	2.097	20.194	-0.108
Common aspen	0.79	1.781	31.832	-0.385	0.80	1.740	39.671	-0.434	0.80	1.754	22.953	-0.141

* All parameters b_1 and β_2 are significant ($p<0.05$)

best fit to data was achieved by using Equation 2 for the prediction of BP (Table 3).

The tree height turned out to be the best predictor for the bark proportion explaining 56 – 90% of the variations depending on tree species. However, equations where the total volume and breast height diameter is used as predictors produced the R^2 values that are just slightly lower than for tree height – 2% and 5% respectively. In practice, the use of breast height diameter as the variable for prediction of BP is more convenient because it can be measured more precisely in the forest whereas the correct estimation of tree height is often more complicated and may produce substantial measurement errors. In respect to this, the use of Equation 1 can provide a more exact estimation of BP if the tree variables have to be obtained by direct measurements in the forests instead of using the forest monitoring data.

Discovering the residual plots for Equation 1, it is evident that the residuals are distributed evenly regarding the dimensions of the stems (Figure 2). The prediction ability of all models based on power equations produced good results; however, application of these equations might produce a slight underestimation of bark proportion of bigger dimensions silver birch stems. The examination of more sophisticated models for prediction of birch bark proportion can be proposed to produce more accurate results.

T.A. Lestander et al. (2012) in their study obtained BP from biomass functions constructed by L.G. Marklund (1988) and J. Repola (2008, 2009) that are widely used in Sweden and Finland. T.A. Lestander et al. (2012) found that the bark proportion predicted using J. Repola's function was significantly higher for pine than predicted using the L.G. Marklund's function, and the BP is decreasing with an increase of diameter of pine and spruce, but not of the birch. According to L.G. Marklund's function, for birch the smallest BP value is at 12.1 cm breast height diameter - increasing thereafter. However, this relationship is not confirmed by applying J. Repola's functions, in which case no certain minimum BP value is indicated. The proportion of bark and general bark curves obtained in our study for Scots pine, Norway spruce and Silver birch better corresponds to the variation of BP described by the model derived from Finnish biomass functions.

The greatest variation of BP is observed for silver birch that is indicated by the lowest R^2 values (Table 3). The high uncertainty in calculation of birch bark volume compared to that of spruce and pine is pointed out also by I. Liepa (2011). He explains this phenomenon by the peculiarities of the study data where the presence of two birch species (silver and pubescent birch) was possible. However, this explanation cannot be applied to our study where the measurements of exceptional silver birch stems were performed. The reason for the unexplained variation of BP for silver birch stems is not fully understood. One possible explanation for this variation is the different morphological forms of the silver birch. The formation of coarse bark at the base of the birch stems can be very divergent both for different populations of birches and within the same stand. Birch trees sometimes form very distinct ridges in the lowest 3 m sector of the stem while in some cases the matured silver birch stems maintain the thin smooth bark

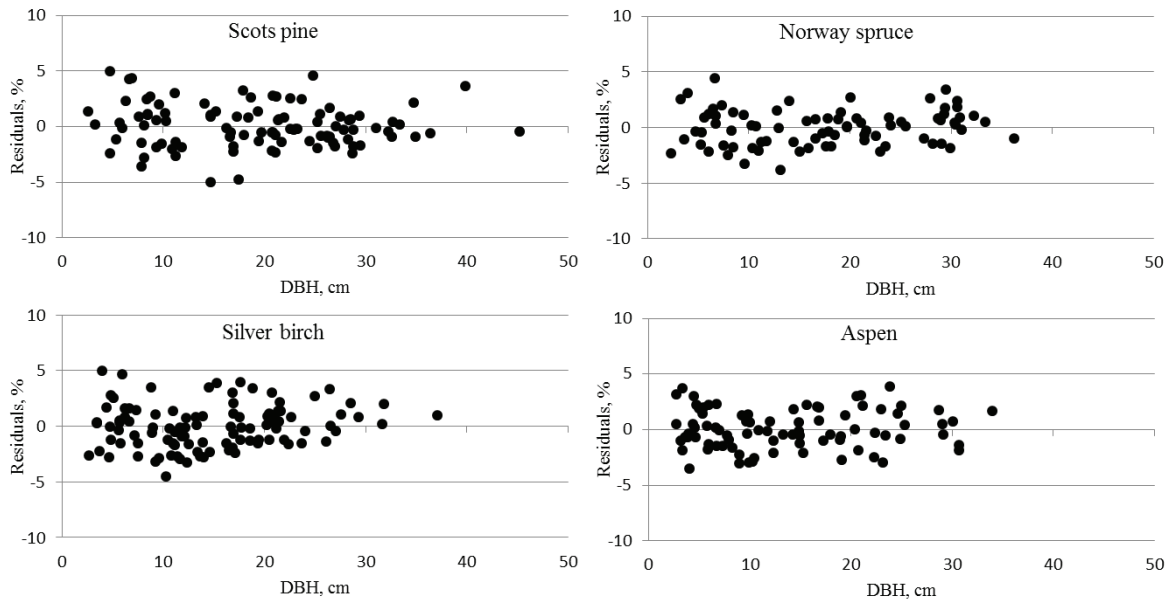

Figure 2. Residual plots (predicted – observed) of bark proportion depending on DBH using Equation (1).

Table 4

Average values of proportion of bark volume for studied tree species, %

DBH, cm	Scots pine	Norway spruce	Silver birch	Common aspen
5	26.9±1.3*	20.9±0.9	16.7±0.4	17.9±0.6
10	18.9±0.7	14.9±0.9	12.1±0.6	12.3±0.4
15	10.9±0.7	11.2±0.5	11.1±0.4	11.0±0.3
20	9.8±0.5	9.6±0.3	10.9±0.3	10.0±0.5
25	8.9±0.5	8.5±0.3	10.5±0.6	10.1±0.6
30	7.7±0.4	8.2±0.3	10.4±0.4	9.1±0.5

*Average BP values ± SE

(Līpiņš and Liepa, 2007). Bark variations of Scots pine have been studied by T. Jelonek et al. (2009). Based on other studies, the authors identified three forms of dead bark: scaly bark, ropy bark, and shell type bark, and distinguished different productivity among the morphological variety of pines.

The average BP values in stem obtained in our study revealed high within-species variation from 5.5 to 34.5% for pine, 6.6 to 28.3% for spruce, 7.9 to 21.5% for birch and 7.0 to 23.6% for aspen. Most of the variations can be explained by the effect of tree age or the size of the tree. At the breast height diameter 5 cm the pine, spruce birch and aspen bark proportion are respectively 26.9%, 20.9%, 16.7% and 17.9%, but if the breast height diameter is increased to 30 cm, then respectively 7.7%, 8.2%, 10.4% and 9.1% (Table 4).

The future studies are needed to increase the number of measured sample trees to clarify the population effect and influence of growing site on BP of the trees. To increase the predicting accuracy for the modelling of bark thickness at a certain height of the stem, the use of more sophisticated models including the effect of the tree age is recommended.

Conclusions

1. The best fit to data (R^2 is 0.90 for pine, 0.89 for spruce, 0.56 for birch, and 0.80 for aspen) was achieved by using tree height for the prediction of bark proportion (BP).
2. The highest proportion of the bark is at upper part of the stem (relative height 95%) for all trees species. Pine stems have a lower BP up to 30% relative height comparing to other species, while the spruce has the lowest bark percentage at the stem base relative to other tested species.
3. Study revealed a high within-species variation of average BP being 5.5 to 34.5% for pine, 6.6 to 28.3% for spruce, 7.9 to 21.5% for birch and 7.0 to 23.6% for aspen. Most of the BP variations can be explained by the effect of tree size – BP of small trees tends to be higher than for bigger dimension trees.
4. There are no significant differences found in BP among stands from different regions for all studied species indicating no need for derivation of separate equations for each region and ascertaining the possibility of use of the average BP values for a whole country.

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References

1. Adler A. (2007) *Accumulation of Elements in Salix and Other Species Used in Vegetation Filters with Focus on Wood Fuel Quality:* Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala 34 p.
2. Cellini J.M., Galarza M., Burns S.L., Martinez-Pastur G.J., Lencinas M.V. (2012) Equations of bark thickness and volume profiles at different heights with easy-measurement variables. *Forest Systems*, 21, pp. 23-30.
3. Chauhan S.K., Gupta N., Yadav R.S., Chauhan R. (2009) Biomass and carbon allocation in different parts of agroforestry tree species. *Indian Forester*, 135, pp. 981-993.
4. Corder S. (1976) Properties and Uses of Bark as an Energy Source. Available at: http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/8209/RP_no_31.pdf, 5 March 2015.
5. Drēska A., Līpiņš L., Sarmulis Z. (2003) Priedes un egles stumbru mizas biezums (The bark thickness of pine and spruce stems). *Mežzinātne*, 45, 131.-137. lpp. (in Latvian).
6. Good practice guidance for land use, land-use change and forestry (2003) The Intergovernmental Panel on Climate Change, 590 p.

7. Guidi W., Piccioni E., Ginanni M., Bonari E. (2008) Bark content estimation in poplar (*Populus deltoides* L.) short-rotation coppice in Central Italy. *Biomass and Bioenergy*, 32, pp. 518-524.
8. Heath L.S., Hansen M., Smith J.E., Miles P.D., Smith B.W. (2009) Investigation into calculating tree biomass and carbon in the FIADB using a biomass expansion factor approach. In: McWilliams W., Moisen G., Czaplewski R. (eds) *Forest inventory and analysis (FIA) symposium 2008*, Park City, *UT. Proceedings RMRS-P-56CD*. US Forest Service Rocky Mountain Research Station. Fort Collins, CO, 24 p.
9. Jelonek T., Pazdrowski W., Arasimowicz-Jelonek M., Gzyl J., Tomczak A., Floryszak-Wieczorek J. (2009) The relationship between the form of dead bark and lignin content in Scots pine (*Pinus sylvestris* L.). *Turkish Journal of Agriculture and Forestry*, 33, pp. 455-462.
10. Kenney W.A., Sennerby-Forsse L., Layton P. (1990) A review of biomass quality research relevant to the use of poplar and willow for energy conversion. *Biomass*, 21, pp. 163-188.
11. Laasasenaho J., Melkas T., Aldén S. (2005) Modelling bark thickness of *Picea abies* with taper curves. *Forest Ecology and Management*, 206, pp. 35-47.
12. Lestander T.A., Lundström A., Finell M. (2012) Assessment of biomass functions for calculating bark proportions and ash contents of refined biomass fuels derived from major boreal tree species. *Canadian Journal of Forest Research*, 42, pp. 59-66.
13. Li R., Weiskittel A.R. (2011) Estimating and predicting bark thickness for seven conifer species in the Acadian Region of North America using a mixed-effects modeling approach: Comparison of model forms and subsampling strategies. *European Journal of Forest Research*, 130, pp. 219-233.
14. Liepa I. (2011) Mizas nozīme krājas tekošā pieauguma noteikšanā (Bark as a factor affecting the assessment of current increment in volume). *Mežzinātne*, 57, 58.-64. lpp. (in Latvian).
15. Līpiņš L., Liepa I. (2007) *Apaļo kokmateriālu uzmērīšana* (Measurment of round timber). LLU, Jelgava, 104. lpp. (in Latvian).
16. Marklund L.G. (1988) *Biomassafunktioner för tall, gran och björk i Sverige* (Biomass functions for pine, spruce and birch in Sweden), Department of Forest Survey, Swedish University of Agricultural Sciences, Umea, Sweden, 73 p. (in Swedish).
17. Misra M.K., Ragland K.W., Baker A.J. (1993) Wood ash composition as a function of furnace temperature. *Biomass and Bioenergy*, 4, pp. 103-116.
18. Passialis C., Voulgaridis E., Adamopoulus S., Matsouka M. (2008) Extractives, acidity, buffering capacity, ash and inorganic elements of black locust wood and bark of different clones and origin. *European Journal of Wood and Wood Products*, 66, pp. 395-400.
19. Repola J. (2008) Biomass equations for birch in Finland. *Silva Fenn*, 42, pp. 605-624.
20. Repola J. (2009) Biomass equations for Scots pine and Norway spruce in Finland. *Silva Fenn*, 43, pp. 625-647.
21. Sarmulis Z., Drēska A., Līpiņš L., Leontjevs D. (2005) Egles stumbra dimensionāls vērtējums (The Evaluation of Spruce Stem Dimensions). *LLU Raksti*, 309, 1.-8. lpp. (in Latvian).
22. Sonmez T., Keles S., Tilki F. (2007) Effect of aspect, tree age and tree diameter on bark thickness of Picea orientalis. *Scandinavian Journal of Forest Research*, 22, pp. 193-197.
23. Wehenkel C., Cruz-Cobos F., Carrillo A., Lujan-Soto J.E. (2012) Estimating bark volumes for 16 native tree species on the Sierra Madre Occidental, Mexico. *Scandinavian Journal of Forest Research*, 27, pp. 578-585.

REGENERATION AND SAPLING GROWTH OF EUROPEAN HORNBEAM AT ITS NORTHERN LIMIT IN LATVIA

Liga Purina[1,2], Roberts Matisons[2], Juris Katrevics[2], Aris Jansons[1,2]
[1]Latvia University of Agriculture
[2]Latvian State Forest Research Institute 'Silava'
liga.purina@silava.lv

Abstract
The regeneration of European hornbeam (*Carpinus betulus* L.) has been assessed in the National Gene Reserve Forest near Lukne in the south-western part of Latvia, which is the northernmost point of hornbeam distribution in Europe. In the studied stand, six sampling plots and four transects were established to assess stand structure and the effect of irradiation parameters on stand regeneration. Successful regeneration of hornbeam was shown by its presence in all height and diameter classes. Nevertheless, in the smallest height and diameter classes, an increased abundance of other shade tolerant species (maple (*Acer platanoides* L.) and lime (*Tilia cordata* Mill.) was observed. Norway spruce (*Picea abies* Karst.) mainly formed a scattered second forest floor and, apparently, competed with hornbeam. Light parameters, particularly, the diffuse radiation, had a significant effect (p=0.05) on the distribution and abundance of hornbeam understory. The threshold values of irradiation parameters for hornbeam were notably higher compared to other species. The number and height of hornbeam saplings correlated tightly with the amount of available light. Nevertheless, under sufficient light conditions hornbeam showed good vitality, thus suggesting suitability of growing conditions.
Key words: *Carpinus betulus*, light, saplings, understory, stand structure.

Introduction

Climate is one of the main factors that determine the distribution of species and ecosystems (Maiorano et al., 2013). Under changing climate, shifts in species distribution have been observed (Kullman, 2008) and forecasted (Hickler et al., 2012). In Northern Europe, forest distribution models predict that coniferous forests will migrate northwards and will be partially replaced with deciduous forests (Hickler et al., 2012). Such shift will inevitably cause ecological and economic impact (Hanewinkel et al., 2012), therefore adjustments of forest management, i.e. application of species suitable for future climates and multi-species forestry, might be necessary to maintain stability of forests (Aitken et al., 2008; Thompson et al., 2009). Migration of species is more evident near the borders of species distribution (Kullman, 2008) thus marginal populations are good bioindicators of changes (Harsch et al., 2009).

European hornbeam (*Carpinus betulus* L.), which is common auxiliary forestry species in Central Europe, known for dense and hard wood (Hornbeam …, 2013), in Latvia occurs at its northern boundary (Anderberg and Anderberg, 2013). Considering that northern range of species distribution is usually limited by temperature in the dormant period – spring and by the length of vegetation period (Harsch et al., 2009), warming of climate apparently will improve growing conditions for hornbeam in Latvia. Such improvement of growing conditions and thus competitive ability can be portrayed by successful natural regeneration (Harsch et al., 2009; Szwagrzyk et al., 2012). The aim of this study was to assess the structure and natural regeneration of hornbeam stand in the south-western Latvia. Considering that hornbeam is often found as an understory species, light conditions are crucial for its regeneration (Diekmann, 1994; Modry et al., 2004). Therefore, the subordinate objective was to evaluate the role of irradiation parameters: canopy closure and amount of solar radiation on sapling/seedling density and size.

Material and Methods

The study was carried out in the National Gene Reserve Forest near Lukne in south-western part of Latvia (56°14'40'' N, 21°25'43'' E). The research territory is one of the few hornbeam stands in Latvia, which in total occupy 50 ha of the forest land. According to data from the National Forest Service, the studied hornbeams were up to 145 years old. The relief was a slight slope with southern exposition, the elevation of studied territory ranged from ~ 30 to 35 meters above the see level. Climate is mild, influenced by dominant western winds, which bring cool and moist air masses from the Baltic Sea and the Atlantic. The mean annual temperature is +7.6 °C, February is the coldest and August the warmest month (mean temperatures are -2.0 and +17.6 °C, respectively).

The studied stand was located on dry sites with loamy soils; the forest type was Oxalidosa. It is considered, that European hornbeam has naturally colonised the studied territories since the Atlantic period. However, the area occupied by hornbeam has varied (decreased) during the recent centuries. Since the mid-19th century, the stand has been intensively managed, particularly to release hornbeam from competition with Norway spruce (*Picea abies* Karst.) (Krauklis and Zariņa, 2002).

For the description of stand structure, six stand sampling plots (20 × 20 m) were arbitrarily established

in 'typical' parts of stand avoiding ecotones and micro-depressions of relief. Within each stand sampling plot all trees were counted according to five height classes: < 1 m, from 1.01 to 2 m, from 2.01 to 5 m, from 5.01 to 10 m and above 10.01 m. For all trees within stand sampling plots higher than 2 m, the diameter at breast height (DBH) was measured to the nearest cm. Sampling was done in August 2013.

For the assessment of the effect of light conditions on sapling/seedling density and size, four 20 m long transects, crossing groups of hornbeam saplings, were established. Along each transect, ten smaller sampling plots (2 × 2 m) were established. Within each of the sampling plots, the height of all saplings and seedlings was measured with accuracy of 5 cm. At the centre of each sampling plot, the canopy image at 1.3 m height was taken by WinScanopy (Regent Instruments) system (digital camera Nikon Coolpix E8400 equipped with fish-eye lens (fish-eye DSLR 4.9 mm-203)). To capture the canopy image, after the height measurements any understory trees covering camera were bent aside.

The mean frequency of each height and diameter class was determined for all stand sampling plots. The diameter classes used were as follows: < 5 cm, 5 to 10 cm, 11 to 20 cm, 21 to 30 cm and > 30 cm. For each sampling plot established along transects, number, mean height and the total length of saplings/seedlings (mean height × count) of each species was determined. Parameters of irradiation: crown density (gap fraction and openness) and solar radiation (direct, diffuse and total radiation under tree crowns) (Zdors and Donis, 2011) were calculated using WinScanopy2006a software. Whole images (no masks) were used; the vegetation period was considered form April 25 to October 28, standard overcast sky (SOC) model considering 48% fraction of diffuse radiation was applied. The total amount of solar radiation above crowns was estimated as 47.5 mol m^{-2} day^{-1}.

For the assessment of the effect of irradiation parameters on regeneration of hornbeam and other species, the mean values of each parameter were compared between sampling plots according to presence/absence of saplings/seedlings by ANOVA and Tukey HSD test. Data from all transects were used together. Considering that the requirements for available irradiation (light) of seedlings of overstorey species differ (Modry et al., 2004), threshold values of irradiation parameters necessary for the presence of saplings/seedlings were estimated by regression analysis. Logarithmic models were fit to total length of saplings and irradiation parameters. Threshold values of irradiation parameters were estimated according to the model equations. Analysis was conducted for overstorey species present in > 10 sampling plots (hornbeam, maple (*Acer platanoides* L.), lime (*Tilia cordata* Mill.) and ash (*Fraxinus excelsior* L.)), only the data for sampling plots with species present were used. To describe the strength of relationships between parameters of saplings/seedlings (number, mean height and total length) and irradiation, bootstrapped (1000 iterations) Pearson correlation analysis was used. The species present in ≥ 15 sampling plots were analysed; only complete pairs were used. Data analysis was conducted in R (R core team, 2014).

Results and Discussion

For 259 trees, DBH was measured and 1560 understory trees shorter than two meters were accounted (Table 1) in stand sampling plots. The studied stand was mixed and several forest floors were evident as shown by tree heights (Fig. 1). The main canopy species (height > 10 m) were hornbeam, lime and silver birch (*Betula pendula* Roth), while the proportion of spruce (*Picea abies* Karst.) and other species was considerably lower. Spruce was the main species (110 trees per ha) in height class from 2 to 10 thus forming a scattered second floor. Most of the birch trees were in the largest height class. Regarding diameter structure, hornbeam was the most abundant in diameter classes from 10 to 30 cm. Similar density (about 60 trees per ha) of lime, spruce and hornbeam was observed in the second diameter class (from 5 to 10 cm). The thickest of the studied trees were birches, which were mainly in diameter class above 30 cm; only a few trees of other species exceeded DBH of 30 cm. The smallest diameter and height classes (< 5 cm and < 1 m) were mainly formed by maple, lime

Table 1

Number of measured trees (higher that two m), accounted seedlings and the total basal area of sampling plots established for the description of stand

	Sampling plot						
	1	2	3	4	5	6	Total
Measured trees	50	41	35	48	32	53	259
Number of saplings in stand sampling plots	107	146	238	158	788	123	1560
Total number of trees in sampling plot	157	187	273	206	820	176	1819
Basal area of measured trees in stand sampling plots, m^2 ha^{-1}	72	57	67	37	71	53	59

and hornbeam (mean density was ~ 3500, 1200 and 1000 tress per ha, respectively). Other species (grey alder (*Alnus incana* (L.) Moench), aspen (*Populus tremula* L.), ash, silver birch, hazel (*Corylus avellana* L.), oak (*Quercus robur* L.), spruce, alder buckthorn (*Frangula* alnus Mill.), spindle (*Euonymus europaea* L.), rowan (*Sorbus aucuparia* L.) and guelder-rose (*Viburnum opulus* L.)) occurred with considerably lower densities, reaching ~ 340 trees per ha (aspen).

The diversity of diameter and height structure and mixture of species in the studied stand (Fig. 1) suggested that natural processes have been prevailing (Angelstam and Kuuluvainen, 2004), despite management (removal of spruce) during the 20th century (Krauklis and Zariņa, 2002). Continuous regeneration of hornbeam was portrayed by its presence in all height and diameter classes (Fig. 1); however, its abundance in diameter class > 30 cm was low, as expected for understory species (Hornbeam…, 2013). Since the last management events, spruce, which has been considered the main competitor of hornbeam in the studied region (Kiršteins and Eihe, 1933), has been re-establishing itself in the studied stand forming scattered second forest floor or even reaching the canopy (Fig. 1). Apparently, such re-establishment of spruce has burdened regeneration of other species including hornbeam as suggested by inverse relationship of abundance of these species in the height classes from 2 to 10 m. Lime, which is considered a late successional species (Pigott, 1991), was the second most abundant species in the height class > 10 m, and it was present in height classes from 2 to 10 m (Fig. 1), suggesting that the stand has not suffered an intensive large-scale disturbance. Birch,

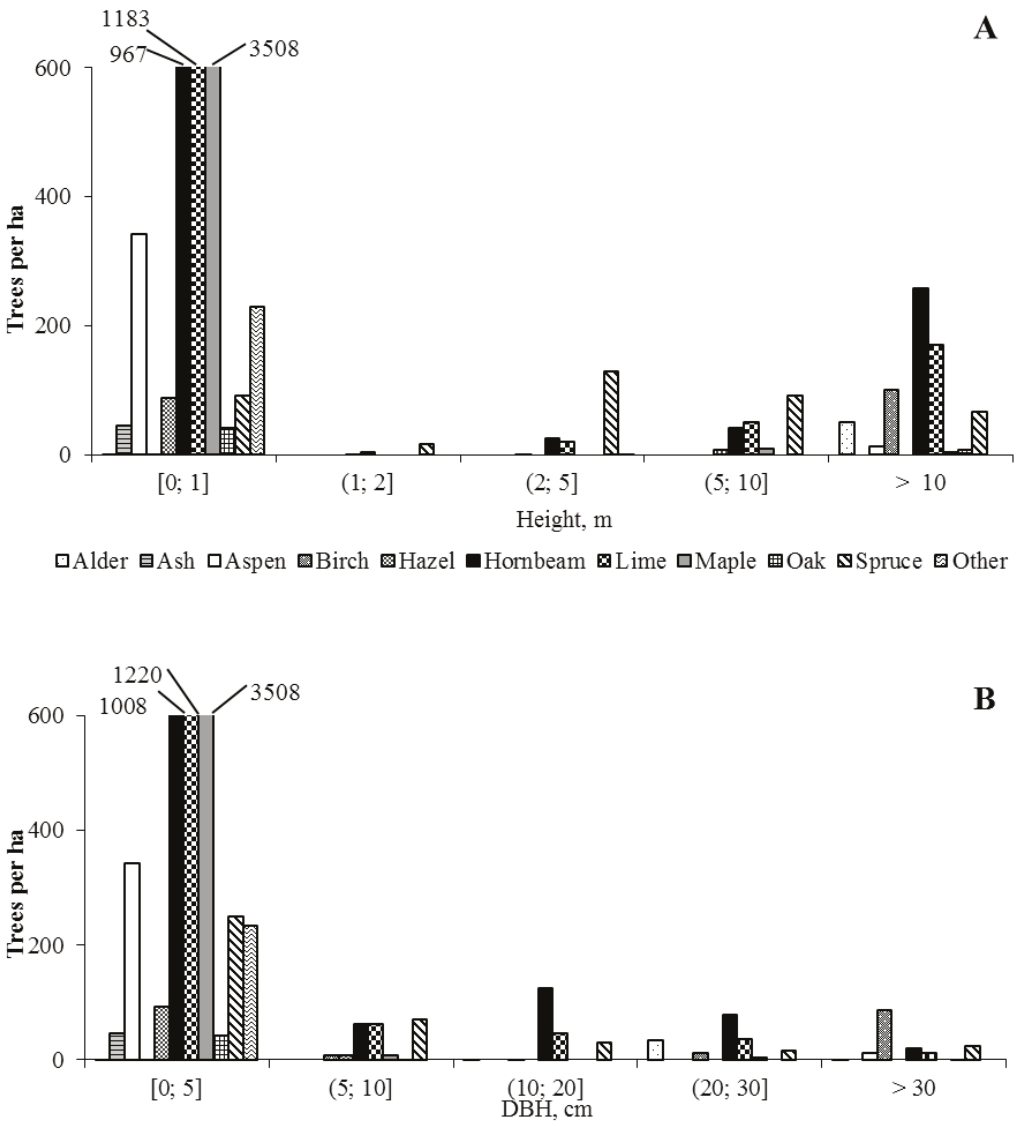

Figure 1. Distribution of studied trees according to height (A) and diameter at breast height (DBH) (B) in stand sampling plots. 'Other' corresponds to alder buckthorn, spindle, rowan and guelder-rose.

Table 2

Statistics of the datasets: number, height and total length of saplings and parameters of solar radiation, used for the evaluation of the effect of irradiation parameters on stand regeneration. Occurrence shows the number of sampling plots where species was present (in total 40 sampling plots were established)

	Min	Max	Mean	Median	St. dev.	Number of saplings/ seedlings	Occurrence
Sapling count							
Hornbeam	0	25	9.18	9	7.30	367	35
Hazel	0	4	0.25	0	0.71	10	7
Maple	0	2	0.38	0	0.67	15	11
Ash	0	5	0.88	0	1.30	35	17
Spruce	0	1	0.13	0	0.33	5	5
Oak	0	3	0.20	0	0.65	8	4
Lime	0	8	1.03	0	1.64	41	17
Other	0	4	0.25	0	0.78	23	15
Sapling height, cm							
Hornbeam	5	133	30	20	29		
Hazel	10	410	80	25	147		
Maple	5	120	31	20	33		
Ash	10	41	23	20	9		
Spruce	20	170	76	50	63		
Oak	10	80	35	25	32		
Lime	5	340	51	13	83		
Other	23	105	61	50	36		
Total length of sapling in sampling plot, cm							
Hornbeam	0	1165	277	153	305		
Hazel	0	410	18	0	73		
Maple	0	120	10	0	23		
Ash	0	205	22	0	43		
Spruce	0	170	10	0	32		
Oak	0	160	8	0	30		
Lime	0	470	52	0	123		
Other	0	210	13	0	40		
All species	0	1275	421	363	361		
Irradiation parameters							
Gap fraction, %	1.85	14.20	5.22	4.24	3.03		
Openness, %	2.15	15.21	5.93	4.68	3.39		
Direct radiation, mol $m^{-2}day^{-1}$	0.72	8.17	3.10	2.48	1.80		
Diffuse radiation, mol $m^{-2}day^{-1}$	0.51	3.28	1.49	1.17	0.87		
Total radiation, mol $m^{-2}day^{-1}$	1.43	11.18	4.60	4.19	2.50		

which is considered to be an indicator of disturbance (Angelstam and Kuuluvainen, 2004), was mainly present in the canopy (height > 10 m) and was thick (mean DBH ~ 38 cm) (Fig. 1), suggesting that the studied stand was locally disturbed some time ago, likely by the management activities (Krauklis and Zariņa, 2002).

In the sampling plots established along transects, height of 504 understory trees of 12 species was measured (including 367 hornbeam) (Table 2). The number of species per plot varied from one to four. The presence of species varied from 35 to 4 sampling plots for hornbeam and oak, respectively. The maximum number of individuals per plot was 25. The mean height of samplings/seedlings ranged from ~ 22 to ~80 cm for ash and hazel, respectively. The absolute height of hornbeam ranged from 5 to 550 cm; however, the mean height of all measured hornbeam was ~30 cm. Total length of all measured individuals reached 1275 cm per plot with mean value of 421 cm per plot.

The smallest height and diameter classes were formed by deciduous species (Fig. 1), whose seedlings/ samplings are shade tolerant (Diekmann, 1994), suggesting that canopy in the studied plots has not been notably disturbed during the recent years. Maple was the dominant species, but lime and hornbeam were also abundant (Fig. 1) suggesting that the

Table 3

Significance of difference (p-values) of mean values of irradiation parameters between sampling plots with and without saplings. Differences with p-value <0.05 are in bold

Species	Gap fraction, %	Openness, %	Direct radiation, mol m^{-2} day^{-1}	Diffuse radiation, mol m^{-2} day^{-1}	Total radiation, mol m^{-2} day^{-1}
Hornbeam	**0.02**	**0.01**	0.05	**0.01**	**0.02**
Hazel	0.36	0.38	1.00	0.47	0.8
Maple	0.43	0.42	0.69	0.49	0.6
Ash	0.58	0.57	0.05	0.54	0.11
Spruce	0.78	0.87	0.78	0.8	0.9
Oak	0.49	0.45	0.12	0.37	0.15
Lime	0.36	0.39	0.35	0.6	0.39
Rowan	**0.04**	0.06	0.88	0.15	0.55

Table 4

Estimated threshold values of irradiation parameter for the presence of hornbeam, maple, ash and lime saplings/seedlings and their coefficients of variation. Calculations are based on the total length of saplings within a sampling plot

Species	Gap fraction, %	Openness, %	Direct radiation, mol m^{-2} day^{-1}	Diffuse radiation, mol m^{-2} day^{-1}	Total radiation, mol m^{-2} day^{-1}	df
Hornbeam	1.64	1.77	0.48	0.54	1.36	34
Maple	0.58	0.67	0.55	0.15	0.87	10
Ash	0.96	0.75	0.42	0.49	0.96	16
Lime	0.95	1.05	0.62	0.24	1.01	16
Variation	43%	47%	17%	53%	20%	

studied stand tends to regenerate with broadleaved species. Such regeneration of broadleaves apparently might be related to a disturbed ground cover (Kobayashi and Kamitani, 2000). The abundance of maple seedlings might be explained by higher shade that might provide advantage for maple also in competition with other saplings. However, maple was absent in height classes from 1 to 5 m, suggesting that further development of saplings has been insufficient. Similar density of lime, which occurs in mid-part of its distribution area (Pigott, 1991), and marginal hornbeam suggests that present climatic conditions are suitable for early development of both species. Low abundance of spruce in height classes below 2 m (Fig. 1, A), suggested that its regeneration has decreased during the recent decades (Niklasson, 2002), that might be related to changes of climate (Hickler et al., 2012).

The canopy was mainly closed as from 3 to 23% (mean value 10%) of the amount of total radiation was able to penetrate the crowns. Irradiation parameters varied greatly among sampling plots, suggesting contrasting light conditions (Table 2). Presence of hornbeam in sampling plots was significantly ($p = 0.05$) affected by availability of light as the irradiation parameters were significantly ($p = 0.05$) lower in plots where the species was absent (Table 3). However, no statistically significant ($p = 0.05$) differences in irradiation parameters were found between sampling plots grouped according to presence/absence of other species, except rowan (gap fraction). Although differences were statistically non-significant ($p = 0.05$), presence of ash tended to be positively affected by direct radiation (mean values were 3.75 and 2.63 mol $m^{-2}day^{-1}$ sampling plots where ash was present and absent, respectively).

The observed threshold values of irradiation parameters necessary for presence of saplings/seedlings were similar for the studied species - hornbeam, maple, ash and lime (not shown) and in most cases were the minimal values of the dataset (Table 2). The estimated threshold values (Table 4) reached about 45 to 83% of the observed for maple and hornbeam, respectively. Such differences were likely caused by the uneven sample size. The estimated threshold values of irradiation parameters differed notably among the studied species and these differences were more expressed for openness and amount of diffuse radiation (highest coefficients of variation). Threshold values of direct and total radiation showed the smallest variability among the species. The lowest threshold values of irradiation parameters, except direct solar radiation, were estimated for maple and the highest values for hornbeam. Lime and ash appeared to be the most sensitive and robust species against the amount of direct solar radiation, respectively.

Table 5

Pearson correlation coefficients calculated between count, mean height and the total length of saplings and irradiation parameters

Species	Gap fraction	Openness	Direct radiation	Diffuse radiation	Total radiation	df
Count						
Hornbeam	0.45*	0.46*	0.41*	0.47*	0.47*	35
Ash	0.05	0.10	0.01	0.26	0.09	17
Lime	-0.13	-0.14	-0.31	-0.18	-0.28	17
All species	0.53*	0.53*	0.47*	0.55*	0.53*	39
Mean height						
Hornbeam	0.42*	0.45*	0.25	0.54*	0.38	35
Ash	0.64*	0.67*	0.65*	0.79*	0.71*	17
Lime	0.08	0.08	0.19	0.05	0.15	17
All species	0.39*	0.41*	0.36	0.47*	0.43*	39
Total length						
Hornbeam	0.48*	0.51*	0.30	0.60*	0.43*	35
Ash	0.28	0.32	0.26	0.49*	0.33	17
Lime	-0.15	-0.15	-0.10	-0.17	-0.13	17
All species	0.54*	0.57*	0.41*	0.65*	0.52*	39

*- correlations significant at p=0.05

Parameters of sapling/seedlings of hornbeam, ash and all understory species together were significantly (p = 0.05) affected by irradiation as shown by correlation analysis; however, no significant correlation (p = 0.05) was observed for lime (Table 5). The significant (p = 0.05) correlation coefficients ranged from to 0.39 to 0.79, suggesting medium tight to tight linkage. According to correlation coefficients, hornbeam and ash showed the highest and the lowest sensitivity to irradiation parameters (mean r was 0.44 and 0.15, respectively). Diffuse radiation apparently had the strongest effect and direct radiation had the weakest effect on the development of understory in the studied stand as suggested by correlation coefficients and their significance (mean r was 0.43 and 0.31, significant (p = 0.05) in four and eight cases, respectively). Number of hornbeam in understory correlated significantly (p = 0.05) with most of the irradiation parameters (the effect of direct radiation on mean height and total length was non-significant). The mean height of ash showed the strongest correlation with irradiation parameters, while the count of ash did not show significant relationship (p = 0.05). Total length of ash correlated significantly (p = 0.05) only with the amount of diffuse radiation.

The distribution of hornbeam saplings within the stand was determined by the availability of light, as shown by the differences of irradiation parameters in plots distinguished by the presence of hornbeam (Table 3). It was also affirmed by the highest requirements for light compared to other tested species (Table 4). The distribution of saplings/seedlings of other species were likely determined by stochastic processes as irradiation parameters generally did not differ in plots distinguished by the presence of species (Table 3) and the estimated threshold values of irradiation parameters (Table 4) were notably lower than the observed minimum (Table 2). Variation of threshold values (Table 4) and correlation analysis (Table 5) suggested that diffuse radiation had the strongest effect on parameters of saplings/seedlings. Considering that canopy in deciduous forests is closed as also observed along transects (mean ~ 5.9%) (Table 2), diffuse radiation has been described as one of the significant light sources for the forest understory (Hutchinson and Matt, 1977). Although the amount of direct radiation was higher compared to diffuse radiation (Table 2), it had a weaker effect on sapling parameters (Table 5). This might be explained by seasonality of the effect as the direct irradiation depends on the time of the year.

When all species were analysed together, light conditions had the strongest effect on the count of individuals, suggesting that light mainly affects germination. However, the effect differed amongst species. Regarding hornbeam, irradiation parameters mainly affected the total length, suggesting that light conditions are crucial for the establishment and early growth of the species. In contrast, no significant relationships were found between parameters of lime understory and irradiation, suggesting that lime can establish and grow under various light conditions and its size is likely related to age. Among the tested parameters of ash, the mean length was affected by irradiation parameters, suggesting that light parameters are crucial for its growth, while germination is apparently limited by other factors.

Conclusions

Successful regeneration of hornbeam was observed in the studied site near Lukne as it has been present in all height and diameter classes. Hornbeam was abundant also in the understory where it formed groups, suggesting that conditions are suitable for its germination and early growth. Nevertheless, competition with other deciduous species has been evident, particularly in the lowest height and diameter classes that might be related to light conditions. Although hornbeam is considered an understory species, the requirements of irradiation of hornbeam saplings were higher compared to native species and spatial distribution, abundance and size of hornbeam saplings/seedlings was affected by light conditions, particularly diffuse radiation. Thus some canopy disturbance and/or management is necessary to facilitate a further development of the species. Hornbeam also might develop in stands with lower crown density.

Acknowledgements

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References

1. Aitken S., Yeaman S., Holliday J.A., Wan T., Curtis-McLane S. (2008) Adaptation, migration or extirpation: climate change outcomes for tree populations. *Evolutionary Applications*, 1, pp. 95-111.
2. Anderberg A., Anderberg A.L. (2013) Den virtuella floran: *Carpinus betulus* L. – Avenbok. Available at: http://linnaeus.nrm.se/flora/di/coryla/carpi/carpbetn.jpg, 22 December 2014.
3. Angelstam P., Kuuluvainen T. (2004) Boreal forest disturbance regimes, successional dynamics and landscape structures — a European perspective. *Ecological Bulletins,* 51, pp. 117-136.
4. Anonimous (2013) Hornbeam *Carpinus betulus* L. In: CABI (ed) *Encyclopaedia of forest trees*. CABI publishing, Wallingford, UK, pp. 101-102.
5. Diekmann M. (1994) Decidious forest vegetation in Boreo-nemoral Scandinavia. *Acta Phytogeographica Suecica*, 80, pp. 1-120.
6. Hanewinkel M., Cullmann D.A., Schelhaas M.J., Nabuurs G.J. (2012) Climate change may cause severe loss in the economic value of European forest land. *Nature Climate Change*, 3, pp. 203-207.
7. Harsch M.A., Hulme P.E., McGlone M.S., Duncan R.P. (2009) Are treelines advancing? A global meta-analysis of treeline response to climate warming. *Ecology Letters*, 12, pp. 1040-1049.
8. Hickler T., Vohland K., Feehan J., Miller P.A., Smith B., Costa L., Giesecke T., Fronzek S., Carter T.R., Cramer W., Kühn I., Sykes M.T. (2012) Projecting the future distribution of European potential natural vegetation zones with a generalized, tree species-based dynamic vegetation model. *Global Ecology and Biogeography*, 21, pp. 50-63.
9. Hutchinson B.A., Matt D.R. (1977) The distribution of solar radiation within a deciduous forest. *Ecological Monographs*, 47, pp. 185-207.
10. Kiršteins K., Eihe V. (1933) Baltā skābarža (*Carpinus betulus* L.) dabiskā izplatība un ekoloģija Latvijā (Ecology and natural distribution of hornbeam (*Carpinus betulus* L.) in Latvia). *Latvijas Universitātes raksti*, 13, 343.-448. lpp. (in Latvian).
11. Kobayashi M., Kamitani T. (2000) Effects of surface disturbance and light level on seedling emergence in a Japanese secondary deciduous forest. *Journal of Vegetation Science*, 11, pp. 93-100.
12. Krauklis Ā., Zariņa A. (2002) Parastais skābardis sava areāla ziemeļu robežas ainavā Latvijā (European hornbeam in the landscape of its northern distribution limit in Latvia). *Folia Geographica*, 10, 16.-47. lpp. (in Latvian).
13. Kullman L. (2008) Thermophilic tree species reinvade subalpine Sweden — early responses to anomalous late Holocene climate warming. A*rctic, Antarctic and Alpine Research*, 40, pp. 104-110.
14. Maiorano L., Cheddadi R., Zimmermann N.E., Pellisser L., Pottier J., Laborde H., Hurdu B.I., Pearman P.B., Psomas A., Singarayer J.S., Broenimman O., Vittoz P., Dubuis A., Edwards M.E., Binney H.A., Guisan A. (2013) Building the niche through time: using 13,000 years of data to predict the effects of climate change on three tree species in Europe. *Global Ecology and Biogeography*, 22, pp. 302-317.
15. Modry M., Hubeny D., Rejšek K. (2004) Differential response of naturally regenerated European shade tolerant tree species to soil type and light availability. *Forest Ecology and Management*, 188, pp. 185-195.
16. Niklasson M. (2002) A comparison of three age determination methods for supressed Norway spruce: implications for age structure analysis. *Forest Ecology and Management*, 161, pp. 279-288.
17. Pigott C.D. (1991) *Tilia cordata* Miller. *Journal of Ecology*, 79, pp. 1147-1207.

18. R Core Team (2014) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at: http://www.R-project.org/, 22 December 2014.
19. Szwagrzyk J., Szewczyk J., Macijewski Z. (2012) Shade-tolerant tree species from temperate forests differ in their competitive abilities: A case study from Roztocze, south-eastern Poland. *Forest Ecology and Management*, 282, pp. 28-35.
20. Thompson I., Mackey B., McNulty S., Mosseler A. (2009) *Forest Resilience, Biodiversity, and Climate Change. A synthesis of the biodiversity /resilience/ stability relationship in forest ecosystems*. Secretariat of the Convention on Biological Diversity, Montreal, Canada. Technical Series no. 43, 67 p.
21. Zdors L., Donis J. (2011) Gaismas režīms vienlaidus un grupu pakāpeniskajās cirtēs (Light regime in uniform and group shelterwood cuttings). *Mežzinātne*, 24, 41.-57. lpp. (in Latvian).

QUALITY ASSESSMENT OF EUROPEAN ASH *FRAXINUS EXCELSIOR* L. GENETIC RESOURCE FORESTS IN LATVIA

Ilze Pušpure[1,2], Linda Gerra – Inohosa[2], Natālija Arhipova[2]
[1]Latvia University of Agriculture
[2]Latvian State Forest Research Institute 'Silava'
ilze.puspure@silava.lv; linda.gerra@silava.lv, natalija.arhipova@silava.lv

Abstract
In Latvia, two European ash (*Fraxinus excelsior*) genetic resource forests (GRF) have been designated in Skrīveri and Bērvircava. However, as the degree of damage of ash by the pathogenic fungus *Hymenoscyphus fraxineus* has increased, many stands have died and many do not comply anymore with minimum requirements for GRF. The aim of the present research was to evaluate and examine the quality of ash GRFs. In each forest unit, one 20×20 m plot was established, and the first (E3) and second (E2) layer projective cover of each species was determined in August 2014. All undergrowth and advance regeneration species were counted and the degree of ash damage by *H. fraxineus* was determined along a diagonal 25×1 m transect in each plot. In total, 101 plots were established. Quality evaluation was carried out according to the basic criteria for selection of GRF as well as based on criteria cited in other research. Their variation was established by using principal component analysis. Ash in layer E3 was better maintained in Skrīveri, but ash regeneration there was worse, as well as a higher degree of damage by *H. fraxineus* was observed. Ash regeneration density is significantly influenced by its cover on layers E3 and E2 as well as by tree species dominating the growth. The most valuable GRFs have been maintained in Skrīveri where 50% of units were rated of average quality and few of bad quality. In Bērvircava, 56% of forest units were of bad and very bad quality.
Key words: Descriptors, natural regeneration, ash dieback, European Forest Genetic Resource Program.

Introduction

The objective of genetic resource forests (GRF) is to maintain the genetic diversity and gene pool of a concrete tree species; and additionally they also have potential economic, environmental, scientific and social value (The State of…, 2014). These forests can provide for adaptation and evolutionary processes of the forest and trees growing in it; they also foster stand productivity (The State of…, 2014).

Within the framework of the European Forest Genetic Resource Program (EUFORGEN), 59 European ash (*Fraxinus excelsior*) gene reserve forests and protected forest areas have been designated in Europe, two of them are situated in Latvia (Pliûra and Heuertz, 2003). The EUFORGEN database indicates that the forest areas are managed for wood production and/ or multiple uses or services (Pliûra and Heuertz, 2003), but several genetic resource forest units are also specified as woodland key habitats, therefore economic activity in these forest units is restricted. In Bērvircava, selective cutting is allowed in three forest units for research purposes.

Ash GRFs are threatened by the ever-increasing infection rate with the pathogenic fungus *Hymenoscyphus fraxineus* which leads to ash dieback. In the last 20 years, the disease has spread widely throughout Europe and it has been found in more than 20 countries. The Baltic states were among the first where ash stand destruction was identified at the beginning of the 1990s (Stener, 2013), but the disease was confirmed in Latvia in 2007 (Kenigsvalde et al., 2010).

Prior to ash dieback, European ash was the most common hard-wood tree species in Latvia and one of the few tree species that regenerated well naturally (Laiviņš and Mangale, 2004). Natural regeneration is one of the basic GRF requirements (Koskela et al., 2013). At present, European ash comprises only 14 582 ha (0.5%) of the total forest area. The increasing degree of ash damage can lead to serious ecological consequences to European biodiversity and forest ecosystems (Pautasso et al., 2013). In Britain, 953 species are connected with ash stands, and the existence of 44 species fully depends on ash (Mitchella et al., 2014). Notwithstanding the extended history of the disease, further development of ash stands cannot be foreseen, because it greatly depends on persistence of natural resistance and further host organism and pathogen interaction over a longer period of cohabitation (McKinney et al., 2011). Therefore genetic resource forests (GRF) stands have become scientifically important forest stands and they are genetic reserves of European ash.

Pan-European minimum requirements for dynamic gene conservation units stipulate that each GRF stand must have a management plan which, based on systemic surveys, is updated every 5 or 10 years (Koskela et al., 2013). In the present study all ash GRF units were surveyed. As ash dieback increases, it becomes evident that ash GRF minimum requirements stipulating that the minimum size of a genetically viable population is 50, preferably 500 to 1000 trees and 400 reproducing trees per hectare (Koskela et al., 2013), cannot be fulfilled in many forest units. At present, EUFORGEN have not established requirements for re-evaluation of the existing stands, so the study is based on the aforementioned requirements for new GFR stand selection. In Latvia, the features of genetic

Table 1

Ash GRF criteria for division into quality classes

Ash quality and descriptor class	Primary descriptors			Secondary descriptors				
	Ash projective cover, %		Ash regeneration, specimens per hectare [1]	Second and undergrowth layer cover, % [2]	Spruce projective cover E3, E2, %	Degree of *H. fraxineus* damage, %	Broad leaved projective cover E3, %	Competition of other species, number [3]
	E3	E2						
1.	> 17	> 11	> 6001	0 – 30	0 – 0.5	0 – 10	6	0 - 15
2.	13 - 16	4 – 10	3001 - 6000	31 – 50	1 – 3	11 – 25	4 - 5	16 - 35
3.	8 – 12	1 - 3	1001 - 3000	51 – 70	4 – 8	26 – 60	3	36 - 60
4.	4 – 7	0.5	801 - 1000	71 – 80	9 – 15	61 – 99	1 - 2	61-100
5.	0 - 3	0	0 – 800	> 81	> 16	100	0	> 101

[1] The number of ashes counted in transect has been recalculated to hectares.
[2] Total projective E2 cover.
[3] Other regeneration growths and undergrowths counted in transect.

forests, namely descriptors, have been developed within the framework of the research 'The long-term maintenance and sustainable use of Latvian forest tree genetic resources' (Gailis et al., 2008), but the descriptors have not been adopted and are not used in practice.

The objective of the research was to survey both GRF ash stands in Latvia, determine their present state and to give a quality evaluation according to a framework of five classes. As ash cover has decreased dramatically, one of the tasks set by the research was to determine the factors that influence the generation of new ash advance regeneration. Whereas Latvian descriptors have been established for Norway spruce (*Picea abies*) genetic resource forests, one of the objectives of the research was to identify and analyse the features that best characterize European ash forests.

Materials and Methods

The research was carried out in August 2014 in two ash genetic resource forests, which are situated in the central part of Latvia: Skrīveri region (Skrīveri, geographical location: X 564257, Y 6281096) and Jelgava region (Bērvircava, geographical location: X 486817 , Y 6251196). Skrīveri forest area is 155.2 ha, on which 28 GRF units were surveyed. In Bērvircava forest 73 units covering 239.6 ha were surveyed. In both regions there were ash stands of different age, with ash being the principal species with wych elm (*Ulmus glabra*), aspen (*Populus tremula*), alder (*Alnus glutinosa*), and silver birch (*Betula pendula*) admixture; in several units ash was the admixture species for birch, spruce etc. forests. Both regions are characterized by fertile development conditions, mostly *Aegopodiosa*, on rare occasions *Dryopteriosa* or *Mercurialiosa* ameliorated forest types, characterized by various broad leaved species.

In each unit one 20×20 m plot was established, and the projective cover percentage of the first (E3, above 7.0 m) and second (E2, 0.5 – 7.0 m) layer of each species was determined. In each plot, all advance regenertion and undergrowth species (up to 7.0 m) were counted and degree of ash damage by *H. fraxineus* (Table 1) was determined in the framework of five classes along a diagonal 25×1 m transect. *H. fraxineus* damage has been assessed according to the visually determined degree of damage of the tree crown and trunk. The final rating was assigned based on the number of woody plants in each damage class. If there were no new specimens found in the transect, the degree of damage was not established. Twenty eight units were surveyed in Skrīveri and 73 units in Bērvircava.

GRF formation criteria were used as the basis for evaluation of forest quality (Koskela et al., 2013), supplemented by the descriptors listed in the report by A. Gailis et al. (2008). After a complex evaluation, each region was given a quality rating in classes from 1 to 5. The number of classes was determined based on the number of descriptor classes in the research made in Latvia (Gailis et al., 2008). The descriptors are divided into two groups: primary (if all descriptors were given equal rating – quality class could be established without taking into account other descriptors), corresponding to GRF formation basic requirements, and secondary – derived from A. Gailis et al. (2008) (Table 1). Criteria class values have been established according to median, quartile, minimum and maximum values of the evaluations obtained in all samples. In ash regeneration and E3 covering class division, Pan-European minimum requirements have been taken into account, stipulating that for an ash stand to be qualified as a GRF at least 50 mature trees and 400 saplings per hectare are required (Koskela et al., 2013). Based on these rules, it was supposed that

the minimum number of advance regeneration ash trees has to be above 800 trees per hectare to qualify as a GRF (Table 1).

Tree level dominance structure has been established according to the principle of dominant and codominant species (Simpson, 2006), where the dominant species comprise ≥ 50% of the total covering or at least exceeds the covering of other species by 20%, and the codominant species is 25 – 50% of the total cover. Vegetation description and growth inventory was done during the 2014 growing season.

In characterizing unit similarities and factors having influence upon them, the detrended correspondence analysis (DCA) method was used. In determining which factors best characterize fluctuation, principal component analysis (PCA) was carried out, the second matrix being basic criteria for GRF selection. Thus criteria were obtained that most precisely characterized forest unit quality; they were taken into account upon determining quality classes. The canopy dominant species' influence on advance regeneration and undergrowth content was analysed by using the DCA method. In determining gradient importance, a randomization test was used for both methods.

The correlation between the degree of ash damage by *H. fraxineus* and the dominant tree species, forest type, new ash advance regeneration density (in classes), shrub layer cover and ash cover in E3 layer, was determined by the general linear model (GLM) method. Analysis of variance (ANOVA) was used to determine whether the number of ash in advance regeneration has been significantly influenced by the forest type and dominant tree species. For the evaluation of ash advance regeneration density, tree and shrub layer projective cover as well as correlations between the number of other species listed in advance regeneration and undergrowth, Pearson and Kendall correlation analysis was carried out. By using the Kendall ratio, it was determined if there was a correlation between shrub layer cover and the number of ash trees in layers E3 and E2. The analyses were carried out at $\alpha = 0.05$. Statistical analyses were made using PC-ORD 6 (Peck, 2010) and R computer programmes.

Results and Discussion

In the majority of GRF units, ash trees were found in admixture with other broad leaved species, complying with ecological requirements (Ahlberg, 2014). In Skrīveri the E3 layer was dominated by birch (29% of units), small-leaved lime (*Tilia cordata*) and elm (both 14%), whereas in Bērvircava it was dominated by ash (27%) and aspen (21%) (Figure 1). In Latvia the following species are recommended as ash satellite species: birch, alder, grey alder (*Alnus incana*) and pedunculate oak (*Quercus robur*) (Sakss, 1997). Apart from these species, lime and elm are also emphasised in Europe (Dobrowolska et al., 2008), although ash trees in elm forests in Latvia have seldom regenerated, based on previous research (Laiviņš and Mangele, 2004). In Skrīveri, the most common broad leaved tree species are the typical *Aegopodiosa* forest site type species - lime, elm and ash. Analysis of variance indicated that ash regeneration density in Skrīveri has been significantly influenced by the dominant species in layer E3 ($p = 0.001$) and forest type ($p = 0.03$), whereas in Bērvircava none of these factors was decisive. In the framework of this research, ash was regenerated best in *Aegopodiosa* and *Mercurialiosa* mel. forest site types, namely, in habitats that are rich in nutrients, biologically active,

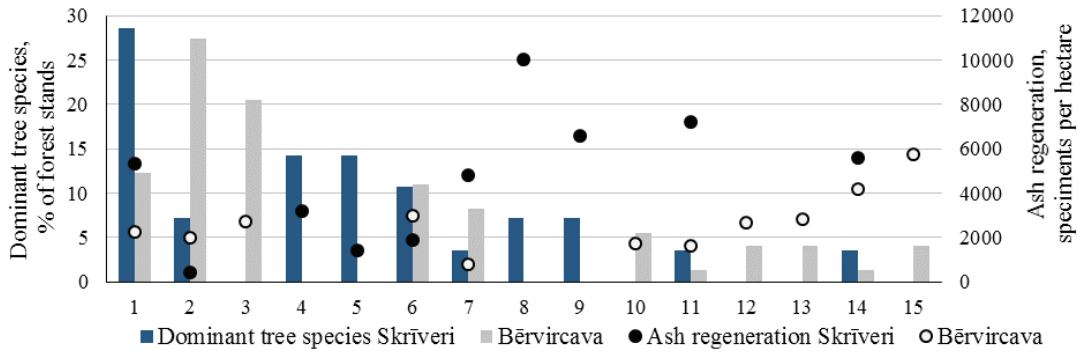

Figure 1. Dominant tree species and ash saplings density: 1 – *Betula pendula*; 2 – *Fraxinus excelsior*; 3 – *Populus tremula*; 4 – *Tilia cordata*; 5 – *Ulmus glabra*; 6 – *Alnus incana*; 7 – *Picea abies*; 8 – *Betula pendula/Ulmus glabra*; 9 – *Fraxinus excelsior/Ulmus glabra*; 10 – *Alnus incana/Fraxinus excelsior*; 11 – *Alnus incana/Betula pendula*; 12 – *Betula pendula/Populus tremula*; 13 – *Betula pendula/Fraxinus excelsior*; 14 – *Alnus glutinosa*; 15 – *Quercus robur.*

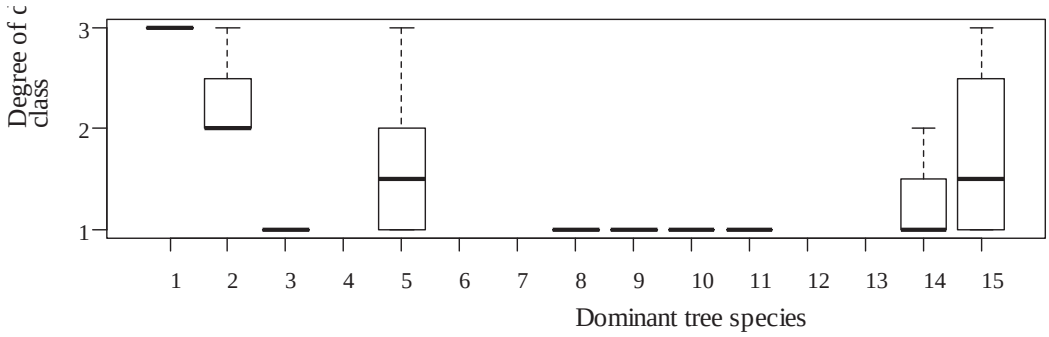

Figure 2. Ash advance regeneration damage degree intensity in stands with different dominant species in Skrīveri: 1 – *Alnus* glutinosa; 2 – Alnus *incana;* 3 – *Alnus incana/Betula pendula*; 4 – *Alnus incana/Fraxinus excelsior*; 5 – *Betula pendula*; 6 – *Betula pendula/Fraxinus* excelsior; 7 – Betula *pendula/Populus tremula*; 8 –*Betula pendula/Ulmus* glabra; 9 – *Fraxinus excelsior*; 10 – *Fraxinus excelsior/Ulmus* glabra; 11 – *Picea abies*; 12 – *Populus tremula*; 13 – *Quercus robur*; 14 – *Tilia cordata*; 15 – *Ulmus glabra.*

moist and seasonally excessively moist, but it was not as successful regenerating in *Dryopteriosa*, as has previously been mentioned in other research carried out in Latvia (Laiviņš and Mangele, 2004; Kenigsvalde et al., 2010).

Better and more regular ash regeneration was observed in Skrīveri, where, in the framework of this research, the greatest number of ash specimens were found in birch/elm (10 000 trees ha^{-1}) and grey alder/birch (7 200 trees ha^{-1}) stands (Figure 1). In ash/elm mixed stands, 6 600 trees ha^{-1} were counted. In Bērvircava the best ash regeneration was observed in oak (7 400 trees ha^{-1}) and alder (4 200 trees ha^{-1}) stands. Ash regeneration below ash stands was not characteristic of any region, but it was higher in Bērvircava (2 000 trees ha^{-1}) (Figure 1).

GLM analysis showed that in Skrīveri the new ash advance regeneration degree of damage was statistically significantly different between stands with various dominant species. In Skrīveri the highest degree of damage of new ash trees was found in alder stands ($p = 0.0004$) (Figure 2). The second class damage degree was found in grey alder, but a higher degree of damage was also found in birch and elm stands. In Bērvircava ash trees damage degree was much lower and statistically did not differ between stands with various dominant species.

In DCA both locations were firstly divided by their different geographical position, because they are situated in differing geobotanical regions. In DCA all gradients were important and they showed that areas differed in canopy composition, and it had significant impact on ash regeneration density, as mentioned in research by M. Laiviņš and D. Mangale (2004). The DCA first variable was best characterized by grey alder and aspen (DCA1) ($p = 0.02$), the second by spruce (DCA2) ($p = 0.03$), and the third by ash together with oak (Figure 3).

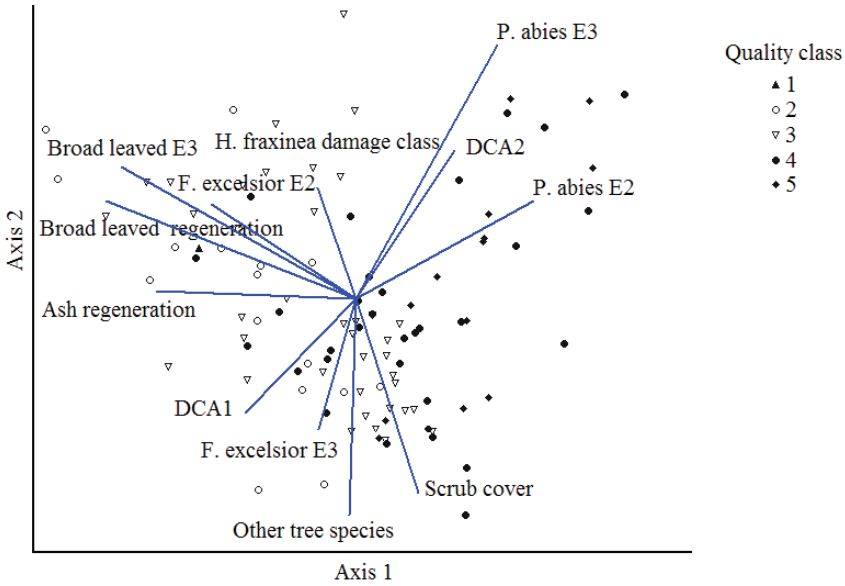

Figure 3. Ash forest quality criteria in PCA analysis.

Ash regeneration density had a statistically significant correlation with a number of woody plants listed in advance regeneration in Bērvircava ($p = 0.03$, $\tau = 0.184$), confirming the previous research in Latvia which showed that regeneration of ash and other woody plants most often takes place in canopy and thinned out places (Sakss, 1997). In Bērvircava two tree species dominated the advance regeneration composition – grey alder (55% of the total number of species, 3 704 trees ha^{-1}) and ash (34%, 2 290 trees ha^{-1}) (Figure 4). Formation of pronouncedly mixed stands with elm (58%, 4 243 trees ha^{-1}), ash (29%, 4 214 trees ha^{-1}), lime (17%, 2 514 trees ha^{-1}) and Norway maple (*Acer platanoides*) (16%, 2 329 trees ha^{-1}) is typical of Skrīveri. Species composition corresponds to the species listed in ash clear-cuts in Lithuania, only the cover was different: birch (in Lithuania – 32.9%), grey alder (32.4%), aspen (11.2%), elm (6.4%) and ash (4.3%, but 13 941 trees ha^{-1}) (Lygis et al., 2014). The results of this research indicated that pure ash stands are not formed by means of natural regeneration, but in both locations ash is maintained as an admixture species. In research by Laiviņš and Mangele (2004) it is foreseen that ash will be maintained in tree layer as a permanent admixture only on average in 5% of broad leaved forests. In Skrīveri the same species regenerate that dominate layer E3 (lime, elm), the same correlation has also been observed in Lithuania (Lygis et al., 2014). Whereas in Bērvircava, where the dominant species is ash, undergrowth species regenerate - hazel (*Corylus avellana*) and bird cherry (*Padus avium*), indicating the beginning of a pronounced process of shrub overgrowth.

In Skrīveri three species were dominant in undergrowth: cherry (39%, 1 071 trees ha^{-1}), hazel (33%, 914 trees ha^{-1}) and fly honeysuckle (*Lonicera xylosteum*) (21%, 586 trees ha^{-1}), but in Bērvircava - cherry (63%, 12 433 trees ha^{-1}) and hazel (20%, 3 945 trees ha^{-1}) (Figure 4). Although hazel is considered a valuable ash forest species (Loidi, 2004), together with cherry they comprised more than 50% of all species composition in both areas, thus leaving little room for growth to other species. The correlation indicated that as the shrub layer cover increases, the density of new ash trees decreases, but statistically it was not significant. Research carried out in Denmark (Bakys et al., 2013) showed that there is greater degree of ash damage in thinned stands, but it is not correlated with ash tree density. In the present research, identical results were obtained, although in Skrīveri it was found out that a higher degree of damage (class 2) can be established in stands with denser shrub cover (Figure 5), in several plots, the degree of damage reached class 3 and 4 in units with greater ash density, but the correlation was not significant. On average, the degree of damage was lower than indicated in the Lithuanian research (Lygis et al., 2014), because 80.8% were rated as class 1,while in Lithuania only 29.3% were considered visually healthy (Lygis et al., 2014). It could not be established that the degree of ash damage is significantly influenced by ash cover in the tree layer, but in stands with greater ash cover, more often a higher regeneration growth degree of damage was found.

GLM analysis showed that statistically the new ash advance regeneration degree of damage does not differ significantly among forest types. The lowest new ash advance regeneration's degree of damage was established in *Mercurialiosa* mel. forest site type ($p=1.26E-05$), where it was not higher than class 1 in any of the units. The highest degree of damage was established in *Dryopteriosa* forest site type (most often class 2). Although there is no united opinion in Europe on whether there is a correlation between ash degree of damage and the ecological conditions in the

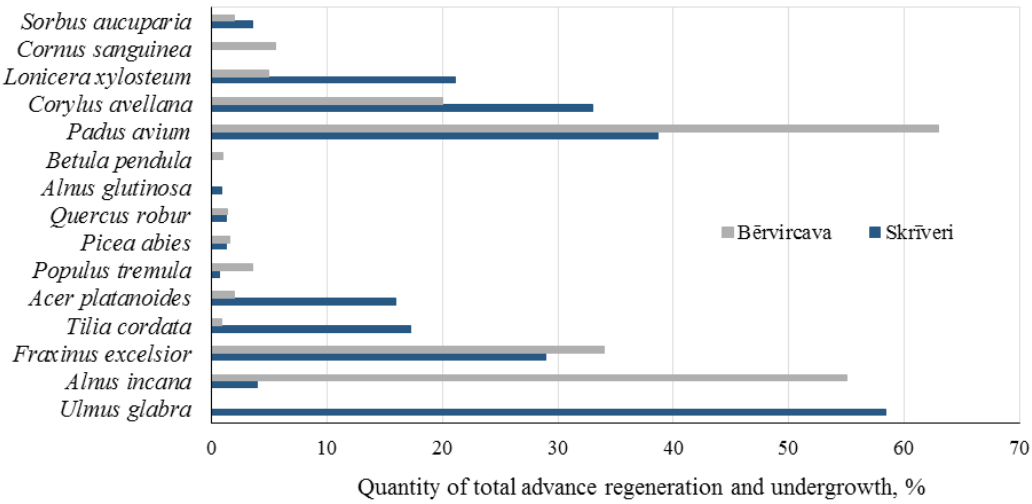

Figure 4. Species composition in advance regeneration and undergrowth.

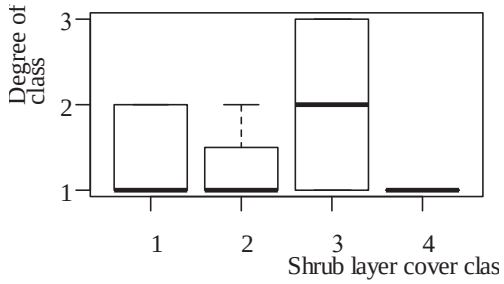

Figure 5. Ash degree of damage depending on shrub layer density in Skrīveri.

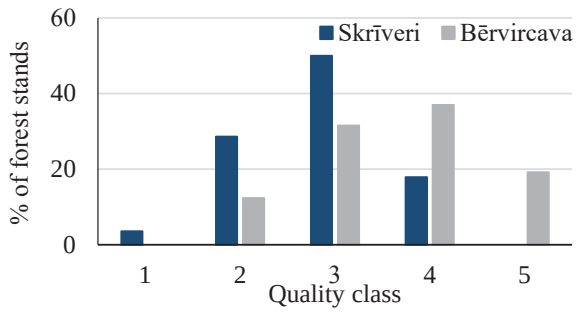

Figure 6. Ash GRF quality evaluation in classes.

locations (Bakys et al., 2013), this research shows that there is a higher degree of damage by *H. fraxineus* in moist circumstances than indicated in A. Gross's research (Gross et al., 2014).

According to the basic criteria for GRFs, the Skrīveri plots corresponded to higher quality classes. In both locations ash regeneration density was statistically significantly influenced by the total canopy cover ($p = 0.02$, $\tau = 0.16$) confirming that ash during its first years of life is ombrophile (Dobrowolska et al., 2008). In research by R. Harmer et al. (2005) it was concluded that the number of ash seedlings was positively related to the number of parent trees, which was also confirmed during this research ($p = 0.001$, $\tau = 0.22$). The number of ash trees in any of the regions was not influenced by DCA1 variable grey alder/ aspen ($p>0.05$), but it negatively influenced the number of spruce in layers E3 and E2. It was more pronounced in Bērvircava ($p = 0.02$, $\tau = -0.2$), confirming that spruce in Latvia is not recommended as an ash satellite species because it decreases soil productivity and creates a strong root system which outcompetes ash (Sakss, 1997). Ash regeneration was strongly influenced by the number of broad leaved species in layer E3 ($p = 0.005$, $\tau = 0.21$) emphasizing the importance of mixed stands (Ahlberg, 2014).

The PCA of all criteria showed that without GRF basic criteria ash stand variation is also well characterized by spruce cover in layers E3 and E2, the total cover of layer 2 and undergrowth layer, DCA1, the number of broad leaved species in layer E3 and other criteria (Figure 3). However, the correlations of these variables with ash regeneration density indicated that DCA1 and the number of broad leaved species do not have a significant impact. Evaluating all criteria (Table 1) better forest condition was found in Skrīveri, where 50% of units were rated with the quality class 3 and there were no evaluations of the lowest class 5 (Figure 6). In Bērvircava, 19% units were rated with class 5 and a relatively similar number of units were rated with class 3 and 4. In several units ash trees have not been maintained neither in layer E3 nor layer E2. In both GRFs, the new ash is mostly young and it is difficult to foresee its further development as well as changes in the evaluation of stands.

Conclusions

1. In the beginning, 12 quality indicators were set for GRF quality evaluation, out of which during the research only 9 were recognized as significant, 3 of them (ash projective cover in canopy and midstorey, ash regeneration density) are considered primary, others have a secondary importance.
2. In the majority of stands, ash is not the dominant species anymore, but a statistically significant correlation remains, namely, ash regenerate best in stands with greater ash projective cover in the canopy, although the number of specimens is comparatively small (2000 trees ha^{-1} in Skrīveri, 400 trees ha^{-1} in Bērvircava).
3. In stands where ash was the dominant species prior to ash dieback, intense shrub overgrowth has started, indicating that change of species is significantly influenced by dominant tree layer species which is typical of *F. excelsior* stands.
4. Ash stand destruction in both regions developed differently. Although ash is better maintained in Bērvircava, the overall state of GRF stands was recognized as worse there, and 19% of units do not comply with GRF criteria anymore.

Acknowledgements

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References

1. Ahlberg A. (2014) *The influence of thinning intensity on stands of European ash (Fraxinus excelsior L.) affected by ash dieback – how should they be managed? A case study based on observations in young stands of ash in Denmark,* Swedish University of Agricultural Sciences, Alnapar, Sweden, 63 p.
2. Bakys R., Vasaitis R., Skovsgaard J.P. (2013) Patterns and severity of crown dieback in young even-aged stands of european ash (*Fraxinus excelsior* L.) in relation to stand density, bud flushing phenotype, and season. *Plant Protection Science*, 49, pp. 120-126.
3. Dobrowolska D., Hein S., Oosterbaan A., Skovsgaard J.P., Wagner S. (2008) Ecology and growth of European ash (*Fraxinus excelsior* L.). Available at: http://www.valbro.uni-freiburg.de/pdf/stsm_ash2.pdf, 7 March 2015.
4. Gailis A., Zariņa I., Baumanis I., Zeps M., Veinberga I. (2008) *Latvijas meža koku ģenētisko resursu ilgtermiņa saglabāšana un ilgtspējīga izmantošana (Long-term maintenance and sustainable use of Latvian forest tree genetic resources).* Available at: http://www.silava.lv/userfiles/file/MAF%202008%20parskati/Silava_MAF_2008_Gailis142.pdf, 6 March 2015. (in Latvian).
5. Gross A., Holdenrieder O., Pautasso M., Queloz V., Sieber T.N. (2014) *Hymenoscuphus pseudoalbidus,* the causal agent of European ash dieback. *Molecular Plant Pathology*, 15, pp. 5-21.
6. Harmer R., Boswell R., Robertson M. (2005) Survival and groth of tree seedlings in relation to changes in the ground flora during natural regeniration of an oak shelterwood. *Forestry*, 78 (1), pp. 21-32.
7. Kenigsvalde K., Arhipova N., Laiviņš M., Gaitnieks T. (2010) Ošu bojāeju izraisošā sēne *Chalara fraxinea* Latvijā (Fungus *Chalara fraxinea* as a causal agent for ash decline in Latvia). *Mežzinātne*, 21 (54), 110.-120. lpp. (in Latvian).
8. Koskela J., Lefèvre F., Schueler S., Kraigher H., Olrik D.C., Hubert J., Longauer R., Bozzano M., Yrjänä L., Alizoti P., Rotach P., Vietto L., Bordács S., Mykingm T., Eysteinsson T., Souvannavong O., Fady B., Cuyper B., Heinze B., Wühlisch G., Ducousso A., Ditlevsen B. (2013) Translating conservation genetics into management: Pan-European minimum requirements for dynamic conservation units of forest tree genetic diversity. *Biological Conservation*, 157, pp. 39-49.
9. Laiviņš M., Mangale D. (2004) Parastā oša (*Fraxinus excelsior*) paaugas izplatība Latvijā (The distribution of young growth of the common ash (*F. excelsior*) in Latvia). *Mežzinātne*, 13 (46), 61.-69. lpp. (in Latvian).
10. Loidi J. (2004) Decidous mixed broad-leaved forests of southwestern Europe. *Tuexenia*, 24, pp. 113-126.
11. Lygis V., Bakys R., Gustiene A., Burokiene D., Matelis A., Vasaitis R. (2014) Forest self – regeneration fallowing clear-felling of dieback-affected *Fraxinus excelsior*: focus on ash. *European Journal of Forest Research*, 133, pp. 501-510.
12. McKinney L.V., Nielsen L.R., Hansen J.K., Kjær E.D. (2011) Presence of natural genetic resistance in *Fraxinus excelsior* (Oleraceae) to *Chalara fraxinea* (Ascomycota): an emerging infectious disease. *Heredity*, 106 (5), pp. 78-97.
13. Mitchella R.J., Beatona J.K., Bellamyb P.E., Broome A., Chetcutic J., Eatond S., Ellisd C.J., Gimonaa A., Harmere R., Hestera A.J., Hewisona R.L., Hodgettsf N.G., Iasona G.R., Kerre G., Littlewooda N.A., Neweya S., Pottsg J.M., Pozsgaia G., Rayc D., Sima D.A., Stockana J.A., Taylor A.F.S., Woodwardh S. (2014) Ash dieback in the UK: A review of the ecological and conservation implications and potential management options. *Biological Conservation*, 175, pp. 95-109.
14. Pautasso M., Aas G., Queloz V., Holdenrieder O. (2013) European ash (*Fraxinus excelsior*) dieback - A conservational biology challenge. *Biological Conservation*, 158, pp. 37-49.
15. Peck J.E. (2010) *Multivariate Analysis for Community Ecologists: Step-by-Step using PC-ORD*. MjM Software Design, Gleneden Beach, OR,162 p.
16. Pliûra A., Heuertz M. (2003) EUFORGEN Technical Guidelines for genetic conservation and use for common ash (*Fraxinus excelsior*). Available at: http://www.euforgen.org/fileadmin/bioversity/publications/pdfs/EUFORGEN/855_Technical_guidelines_for_genetic_conservation_and_use_for_common_ash__Fraxinus_excelsior_.pdf, 5 March 2015.
17. Sakss K. (1997) Osis (Ash). *Meža Dzīve,* 6 (247), 22.-27. lpp. (in Latvian).
18. Simpson M.G. (2006) *Plant Systematics*. Elsevier-Academic Press, UK, 608 p.
19. *The state of world's forest genetic resources* (2014) FAO. Commission on genetic resources for food and agriculture. Available at: http://www.fao.org/forestry/fgr/64582/en/, 4 March 2015.
20. Stener L-G. (2013) Clonal differences in susceptiblity to the dieback of *Fraxinus excelsior* in southern Sweden. *Scandinavian Journal of Forest Research,* 28 (3), pp. 205-216.

EDGE EFFECTS ON EPIPHYTIC LICHENS IN UNMANAGED BLACK ALDER STANDS IN SOUTHERN LATVIA

Līga Liepa, Inga Straupe
Latvia University of Agriculture
liga.liepa@llu.lv; inga.straupe@llu.lv

Abstract
The emergence of human–induced edges in forested landscapes has caused major threat for the existence of habitat specialists. Woodland key habitat (WKH) concept has been created in the Baltic and Fennoscandian forests to preserve small forest parcels with a high biodiversity value in the production forests. In this study we investigated the occurrence of epiphytic lichen indicator species in black alder WKHs in Southern Latvia. In total 30 black alder WKHs with age of 84 to 129 years were chosen for analysis including stands adjacent to young, middle–aged and mature stands. Sample plots were placed at three distances from the forest edge. Our results indicate significant differences in number of species per sample plots adjacent to stands of different age. Lichen indicator species were considerably more common in habitats adjacent to mature forest stands and further (40–50 m) from the edge. From four lichen indicator species found in this study, sample plots adjacent to young stands hosted only two species. We argue that the indicator species response to human–induced edges is species specific and some of them are resistant to microclimatic changes near the edges.
Key words: Edge effects, epiphytic lichens, woodland key habitats, indicator species, black alder.

Introduction

During the last centuries European forest landscape has changed from mostly natural conditions of forest growth to the dominance of production forests (Kuuluvainen, 2009; Löfman and Kouki, 2001; Vanbergen et al., 2005). In the 21st century, the majority of forests are affected by intensive silvicultural practices and only few areas of production forest are left intact (Timonen et al., 2010). Intensive silvicultural practices and logging have caused landscape fragmentation and changed the forest structural composition, and reduced the presence of forest–dwelling species in the Baltic and Fennoscandian forests (Hanski, 2005). Landscape fragmentation and habitat depletion has been defined as a major threat for biodiversity in forest ecosystems (Aune et al., 2005). For instance, habitat fragmentation decreases the patch size and core habitat for species, decreases the connectivity and increases the edge effects (Laurance et al., 2008). It is known that large part of forestry practices are negatively influenced by edge effects (Harper et al., 2005) and therefore the effects of human–induced edges in forest landscape have been widely studied during the last decades (Murcia, 1995; Ries et al., 2004; Aune et al., 2005; Laurance et al., 2008; Baker et al., 2013). Most of such studies have focused on the gradient from the edge to forest interior or have dealt with the comparisons of focal species abundance, diversity, growth rate and occurrence between managed and old–growth forest stands (Chen et al., 1993; Hylander 2005). Human–induced edges influence the environment in forest parcels due to changes in biotic and abiotic conditions and many taxonomic groups are responding to these changes (Ries et al., 2004). Some species are adapted to new conditions following the formation of human–induced edges, while others are responding negatively to changes in microclimatic conditions (e.g. increased exposure to sunlight and wind) and altered species interactions (Murcia, 1995). For instance, many studies revealed that epiphytic lichens (Esseen and Renhorn, 1998; Moen and Jonsson, 2003), bryophytes and herbaceous plants (Jules, 1998) are responding negatively to human–induced forest edges and their abundance is considerably lower than in the forest interior. Conversely, only few studies suggest that lichens and bryophytes respond positively to forest edges (e.g. Caruso et al., 2011).

Lichens are key elements of biodiversity in boreal and temperate forest ecosystems (Gilbert, 2000). In hemiboreal forests, south and south–west expositions have been used for the estimation of microclimatic changes in assessing edge effects (Aune et al., 2005). We investigated the influence of edge effects from south and south–west facing edges on indicator species of epiphytic lichens in black alder woodland key habitats. Woodland key habitats (WKHs) are small forest parcels in production forest which are particularly important for maintaining biodiversity at the landscape level (Timonen et al., 2010), but they are strongly influenced by forestry actions in adjacent stands. Indicator species have been used as a component for determination WKHs in the Baltic and Fennoscandian forests (Straupe and Donis, 2008). In addition, the presence of indicator species should be correlated with red–listed species in WKHs. These species in WKHs are vascular plants, epiphytic lichens and bryophytes (Ek et al., 2002).

The human–induced edges reduce the forest interior area and affect species of both mature and young forest stands (Murcia, 1995). It is known that edge effects could be more crucial for species

persistence than the isolation or habitat loss (Moen and Jonsson, 2003). For instance, lower colonization rate of epiphytic lichens has been found closer to habitat edges (Hilmo and Holien, 2002).

The aim of this study was to test edge effects on indicator species of epiphytic lichens in black alder WKHs. Further, we hypothesize that the distance from edge to forest interior affects the presence of epiphytic lichens. We also tested the influence of adjacent forest in different age stages on the occurrence of epiphytic lichens in black alder WKHs.

Materials and Methods

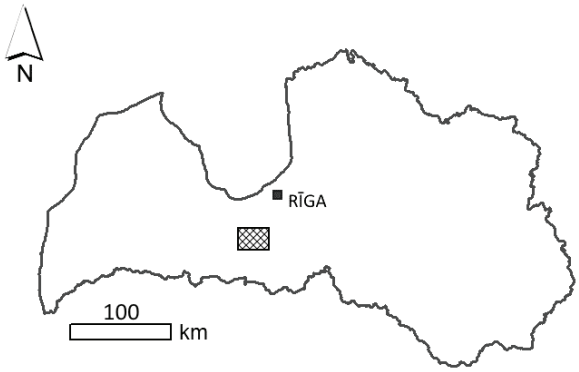

Figure 1. Location of the study sites.

Latvia falls into hemiboreal vegetation zone (Sjörs, 1963). The studied sites were located in Southern Latvia, particularly in Ozolnieki and Jelgava municipalities (Fig. 1) with elevation ranging from 0 to 20 m a.s.l. The average temperature is –5.3 °C in January and 17 °C in July and the mean annual precipitation reaches 667 mm (www.meteo.lv). This region is dominated by agricultural lands, the forest covers approximately 20% of area and it is dominated by mixed coniferous–deciduous tree species. Major tree species are Scots pine *Pinus sylvestris* L., Norway spruce *Picea abies* (L.) H. Karst., birch species *Betula pendula* Roth. and *Betula pubescens* Ehrh., grey alder *Alnus incana* (L.) Moench., black alder *Alnus glutinosa* (L.) Gaertn. (State Forest Service, 2008). Other species occurred sparsely. This forest region is dominated by the production forest and only small forest parcels (WKHs) are excluded from silvicultural practices. The study sites represented black alder WKHs with age of 84–129 years. All studied stands were semi–natural, located in close proximity to each other and had been managed in a similar manner. The evident influence of silvicultural practices of forests within existing WKHs likely consisted of thinning; forest drainage; few of them are located nearby forest roads. In total 30 sites were chosen for analysis. The study sites were established in three forest types: *Dryopterioso–caricosa, Filipendulosa* and *Oxalidosa* turf. mel. were dominated by *Alnus glutinosa*.

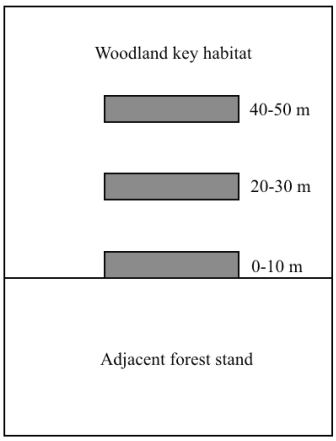

Figure 2. Schematic design of sample plots in relation to habitat edge.

During the vegetation season of 2013 a string of permanent sample plots was established in each WKH from the stand edge into forest interior (from S or SW side) to describe the gradient (Fig. 2). The size of sample plots was 20×50 m and each plot was divided into three zones with distances from edge 0–10 m, 20–30 m and 40–50 m (each zone was area of 200 m^2). Plots representing edges with S or S–W exposition were chosen: 10 with clearcut and young stand, 10 with middle–aged and 10 with mature stands (Fig. 2). We tested in each zone for the occurrence of lichen indicator species on randomly chosen black alder trees at the height of 0.5 m and 1.5 m from the ground.

The number of epiphytic lichen indicator species for the distance from edge and adjacent forest categories were tested for normality with the Shapiro–Wilk test. Non–parametric Kruskal–Wallis rank sum test was used to test the significance between groups and distances from the edge. We carried out pair–wise comparisons between the adjacent forest stands and distances from edge to interior using Wilcoxon signed rank test with Bonferroni adjusted p–values (at confidence level p=0.05). All statistical analyses were performed in R 3.1.1 (R development core team, 2013).

Results and Discussion

Species composition

In total four crustose lichens indicator species were found in the studied black alder WKHs. Three of them were especially protected species in Latvia (*Arthonia leucopellea* (Ach.) Almq, *Arthonia spadicea* Leight. and *Arthonia vinosa* Leight.), and one – common species *Graphis scripta* (L.) Ach. Two species were found in the study sites with adjacent young forests stands and four species were found in sites with adjacent mature forest stands. The richness of lichen indicator species was differed between none of species to two species in sites with adjacent young

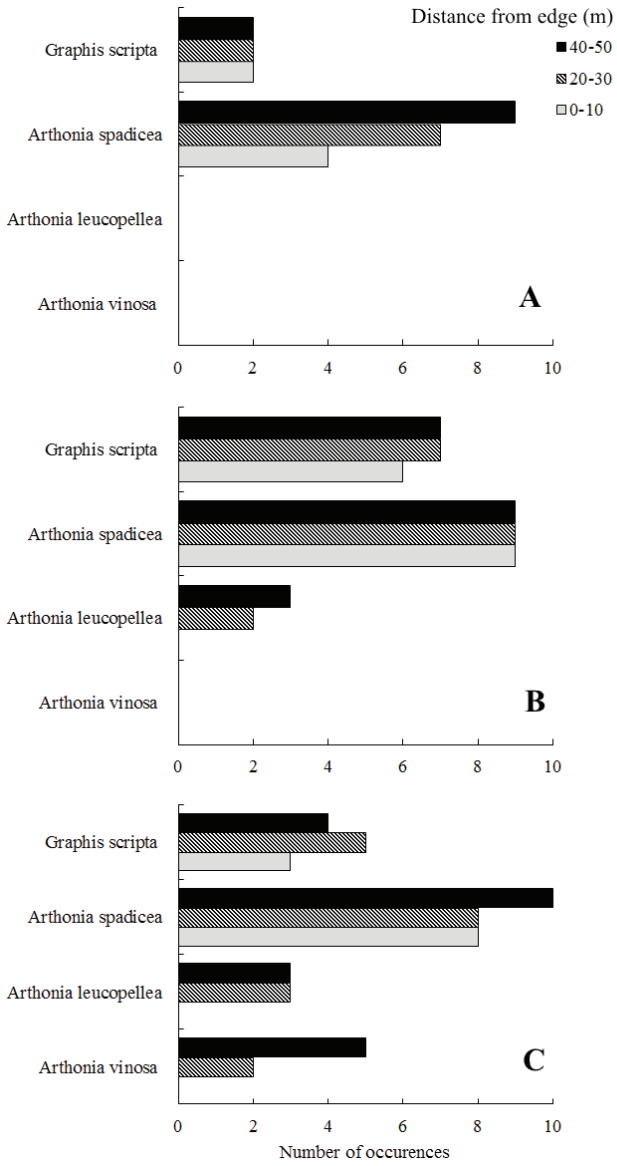

Figure 3. Edge effects on the number of lichen species occurrence in WKHs with adjacent young forest stands (A), middle–aged forest stands (B) or mature forests (C).

stands, and from none to three indicator species in sites with adjacent middle–aged stands and from one to four species in sites with adjacent mature forests.

The epiphytic lichens were affected by the distance from the forest edge and by adjacent young forests. Compared with adjacent mature forests, the number of observed species was lower in sites adjacent to young forest (Fig. 3). At least some epiphytic indicators (*A. spadicea* and *G. scripta*) are able to colonize and survive in habitats near edges (Fig. 3). This is explained by the fact that certain indicator species are more resistant to microclimatic changes and respond positively to edge effects. For instance, Hylander (2009) did not find any edge effects on ground–living bryophytes. This is in contrast with our study, which shows significant influence from adjacent forest. Our study also showed that more species are found with increasing distance from the edge (40–50 m).

Effects of distance from edge and stand age of adjacent forests on species occurrence

Our results show that indicator species occupancy increased with the distance from the edge into the forest interior (Fig. 4). There were significant differences between the number of indicator species in different groups of adjacent forests (p=0.001). Furthermore, we found that the number of epiphytic lichen species differed significantly in habitats adjacent to mature forests between distances 0–10 m and 40–50 m (p=0.03). Lower number of species

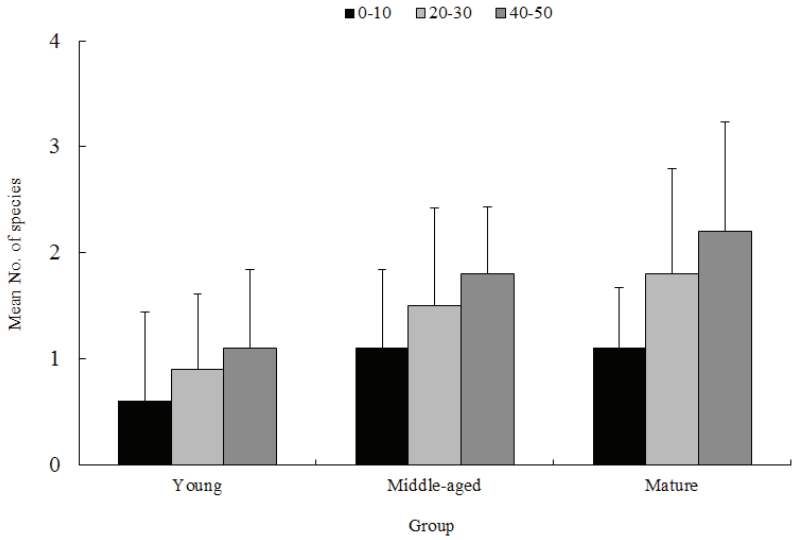

Figure 4. Edge effects on species composition in black alder WKHs with different groups of adjacent forests and the distance from forest edge to interior. Error bars indicate standart deviation (SD).

was found from the edge and highest number (n=4) was found from distance 40–50 m from the habitat edge. Previous studies indicated that edge effects are gradually decreasing with increasing distance from the edge (e.g. Murcia, 1995). It has been reported that WKHs due to their small size (avarage from 0.5–2.5 ha) are strongly influnced by edge effects (Aune et al., 2005). In addition, edge effects are induced by the changes in abiotic and biotic conditions, which may negatively affected lichen abundance (Esseen and Renhorn, 1998). Some studies also argued that WKHs have a lack of core area and entire stand is influenced by the edge effects (e.g. Aune et al., 2005).

The occurrence patterns of indicator species in our study were affected by the age of adjacent forest. Significant differences were found in a number of species in habitats between forest stands adjacent to young and middle–aged (p=0.0004) and young and mature forests (p=0.0006). All four epiphytic indicator species were found in habitats with adjacent mature forests (Fig. 4). One study demonstrated (Mancke and Gavin, 2000) that in fragmented landscape multiple edge effects could be stronger than one side edge influences. In highly fragmented forest areas, the greater tree mortality near clear–cut edges are from windthrow (Harper et al., 2005), which also caused the lack of the substrate for epiphytic lichen species. Edge effects on large forest remnants with adjacent clear-cuts could reach 10–25 m, but in scattered forest parcels up to 60 m (Mascarúa López et al., 2006). To reduce the impact of edge effects and preserve forest–dwelling species, the creation of wider buffer zones are essential. We show that some of indicator lichen species are able to survive near the forest edges with young adjacent forest. As we hypothesized, the adjacent forest age stages and recent forestry practices also influenced indicator species presence in WKHs. Some indicator species could occur near the edges of adjacent forests of clear-cuts and young forests where particular contrasts in microclimate occurred from south–facing edges. Studies investigating the presence of epiphytic lichens and bryphytes have showed an association with old–growth or late successional stage forests (Hedenås and Ericson, 2003). The main results from this study illustrated that the occurrence of indicator lichens could be influenced by the condition of adjacent forest stands.

Conclusions

Our results also show that the preservation of small forest parcels as woodland key habitats could be an efficient conservation tool in production forest landscapes with even–aged stands. In addition, changes in microclimatic conditions could also be crucial for sensitive epiphytic lichen species. The consideration of buffer zones or retention tree line from south–facing edges are also important to considered. In addition, other biological factors also influenced the persistence of indicator species on black alder trees. Further studies are needed to investigate the interactions between the occurrences of other lichens species, for instance, *Lepraria spp*. occurrence on black alder tree stems with the absence of epiphytic indicators. These additional factors have to be taken into account when estimating the colonization of indicator species in black alder WKHs. The persistence of edge effect studies on WKHs is important considering forestry practices planned in adjacent stands.

References

1. Aune K., Jonsson B.G., Moen J. (2005) Isolation and edge effects among woodland key habitats in Sweden: Is forest policy promoting fragmentation? *Biological conservation*, 124(1), pp. 89-95.
2. Baker S.C., Spies T.A., Wardlaw T.J., Balmer J., Franklin J.F., Jordan G.J. (2013) The harvested side of edges: effect of retained forests on the re–establishment of biodiversity in adjacent harvested areas. *Forest Ecology and Management*, 302, pp. 107-121.
3. Caruso A., Rudolphi J., Rydin H. (2011) Positive edge effects on forest–interior cryptogams in clear–cuts. *PloS one*, 6(11), e27936.
4. Chen J., Franklin J.F., Spies T.A. (1993) Contrasting microclimates among clearcut, edge, and interior of old–growth Douglas–fir forest. *Agricultural and forest meteorology*, 63(3), pp. 219-237.
5. Ek T., Suško U., Auziņš R. (2002) *Inventory of woodland key habitats. Methodology*. State Forest Service, Latvia, Regional Forestry Board, Ostra Gotland, Sweden, Riga, 72 p.
6. Esseen P.A., Renhorn K.E. (1998) Edge effects on an epiphytic lichen in fragmented forests. *Conservation biology*, 12(6), pp. 1307-1317.
7. Gilbert O. (2000) *Lichens, The New Naturalist*. Trafalgar Square, 288 p.
8. Hanski I. (2005) Landscape fragmentation, biodiversity loss and the societal response. *EMBO reports*, 6 (5), pp. 388-392.
9. Harper K.A., Macdonald S.E., Burton J.P., Chen J., Brosofske K.D., Saunders S.C., Euskirchen E.S., Roberts D.A.R., Jaiteh M.S., Esseen P.A. (2005) Edge influence on forest structure and composition in fragmented landscapes. *Conservation Biology* 19 (3), pp. 768-782.
10. Hedenås H., Ericson L. (2003) Response of epiphytic lichens on *Populus tremula* in a selective cutting experiment. *Ecological Applications*, 13(4), pp. 1124-1134.
11. Hilmo O., Holien H. (2002) Epiphytic lichen response to the edge environment in a boreal *Picea abies* forest in central Norway. *The Bryologist*, 105(1), pp. 48-56.
12. Hylander K. (2005) Aspect modifies the magnitude of edge effects on bryophyte growth in boreal forests. *Journal of Applied Ecology*, 42(3), pp. 518-525.
13. Hylander K. (2009) No increase in colonization rate of boreal bryophytes close to propagule sources. *Ecology*, 90(1), pp. 160-169.
14. Jules E.S. (1998) Habitat fragmentation and demographic change for a common plant: Trillium in old–growth forest. *Ecology*, 79(5), pp. 1645-1656.
15. Kuuluvainen T. (2009) Forest management and biodiversity conservation based on natural ecosystem dynamics in northern Europe: the complexity challenge. *AMBIO: A Journal of the Human Environment*, 38(6), pp. 309-315.
16. Latvijas Vides, Ģeoloģijas un Meteroloģijas centrs. Meteroloģijas novērojumu pārskats. Available at: http://www.meteo.lv/meteorologija–datu–pieejamiba/?nid=462, 15 February 2015.
17. Laurance W.F. (2008) Theory meets reality: how habitat fragmentation research has transcended island biogeographic theory. *Biological conservation*, 141(7), pp. 1731-1744.
18. Löfman S., Kouki J. (2001) Fifty years of landscape transformation in managed forests of southern Finland. *Scandinavian Journal of Forest Research*, 16(1), pp. 44-53.
19. Mancke R.G., Gavin T.A. (2000) Breeding bird density in woodlots: effects of depth and buildings at the edges. *Ecological Applications*, 10(2), pp. 598-611.
20. Mascarúa López L.E., Harper K.A., Drapeau P. (2006) Edge influence on forest structure in large forest remnants, cutblock separators, and riparian buffers in managed black spruce forests. *Ecoscience*, 13(2), pp. 226-233.
21. Moen J., Jonsson B.G. (2003) Edge effects on liverworts and lichens in forest patches in a mosaic of boreal forest and wetland. *Conservation Biology*, 17(2), pp. 380-388.
22. Murcia C. (1995) Edge effects in fragmented forests: implications for conservation. *Trends in Ecology and Evolution*, 10(2), pp. 58-62.
23. R Development Core Team (2013) R language and environment for statistical computing.
24. Ries L., Fletcher J., Battin R.J., Sisk T.D. (2004) Ecological responses to habitat edges: mechanisms, models, and variability explained. *Annual Review of Ecology, Evolution, and Systematics*, pp. 491-522.
25. Sjörs H. (1963) North Atlantic biota and their history. In: Á. Löve, D. Löve (eds) *Amphi–atlantic zonation, nemoral to arctic*, Pergamon Press, Oxford, pp. 109-125.
26. State Forest Service (2008) Forest statistics 2007. (MS Excel Spreadsheets), [CD ROM], Riga, Latvia. (in Latvian).

27. Straupe I., Donis J. (2008) The lichoindicative evaluation of black alder woodland key habitats in Latvia. In: Ozolinčius R., Stakenas R., Buožyte V. (eds) Climate change and forest ecosystems, *Proceedings of International Scientific Conference of Lithuanian Forest Research Institute*, Vilnius, Lithuania, pp. 148-154.
28. Timonen J., Siitonen J., Gustafsson L., Kotiaho J.S., Stokland J.N., Sverdrup–Thygeson A., Mönkkönen M. (2010) Woodland key habitats in northern Europe: concepts, inventory and protection. *Scandinavian Journal of Forest Research*, 25(4), pp. 309-324.
29. Vanbergen A.J., Woodcock B.A., Watt A.D., Niemelä J. (2005) Effect of land-use heterogeneity on carabid communities at the landscape scale. *Ecography*, 28(1), pp. 3-16.

GREY ALDER *ALNUS INCANA* (L.) MOENCH ADDITIONAL GROWTH CHANGES AFTER THINNING IN *AEGOPODIOSA* SITE TYPE

Olga Miezīte, **Imants Liepa**, **Arnita Šereiko**, **Solveiga Luguza**
Latvia University of Agriculture
olga.miezite@llu.lv

Abstract
Grey alder stands *Alnus incana* (L.) Moench have a number of distinctive features. In fertile soils it successfully forms productive forest stands without any human intervention. Therefore, relatively few publications can be found on the thinning effects on stand reaction after thinning. It is possible that due to the highly intensive circulation of substances in the ecosystems of grey alder (high photosynthesis and canopy thinning, withering and breaking off of the lower branches, litter decomposition within a few years, thereby ensuring a continuous and stable plant mineral nutrition substance complementarity in the soil) response reaction of the remaining trees and management of grey alder forest stands could be different comparing to other tree species. The study analyses stock volume additional increment dynamics during 10-year period after the thinning in 24-year-old grey alder pure stands in *Aegopodiosa* site type. Thinning of grey alder forest stands have caused a moderate positive reference reaction – during 10 years, in addition to the total increase, 3.17 m^3 ha^{-1} have been added. During the valuation interval response reaction differs among the years. In the first four years it is relatively small as accumulation of the growing potential is taking place. From the fifth to seventh year after felling an intensive growing takes place, which results in repeatedly additional annual increment. Starting from the eighth year, the trees show tendency to return to a steady state as it was before the thinning.
Key words: grey alder, effect of thinning, additional volume increment, *Aegopodiosa* site type.

Introduction

Thinning is always such a radical intervention in any forest stand that its effect persists for years after the thinning (Liepa and Zaļkalns, 2014). The nature and intensity of the impact depends on a wide variety of conditions. So during the long stand thinning history numerous studies have been done to find an environmentally substantiated and economically advantageous way of thinning (Zviedris et al., 1961). The criterion for comparing of different study results is the state of health and productivity changes of thinned stands (Eberts, 1996; Zālītis, 2010). There is no doubt that the thinning should not become a risk factor of explosion of tree diseases, such as root rot or enhanced proliferation of pests, for example a massive invasion of needles consumers. No less important is to increase or at least keep the pre-thinning timber productivity. This is being substantially dependent on the tending intensity (Антанайтис и др., 1986). Experience has shown that the selection of inappropriate thinning efficiency criteria, such as the annual tree ring width change after the thinning can lead to, although scientifically based, over-rarefying of the stands. In this case, the width of tree ring annual increase cannot compensate for the increase of the thinned trees, thereby resulting in the decrease of the productivity of the remaining forest stand. For the most tree species this problem has been identified and partially solved by the development of thinning regulations (Donis et al., 2012).

The situation is different with the grey alder *Alnus incana* (L.) Moench stands management research. As a reason two considerations can be mentioned – wood of grey alder is with relatively low assessment comparing to other tree species, as well as grey alder biological characteristics. The use of wood depends on the physical and mechanical properties, chemical composition, dimensions of the derived wood products, wood defects and other factors. According to these conditions, grey alder wood is mainly used in containers, wood fibre and board industry, lathing, charcoal, firewood, meat and fish smoking (Daugavietis, 2006). New opportunities for the use of grey alder can be given for renewable energy production. This tree species is quite suitable for use in heat energy industry because of its outstanding fast growth, high biomass productivity, easy afforestation and foster regeneration as well as wide occurrence. Latvia has a considerable amount of grey alder resources. This refers to both the forest and in particular abandoned agricultural lands occupied area as well as to the stock volume and the amount of the biomass (Miezīte, 2008; Daugavietis et al., 2009; Miezīte et al., 2011). According to the State Forest Service data (Meža statistikas..., 2014), the total area of grey alder stands in Latvia is 210,704.5 hectares with a total volume stock of 30,305,201 m^3, which is an important alternative for energy production. Especially important is the fact that grey alder mostly regenerates naturally in fertile forest site types and in uncultivated agricultural land forms healthy young stands. Reasonable use of these properties of grey alder allows the forest owner to avoid the expenditure for the planting and reproductive material, focusing more on further forest pre-commercial thinning. In dry and sandy soils feasible is planting of the grey alder too (Rokjānis, 1957). Economic significance of the grey alder is not yet sufficiently identified. Over

time, the treatment of this tree species has changed in a very wide range from hopeful suggestions on wood plasticizing (Kärki, 1999; Zīverts, 2008; Morozovs, 2008) and ending with the calling the grey alder a forest weed, whose admixture impacts negatively the target species such as Scots pine and Norway spruce, reducing their productivity and quality. Because of this, even the regulatory guidance materials recommended to exclude the grey alder from conifer stands (Norādījumi par..., 1993).

It should be emphasized that considerably more than the practical use of grey alder wood, ecological role of grey alder in forest ecosystem is especially high. This is a tree species that improves the growth conditions for the more commercially valuable tree species (Indriksons, 2006). It is convincingly proved that the grey alder increases soil fertility, reducing the acidity of the soil and improving its structure, aeration, plant nutrient substance attraction (nitrogen), soft humus and mycorrhiza formation, as well as increasing the tree resistance to root rot infection (Gaitnieks et al., 2000; Rytter, 1996). However, despite the many irreplaceable grey alder characteristics, in forestry practice this tree species remained outside the forest managers' attention. In general, it can be said that so far grey alder stands have been left to grow wild, paying attention just to cutting in clear felling. It is evidenced by the forest statistics (Meža statistikas..., 2014), describing the activities in forest and their intensity in different tree species stands. Grey alder even does not have a defined final cutting age, leaving all the rights of the cutting decision to the forest owner (Meža likums, 2000). Regeneration of these stands with the same tree species – grey alder - last year reached just 5,309 ha or 13.1%. In addition, in the majority of cases (99.9%) regeneration occurs naturally and does not require any effort and expense from forest owner or legal manager.

A similar attitude has been observed in thinning of grey alder stands. For example, in year 2013 in the whole 1,641.9 ha of grey alder stands thinned were 33,710 m^3 or 20.53 m^3 ha^{-1}. Perhaps this is due to the indifferent attitude observed in practice – in the fertile soils grey alder appears naturally and forms productive stands without any human intervention. At least according to the thinning of stands, the following considerations should be evaluated and empirically verifiable. Grey alder usually forms sparse stands where individual tree crowns relatively undisturb one another to receive the necessary amount of light for photosynthesis. Where illumination decreases below the critical level, the thinnest branches, particularly the lower part of the crown, quickly die and break off together with leaves supplementing the litter layer. This process is continuous from year to year. Comparing to other species more important for forestry is the fact that grey alder litter decomposes in a year or two, constantly adding nutrients to the soil. Such substances and energy cycle ensure sustainable and balanced tree supply with the existence resources. Therefore, the annual increment in the unthinned grey alder stands is high and stable. The situation can be changed radically after the first thinning. Canopy thinning gives an opportunity to increase the capability of light influx, which leads to the loss of some small branches. Therefore, the annual amount of litter in the coming years after thinning substantially reduces. On the other hand, litter in the grey alder stands decomposes so quickly that it is often most drained by surface runoff or filter in deeper soil horizons. Consequently, it partly suspends the previous steady nutrient flow to the roots of the trees, which is a reason for the stand productivity decline. How long and strong is the influence? Is the long-term stand additional volume increase able to compensate the loss of the increment connected with the cutting of the part of the trees during the thinning? These and other issues are explained in this study evaluating the results of thinning in grey alder 24-year-old pure stands in the site type *Aegopodiosa*. The aim of the research is to analyse grey alder additional growth changes after thinning in *Aegopodiosa* site type. This work is a continuation of the authors' previous study of the productivity and rational management of grey alder stands in the site type *Aegopodiosa* (Miezīte et al., 2011).

Materials and Methods

Collection of empirical materials was carried out in two pure stands of grey alder in *Aegopodiosa* site type arranging 0.12 ha plot in each stand. In one of these stands in the year 2002 the thinning was done, in the other one – control stand was left undisturbed. Edaphic and phytocenotic situation in both stands was similar. Characteristics of the thinned stand: location coordinates X:466335 Y:6293276 (private farm Spulles); stand area 1.0 ha; species composition – 100% grey alder; age - 34 years; site index class I; stand density 0.8; stand average tree diameter was 18.0 cm; average height - 17.0 m; basal area 23.0 m^2 ha^{-1}; stock volume 189 m^3 ha^{-1}. The control stand characteristics: location coordinates X:467685 Y:6290835 (private farm Medņi); stand area 1.7 ha; species composition – 100% grey alder; age - 38 years; site index class I; stand density 0.8; stand average tree diameter was 16.0 cm; average height - 17.0 m; basal area 22.0 m^2 ha^{-1}; stock volume 185 m^3 ha^{-1}. In both stands soil characteristics is typical to *Aegopodiosa* site type - sod calcareous soil with a neutral reaction. In both stands the undergrowth *Picea abies* (L.) H. Karst, *Betula pendula* Roth, *Quercus robur* L., *Fraxinus excelsior* L. and *Acer platanoides* L. are represented, but *Padus*

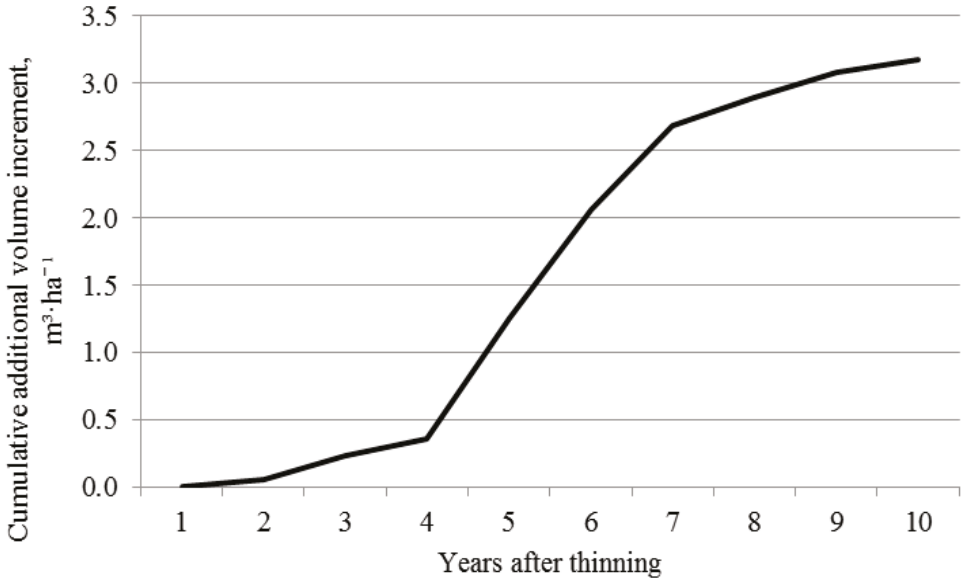

Figure 1. Dynamics of the cumulative additional tree volume increment during 10 years after the thinning in grey alder stands in *Aegopodiosa* site type.

avium Mill., *Corylus avellana* L., *Sorbus aucuparia* L. are presented in understory, and ground vegetation consists of *Oxalis acetosella* L., *Paris quadrifolia* L., *Aegopodium podagraria* L., *Urtica dioica* L. and *Anemone nemorosa* L.

Field works were implemented in October 2012. In each sample plot the diameters of all trees were measured at 1.3 m above the root collar; using ordinary dial calliper (accuracy 0.1 cm) and hypsometer SUUNTO the height of 25 trees (reading accuracy of each measurement - 0.5 m) was measured. In thinned stand using M. Pressler's auger 21 wood samples were collected. In turn, in the control stand 50 wood samples were collected. Drilling was conducted at a breast height, selection of sampled trees - random. Drilling depth was up to core, drilling direction - perpendicular to the growth axis of the trunk. Each core was put in separate straw thus preventing from breakage and drying before reaching the laboratory.

The last 20 tree ring widths of each core were measured in the laboratory with accuracy 0.01 mm using measuring table with Lin TAB system microscope and T-Tools Pro software. Before the measuring all cores were abraded and stained using dilute iodine solution for better differentiation of ring borders.

The dendrometric parameters of both stands are calculated using forest inventory methods (Liepa, 1996). To avoid misunderstanding, it should be added that the forest stand average diameter was calculated as geometric mean using all tree diameter measurements and the mean height - as a function of the average diameter trend line. Response reaction after thinning was evaluated assessing the additional tree volume increment (Liepa and Zaļkalns, 2014). Both the cumulative and the current (average periodical) additional tree volume increment are calculated. Dynamics of both kinds of additional increment are tracked for 10-year long period after thinning –starting from the year 2003 up to year 2012. Descriptive statistics is used for the data analysis (α=0.05).

Results and Discussion

Timber volume additional increment is that part of the tree or tree cluster (e.g. forest stand) increment which can be explained by the researched factor. This indicator is free from that part of increment which in a given time period should be formed without this effect. This is very important because it avoids a distorted reflection of the impact of the annually fluctuating environmental impact. Additional impact is perceived being positive if the researched influence improves the wood formation conditions and negative - if it worsens it.

It should be underlined that additional cumulative increment expresses the yield accumulation during the whole researched interval. Therefore, the figure of this parameter (Fig. 1.) represents the equalized dynamics of the investigated factor.

By contrast, the annual additional increment characterises the factor's impact annual fluctuations (Fig. 2), because of that this indicator is perfect for the meteorological analysis of the stand productivity changes (Liepa, 1996).

Both images show that the response reaction of grey alder to the stands thinning started immediately after the thinning and trend is to continue throughout

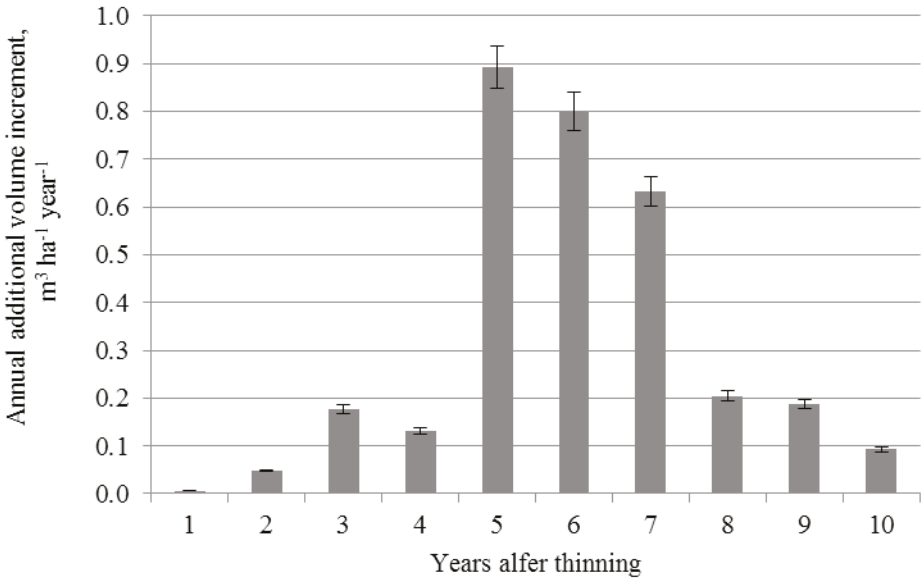

Figure 2. Dynamics of the annual additional tree volume increment during 10 years after the thinning in grey alder stands in *Aegopodiosa* site type.

all the evaluation interval (Fig. 1.). However, over the years there are distinct differences. Especially well it can be seen in the graph that shows annual additional increase (Fig. 2.). During the first four years, after thinning it is minimal and detectable only by scrupulous measurements and calculations. However, unlike a similar situation in coniferous stands where after-thinning stress in the first two or three years results in the stand productivity decline (Лиепа, 1980), in the researched grey alder stands negative additional increment is not observed. Apparently, in *Aegopodiosa* site type grey alder forest the stand adaptation to dramatically different growing conditions, which occur after thinning, is less tense, because of great amount of nutrients accumulated in the soil before. Impetuous increase of additional increment growth begins in the fifth year after the thinning and continues for the next three years, and then gradually decreases. The authors assume that the base of such tree reaction course is decomposition of felling residuals.

It is possible that grey alder stand requires at least the first four years to thinning residues get mineralized and released nutrients get involved in biomass synthesis. In addition, intensive photosynthesis regeneration happens during this period, when the canopy of left trees grows and occupies the canopy openings of felled trees. This gradually lifts up the tree growth potential. It can be seen in the fifth year after felling in our example. The potential runs out in three years and in the eighth year the yield additional annual increase indicates the trend to return to the steady state of stand as it was prior the thinning. The question remains - how many years it would take to reach balance and what will be the total effect of thinning (additional cumulative stand volume increment)?

The analysis of other tree species stands thinning effect shows that the reaction of the trees after thinning is significantly dependent on the felling intensity (Zālītis and Dubrovskis, 2002; Prindulis et al., 2013). Unfortunately, this study cannot be ascertained for two reasons. First, in the year 2002, during the thinning, the measurements of felled trees height and diameter were not performed, which excludes the possibility to calculate the amount of stand volume. Second, the dead organic matter decomposition was so intense that in autumn of 2012 there were no stumps left of the felled trees.

However, it is likely that thinning intensity was moderate. This is suggested by fact that the previous 10 years, the researched stands have successfully renewed the stand density what was before the thinning. Using P. Mūrniek's yield tables for grey alder stands (Sacenieks, Matuzānis, 1964), it is found that in October 2012 stand density was 0.73. Supporting that argument must be the fact that the overall thinning effect of the researched stand considered to be small – in 10 years the cumulative additional increment affected by thinning is only 3.17 m^3 ha^{-1} stem yield, which significantly lags behind the thinning effectiveness of other tree species stands. It is possible that it is based on a number of causes, such as grey alder stand specifics in the forest ecosystem movement of substance or delayed thinning. The

optimal age for thinning of this peculiar tree species stands to raise the productivity of the forest land could be up to 10 - 15 years. This conclusion, which is quite topical for the private forest owners (around 95% grey alder stands in Latvia are owned by private forest owners (Meža statistikas CD, 2014), should be empirically approved continuing initiated series of studies of grey alder ecosystems.

Conclusions

1. The thinning of grey alder forest stand in *Aegopodiosa* site type has caused a positive reference reaction which generally can be assessed as moderate. Thinning effect over 10 years in addition to the total increase have given only 3.17 m^3 ha^{-1}, - comparing to other tree species it is considered to be negligible.
2. During the valuation interval response reaction differs among the years. In the first four years it is small, completing the canopy openings. From the fifth to the seventh year after felling an intensive growing takes place, which results in repeatedly additional annual increment. Starting from the eighth year, the trees show the tendency to return to a steady state as it was before the thinning.

References

1. Daugavietis M. (2006) Baltalkšņa koksnes izmantošanas iespējas (Grey alder wood utilization options). In: *Baltalksnis Latvijā* (Grey alder in Latvia). LVMI Silava, 107; 114. lpp. (in Latvian).
2. Daugavietis M., Daugaviete M., Bisenieks J. (2009) Management of Grey Alder (*Alnus incana* Moench.) stands in Latvia. In: Annual 15th International Scientific Conference Proceedings *Research for Rural Development 2009*, Latvia University of Agriculture, Jelgava, Latvia, pp. 229-234.
3. Donis J., Šņepsts G., Zdors L., Šēnhofs R. (2012) Mežaudžu augšanas gaitas un pieauguma noteikšana, izmantojot pārmērītos meža statistiskās inventarizācijas datus (Growth of forest stands and increment determination, using remeasured data of statistical forest inventory). Projekta 1. starpatskaite (2. etaps). Salaspils, LVMI Silava, 111 lpp. (in Latvian).
4. Eberts H.P. (1996) Mērķa koku audzēšana (Growing of target trees). *Meža Dzīve*, 4. 11. lpp. (in Latvian).
5. Gaitnieks T., Liepa I., Rokjānis B. (2000) The influence of grey alder on the mycorrhiza in Norway spruce stands infected by root rot disease. Proceedings of Latvia University of Agriculture. pp. 60-64.
6. Indriksons A. (2006) Baltalkšņa loma meža ekosistēmās (The role of grey alder in forest ecosystems). In: Baltalksnis Latvijā (Grey alder in Latvia). LVMI Silava, 20.-27. lpp. (in Latvian).
7. Kärki T. (1999) Predicting the value of grey alder (*Alnus incana*) logs based on external quality. *Silva Fennica*, 33 (1), pp. 13-23.
8. Liepa I. (1996) *Pieauguma mācība* (Increment Science). Jelgava, LLU, 123. lpp. (in Latvian).
9. Liepa I., Zaļkalns O. (2014) The Diversity of the Environmental Impact in Kurzeme. *Journal of Life Sciences*, USA. July 2014, 8 (7), pp. 570-581.
10. *Meža statistikas CD 2014* (Forest statistics CD 2014). Available at: www.vmd.gov.lv/valsts-meza-dienests/statiskas-lapas/publikacijas-un-statistika/meza-statistikas-cd?nid=1049#jump, 20 February 2015.
11. Miezīte O. (2008) *Baltalkšņa audžu ražība un struktūra* (Productivity and structure of grey alder stands). Promocijas darbs mežzinātņu doktora (Dr.silv.) zinātniskā grāda iegūšanai Mežzinātnes nozarē Meža ekoloģijas un mežkopības apakšnozarē. Jelgava, LLU 127. lpp. (in Latvian).
12. Miezīte O., Liepa I., Lazdiņš A. (2011) Carbon accumulation in overground and root biomass of grey alder (*Alnus incana* (L.) Moench) in *Aegopodiosa*. In Annual 17th International Scientific Conference Proceedings *Research for Rural Development 2011*, 2. – Jelgava: Latvia University of Agriculture. pp. 46-51.
13. Morozovs A. (2008) *Koksnes materiālu uguns reakcijas un mehānisko īpašību pētījumi un jaunu produktu izstrāde* (Wood materials reaction to fire and mechanical research and development of new products). Pasūtītājs LR ZM Lauku atbalsta dienests, MEKA projekta pārskats. Jelgava, 131. lpp. (in Latvian).
14. Norādījumi par kopšanas cirtēm (1993) (Instructions for thinnings). Rīga, 36. lpp. (in Latvian).
15. Prindulis U., Donis J., Šņepsts G., Strazdiņa L., Liepiņš J., Liepiņš K. (2013) Apaļkoksnes sortimentu iznākuma modelēšana krājas kopšanas cirtēs bērza stādījumos (Modelling roundwood assortment yield in thinning birch plantations). *Mežzinātne*, 27(60), 3.-16. (in Latvian).
16. Rokjānis B. (1957) *Baltalkšņa mākslīga ieaudzēšana un augšanas gaita dažos meža augšanas apstākļu tipos Latvijas PSR*. Disertācija lauksaimniecības zinātņu kandidāta grāda iegūšanai (The artificial afforestation with grey alder and growth dynamics at several forest site types in Latvia SSR. Dissertation on the candidate degree of agricultural sciences). Jelgava, LLU Fundamentālā bibliotēka. 361. lpp. (in Latvian).

17. Rytter L. (1996) Grey alder in forestry: a review. *Norwegian Journal of Agricultural Sciences.* Supplement no. 24. pp. 62-78.
18. Sacenieks R., Matuzānis J. (1964) *Mežsaimniecības tabulas* (Forestry table). Rīga, Latvijas valsts izdevniecība, 207. lpp. (in Latvian).
19. Zālītis P. (2010) Intensīvi izretināto vai reto baltalkšņa jaunaudžu struktūra (Structure of intensively thinned or low density grey alder young forest stands). *Mežzinātne*, 21(54), 45.-55. lpp. (in Latvian).
20. Zālītis P., Dubrovskis D. (2002) Priežu mežu ražība un krājas kopšanas ciršu modeļi (Productivity of pine stands and the thinning models). *Latvijas Lauksaimniecības universitātes raksti* / LLU. Jelgava: LLU, 2002, 5, 44.-52. lpp. (in Latvian).
21. Zīverts K. (2008) *Blīvinātas koksnes stabilizēšana ar termisko modifikāciju* (Densified wood stabilization with thermal modification). Maģistra darbs maģistra grāda iegūšanai inženierzinātnēs, apakšnozarē Koksnes materiāli un tehnoloģijas. Jelgava, LLU, 60. lpp. (in Latvian).
22. Zviedris A., Sacenieks R., Matuzānis J. (1961) *Kopšanas cirtes Latvijas PSR mežos* (Thinnings in the forests of Latvia SSR). Rīga, LPSRZAI, 155. lpp. (in Latvian).
23. Антанайтис В.В., Тыбера А.П., Шянятене Я.А. (1986) *Законы, закономерности роста и строения древостоев* (Laws of growth and structure of forest stands). Каунас. 158 с. (in Russian).
24. Лиепа И.Я. (1980) *Динамика древесных эапасов*. Прогнозирование и экология (Stand volume dynamics. Forecasting and ecology). Рига, Зинатне, 173 с. (in Russian).

BIRCH GROWTH RESPONSES TO THE INSECT INJURY SIMULATIONS

Valda Araminienė, Iveta Varnagirytė-Kabašinskienė
Lithuanian Research Centre for Agriculture and Forestry
valda.vik@gmail.com; iveta.kabasinskiene@mi.lt

Abstract
The tree growth compensation followed by insect damage is important for tree survival. Insect damage by making 3 and 6 holes per each leaf, and clipping one third of a leaf were simulated for one-year old silver birch (*Betula pendula* Roth) seedlings once, at the beginning of the vegetation season. The height, aboveground and root biomass, root length, stem diameter and leaf area were measured for all damaged and control seedlings. The aim of the study was to examine the effects of different insect-damage simulations on silver birch growth.
Our study demonstrated that leaf dry mass decreased in response to leaf perforations and clipping one third of leaf. However, at the end of the experiment, the cumulative dry mass reached the level of the control. We found no statistically significant effect on the aboveground and total biomass of damaged seedlings compared to the control. The leaf clipping decreased the leaf area and stem diameter compared both to the treatment with hole-damaged seedlings and the control. The induced birch growth response showed that tree seedlings were able to compensate their growth up to the control level after the insect damage in eight weeks.
Key words: Silver birch, seedling, leaf damage, growth compensation.

Introduction

The current research studies, based on the changing environment with all upcoming consequences, indicate that the increase of the insect herbivores abundance could be expected (Jepsen et al., 2011; Huttunen et al., 2013). Simultaneously, the changes of insect-plant interactions may occur. Among a variety of insect species, approximately two thirds of all known herbivorous insect species are leaf-eating beetles (*Coleoptera*) or caterpillars (*Lepidoptera*) (Schoonhoven et al., 1998). In turn, insects use various feeding strategies to obtain nutrients from aboveground and belowground plant compartments (Howe and Jander, 2008). This biotic stressor may damage plant tissue and disrupt tissue with varying intensities. Generally, insect-caused damage reduces the total leaf area of the plant. As a consequence, the changes in photosynthetic activity could be expected and the decrease in height and diameter increment, also lower mass production, could occur (Schat and Blossey, 2005; Huttunen et al., 2007). Surveys, such as that conducted by Byington et al. (1994) and Stevens et al. (2008), have shown that individual tree response depends both, on the internal features, time required for plant recovery and growth potential and on the type, duration and intensity of insect damage.

During the last three decades, a number of studies have shown different growth responses to insect damage: plant biomass of damaged plants decreased after the damage event or it was to some extent compensated by intensified growth of the remained tissues (Lacery and Poolean, 1981; McNaughton, 1986; Oesterheld, 1992; Anten and Ackerly, 2001; Ferraro and Oesterheld, 2002; Wise and Abrahamson, 2008). The compensation for insect-damaged trees was identified by Osier and Lindroth (2004) and Landhäusser and Lieffers (2012). The studies based especially on the growth response of birch species damaged by insects were conducted by Mutikainen et al. (2000), Anttonen et al. (2002) and Huttunen et al. (2013). The decrease of foliage changes the partitioning between aboveground and root biomass, i.e. decrease in root/shoot ratio could be indicated (Oesterheld, 1992; Markkola et al., 2004).

Despite quite a lot above-mentioned published issues, we have not succeeded to find any significantly sound data of similar research in the Baltic region. With caution, we state that this is the first attempt to simulate such damage types in our climatic conditions and to obtain their effects on tree growth. In the present study, we examine the effects of different intensities and types of insect-damage simulations on the growth of the fast growing successional tree species - silver birch - seedlings. We have raised the hypothesis that the seedlings that are affected by insects grew better than undamaged seedlings, even after damage.

Materials and Methods

This study was designed as a pot-cultivated experiment and it was conducted in the central part of Lithuania at the Dubrava Experimental and Training Forest Enterprise. One-year old visually healthy Silver birch (*Betula pendula* Roth) seedlings were used as plant material. The birch seedlings of approximately equal height were selected and planted into plastic pots of 3 liters filled with the mixed peat and sand soil on April 2, 2014. During the experiment, weed control was carried out; birch seedlings were regularly watered but never received any fertilizer. Three different types of insect damage were simulated: (1) three and (2) six perforations (0.33 cm^2) per each leaf using a steel hole-punch, and (3) clipping one-third of each leaf using scissors, were simulated on June 17, 2014. The clipping treatment was used as largest

damage aiming to simulate the completely different damage type, i.e. when insects damage leaf tips. Non-damaged seedlings were also set as control. Totally, 20 birch seedlings were set in each treatment.

At the end of the experiment, eight weeks post-simulation, the following indices of each seedling were assessed: (1) height; (2) total dry mass, including leaf, stem, shoots and roots mass; (3) the diameter of main stems at a 2 cm distance above the stump-base using an electronic digital calliper; the length of main-root and leaf area of three leaves, taken randomly from each seedling per each treatment, using a scanner with leaf area analysis software WinFOLIA 2004a (Regent Instruments Inc., Quebec, Canada). All collected samples were oven-dried at 60 °C and weighted.

The total biomass of each tree was calculated by the summation of the aboveground and root dry mass, in grams. The cumulative leaf, aboveground and total dry mass was calculated by summing the dry mass at harvest and the leaf mass removed during insect damage simulations.

Root dry mass was expressed in relation to the aboveground dry mass (root/shoot ratio), cumulative leaf mass - in relation to root dry mass (cumulative leaf mass/root mass ratio), and leaf dry mass – in relation to the total biomass (leaf weight ratio).

The data was statistically analysed. First, the data normality was checked by Lilliefors and Kolmogorov-Smirnov tests, then the nonparametric Kruskal-Wallis analysis of variance (ANOVA) test was used to ascertain the significant differences in dry mass between the control, 3 and 6 holes per leaf and clipped one-third of leaf. The data presented in the text, tables and figures are given as means with the standard error of the mean. A level of significance of $\alpha = 0.05$ was chosen. Statistical analyses were conducted using the software Statistica 7.0.

Results and Discussion

In order to clarify how the trees damaged by insects respond to this stress, how they grow, what increment could be expected in the future, the field experiment with artificially perforated birch seedlings was performed in the summer of 2014. The two types of damage were examined: the first, the effect of 3 and 6 holes per each leaf, and, the second, the leaf clipping effect.

Irrespective of insect damage type and intensity, the mean leaf mass varied between 1.8±0.1 and 2.0±0.1 g per seedling, and these values were up to 15% lower than leaf mass in the control seedlings (Fig. 1). When the cumulative leaf dry mass of the silver birch seedlings was calculated, the significant main effect on the leaf mass was found in the seedlings with clipped leaves. Here, the greatest mean cumulative leaf mass (2.5±0.1 g per seedling) was recorded. As a point of comparison, the birch seedlings that were subjected to the insect holes did not change their cumulative mass and it varied in the range similar to the control (Fig. 1).

Except for leaf dry mass, no statistically significant effect on other aboveground biomass compartments (shoot, stem) were obtained after insect damage simulation. The mean values of stem mass varied in a range between 3.6±0.1 (clipped 1/3 of leaf) and 4.1±0.2 g (control) per seedling, with a slight reduction moving from 3 to 6 holes, and further to the clipped treatment (data not shown). Root dry mass statistically non-significantly declined in the following sequence: control > 3-holes ≥ 6-holes

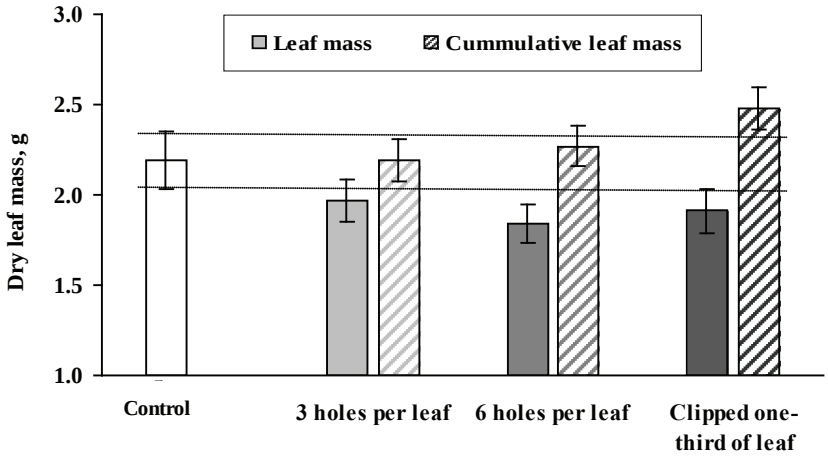

Figure 1. The comparison of leaf and cumulative (*leaf mass at harvest plus leaf mass removed during simulations*) leaf dry mass of silver birch seedlings eight weeks post-simulations.
Note: One column for the Control shows the same value both for leaf and cumulative leaf mass.

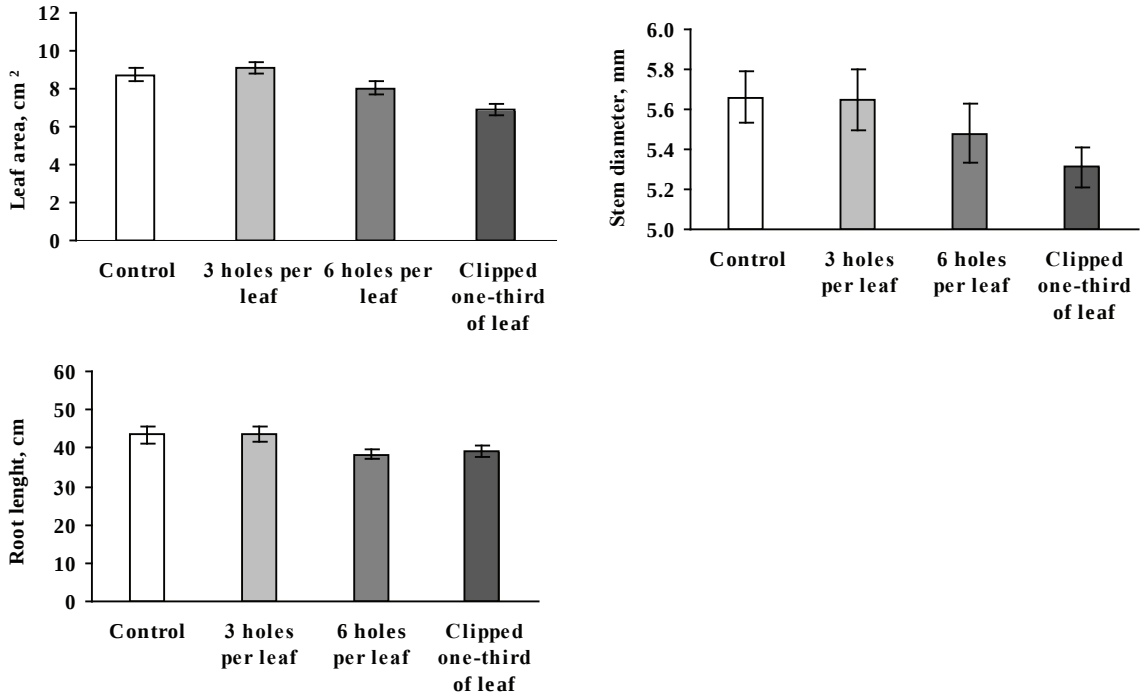

Figure 2. Impact of different insect damage on mean leaf area, stem diameter and length of the main root of the silver birch seedlings eight weeks post-simulation.

= clipped 1/3 of leaf, and it amounted to 5.3±0.3; 4.9±0.3; 4.7±0.3 and 4.8±0.3 g, respectively.

Rising step upwards, the differences between the treatments disappeared in the aboveground biomass measurement, without the interpretation of the calculated total biomass. Total cumulative dry mass of birch seedlings varied in a very narrow range between 11.2±0.5 and 12.0±0.7 g per seedling.

Most of the measurements, which were conducted for the birch seedlings eight weeks post-simulation, confirmed our earlier findings. The clipping of each leaf per seeding induced the reduction of leaf area and stem diameter compared both with the control and hole-damaged seedlings (Fig. 2). However, the estimated root length remained unaffected.

No significant response of 3-, 6-holes per leaf, or clipped leaf treatment to the root/shoot ratio was obtained (Fig. 3). However, the cumulative leaf mass/root ratio increased toward a higher intensity of the damage, i.e. clipped treatment was higher than 6 holes, which, in turn, was higher than 3 holes. Generally, the data showed an increase trend in all estimates, compared to the control (Fig. 3). During our experiment we were not able to sustain the Markkola et al. (2004) finding that the root/shoot ratio decreased as a response of insect damage. Probably, in our case, the damage was not very significant.

Continuing discussion, we can state that until the current decade, birch stands have not been well evaluated in Lithuania because of economic reasons. However, the situation has changed and, recently, this tree species is one of the most promising, which comprise over 22.4% of all stands (ME/SFS, 2014). Silver birch (*Betula pendula* Roth.) is more common in Lithuanian forests. Mean defoliation of birch trees in Lithuania during the last two decades ranged between 16.2 and 23.0% and showed a very slight trend of degradation (Araminienė et al., 2013). According to the Forest statistics and our earlier findings, the number of birch trees damaged by insects comprises about 62% of biotic damage and almost half of total birch damage (Araminienė et al., 2013; Stakėnas et al., 2013). Severe insect damage could result in economic loss to birch plantations because it may lead to enhanced loss of foliage and lower final biomass. As it is already known from Hoogesteger and Karlsson (1992), severe defoliation (more than 80% loss of foliage) reduces the annual ring width considerably for one or more years.

Our results indicated that simulated insect damage affected the growth and biomass of the studied silver birch seedlings, and that the magnitude of the effect depended on the damage intensity and type. Among those silver birch seedlings that were damaged by holes and clipped, it is typical that main effects occurred in the birch foliage. It seems that the differences disappeared when the total biomass was re-calculated. No evident changes of stem, branches and root mass compared with the control were obtained. Both tested simulations of insect holes had similar effects on

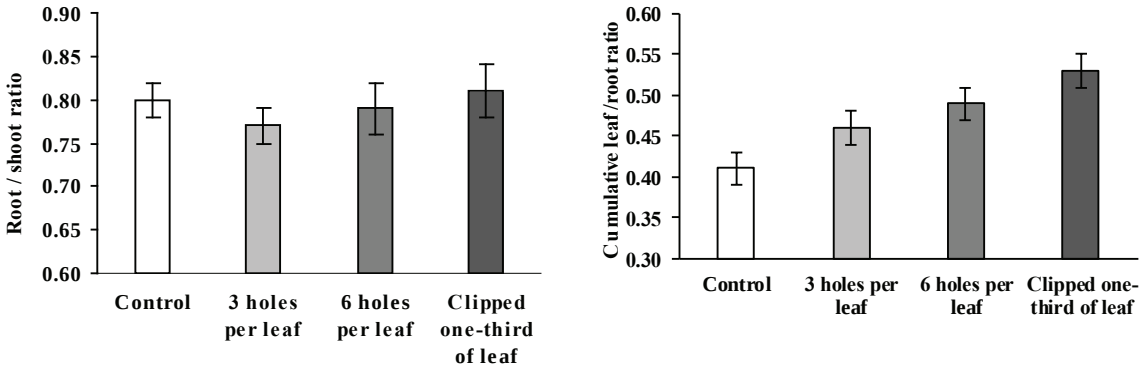

Figure 3. The comparison of the root / shoot and cumulative leaf / root mass ratios (dry mass per each biomass compartment) in the silver birch seedlings eight weeks after the insect-damage simulations.

seedlings; they both were less different than control, compared with the clipped treatment.

As presumed in our hypothesis, we partly confirmed the assertion that insect damage induced to some extent a higher ability to regrow the lost foliage. Some further assumption could be made, as the recovery time during one vegetation season possibly was too short. It is worth mentioning that some of insects attack plants at different times of the season. In this case, we were not able to demonstrate the response of repetitive attacks.

Nevertheless, if we succeed to observe the increased trend of cumulative biomass over very short period, the longer time for regrowth should be even more promising.

Conclusions

1. Despite the decrease of leaf dry mass in response to leaf perforation with 3 and 6 holes, and leaf clipping, the final cumulative dry mass amounted to the control level. No statistically significant effect on the aboveground and total biomass was found after insect damage simulation.
2. No significant response of 3-, 6-holes per either leaf, nor clipped leaf treatment to the root/shoot ratio was obtained. The clipping of each leaf per seeding decreased the leaf area and stem diameter compared to the control and hole-damaged seedlings.
3. The study results showed that birch seedlings, to which the insect damage was simulated, were able to compensate their growth up to the control level in eight weeks.

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References

1. Anten N.P.R., Ackerly D.D. (2001) Canopy-level photosynthetic compensation after defoliation in a tropical understorey palm. *Functional Ecology*, 15, pp. 252-262.
2. Anttonen S., Piispanen R., Ovaska J., Mutikainen P., Saranpää P., Vapaavuori E. (2002) Effects of defoliation on growth, biomass allocation, and wood properties of *Betula pendula* clones grown at different nutrient levels. *Canadian Journal of Forest Research*, 32, pp. 498-508.
3. Araminienė V., Varnagirytė-Kabašinskienė I., Stakėnas V. (2013) The Influence of Abiotic and Biotic Factors on the Condition of Birch Species in Lithuania. In: The Sixth International Scientific Conference Rural development 2013. Proceedings, 6 (3), ASU, Kaunas, Lithuania, pp. 182-186.
4. Byington T.S., Gottschalk K.W., McGraw J.B. (1994) Within-population variation in response of red oak seedlings to herbivory by gypsy moth larvae. *The American Midland Naturalist*, 132, pp. 328-339.
5. Ferraro D.O., Oesterheld M. (2002) Effect of defoliation on grass growth. A quantitative review. *Oikos*, 98, pp. 125-133.
6. Hoogesteger J., Karlsson P.S. (1992) Effects of defoliation on radial stem growth and photosynthesis in the mountain birch (*Betula pubescens* ssp. *tortuosa*). *Functional Ecology*, 6, pp. 317-323.
7. Howe G.A., Jander G. (2008) Plant Immunity to Insect Herbivores. *Annual Review of Plant Biology*, 59, pp. 41-66.

8. Huttunen L., Ayres M.P., Niemelä P., Heiska S., Tegelberg R., Rousi M., Kellomäki S. (2013) Interactive effects of defoliation and climate change on compensatory growth of silver birch seedlings. *Silva Fennica*, 47(3), article id 964. 14 p.
9. Huttunen L., Niemelä P., Peltola H., Heiska S., Rousi M., Kellomäki S. (2007) Is a defoliated silver birch seedling able to overcompensate the growth under changing climate? *Environmental and Experimental Botany*, 60, pp. 227-238.
10. Jepsen J.U., Kapari L., Hagen S.B., Schott T., Vindstad O.P.L., Nilssen A.C., Ims R.A. (2011) Rapid northwards expansion of a forest insect pest attributed to spring phenology matching with sub-Arctic birch. *Global Change Biology*, 17, pp. 2071-2083.
11. Lacery J.R., Van Poollean H.W. (1981) Comparison of herbage production on moderately grazed and ungrazed western ranges. *Rangeland Ecology and Management,* 34, pp. 210-212.
12. Landhäusser S.M., Lieffers V.J. (2012) Defoliation increases risk of carbon starvation in root systems of mature aspen. *Trees*, 26, pp. 653-666.
13. Markkola A., Kuikka K., Rautio P., Härmä E., Roitto M., Tuomi J. (2004) Defoliation increases carbon limitation in ectomycorrhizal symbiosis of *Betula pubescens*. *Oecologia,* 140, pp. 234-240.
14. McNaughton S.J. (1986) On plant and herbivores. *American Naturalist*, l28, pp. 765-770.
15. Mutikainen P., Walls M., Ovaska J., Keinänen M., Julkunen-Tiitto R., Vapaavuori E. (2000) Herbivore resistance in *Betula pendula*: effect of fertilization, defoliation and plant genotype. *Ecology*, 81, pp. 49-65.
16. Oesterheld M. (1992) Effect of defoliation intensity on aboveground and belowground relative growth rates. *Oecologia*, 92, pp. 313-316.
17. Osier T.L., Lindroth R.L. (2004) Long-term effects of defoliation on quaking aspen in relation to genotype and nutrient availability: plant growth, phytochemistry and insect performance. *Oecologia*, 139, pp. 55-65.
18. Schat M., Blossey B. (2005) Influence of natural and simulated leaf beetle herbivory on biomass allocation and plant architecture of purple loosestrife (*Lythrum salicaria* L.). *Environmental Entomology*, 34(4), pp. 906-914.
19. Schoonhoven L.M., Jermey T., Loon J.J.A. (1998) *Insect-Plant Biology: From Physiology to Evolution*, Chapman & Hall, London, UK, 409 p.
20. Stakėnas V., Beniušis R., Varnagirytė-Kabašinskienė I., Araminienė V., Žemaitis P., Čapkauskas G. (2013). Medžių būklės kaita Lietuvoje 1989-2012 metais (The changes of tree condition in Lithuania in 1989–2012). Miškininkystė. 1(73). pp. 7-18. (in Lithuanian with English and Russian summaries).
21. Stevens M.T., Kruger E.L., Lindroth R.L. (2008) Variation in tolerance to herbivory is mediated by differences in biomass allocation in aspen. *Functional Ecology*, 22, pp. 40-47.
22. ME/SFS (2014) Lietuvos valstybinių miškų 2013 m. sanitarinės būklės apžvalga (Overview of Lithuanian State Forests condition in 2013). Valstybinė miškų tarnyba Miško sanitarinės apsaugos skyrius. Available at: http://www.amvmt.lt/2014/ST2014.aspx?&MID=0&AMID=863, 14 August 2015 (in Lithuanian).
23. Wise M.J., Abrahamson W.G. (2008) Applying the limiting resource model to plant tolerance of apical meristem damage. *The American Naturalist*, 172, pp. 635-647.

INFLUENCE OF POST-FIRE MANAGEMENT ON REGENERATION OF SCOTS PINE (*PINUS SYLVESTRIS* L.) IN NORTH-WESTERN LATVIA

Mara Zadina[1,3], Jānis Donis[2], Aris Jansons[1]
[1]Latvian State Forest Research Institute 'Silava'
[2]Forest Competence Centre
[3]Latvia University of Agriculture
aris.jansons@silava.lv

Abstract
Fire is a frequent disturbance in hemiboreal forests that in Latvia affects mostly Scots pine (*Pinus Sylvestris* L.) stands. Increased forest fire risk is predicted in future as a result of climatic changes. Therefore the aim of our study was to assess Scots pine regeneration after forest fire in different forest types and with different regeneration methods. Tree height was measured and browsing damage assessed seven years after the forest fire in six different forest types, where planting and natural regeneration (in a clearcut and without management) occurred in compartments randomly selected from a list of stands severely affected by forest fire. The height of Scots pine was significantly affected both by forest type and regeneration method. Notable advantages of planting based on tree height were found in wet mineral soils and peat soils. Trees on poor (dry, wet, peat) soils were higher in natural regeneration after clearcut than in natural regeneration without clearcut. The density of Scots pine trees was significantly affected by the forest type but not by regeneration method (planting, natural regeneration, natural regeneration after the clearcut). The most abundant tree species in natural regeneration after clearcut in all forest types was silver birch (*Betula pendula* Roth.). The height of silver birch exceeded that of Scots pine in all analyzed soils in clearcut areas except Vaccinoso-sphagnosa forest type, emphasizing the importance of thinning to ensure a successful development of Scots pine stands.
Key words: natural regeneration, natural succession, salvage logging, browsing.

Introduction

Latvia is located in the northeastern part of Europe in hemiboreal forest zone (Ahti et al., 1968) and 52% of its area is covered by forests. Scots pine (*Pinus sylvestris* L.) is the most common conifer species in northern hemisphere (Nikolov and Helmisaari, 1992) and, according to State Forest Service statistics, dominates in 35% of the forest area in Latvia, mostly on sandy and loamy automorphic soils (*Cladinoso-callunosa, Vacciniosa, Myrtillosa, Hylocomiosa* forest types), on sandy semihydromorphic soils (*Callunoso-sphagnosa, Vaccinoso-sphagnosa* forest types) and on poor peat soils (*Shpagnosa, Caricoso-phragmitosa* forest types). According to data from the State Forest Service, regeneration of Scots pine is mostly done by planting, for example, in 2013 altogether 8507 ha were regenerated by this tree species, from it 79% by planting.

On average, in Latvia forest fire affects 1083 ha of forest stands per year, 90% of it – Scots pine dominated areas. Regeneration in post-fire areas is affected by environmental factors which have been altered by fire severity and intensity (Keeley, 2009) and in most cases differ from those in the clearcut. Post-fire areas are characterized by thinner soil humus layers, higher pH and more available nutrients in soil for plants (Simard et al., 2001). After a high intensity forest fire soils aggregates lose their stability, therefore enhancing soils degradation (Vacchiano et al., 2014). Consequently, natural regeneration after the fire also differs from that after the clearcut: broadleaved tree species still dominate early stages of it, but transition to dominance of coniferous trees takes place later (Ilisson and Chen, 2009), 60-180 years after the forest fire (Gauthier et al., 2010; Chen et al., 2014). In contrast, no significant differences were found in regeneration (diversity and productivity) 25-40 and 70-100 years after fire and harvesting in south-western boreal forests in USA (Reich et al., 2001).

Natural regeneration can be severely impacted by browsing damage, caused by cervids: tree species preferred by these animals (like Scots pine and trembling aspen (*Populus tremula* L.)) can be outcompeted by less-browsed ones (Meža kultūru.., 1984), in this way changing the composition of the stands.

Since the information on post-fire regeneration in hemiboreal forests usually covers short time span and only a single regeneration method, the aim of our study was to assess Scots pine regeneration in different forest types and with different regeneration methods.

Materials and Methods

The study was carried out in north-western part of Latvia, in area that 10 000 years ago was a part of the ancient Baltic Sea. Gradual receding of the sea to its current coastline has created unique complexes of dunes and depressions. Flat terrain hampers water draining thus enhancing formation of wetlands and marshes.

Forest fire occurred in the study area in 1992, affecting mostly (98%) Scots pine dominated forests. After forest fire in a part of the area salvage-logging was carried out, creating a large clearcut. In this

Table 1

Perspective Scots pines per ha in different regeneration methods and forest types

Forest type	Regeneration method		
	planting (P)	natural (N)	natural after clearcut (NC)
Cladinoso-callunosa (Sl)	8320*	3400	2280
Vacciniosa (Mr)	2720	5720	6280
Vaccinoso-sphagnosa (Mrs)	3520	10800	7640
Sphagnosa (Pv)	1800	3000	2520
Caricoso-phragmitosa (Nd)	4480	0	1720
Myrtilloso-sphagnosa (Dms)	-**	1360	4800

*direct seeding; **- – No sampling plots

area Scots pine was planted with the initial stand density of 5000 trees ha^{-1}, except on very poor sandy soil, were direct seeding was used, creating 10000 seed beds per ha. The other part of the burned area remained untouched, but in some parts small clearcuts were created and skidding used to move logs to the roadside. In both of these parts sites were left for natural regeneration.

Study sites were selected only in the compartments affected by stand-replacing fire (according to the inventory after the fire). In each of the three groups with different regeneration – planting (P), natural regeneration after forest fire with no intervention (N) and natural regeneration after clearcut (NC) – compartments for the study were selected randomly within each of the represented forest types.

To assess the regeneration seven years after the fire, in each compartment at least four 25 m^2 sized circular plots were placed systematically on the longest diagonal of the compartment. The total plot area per each compartment was at least 1.5% of its total area. In each plot the height of all growing trees (height > 10 cm) was measured with a metric rule (cm). During the inventory trees were divided in 'perspective' – the highest Scots pines with the distance ≥ 50 cm between them – and 'others'.

Damages caused by cervids were assessed using 4 grade scale:

1 – undamaged;
2 – leading shoot undamaged, lateral branches damaged ≤ 25%;
3 – leading shoot damaged partly, lateral branches damaged ≥ 25%;
4 – leading shoot damaged heavily (two and more times).

Climatic conditions in the study area are strongly influenced by the Baltic Sea: climate is more maritime in comparison to other regions of Latvia, characterized by lower amplitudes of temperature, colder summers and warmer winters. July is the warmest month of the year with the average temperature from +16.4 to +16.7 °C, the coldest month of the year is February with the average temperature from -3.9 to - 4.7 °C. The mean annual precipitation sum is 568 mm, which is one of the lowest in the territory of Latvia according to statistics of the Latvian Environment, Geology and Meteorology Centre.

Shapiro–Wilk test for normality was applied and ANOVA used to estimate the significance of observed differences.

Results and Discussion

The density of perspective Scots pines per ha was used to characterize regeneration in different forest types (Table 1). The highest density of such trees (10800 trees ha^{-1}) was observed in natural regeneration without any human activity in *Vaccinoso-sphagnosa* (Mrs) forest type, second highest – in *Cladinoso-callunosa* (Sl) forest type in post-fire area where the direct seeding was applied: 8320 trees ha^{-1}. In general, density of Scots pine was lower in the forest types on wet poor peat soil (*Sphagnosa* (Pv), *Caricoso-phragmitosa* (Nd)) and the highest (except one case with direct seeding) – on wet poor mineral soil (Mrs) in post-clearcut and post-burned areas which regenerated naturally without human intervention; the influence of forest type on this trait was statistically significant ($p<0.05$). The density of perspective trees in most cases was higher in naturally regenerated than in planted sites, however, the influence of regeneration method was not statistically significant ($p>0.05$).

The height of Scots pine was used to characterize the growth (vitality) of trees (Fig. 1). Both forest type and regeneration method had a significant ($p<0.05$) influence on the height of trees. In natural regeneration the highest pines were found on dry and wet mineral soil (Sl, Mr) and trees in all forest types were higher in natural regeneration after the clearcut than in post-fire area (except Dms). Planting seemed to result in a slightly slower growth than natural regeneration in forest types on dry mineral soil (Sl, Mr) but significantly better on wet mineral soils (Mrs) and on peat soils (Pv, Nd) in post-fire areas.

Criteria of successful forest regeneration, as defined in the legislation, are: at least 3000 trees ha^{-1} (of it at least 80% Scots pine), height ≥ 0.1 m shall be present in Sl, Mr, Mrs and the same density of Scots pines or, alternatively, at least 2000 broadleaved

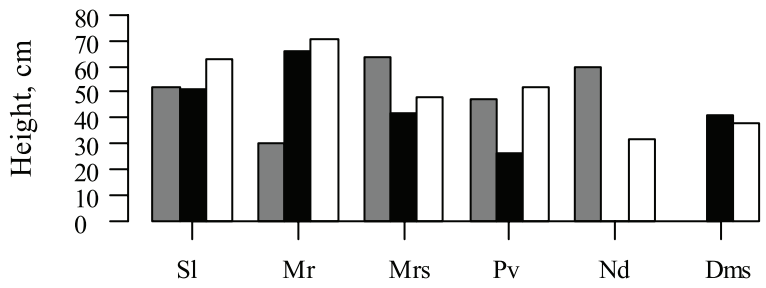

Figure 1. Height (cm) of perspective Scots pines in different forest types and regeneration methods planting, natural, natural after clearcut, Sl - Cladinoso-callunosa, Mr - Vacciniosa, Mrs - Vaccinoso-sphagnosa, Pv - Sphagnosa, Nd - Caricoso-phragmitosa, Dms - Myrtilloso-sphagnosa forest types.

trees ha^{-1} (height ≥ 0.2 m) in Nd, Dms and Pv (Meža atjaunošanas.., 2012). Based on these criteria Scots pine planting was successful (the density of perspective trees exceeds 2400 per ha) in all forest types except Pv; natural regeneration of this tree species – in all forest types except Nd and Dms and natural regeneration after the clearcut – in all except Sl, Nd, Ks. The density and height of broadleaved trees (mainly Silver birch (*Betula Pendula* Roth) fulfilled the requirements for successful natural regeneration in Pv, Nd, Dms, Ks. Supplemental planting of Scots pine is needed in post-clearcut area in natural regeneration in Sl forest type to ensure a successful forest regeneration.

According to our results, the density of Scots pine in planted stands was lower than in naturally regenerated ones (except in Nd), but direct seeding in Sl ensured higher density than natural regeneration. Relatively low density of natural regeneration in stands on peat soils (Nd, Pv) can be the result of combination of scarcity of suitable seedbeds and intense competition by other tree species (that was minimized in planted stands). The competition by other tree species have been noted as an important factor also in other studies, highlighting the importance of early management on the growth of Scots pine (Xenakis et al., 2012). Also, the density of Scots pines in *Cladinoso-callunosa* is relatively low and the result contradicts the common belief, that such conditions (poor sandy soil after forest fire) are most suitable for natural regeneration of this tree species. However, in *Vacciniosa* forest type natural regeneration of Scots pine is notably more successful.

The planted Scots pines were higher than naturally regenerated ones (except in Mr) in post-fire areas. It can be the result of tree breeding, ensuring improved growth rate and a higher disease resistance (Jansons, 2012), combined with a higher vigour of planted trees within the first years after planting due to better root system and nutrient reserves (Mangalis, 2004). The age structure of trees was not analysed in the study, but could also be part of the explanation of the observed tree height differences. Planting happened 1-2 years later than the first natural regeneration, however, the biological age of trees is assumed to be the same. Still, the natural regeneration probably continued for several years, therefore some of the seedlings in natural regeneration could be younger than the planted ones.

A study in Germany has demonstrated an improved regeneration and growth of Scots pine after medium-intensity forest fire in *Oxalio-Myrtillo-Cultopinetum sylvestris* forest type (Hille and den Ouden, 2004). In contrast, after high-intensity forest fire slower growth of trees has been observed (Dzwonko et al., 2015). It might be explained by the effect of fire on soil characteristics (porosity, structure) and significant reduction of nutrient availability, since notable amount of organic carbon (Certini, 2005) in soil and alive or dead biomass (Seedre et al., 2014) is consumed in the fire.

Abundance of other tree species was assessed in the study area to characterize the stand structure. Data were collected only in naturally regenerated stands where no thinning had been carried out (Fig. 2). Besides Scots pine in these stands 8 other tree and shrub species were growing: silver birch, trembling aspen (*Populus tremula* L.), common alder (*Alnus glutinosa* Gaerth.), goat willow (*Salix caprea*), other willow (*Salix*) species, Norway spruce (*Picea abies* L.), mountain ash (*Sorbus aucuparia* L.) and glossy buckthorn (*Frangula alnus* Mill.). Natural regeneration of tree species other than Scots pine were notably and significantly denser after the clearcut than in sites with no human intervention in post-fire area. The highest density of other tree species was found in forest types on wet (or drained) peat soil and wet fertile mineral soil (Nd, Pv, Ks, Dms). In this group of forest types the density of naturally regenerated Scots pine after the clearcut was lowest, presumably due to high competition. Only in Pv and Sl (poorest soils) density of other tree species was similar in areas with or without clearcutting. The lowest density of other tree species was observed in Sl, Mr, Mrs where the density of Scots pine was the highest (Table 1) in

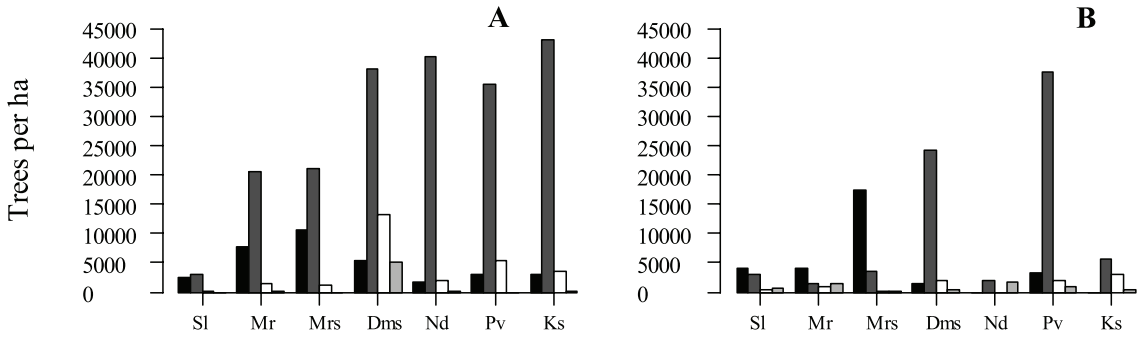

Figure 2. Total density trees ha^{-1}, depending on regeneration methods: **A**– natural regeneration after clearcut, **B**- natural regeneration. Scots pine, silver birch trembling aspen and willows other tree species Sl - *Cladinoso-callunosa*, Mr - *Vacciniosa*, Mrs - *Vaccinoso-sphagnosa*, Dms - *Myrtilloso-sphagnosa*, Nd - *Caricoso-phragmitosa*, Pv - *Sphagnosa*, Ks – *Myrtillosa turf.mel.* forest types.

natural regeneration without clearcutting in Sl, Mr and Mrs density of Scots pine exceeded that of other tree species.

Silver birch was the most abundant tree species in natural regeneration in post-clearcut areas: its share of the total number of trees was from 54.9% in Sl to 91.0% in Nd. Moreover, in all forest types with this regeneration method silver birch was more abundant than Scots pine (Fig. 2, A). Only in Sl forest type the mean density of Scots pine was similar to that of silver birch: 2280 and 3120 trees ha^{-1}, respectively. Moreover, Silver birch was higher than Scots pine in all forest types (except in Mrs); height differences were smaller in forest types on poor dry and wet mineral soil, where differences in abundance between pine and other tree species also were smallest: Sl, Mr, Mrs (Fig. 3). The mean height of birch in Ks, Nd, Pv, Dms exceeded that of Scots pine by 52, 43, 28, 24 cm, respectively, i.e. on average 0.5 times.

Similar to our results, the high density of broadleaves, especially silver birch, after clearcutting or natural disturbances has been found in numerous studies (Sarma, 1954; Ilisson and Chen, 2009; Gauthier et al., 2010; Chen et al., 2014; Dzwonko et al., 2015). Also, in areas not affected by forest fire natural regeneration after clearcutting had a higher density of other tree species in forest types on wet soils, but density of Scots pine was higher in forest types on poor (and) sandy soils (Saliņš, 2002). Regeneration of Scots pine on more fertile soils can be difficult due to rich vascular plant layer and more intense competition with other tree species, mainly silver birch (Elksnis, 1974). Other factors, like availability of seeds, can also affect the success of regeneration and stand composition. In Central Europe the main limiting factors for Scots pine regeneration in post-fire areas is the amount of produced seeds and the distance from the seed trees: if it exceeds 50-100 m, availability of seeds can be insufficient (Dzwonko et al., 2015). In our study the distance or direction to the nearest surviving tree (a possible seed source) was not measured, since there was no simple way to determine, which trees survived a few years after fire (to the first seed crop) and which died instantly in the fire (Donis

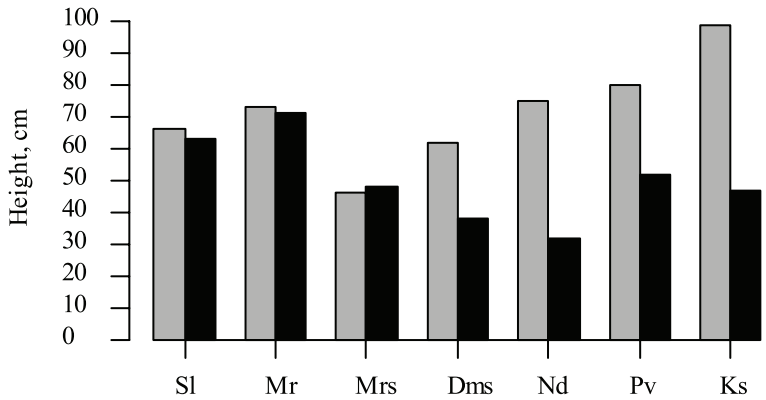

Figure 3. Mean density and height of naturally regenerated Scots pine and silver birch in clearcuts Scots pine, Silver birch, Sl - *Cladinoso-callunosa*, Mr - *Vacciniosa*, Mrs - *Vaccinoso-sphagnosa*, Dms - *Myrtilloso-sphagnosa*, Nd - *Caricoso-phragmitosa*, Pv - *Sphagnosa*, Ks-*Myrtillosa turf.mel* forest types.

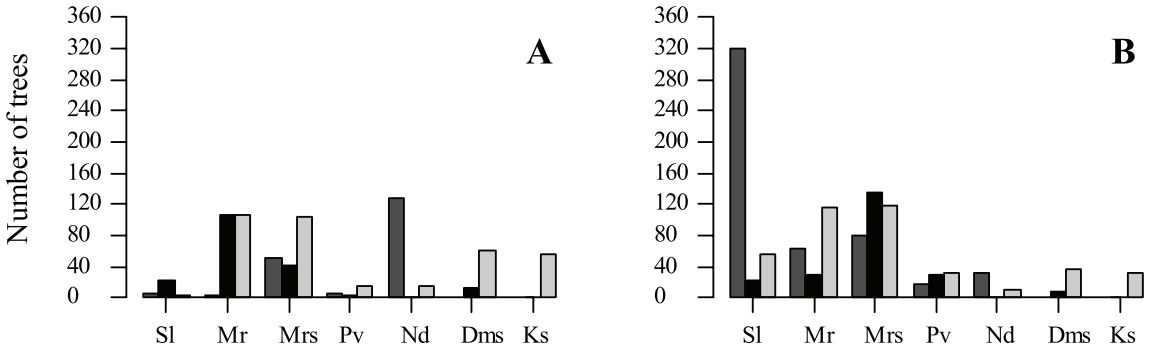

Figure 4. Number of Scots pines with (A) and without (B) browsing damage
Planting Natural regeneration Natural regeneration after clearcut, Sl - *Cladinoso-callunosa*, Mr - *Vacciniosa*, Mrs - *Vaccinoso-sphagnosa*, Pv - *Sphagnosa*, Nd - *Caricoso-phragmitosa*, Dms - *Myrtilloso-sphagnosa*, Ks- *Myrtillosa turf.mel* forest types.

et al., 2010). Also, the timing of the fire might have played a crucial role in the determination of species composition in young stands: it occurred just before birch seeds were ripening, preparing the perfect seed bed (mineralized soil surface, no plant competition) for far-flying seeds of this tree species.

Our results demonstrate that regeneration in post-clearcut areas not only abundance, but also height of silver birch on more fertile wet or drained soils notably exceeds that of Scots pine. A number of studies have suggested that the shift from broadleaved tree dominated forests to Scots pine dominated ones in boreal zone occurs 60-180 years after forest fire (Gauthier et al., 2010; Chen et al., 2014). In nemoral zone broadleaved trees dominated the regeneration for at least 15 years after severe forest fire on mesic soils (Dzwonko et al., 2015). These results suggest that long-term studies are necessary to increase the knowledge on the role of forest fires in survival of Scots pine in hemiboreal forests. It might be that other factors besides forest fire have played an important role in keeping the Scots pine dominated forests in high proportion e.g. human activity or browsing pressure by cervids.

To assess the factors affecting browsing damage in post-fire regeneration, a mixture of Scots pine, trembling aspen and willows – the species most preferred by cervids – were analyzed in naturally regenerated stands with or without clearcutting. Trembling aspen was present in natural regeneration in all forest types, including those on poor sandy soil (Sl, Mr), except one (Nd in sites without clearcuting). The highest density of trembling aspen in natural regeneration (both with and without clearcutting) was in Dms; this was also the only forest type where density of it was higher than that of Scots pine (Fig. 2). In former clearcuts willows were present in all, except the poorest soils (Sl), in contrast to natural regeneration without human intervention, where willows were found only in two forest types (Pv and Ks). Besides, the density of young trembling aspen and willows were higher in stands after clearcutting than in areas without human intervention, suggesting, that additional soil scarification due to skidding has played an important role in the success of their regeneration.

The number of damaged Scots pines exceed undamaged trees mostly in forest types on wet (Dms, Nd) or drained (Ks) soils (Fig. 4). The proportion of trees with browsing damage was similar in planted and naturally regenerated stands (30% and 31%, respectively), but notably higher in natural regeneration after the clearcuts (46%).

Differences in amount of browsing damage on Scots pines (both between regeneration methods and forest types) might at least partly be explained by preference of cervids to feed in the areas with higher availability of diverse feed stock. In Switzerland the quantity feed stock was found to be an insufficient indicator to determine roe deer feeding spots; also structural components of forests played an important role (Moser et al., 2008). It is in line with results from another study in Central Europe, where intensity of browsing damages in large post-fire area was dependent on availability of security cover (hiding places) for the animals, but not regeneration method (Borkowski and Ukalski, 2012). In our study, notably more hiding places for animals could be found close to areas with natural regeneration rather than in planted stands, located in large clearcut with trees notably lower than the height of the cervids. Other studies (Jaunzeme, 1980) in Latvia also have found more damage in small (0.4 – 1.0 ha) than in large (>3.1 ha) young stands, suggesting that it is the combined effect from availability of feed stock and hiding places. The design of our study did not permit the analysis of browsing damage depending on the distance from the edge of clearcut in planted stands, however, in areas of the same regeneration method (and availability of

hiding places) stands (and sample plots) with a higher admixture of broadleaved trees had more damages also on Scots pine.

Conclusions

1. Seven years after forest fire the density of Scots pine trees was significantly affected by the forest type but not by regeneration method (planting, natural regeneration, natural regeneration after clearcut).
2. The height of Scots pine was significantly affected both by the forest type and regeneration method. Notable advantages of planting based on tree height were found in wet mineral soils and peat soils (*Vaccinoso-sphagnosa, Caricoso-phragmitosa* forest type). Trees in all forest types were higher in natural regeneration after clearcut than in natural regeneration in post-fire area (except *Myrtilloso-sphagnosa* and forest type).
3. The most abundant tree species in natural regeneration (after clearcut) in all forest types was silver birch. Also, its height in clearcut areas exceeded that of Scots pine in all forest types, except in *Vaccinoso-sphagnosa* forest type.
4. The density of Scots pine exceed that of other species in *Vaccinoso-sphagnosa* forest type in post-burned areas without human intervention; Scots pine dominates in tree species composition in *Cladinoso-callunosa* and *Vaccinosa* forest types.
5. A higher amount of browsing damage on Scots pines were observed in the forest types with the highest admixture of broadleaved trees and shrubs (trembling aspen, willows).

Acknowledgments

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References

1. Ahti T., Hamet-Ahti L., Jalas J. (1968) Vegetation zones and their sections in North-Western Europe. *Annales Botanici Fennici*, 3(5), pp. 169-211.
2. Meža atjaunošanas meža ieaudzēšanas un plantāciju meža noteikumi (Regulations of forest restoration, afforestation and plantations) (2012) MK Noteikumi Nr. 308. Available at: http://likumi.lv/doc.php?id=247349, 1 February 2015. (in Latvian).
3. Beghin R., Lingua E., Garbarino M., Lonati M., Bovio G., Motta N., Marzano R. (2010) Pinus sylvestris forest regeneration under different post-fire restoration practices in the northwestern Italian Alps. *Ecological Engineering*, 36, pp. 1365-1372.
4. Borkowski J., Ukalski K. (2012) Bark stripping by red deer in a post-disturbance area: The importance of security cover. *Forest Ecology and Mangment*, 263, pp. 17-23.
5. Certini G. (2005) Effects of fire on properties of forest soils: a review. *Oecologia*, 143, pp. 1-10.
6. Chen W., Moriya K., Sakai T., Koyama L., Cao C. (2014) Post-fire forest regeneration under different restoration treatments in the Greater Hinggan Mountain area of China. *Ecological Engineering*, 70, pp. 304-311.
7. Donis J., Bičevskis M., Zdors L., Šņepsts G. (2010) *Meža ugunsgrēka ietekmes uz koka dzīvotspēju novērtēšanas metodikas izstrāde. Gala atskaite (Development of assessment methods of forest fire influence on tree vitality. Final report)*. Latvijas Valsts mežzinātnes institūts 'Silava', Salaspils, 98. lpp. (in Latvian).
8. Dzwonko Z., Loster S., Gawronski S. (2015) Impact of fire severity on soil properties and the development of tree and shrub species in a Scots pine moist forest site in southern Poland. *Forest Ecology and Management*, 342, pp. 56-63.
9. Elksnis J. (1974) *Dabiskās atjaunošanās novērtējums dažos galvenajos meža augšanas apstākļu tipos Cēsu mežrūpsaimniecībā (Assessment of natural regeneration in main forest types in Cesu forestry district)*. Jelgava, 137. lpp. (in Latvian).
10. Gauthier S., Boucher D., Morissette J., De Grandpre L. (2010) Fifty-seven years of composition change in the eastern boreal forest of Canada. *Journal of Vegetation Science*, 21, pp. 772-785.
11. Hille M., den Ouden J. (2004) Improved recruitment and early growth of Scots pine (*Pinus sylvestris* L.) seedlings after fire and soil scarification. *European Journal of Forest Research*, 123, pp. 213-218.
12. Ilisson T., Chen H.Y.H. (2009) Response of Six Boreal Tree Species to Stand Replacing Fire and Clearcutting. *Ecosystems*, 12, pp. 820-829.
13. Jansons Ā. (2012) Tree breeding as a tool to minimze possible adverse effects of climate change on forest trees. In: M. Klavins, A. Briede (eds.) Climate change in Latvia and adaptation to it. LU, Riga, pp. 158-169.

14. Jaunzeme R. (1980) *Aļņu, staltbriežu un stirnu postījumu ietekme skuju koku kultūrās Liepājas MRS Cīravas mežizstrādes iecirknī – mežniecībā (Moose, Red Deer and Roe deer damage influence on conifers in Liepaja's region, Ciravas forestry district)*. LLA, Jelgava, 82. lpp. (in Latvian).
15. Keeley J.E. (2009) Fire intensity, fire severity and burn severity: a brief review and suggested usage. *International Journal of Wildland Fire*, 18, pp. 116-126.
16. Mangalis I. (2004) *Meža atjaunošana un ieaudzēšana (Forest regeneration and afforestation)*. Et Cetera, Rīga, 455. lpp. (in Latvian).
17. *Meža kultūru aizsardzība pret briežveidīgo bojājumiem: apskats (Forest protection against damage of cervids: Review)* (1984) LZTIPI, Rīga, 42. lpp. (in Latvian).
18. Moser B., Schutz M., Hindenlang K.E. (2008) Resource selection by roe deer: Are windthrow gaps attractive feeding places? *Forest Ecology and Management*, 255, pp. 1179-1185.
19. Nikolov N., Helmisaari H. (1992) Silvics of the circumpolar boreal forest tree species. In: Shugart H., Leemans R., Bowan G. (eds) *A Systems Analysis of the Global Boreal Forest*, Cambridge, UK, pp. 13-84.
20. Reich P.B., Bakken P., Carlson D., Frelich L.E., Friedman S.K., Grigal D.F. (2001) Influence of logging, fire, and forest type on biodiversity and productivity in southern boreal forest. *Ecology*, 82, pp. 2731-2748.
21. Saliņš Z. (2002) *Mežs – Latvijas nacionālā bagātība (Forest-National treasure of Latvia)*. LLU, Jelgava, 250. lpp. (in Latvian).
22. Sarma P. (1954) *Latvijas PSR meža tipi (Forest types in Latvia)*. Latvijas valsts izdevniecība, Rīga, 44. lpp. (in Latvian).
23. Seedre M., Taylor A.R., Brassard B.W., Chen H.Y.H., Jõgiste K. (2014) Recovery of ecosystem carbon stocks in young boreal forests: a comparison of harvesting and wildfire disturbance. *Ecosystems*, 17(3), pp. 851-863.
24. Simard D.G., Fyles J.W., Paré D., Nguyen T. (2001) Impacts of clearcut harvesting and wildfire on soil nutrient status in the Quebec boreal forest. *The Canadian Journal of Soil Science*, 81, pp. 229-237.
25. Vacchiano G., Stanchi S., Marinari G., Ascoli D., Zanini E., Motta R. (2014) Fire severity, residuals and soil legacies affect regeneration of Scots pine in the Southern Alps. *Science of Total Environment*, 472, pp. 778-788.
26. Xenakis G., Duncan R., Mencuccini M. (2012) Effects of climate and site characteristics on Scots pine growth. *European Journal of Forest Research*, 131, pp. 427-439.

VEGETATION COVER 47 YEARS AFTER WIND STORM AND CLEARCUT IN WESTERN LATVIA

Liga Purina[1,2], Inga Straupe[3], Liga Liepa[3], Juris Katrevics[1], Aris Jansons[1]
[1]Forest Competence Centre, Latvia
[2]Latvian State Forest Research Institute 'Silava'
[3]Latvia University of Agriculture
aris.jansons@silava.lv

Abstract
Wind is an important natural disturbance factor in a forest ecosystem. It creates gaps in a forest canopy, providing microenvironmental conditions, suitable for forest regeneration and affects the species composition of ground vegetation. Most of the studies analysing consequences of wind-storm have addressed short-term changes or influence the stand structure, but the aim of our study is to analyse ground-vegetation long time after windstorm in hemiboral forests. Data on ground vegetation cover have been collected in areas affected by the storm of 1967, where due to salvage-logging 200-400 m wide clearcuts were created. Sample plots (1×1 m) were placed in different distance from the edge of former clearcuts and projective cover of ground vegetation assessed using Braun-Blanquet method in *Myrtillosa mel.* forest type on 5 sites in north-western part of Latvia. Results reveal that in all sites species belonging to boreal, boreal-temperate and temperate biome were present, but their proportions varied between sites. In total 82 species of vascular plants were found, most frequent among them *Maianthemum bifolium* (L.) F.W.Schmidt (species characteristic to Norway spruce forests), *Vaccinium myrtillus* L. and *Vaccinium vitis-idaea* L. (associated with Scots pine forests) as well as *Molinia caerulea* (L.) Moench and *Deschampsia caespitosa* (L.) P.Beauv. (both characteristic to wet soils). Results suggest, that even 47 years after the storm microenvironmental conditions in the sites are not stable. Ellenberg's indicator values reveal, that most of the sites are in semi-shade, cool and moist conditions, placed on acidic, nitrogen-poor (in few sites – also nitrogen rich) soils.
Key words: ground-vegetation, windthrow, natural disturbance, paludification, natural succession.

Introduction

Disturbances are characteristic to forest ecosystem. Natural disturbance can be caused by fire, water (flood), insects, pathogens, mammals, and wind (Kuuluvainen, 2002). Wind throw is an important natural disturbance factor in hemiboreal forests (Gromtsev, 2002). It is important, natural phenomena in the forest (Pickett and White, 1985; Kuuluvainen, 1994). Amplitude of wind disturbance ranges from minor, affecting (breaking or uprooting) only few trees in a particular stand to major, affecting notable forest areas at a landscape scale (Pickett and White, 1985; Kuuluvainen, 1994). Stands of coniferous trees are affected by wind, if its speed exceeds 20-25 m s^{-1}. Windthrows create a mosaic of forest structure, increasing a diversity of ground vegetation species and creating an uneven age forest stands (Gromtsev, 2002). As a result of wind damages on trees, gaps of different sizes are created in crown cover of the stand that, in turn, changes the light conditions on forest floor, moisture regime and other microclimatic conditions, affecting both natural regeneration and ground-vegetation. Effect of large scale (stand-replacing) windthrows can be comparable to that of clearcut, since in both cases forest stand, that ensured the specific conditions (minimized the temperature fluctuations and therefore risks of frost damages to ground vegetation and advanced regeneration, provided a shade, ensured a water uptake and transpiration) does not exist anymore. Especially significant is the impact on water balance, since transpiration of trees reduces excess moisture in wet (patches of) forest (Zālītis, 2012).

Increase of maximum wind-speed in storms and/or frequency of storms are predicted due to climatic changes (Beniston et al., 2007); consequently, more wind damages can be expected in forests. Most of the studies dealing with influence of windthrows focus on tree cover (stability, financial losses, regeneration) or short-term effects, however, it is important to understand a long-term consequences of this event to different components of forest ecosystem, including ground vegetation. Few studies have indicated an increase of species diversity in ground-vegetation few years after the storm as a result of changes in micro-relief (creation of pit-and-mound mosaic) (Ulanova, 2000). Some studies suggest that ground vegetation will stabilize 80-100 years after the storm and microrelief structures will completely disappear after 300-500 years (Skvortsova et al., 1983). Analysis of vegetation in gaps created wind in forest canopy in boreal forests in Russia reveals no significant changes in ground vegetation, if the size of the opening is smaller than the mean height of the neighbouring trees (Ulanova, 2000), but a storm affecting large forest might have a different impact. Therefore, the aim of our study was to characterise ground-vegetation long time after stand-replacing windstorm in hemiboral forests, the western part of Latvia.

Materials and Methods

Data collection was carried out in the summer of 2014 in the north-western part of Latvia in five areas (close to Pope and Pāce) affected by the storm of 1967, where due to salvage-logging 200-400 m wide clearcuts were created in drained mineral soils (forest type: *Myrtillosa mel.*). Currently the young stands are dominated by Norway spruce *Picea abies* (L.) H. Karst. and silver birch *Betula pendula* Roth (together 85-90% from total number of trees) with admixture of Scots pine *Pinus sylvestris* L. and trembling aspen *Populus tremula* L. Transects were drawn perpendicular to the edge of the former clearcut. Sample plots (size 1x1m) were placed systematically (every 30 m) on those transects: 3 m on each side of the transect in each of the points. Altogether 69 sample plots were measured (from 8 to 31 in each study area). Data collection of ground vegetation was carried out using Braun-Blanquet method (Braun-Blanquet, 1964). Projective cover of each ground vegetation species (%) was assessed as well as total projective cover of layer herbaceous plants and shrubs (E1) and layer mosses and lichens (E0) with the precision of 1%. In case some species are detected, but projective cover does not reach 1%, it is stated as 0.1%.

Information from databases BioPop, Ecological Flora Database, Bioflora on functional types of plants, types of seed dispersal, plant strategies (c – competitors, s – stress-tolerators, r – ruderals), Raunkier *life forms* and Ellenberg's indicator values (Ellenberg et al., 1992) were assessed and compared between study areas. Occurrence of plants was characterized by their constancy, calculated as a proportion of sample plots, where the plant is present from the total number of sample plots. Based on frequency of occurrence constancy a class was assigned to each species (I – occurence < 21%, II – 21-40%, III – 41-60%, IV – 61-80%, V – 81-100%) (Markovs, 1965, Muller – Dombois, Ellenberg, 1974). Significance of differences was calculated using ANOVA.

Results and Discussion

In total, 45 plant species were found in *site Pope-I*, the number of species per sample plot ranged from 7 to 22 and was 14 on average. Most frequently occurring species (constancy class IV) were *Maianthemum bifolium* (L.) F.W.Schmidt (characteristic to Norway spruce forests), *Melampyrum pratense* L. and *Potentilla erecta* (L.) Raeusch. (characteristic to wet forests). Frequently occurring species (constancy class III) were *Deschampsia caespitosa* (L.) P.Beauv., *Filipendula ulmaria* (L.) Maxim., *Lysimachia vulgaris* L. (characteristic to black alder swamp forests), indicating wet conditions on the site, as well as *Viola riviniana* Rchb. (characteristic to dry sites). The rest of the species were rare (14 species had constancy class I and 11 species constancy class II). Boreo-temperate species dominated on the site (60%), boreal species and temperate species were represented similarly (21.8% and 18.1%, respectively). Dispersal of seeds or spores was determined primarily by wind (29% the ground-vegetation species), to some extent by water, ants and birds (17.5, 16.3 and 8%, respectively), but notable proportion of species (22.7%) had self-dispersal strategy. Majority of species were hemicryptophytes (78.1%) with over-wintering buds close to surface of the ground (herbaceous plants), but chamaephytes (mostly dwarf shrubs with over-wintering buds in snow-cover), geophytes (with over-wintering buds under the ground) and helophytes (plants characteristic to wet soils) were represented similarly (7.1%, 7.3% and 6.6%, respectively). Therophytes (plants overwintering in a form of seeds or spores) were less than 1% form total number of species. Changing conditions in the site was indicated by plant strategies: most frequent were plants with mixed strategies (67.1%) followed by competitors (23.8%), characterized by ability to colonize the areas and well developed root system (Grime, 1979). Ellenberg's indicator values showed that semi-shade, cool and moist conditions dominated in the site, soil was moderately acidic, poor to moderately rich in nitrogen.

In total, 39 plant species were found in *site Pope-II*, the number of species per sample plot ranged from 4 to 14 and was 8 on average. Most frequently occurring species (constancy class IV) was *Deschampsia caespitosa*, but frequently occurring species characteristic to Scots pine forests was *Vaccinium myrtillus* L. (constancy class III). Other species occurred infrequently (28 species had constancy class I). Most represented in the site were temperate species (45.3%), slightly less represented: boreo-temperate species (34%) and boreal species (20.5%). Dispersal of seeds or spores was predominantly done by ants (32.4% species), to lesser extent by birds, wind, water (20.5%, 19.8% and 11.8%, respectively) and also plants with self-dispersal were present (12.7%). Most of the species were hemicryptophytes (32.9%) or therophytes (28%), but chamaephytes and helophytes were less common (16.7% and 14.2%, respectively). Least represented plant group was geophytes (7.6%). Also changing environmental conditions were found on this site: most plants had mixed strategies (80.3%) followed by competitors (10.4%) and stress-tolerators (8.7%). Ellenberg's indicator values showed that semi-shade, cool and moist conditions dominated onn the site, soil was moderately acidic, poor in nitrogen.

Notably lower number of species was found in *site Pope-III*: in total only 16; the number of species per sample plot ranged from 2 to 6 and was 4 on average. Most frequently occurring species (constancy class V)

was *Molinia caerulea* (L.) Moench, characteristic to coniferous and mixed forests with high soil humidity and grass swamps; also *Vaccinium myrtillus* and *Vaccinium vitis-idaea* L. characteristic to Scots pine forests as well as *Deschampsia caespitosa* were frequent (constancy class IV). *Melampyrum pratense* had constancy class III, but other 12 species - constancy class I. Temperate plant species dominated the site (46.8%), followed by boreal species (44.2%); boreo-temperate species were notably less common (8.9%). Most of the pants, similar to other sites, had seeds or spores dispersed by ants (46.6%), other dispersal factors were birds (32.1%), wind (11.9%) and water (8.3%); plants with self-dispersal were less common (<1%). Different from other sites, most of species were chamaephytes (39.9%) and therophytes (33.6%), but hemicryptophytes and helophytes were much less common (19.4 and 6.3% respectively). Plants with mixed strategies dominated in this site (85.3%). Ellenberg's indicator values showed that semi-shade, cold and moist conditions dominated on the site, soil was acidic, poor in nitrogen.

In total, 37 species were found on *site Pope-IV*, the number of species per sample plot ranged from 3 to 14 and was 10 on average. Most frequently occurring species (constancy class IV) was *Maianthemum bifolium* (characteristic to Norway spruce forests). *Vaccinium vitis-idaea* L., characteristic to Scots pine forests, was frequently present (constancy class III), but the rest of the species were not (22 ground-vegetation species had constancy class I). Temperate plant species dominated the site (48.4%), followed by boreal species (33.2%); boreo-temperate species were notably less common (18.4%). Most of the plants, similar to other sites, had seeds or spores dispersed by ants (34.6%), other dispersal factors were water (20.3%) and wind (17.4%). Self-dispersal was relatively common (16.5%); smaller proportion of species were dispersed by birds (11%). Most of the plant species were hemicryptophytes (54.8%), fewer – therophytes (20.1%) and helophytes (14.6%), but very few – chamaephytes and geophytes (6.5% and 3.7%, respectively). Most of the plants belonged to the group with mixed strategies (82%) or competitors (17.1%). Ellenberg's indicator values showed that semi-shade - semi-light, cool and moist conditions dominated in the site, soil was moderately acidic to acidic, poor in nitrogen.

The highest number of species was found on *site Priedaine* – in total 43, but the number of species per sample plot ranged from 1 to 11 – not higher than on other sites. Most frequently occurring species (constancy class III) were *Maianthemum bifolium* (characteristic to Norway spruce forests) and *Vaccinium vitis-idaea* L. (characteristic to Scots pine forests). The rest of the species were present relatively un-frequently (33 ground-vegetation species had constancy class I). On this site almost half of all species (45.8%) were boreal, 38.0% were temperate and only 16.2% boreo-temperate. Seeds or spores were dispersed to a similar extent by wind, ants and birds (25.2%, 24.1% and 23.2%, respectively). Also, water and self-dispersal played an important role (15.4% and 11.7%, respectively). Most of species were chamaephytes (35.7%) and hemicryptophytes (28.0%), followed by therophytes (21.1%) and helophytes (14.0%). Plants with mixed strategies were more than half on this site (64.8%), followed by

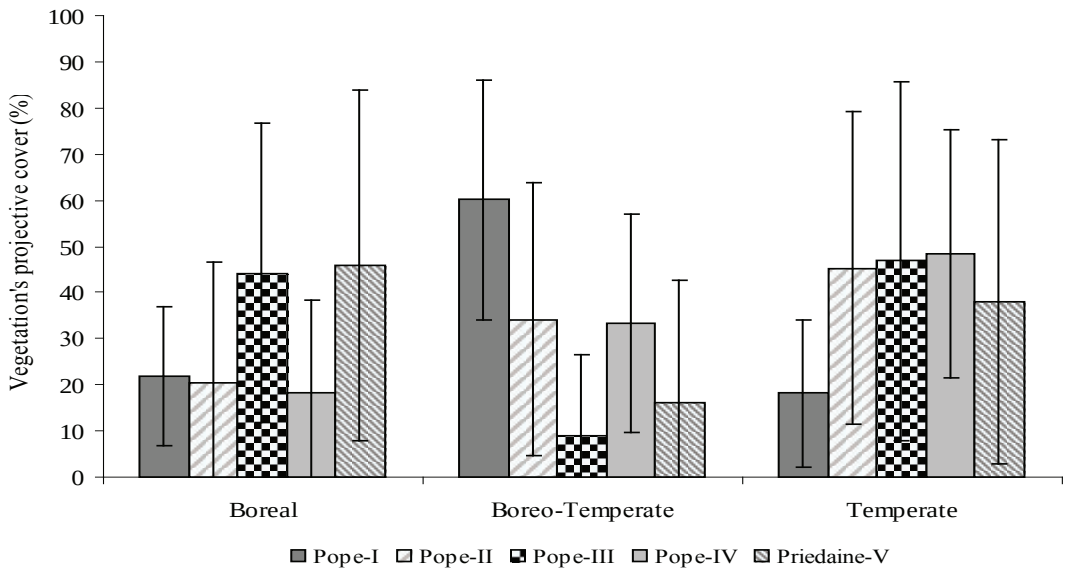

Figure1. The proportion (%) of plant species for biomes in objects (±SD).

competitors and stress-tolerators (18.5% and 15.3%, respectively). Ellenberg's indicator values showed that semi-shade, cold and moist conditions dominated on the site, soil was acidic, poor in nitrogen.

The proportion of temperate biome species on the sites were similar (from 38 to 48%), only on *site Pope-I* it was significantly smaller (18%). From 20 to 46% from herbaceous plant layer species belonged to boreal biome, on *site Priedaine* this proportion was significantly ($p<0.05$) higher than on *sites Pope-I*, *Pope-II* un *Pope-IV* (Fig. 1); also proportion of these groups of species on *site Pope-III* was relatively high, but differences with other sites were not statistically significant. Proportion of species belonging to boreo-temperate group differed notably between sites and on *site Pope-I* it was significantly ($p<0.05$) higher than on others.

Dispersal strategies of plants were rather different between sites. From 16 to 47% of plants had seeds or spores dispersed by ants, significant differences in proportion of this group of plants ($p<0.05$) was found between sites *Pope-I* and *Pope-III*. On *site Pope-III* proportion of plants with self-dispersal strategy was significantly ($p<0.05$) smaller than on the rest of the sites. Plants with other seed dispersal strategies (by birds, water, wind etc.) were represented differently in different sites; however, observed differences were not statistically significant.

The proportion of chamaephytes ranged from 7 to 40% on different sites; it was significantly higher on sites *Pope-III* and *Priedaine* thanon the rest of the sites. Geophytes and helophytes were the least represented groups and there were no significant differences between sites in the proportion of these groups of plants. The presence of helophytes indicates the existence of different microrelief forms on all sites and occurrence of wet patches. The proportion of hemicryptophytes ranged from 19 to 78% from all plants in ground vegetation,o site *Pope-I* they were significantly ($p<0.05$) more than on sites *Pope-II*, *Pope-III* and *Priedaine*. Therophytes were represented similarly in all sites (20-36%) except in *Pope-I*, where proportion of this group of plants were significantly ($p<0.05$) smaller. It indicated presence of open ground, where this group of plants can be regenerated by seeds.

Plants with mixed strategy were the most represented group on all sites and significant ($p<0.05$) differences in their presence were found only between sites *Pope-I* and *Priedaine* (Fig. 2). On *Pope-I* higher proportion of mixed-csr strategy plants were detected, but in *Priedaine* – higher proportion of mixed-cs strategy plants. Presence of these groups of plants indicates unstable microevironmental conditions. Proportion of plants with competitor strategy ranged from 6 to 24%, on site *Pope-I* it was significantly higher than on sites *Pope-II* and *Pope-III*. Stress-tolerators had minor representation on all sites (differences between sites were not significant). Ruderals were the least represented group, indicating, that early succession phase (characterised by high representation of weeds) has been replaced by the next phase, dominated by perennial herbaceous plants.

Diversity of microenvironmental conditions on the sites was defined also by high number of plant species, that presumably will be replaced with fewer, more stress-tolerant plants in later phases of succession. Light conditions, described by Ellenberg's indicator values, demonstrated, that *site Priedaine* was significantly ($p<0.05$) more shady than sites *Pope-I* and *Pope-II*. Significant differences in this trait between the rest of the sites were not found

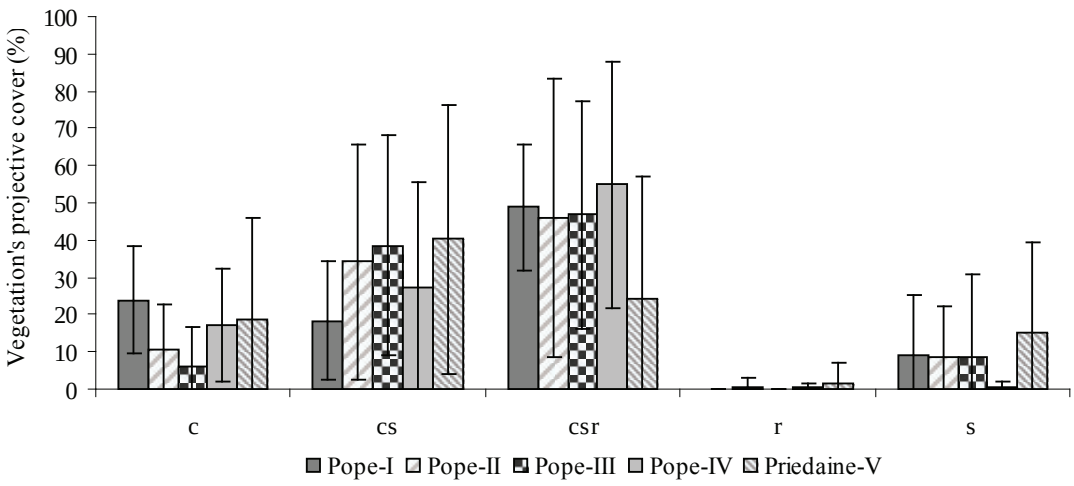

Figure 2. The proportion (%) of plant species for plant strategies in objects (±SD): c – competitors, s – stress-tolerators, r – ruderals, cs and csr – mixed strategies.

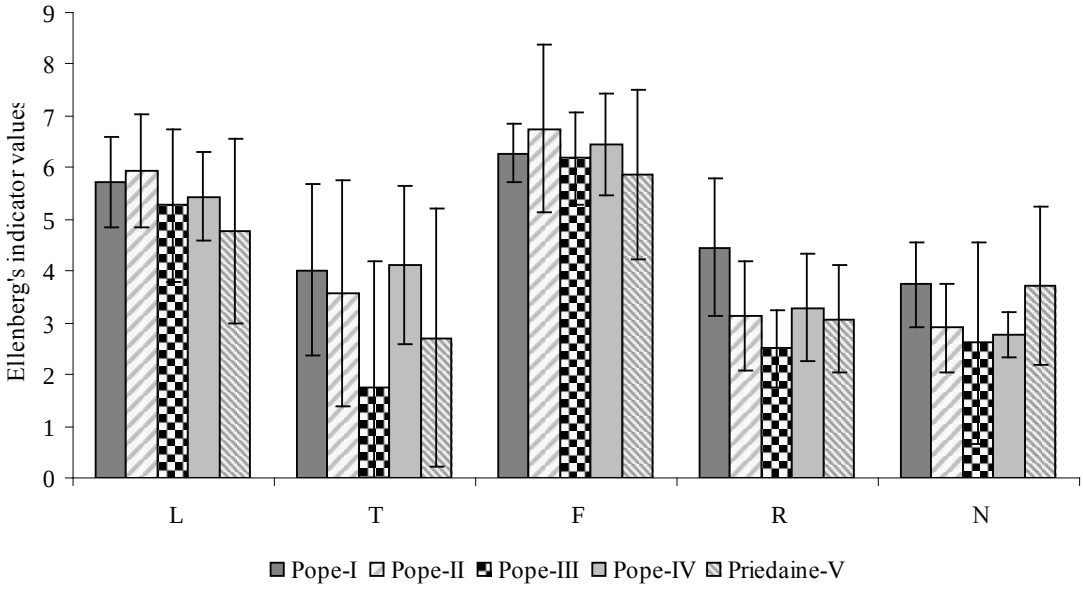

Figure 3. Ellenberg's indicator values of plant species in objects (±SD):
L – light, T –temperature, F – moisture, R – soil reaction, N – the amount of nitrogen in soil.

(Fig. 3). On sites *Pope-I* and *Pope-IV* microenvironment was significantly warmer than on sites Pope-III and Priedaine as indicated by Ellenberg's values, but no significant differences in soil moisture between sites were found. Soils on sites *Pope-I* and *Priedaine* have more nitrogen and on *Pope-I* is significantly less acidic than on the rest of the sites.

Conclusions

1. In all study areas temperate biome species are represented to a similar extent, less common are boreal biome species, but occurrence of species of boreal-temperate biome differ between sites.
2. Most frequent among them *Maianthemum bifolium* (L.) F.W.Schmidt (species characteristic to Norway spruce forests), *Vaccinium myrtillus* L. and *Vaccinium vitis-idaea* L. (associated with Scots pine forests) as well as *Molinia caerulea* (L.) Moench and *Deschampsia caespitosa* (L.) P.Beauv. (both characteristic to wet soils).
3. Most frequent dispersal agents of plants in the study area are wind, ants and birds, but also plants with self-dispersal strategy are common.
4. Plants with mixed strategy are the most common group in the areas 47 years after the windthrow, indicating unstable (changing) environmental conditions.
5. Ellenberg's indicator values reveal that most of the sites are in semi-shade, cool and moist conditions, placed on acidic, nitrogen-poor (in few sites – also nitrogen rich) soils.

Acknowledgements

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References

1. Beniston M., Stephenson D.B., Christensen O.B., Ferro C.A.T., Frei C., Goyette S., Halsnaes K., Holt T., Jylhä T., Koffi B., Palutikof J., Schöll R., Semmler T., Woth K. (2007) Future extreme events in European climate: an exploration of regional climate model projections. *Climatic change*, 81, pp. 71-95.
2. Braun-Blanquet J. (1964) *Pflanzensoziologie. Grundzüge der Vegetationskunde (Plant Sociology. Broad Vegetation Science)*. Berlin, Springer-Verlag, Wien, New York, 865 S. (in German).
3. Ellenberg H., Weber H.E., Düll R., Wirth V., Werner W., Paulißen D. (1992) *Zeigerwerte von Pflanzen in Mitteleuropa (Indicator Values Of Plants In Central Europe).* Verlag Erich Goltze KG, Göttingen, 258 S. (in German).
4. Grime Ph. (1979) *Plant Strategies And Vegetation Processes*. John Willey & Sons, Chichester, UK, 222 p.
5. Gromtsev A. (2002) Natural disturbance dynamics in the boreal forests of European Russia: a review. *Silva Fennica*, 36 (1), pp. 41-55.

6. Kuuluvainen T. (1994) Gap disturbance, ground microtopography, and the regeneration dynamics of coniferous forests in Finland: a review. *Annales zoologici fennici*, 31 (1), pp. 35-51.
7. Kuuluvainen T. (2002) Disturbance dynamics in boreal forests: defining the ecological basis of restoration and management of biodiversity. *Silva Fennica*, 36 (1), pp. 5-10.
8. Markovs M. (1965) *Vispārējā ģeobotānika (The General Geobotany)*. Liesma, Rīga, 435. lpp. (in Latvian).
9. Mueller-Dombois D., Ellenberg H. (1974) *Aims And Methods Of Vegetation Ecology.* John Willey & Sons, New York, USA, 547 p.
10. Pickett S.T.A., White P.S. (eds) (1985) *The Ecology Of Natural Disturbance And Patch Dynamics.* Academic press, Orlando etc., 204 p.
11. Skvortsova E.B., Ulanova N.G., Basevich B.F. (1983) Наука (Ecological Role Of Windthrow). Moscow, 122 c. (in Russian).
12. Ulanova N.G. (2000) The effects of windthrow on forests at different spatial scales: a review. *Forest ecology and management*, 135, pp. 155-167.
13. Zālītis P. (2012) *Mežs un ūdens (Forest And Water)*. Latgales Druka, Rēzekne, Latvija, 356. lpp. (in Latvian).

IMPACT OF BIOMASS EXTRACTION METHOD ON DAMAGE TO REMAINING TREES IN MECHANIZED THINNING OF DECIDUOUS STANDS

Uldis Prindulis[1,2], Andis Lazdiņš[3], Santa Kalēja[3]
[1]Latvia University of Agriculture
[2]Latvian State Forest Research Institute 'Silava'
[3]Forest Sector Competence Center Ltd.
uldis.prindulis@silava.lv; andis.lazdins@silava.lv

Abstract
Thinning of young forest stands is a contribution to the future of the stand development. Our study focuses on damage of the remaining trees and soil. Now it is common to see thinning of young stands with heavy forest machines, but most of these operations take place in commercial thinning. This study is focused on precommercial thinning to evaluate different mechanized thinning methods in relation to the damage done to the remaining trees and soil in deciduous tree stands. Data were collected in four stands where the average diameter of trees at breast height was 6.2 cm, the height of average trees - 9.5 m, but number of trees per hectare was more than 2900. The stands regenerate naturally. Damage was evaluated separately after harvester and forwarder operations. The study proves that forwarding makes much less damage to the remaining trees than harvesting. According to the study data, the traditional method results in the largest number of damaged trees, because operators need to cut all trees closer than 1.5 m from the target tree. Both schematic thinning methods result in significantly less damage. A statistically significant difference ($p<0.001$) was found in a proportion of damaged remaining trees between all of the applied working methods. The smallest amount of damage is associated with complex symmetrical thinning method. The most damage appears during harvesting. The aim of this study was to compare three working methods of biofuel production in pre-commercial thinning using harvester John Deere 1070D with accumulating felling head Bracke C16.b in grey alder (*Alnus incana*) pure stand.
Key words: tree damage, pre-commercial thinning, biomass production, grey alder.

Introduction

Grey alder (*Alnus incana* (L.) Moench) is one of pioneer-tree species in Latvia and it belongs to fast growing trees species. Recently it has obtained a higher popularity in the private forest sector. In Latvia grey alder is economically important tree species. Grey alder is used, for example, as firewood and in furniture industry (Rytter et al., 2000). Grey alder is particularly interesting for private forest owners, because it does not have a determined cutting age like spruce, pine or birch, and it regenerates naturally as coppice crop.

The total area covered by grey alder has increased a lot from year to year because it is a pioneer species, and it starts to grow on agricultural lands, if not managed for some years. According to literature, in 1925 grey alder stands in Latvia took up 3962 ha (0.3% of total forest area), but after 35 years, in 1960, the total area of grey alder stands had increased for more than 15 times and reached 80895 ha (4.5% of the total forest area. Latvijas meži, 1987). The area of grey alder stands continued to grow and in 2003 it reached 188992 ha (6.4% of the total forest area), but according to the latest data, in 2010 it reached 210677 ha (7.3% of the forest area. Gadskārta, 2014).

Growing potential for this species is really significant and it mostly depends on soil chemical composition and water regime. The best soil types for grey alder are fertile loam and clay soils or sandy loam soils where grey alder is able to achieve considerable dimensions (Rokjānis, 1957). In naturally regenerated unmanaged alder stands are typically winding, branched and low quality stems, but it does not reflect the productivity and real growth potential of this species (Liepiņš and Liepiņš, 2010). Growing of good quality, valuable grey alder stand requires implementation of the full cycle of forest management. Besides, if a tree has open growing space around it during the whole growing cycle, the quality improvements will be visible after 25…30 years. In the studies of some Latvian researchers it is mentioned that, if we are growing grey alder on agricultural land like a plantation for sawlog production and a stand is managed applying the best available practices, in 30 years we can get approximately 300 m^3 ha^{-1} (up to 400 m^3 ha^{-1}), and output of valuable sawlogs is about 70% (Daugaviete and Daugavietis, 2008).

Pre-commercial thinning with forest machines became so popular because of productivity, if compared with motor-manual operations and ability to get the first income earlier by production of biofuel from small trees. Popularity of biofuel production in pre-commercial thinning is on the increase due to the European Union (EU) targets in renewable energy production and the climate policy. According to recently proposed policies, the EU has to reduce greenhouse gas (GHG) emissions in 2030 by 40% in comparison to 1990. Biomass from forest plays the most significant role in reaching this target, therefore, it is necessary to be prepared for an increased demand and willingness to produce biofuel from early forest management operations, which traditionally do not

Table 1

The main indicators of stand inventory

No of stand	Diameter ($H_{1,3}$), cm	Height, m	Basal area, m^2 ha^{-1}	Volume, m^3 ha^{-1}	Biomass, kg ha^{-1}	Trees, per ha^{-1}	Volume of average tree, m^3
1	7.2	10.9	28.4	166.9	57 763.4	6 400	0.026
2	5.7	8.3	18.1	83.7	28 919.4	6 800	0.012
3	5.7	7.3	20.8	85.3	33 898.5	7 600	0.011
4	6.4	11.6	24.8	155.4	44 148.0	7 333	0.021

$H_{1,3}$ – Diameter at breast height

produce any wood product. In the period between 2020 and 2030, Latvia has to reduce GHG emissions by 8% (Green book…, 2013). To achieve this goal the main task is to reduce the use of fossil fuels replacing them with renewable biofuel like wood chips from pre-commercial thinning.

This study is about the working methods in pre-commercial thinning of deciduous, naturally regenerated stands, to understand how to get the greatest possible benefit (biofuel) from thinning, while increasing the growth potential of the remaining stand. The information available in literature on this topic is very limited due to the relatively small distribution of grey alder stands in Nordic countries, where pre-commercial thinning for biofuel production has already become a significant source of biomass. Similar studies have elaborated on coniferous tree stands, also in Latvia, but the situation with deciduous stands is much different due to the structure of stands, regeneration history, and visibility in stand.

Materials and Methods

Description of research object

The research objects are located in Birzgales parish, Ķegums municipality (56°32.98639' N, 024°41.23923' E) in 2 blocks and 4 forest compartments with the total area of 8 ha. Grey alder dominated forest stands with high initial density (at least 6000 trees per ha) were selected for the study (Table 1). All of the stands are naturally regenerated after clear cut and the age of the stands is less than 10 years. In all of the selected stands, the forest site type is *Oxalidosa*.

Data collecting

Circular sample plots (further in text – SP) with radius of 2.82 m (area 25 m^2) were established in all stands before thinning for characterization of stand properties. Number of SP were chosen according to the requirements in regulations of Cabinet of Ministers (Noteikumi par…, 2013) terms of tree felling in the forest. At least a 100 trees were measured in each stand. All trees in SP were measured if the diameter of a tree at breast height exceeded 4 cm. Undergrowth trees and shrubs were also counted and measured in all SP; the average height and total number of stems of undergrowth trees and bushes were noted in each SP. The tree diameter and height were measured in each stand and SP separately. Characteristics of stand after thinning and counting of damaged trees after harvesting and forwarding were done in rectangular SP covering strip-road and thinned stand area, similarly to D. Bergstrom et al. (2010).

SP were established in every strip-road and no closer than 10 m from both ends of strip-roads. The distance between SP may vary, because of different length of the strip-road. If the strip-road is shorter than 160 m, the distance between SP is 20 m, but if the strip-road is longer than 160 m, the distance between SP is 40 m. SP is 20 m long rectangle with 20 m long sides; the area of SP is 400 m^2. Plots are located on parallel with strip roads so that their mid-axis are on one line with strip road mid-axis, but SP side lines are osculating but not overlapping.

All trees with the diameter at breast height above 4 cm were measured in SP. The tree diameter, distance between the tree and strip road centre were measured and tree species were identified. Measurements of height of representative number of trees (10-20 trees of each species) were done before thinning and the same height curve was applied to the measurement data before and after thinning. Damage of remaining trees, divided in 4 groups, was assessed in all sample plots. Data of tree damage were analysed as the proportion of damaged trees was expressed as a difference between damaged trees and all of remaining trees. Mostly data were analysed grouped by working methods.

Trees were marked as damaged if they matched one of the criteria in Table 2. These criteria are used also in joint stock company 'Latvian State Forests'. Soil damage on strip-roads (length of ruts) was also evaluated after forwarding. The threshold value for ruts is more than 10 cm from topsoil. Ruts were measured on both sides of strip-road.

Damage of trees was classified in four groups:

1. Damage above 0.5 m;
2. Damage below 0.5 m;
3. Damage of roots;
4. Damage caused by chain.

Table 2

Indicators of mechanically damaged trees in thinning*

Location of damage	Type of damage	Description of damage
Crown	Broken top	Broken off top
	Broken branches	More than 60% from crown
Stem	Stem part without bark	The area without bark is more than 25% from stem girth at the damage location.
Roots	Broken root	Root that is thicker than 2 cm broken up to 70 cm from stem.

Norādījumi koku bojājumu novēršanai. 2012.

Description of working methods

Three mechanized thinning methods were compared in the study using John Deere 1070 harvester equipped with felling head Bracke C16.b:

1. Traditional method: the operator evaluates each tree individually, leaves only the best trees with straight stems and qualitative crown and cuts down all potentially competing trees around it. At the first step of thinning, the operator makes a strip-road and cuts 1-1.5 m wide (width of Bracke C16.b harvester head) 'pockets' on both sides of the strip-road, usually in 90° direction from the strip-road, where to put down all extracted trees. The distance between 'pockets' depends on the density of stand. Then the operator does thinning on both sides of the strip-road. The average distance between pockets in the study was 5 m.
2. Simple symmetric method: trees are not evaluated individually and target trees are not identified during thinning. Like in the first method, the operation starts with cutting the strip-road, then perpendicularly to harvester the operator cuts 1-1.5 m wide and 10 m long 'pockets' where to put the extracted tree. This cycle is repeated every 2-3 m to the entire length of the strip-road; no thinning is done if trees are less than 4 cm in diameter at breast height; angle of 'pockets' can be adopted to improve the thinning quality
3. Complex symmetric method: the difference from the second method is the cutting of 1-2 additional stripes near each 'pocket' so that these stripes are branching from the 'pocket' at 30-45° angle. Material is stored in the main 'pockets' as well as in additional stripes, depending on the amount of material. Harvester repeats this operation every 5-6 m.

Visualization sample of the 2nd and 3rd method is given in Figure 1.

Normality of variables was checked by the Kolmogorov-Smirnov test. The data did not follow a normal distribution, or occurred inhomogeneity of group variance the nonparametric Mann-Whitney Test

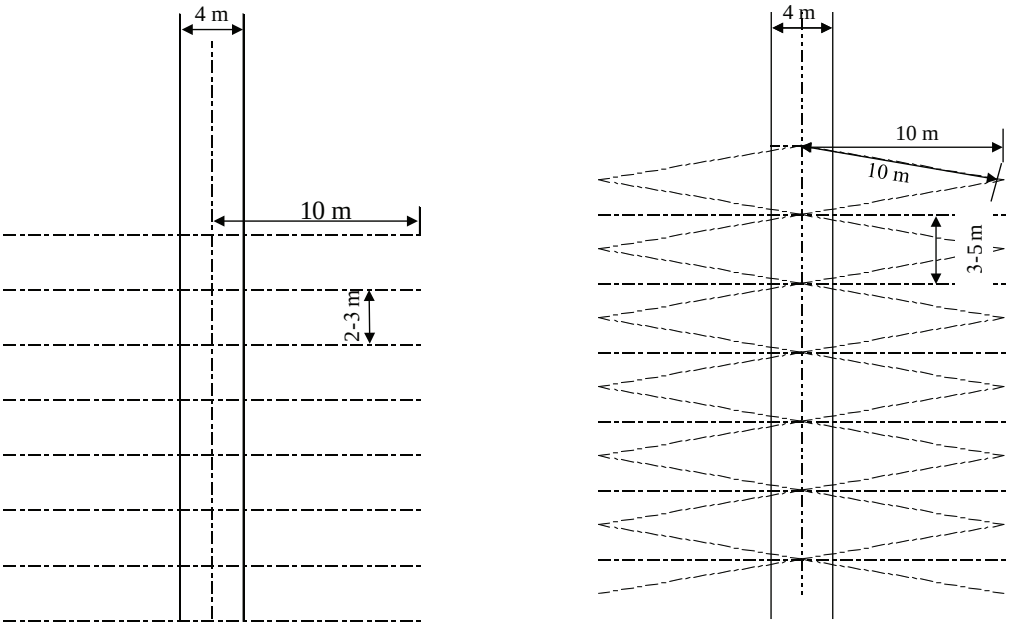

Figure 1. Technological scheme for Simple symmetric (left) and Complex symmetric (right) working methods.

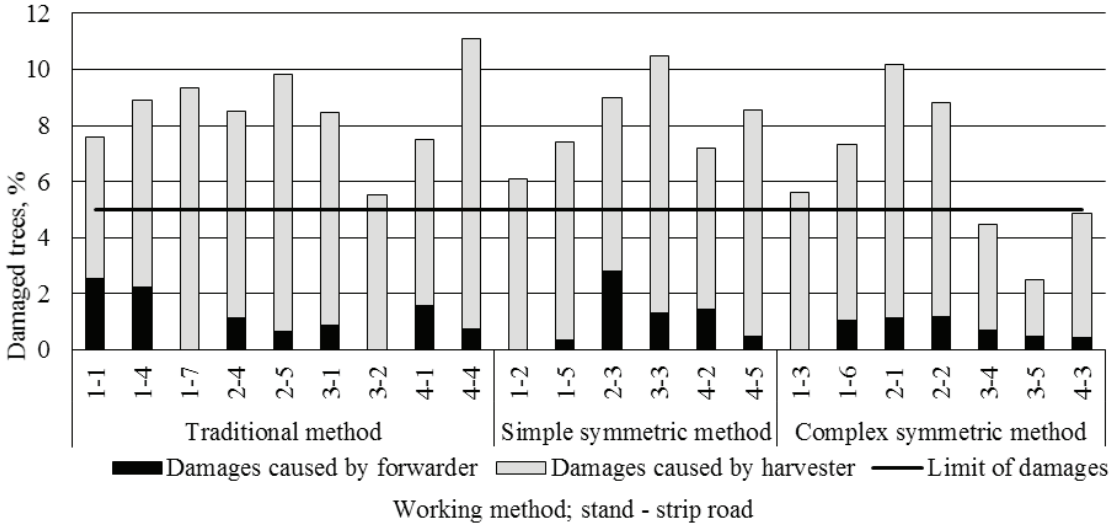

Figure 2. Proportion of damaged trees depending on working method and on each strip road, %.

analysis of variance was used. In all cases the level of significance α = 0.05 was accepted. Difference between working methods was calculated using Dwass-Steel-Critchlow-Fligner procedure and for data analyses the software SPSS Statistics 17.0 was used.

Results and Discussion

The proportion of damaged trees, depending on the working method and in each strip road, is shown in Figure 2. Uninterrupted line represents the maximum permissible proportion of damaged trees (5%) according to the quality requirements of the JSC 'Latvian State Forests' in the forest thinning operations (Norādījumi koku…, 2012). According to the study results, only 3 strip roads from 22 fulfilled the quality requirements for permissible level of damaged trees. The strip-roads with the smallest proportion of damaged trees were thinned with the complex symmetrical method, while the largest proportion of damaged trees were mostly found when the thinning method called traditional working method was used. Most of damage was caused by the harvester; amount of damage caused by forwarder is relatively small on all strip-roads. Damage caused by forwarder does not depend on the applied working method.

The total average proportion of damaged trees by the traditional method was 8.7%, by the simple symmetric working method – 7.9% and by complex symmetric method – 5.9%.

The proportion of damaged trees was calculated separately for used machinery for each of the working methods: for harvester at the first method – 7.7, at second method – 6.9 and at third method 5.2%, but for forwarder 0.9, 1.0 and 0.7% respectively. Scientists in other countries are also mentioning 5% threshold as maximum allowable percentage of damaged trees regardless of trees species (Bäcke, 1997). It was found in the study that all of the applied working methods result in a higher proportion of damaged trees; however, symmetrical thinning methods are more favourable from the perspective of proportion of damaged trees.

The level of difference in the proportion of damaged trees between working methods is significant in all of variants. Results show statistically significant differences between all of the working methods ($p<0.001$).

The proportion and frequency of different types of damage are also analysed depending on the applied working method. It is found that most damage is on stems and they are caused by harvester head or other processed trees. When the 1st working method is used, more than half of damage is detected in the group 'damage below 0.5 m' (56.3%). If symmetrical thinning methods are applied, about half of damage belongs to the group 'damage above 0.5 m' respectively 53 and 52% (Figure 3). The smallest amount of damage is detected for the groups 'damage caused by chain' and 'damage of roots' (not more than 4% in all working methods). Other authors in their studies have mentioned that summarizing the volume of both groups of damage results in stem damage between 90 and 98%. In this study it is also proved that the stem damage is within the range mentioned by other scientists (Sirén, 1982; Fröding, 1992; Jaghagen and Lageson, 1996).

The number of trees in stands after thinning against limiting values determined in regulations and the location of trees in a stand is shown in Figure 4 and Figure 5. Actually it shows the quality of thinning - if the distance between the strip-road centre and tree is growing, then also the number of trees of remaining stand is growing (Figure 4).

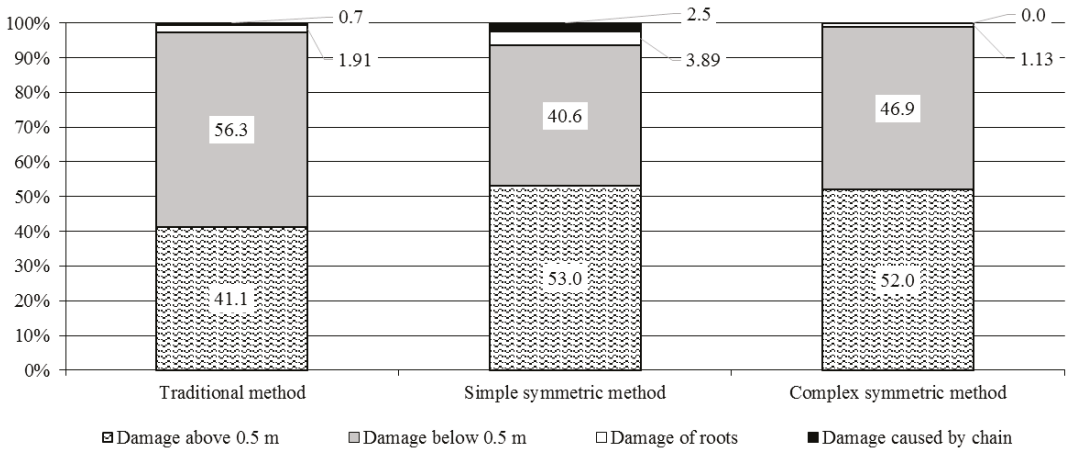

Figure 3. Proportion of different types of damage according to working methods.

According to the charts, the experimental stands are not thinned evenly in any of the used working methods and there are denser areas between strip roads which are not thinned correctly. Intensity of thinning could be increased, because the number of remaining trees is twice higher than the legal thresholds, and it was possible to extract much more biomass from the experimental stands making thinning more feasible (Figure 5).

Soil damage (length of ruts deeper than 10 cm) was measured in each strip road. Forwarding of biomass was done in unfavourable weather conditions (in early

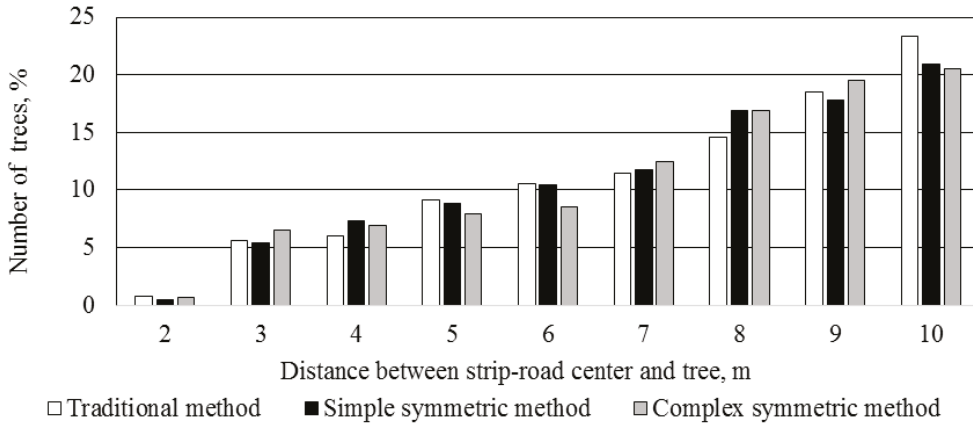

Figure 4. Proportion of trees in distribution by groups of average distance between trees and strip road centre depending on the used working method.

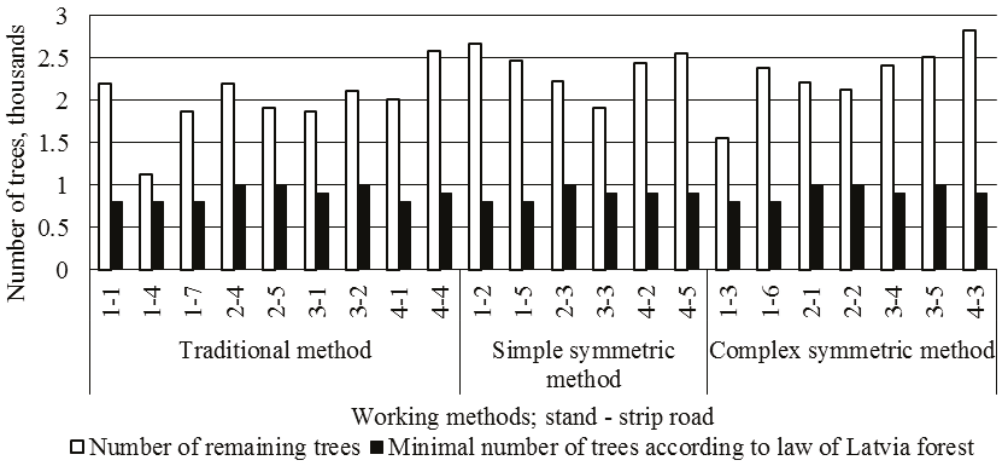

Figure 5. Minimal number of trees (in thousands) according to requirements of regulations (Noteikumi par…, 2013) in comparison with number of remaining trees after thinning.

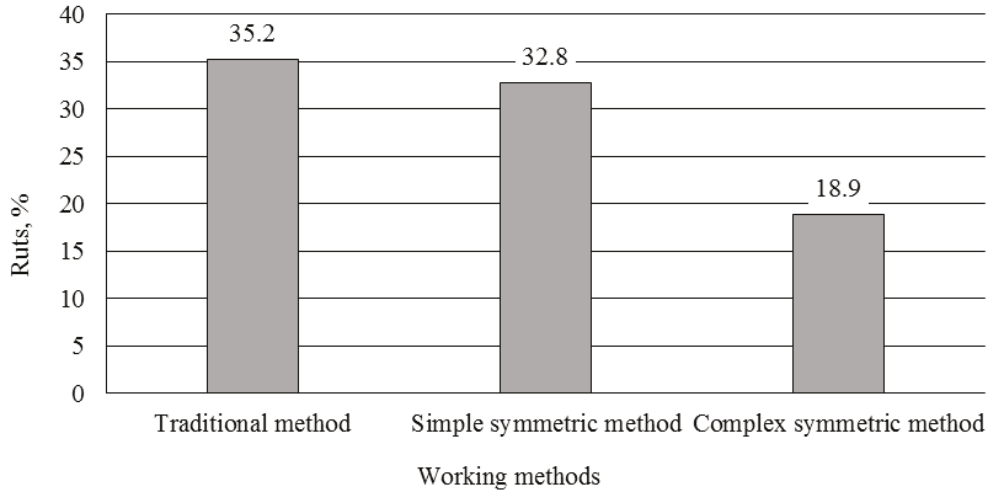

Figure 6. Proportion of ruts from total length of strip-roads depending on the working method.

spring during thaw), when soil became soft; therefore, a lot of soil damage was found. Notably, the formation of ruts mainly relates to forwarding; harvesting did not result in significant soil damage. The proportion of length of ruts was also analysed according to the working methods, assuming that different initial impacts of harvester and location of biomass, besides the strip-roads, might affect the formation of ruts during forwarding.

The smallest proportion of ruts was found on strip-roads where complex symmetric working method was applied (18.9% of the total length of strip roads). The proportion of ruts was more than 30% when the traditional and simple symmetric working method was applied, respectively 35.2% and 32.8% of the total length of strip-roads (Figure 6). The average length of ruts in percentage of the total length of strip-roads grouped by stands and initial number of trees is shown in Figure 7.

The most intensive soil damage was found in the stand with 6800 trees per ha, where ruts covered more than 50% of the total length of strip-roads, while the smallest proportion of ruts was found in the stand with 7600 trees per ha, where ruts covered only 8% of the total length of strip-roads. Differences in soil damage between objects show that soil structure and bearing capacity differ between stands and stand type; also the number of trees per ha is not always a sufficient parameter to predict soil bearing capacity. L. Eliasson (2005) in his research mentioned that rut depth increased significantly ($p<0.001$) with the number of machine passages, but in my research this impact was not observed. Also he mentioned that longer corridors are always subject to heavier damage, but in Figure 8 it is shown that there are not any logical relations. It is possible that this is due to the weather conditions during the forwarding operations. In real life conditions, forwarding had to be stopped and

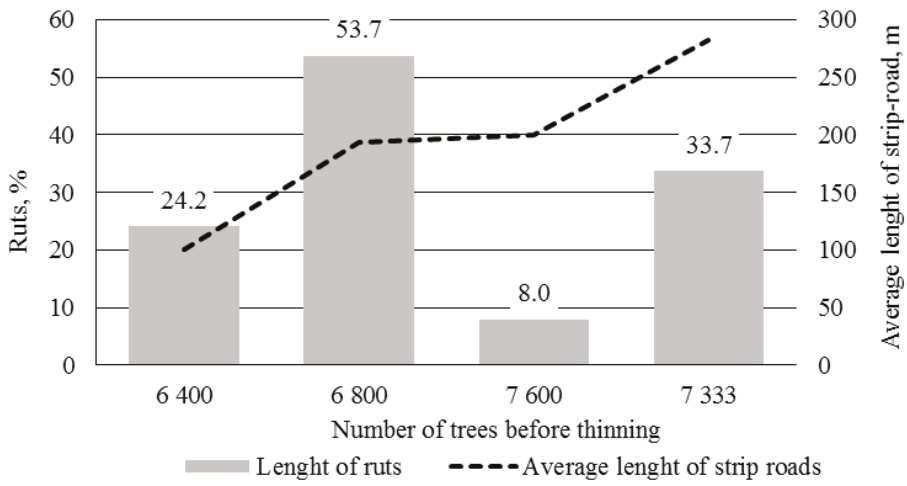

Figure 7. Average length of ruts in percentage of total length of strip-roads grouped by stands and initial number of trees.

continued during more favourable weather conditions. A great benefit of the Bracke C16.b felling head, which is also sometimes called the biggest drawback of this type of felling heads, is the ability to produce only biofuel assortment, that is, it lacks delimbing and cut-to-length function. The benefit is in fact that biofuel can be stored in forest for several months, in contrast to roundwood assortments, and its quality is increasing during storage – small branches become brittle and separate from the main stem, moisture content is reducing and potassium, as well as other easily soluble elements, are partially washed out from biomass. However, utilization of this benefit requires more flexible organization or forest operations.

Conclusions

1. Statistically significant difference ($p<0.001$) was found in the proportion of damaged remaining trees between all of the applied working methods. The smallest amount of damage is associated with the complex symmetrical thinning (3rd method). The most damage appears during harvesting.
2. Regardless of the applied working method, the proportion of damaged trees is above the maximal threshold value of 5%. Respectively, working methods, technical conditions of harvester or operator's skills need to be considerably improved to fulfil the quality requirements.
3. Intensive formation of ruts on strip-roads was determined by unfavourable weather conditions; however, it was found that forwarding of material extracted on strip-roads, where the 3rd method was applied, results in a smaller proportion of ruts.
4. The result of the study proves that it is necessary to improve the working methods, skills of operators and also technical condition of machines, because none of the methods resulted in sufficient thinning quality.

References

1. Bäcke J. (1997) Gallringsundersökningen Produktion (Thinning survey production). Miljö, Skogsstyrelsen, Meddelande 8 – 1998, 15 p. (in Swedish).
2. Bergström D., Bergsten U., Nordfjell T. (2010) Comparison of boom-corridor thinning and thinning from below harvesting methods in young dense Scots pine stands. *Silva Fennica* 44(4), pp. 669-679.
3. Daugaviete M., Daugavietis M. (2008) The resources and availability of Grey alder (*Alnus incana* (L.) Moench.) wood in Latvia. Proceedings of the 4th meeting of the „Nordic Baltic Network in Wood Material Science and Engineering (WSE)". November, 2008, Riga, Latvia, pp. 5-10.
4. Eliasson L. (2005) Effects of forwarder tyre pressure on rut formation and soil compaction. *Silva Fennica* 39(4) pp. 549-557.
5. Fröding A. (1992) Thinning damage - a study of 403 stands in Sweden in 1988. *Swedish University of Agricultural Sciences*, Garpenberg, Dept. of Operational Efficiency, Rep. No. 193. 45 p. (in Swedish with English summary).
6. Green book (2013) Preparing for a fully converged audiovisual world: growth. European commission, creation and values. *27.3.2013 COM. 169 final. Brisel*. 17 p. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0231:FIN:EN:PDF, 29 January 2015.
7. Jaghagen K., Lageson H. (1996) Timber quality after thinning from above and below in stands of Pinus sylvestris. *Scandinavian Journal of Forest Research* 11(4) pp. 336-342.
8. Latvijas meži (Forests of Latvia) (1987) Avots, Rīga, 84.-91. lpp. (in Latvian).
9. Liepiņš K., Liepiņš J. (2010) Field performance of grey alder (*Alnus incana* L. (Moench)) and common alder (*Alnus glutinosa* L.) container seedlings in experimental plantation on former farmland. *Mežzinātne. Forest Science* 21(54) pp. 4-15.
10. Norādījumi koku bojājumu novēršanai (2012) Akciju Sabiedrība Latvijas Valsts meži (Directions to prevent damage to trees). 5 lpp. (in Latvian).
11. Noteikumi par koku ciršanu mežā (2013) Noteikumi Nr. 935 (Terms of tree felling in the forest). Ministru kabinets. *Latvijas Vēstnesis*, 203 (4806), 28.12.2012. OP Nr: 2012/203.42 (in Latvian).
12. Rokjānis B. (1957) Baltalkšņa mākslīgas ieaudzēšanas iespējas un augšanas gaita dažos meža augšanas apstākļu tipos (Gray alder artificial afforestation opportunities and growth pace in some forest site types). *Disertācija*. LPSR, Rīga, 361 lpp. (in Latvian).
13. Rytter L., Sennerby-Forsse L., Alriksson A. (2000) Natural regeneration of grey alder (*Alnus incana* (L.) Moench.) stands after harvest. *Frontiers of Forest Biology*, pp. 287-294.
14. Sirén M. (1982) Stand damage in thinning operation with a grap loader processor. *Folia Forestalia polonica* 528, pp. 1-16.
15. Valsts meža dienesta 2013. gada publiskais pārskats (State Forest Service 2013 Public Report) (2014) Gadskārta. Apstiprināts ar Valsts meža dienesta 2014. gada 12. jūnija rīkojumu Nr.101. 40 lpp. (in Latvian).

LEACHING AND DURABILITY OF COPPER TREATED SCOTS PINE (*PINUS SYLVESTRIS* L.) WOOD

Anete Meija-Feldmane
Latvian State Institute of Wood Chemistry
Latvia University of Agriculture
a.meija.feldmane@gmail.com

Abstract
Scots pine (*Pinus sylvestris* L.) is the most common wood species in Latvia. It is classified as not durable, therefore additional protection against microorganisms is needed prior its use outdoors. Presently Cu-containing wood preservatives are commonly used, but the biggest drawback is the poor Cu fixation, therefore raising concerns about the impact on the environment. Three types of specimens were used to carry out the experiments – untreated, Latvian originated Scots pine; Scots pine commercially treated with preservatives that belong to a group of Cu-boron-triazole (CBA) products; and Scots pine, impregnated with micronized-Cu solution using a standard full cell process. In order to make sure that all of the specimens are equal in their components, elemental analysis was performed and content of nitrogen (1.2 – 2.5 g kg^{-1}), carbon (485.5 g kg^{-1}), oxygen (456.0 g kg^{-1}) and hydrogen (55.6 g kg^{-1}) was determined. The treated specimens were leached according to the European standard EN 84. For micronized-Cu impregnated Scots pine the total Cu content in leachates obtained by atomic absorption spectroscopy was 0.15 mg g^{-1} of wood, and 0.06 mg g^{-1} of absolute dry matter with CBA preservative impregnated Scots pine wood. Subsequently, according to the European standard EN 113, treated Scots pine blocks were exposed to brown-rot fungus C*oniophora puteana* and to white-rot fungus *Trametes versicolor* for 16 weeks. Mass loss for wood treated with micro-Cu was 48.4% (484 g kg^{-1}) and 1.5% (15 g kg^{-1}) respectively, but for CBA – 49.5 % (495 g kg^{-1}) and 1.2% (12 g kg^{-1}). Both samples proved to be inappropriate for outdoor use (use class 3).
Key words: copper, leaching, Scots pine, fungal decay.

Introduction

Wood is a very valuable material, being rather inexpensive and easy to process, it has good mechanical properties and aesthetic appeal. But as every material does, it has some drawbacks. The strongest drawback being, microorganisms degrade wood during its usage, especially, when this material is used outdoors. Among the microorganisms, brown-rot fungi cause the most considerable damage during the wood service life (Irbe et al., 2006). Scots pine (*Pinus sylvestris* L.) is the most common wood species in Latvia and according to European Standard EN 350-2 (1994) its sapwood is considered to belong to durability class 5 - naturally not durable. To prevent wood from biodegradation, wood protecting substances are used, water-born solutions being the most popular among them. Chromated copper arsenate (CCA) was the most frequently used solution historically, however, since 2003 (Commission Directive 2003/2/EC, 2003) two main components of this substance – Cr^{6+} and As^{5+} are prohibited because of the toxicity to human health and the environment (Shibata et al., 2007). Only Cu^{2+} which was also a CCA component is allowed today, and thus many Cu based wood preservatives have been developed. Cu has many advantages – it is relatively easy to create waterborne formulations, analyze and determine its penetration in wood; additionally Cu slows wood degradation by UV radiation and water. Preservatives contain Cu as the main fungicide, along with additional organic fungicides, protecting wood from such fungi species as *Serpula*, *Antrodia* and *Postia* that benefit from presence of Cu (Grantiņa-Ieviņa, 2013). Usually quats, azoles or borates are used as additional fungicides. These preservatives contain amines or ammonia as Cu soluble and complexing substances (Temiz et al., 2006; Hasan et al., 2010). Nordic Wood Preservation Council (Salminen et al., 2014) has approved many preservatives, among them Cu-boron-triazole (CBA) products that can be used for treatment of wide range of softwood species.

One of the processes in material usage outdoors is leaching, in this process components of wood preservatives seep in the environment and therefore can pose a threat to it (Vetter et al., 2008). Leaching is a standardized procedure for accelerated ageing (EN 84, 1997) and is commonly used for impregnated wood testing. Insufficient fixation is the main drawback of Cu usage (Wang et al., 2013). Previously used chrome substances currently are replaced with amines, predominately, ethanolamine (Pankras et al., 2012) or micronized-Cu solutions (Matsunaga et al., 2008; Stirling et al., 2008; Xue et al., 2012) with poor fixation properties. Although Cu is an essential micronutrient for most living cells, in larger doses it acts as an algaecide, bactericide, fungicide, insecticide and moldicide (Freeman and McIntyre, 2008). Therefore raising concerns about environmental impact of treated wood in areas of agricultural use (Love et al., 2014).

The aim of this study was to compare Scots pine treated with Cu containing preservatives in terms of fixation and decay resistance.

Materials and Methods

The experiments were carried out in the Laboratory of Wood Biodegradation and Protection of the Latvian State Institute of Wood Chemistry from August 2014 till March 2015.

Specimens

All of the samples were tested keeping in mind that material should agree with the European Standard EN 350-2 (1994) Class 3 – to be used in a situation in which the wood or a wood–based product is not under cover, and not in contact with the ground. Three types of specimens were used to carry out the experiments – untreated Latvian originated Scots pine from sawmill; Scots pine wood treated with preservative that belongs to a group of Cu-boron-triazole products, containing 295 g kg^{-1} $CuCO_3$, 45 g kg^{-1} H_3BO_3, 2.3 g kg^{-1} tebukonazol and 2.3 g kg^{-1} propicionazol. For the third type Scots pine planks were conditioned and afterwards impregnated with micronized Cu containing solution (ethanolamine < 60 g kg^{-1}, CuO complex < 25 g kg^{-1}, alkildimethylbenzilamonnia chloride < 10 g kg^{-1} and didecildimethyl ammonium chloride < 10 g kg^{-1} using a standard full cell (Bethell) process (30 min vacuum 0.2 bar, 60 minutes pressure 10 bar, 15 min vacuum 0.5 bar). Afterwards samples, free of any physical defects, were sawn in 50 × 25 × 15 mm blocks for leaching and decay tests, part of the samples was chopped to sawdust with Retsch SM100 mill, mesh size 2 mm for elemental analysis.

Elemental analysis

Elemental analysis of the specimens was conducted according to standard LVS EN 15104 (2011) using Vario MACRO CHNS, Germany, carbon/nitrogen/hydrogen and sulfur analyzer with helium as carrier gas. Three replicates of 20-30 mg are packed in aluminium foil, weighted, WO_2 powder is added at ratio 1:3 and combusted in the presence of oxygen in a flowing helium stream. The original matrix of the sample is destroyed under these conditions and through subsequent catalytic reactions, the analyte components are formed into CO_2, N_2, H_2O and SO_2. The oxygen content is calculated as shown in Equation 1:

$$1000g - (C + H + N + S) = O \qquad (1)$$

where
C – total carbon concentration, g kg^{-1}
H – total hydrogen concentration, g kg^{-1}
N – total nitrogen concentration, g kg^{-1}
S – total sulfur concentration, g kg^{-1}
O – total oxygen concentration, g kg^{-1}

Leaching

Material preparation and leaching procedure was developed according to European Standard EN 84 (1997). The leaching procedure consisted of an initial impregnation with distilled water under 4 kPa vacuum for 20 min. The water was subsequently replaced 2 h after the impregnation, continuing at 24 h and 48 h, and another seven times in the next 12 days at intervals of not less than 1 day and not more than 3 days. The leachates were collected, their volume measured and stored in 5 °C until the Cu content analysis. The Cu content was determined by an atomic absorption spectroscopy. The atomic absorption was carried out using Atomic absoption spectophotometer SHIMADZU AA-6300.

Fungal strains

Two fungal strains were used in this study: the brown-rot fungus *Coniophora puteana* (Schum.: Fr.) Karst (BAM Ebw. 15) and the white-rot fungus *Trametes versicolor* (L.) Lloyd (CTB 863A). Isolates were maintained in Petri dishes on a medium containing 50g kg^{-1} malt extract concentrate and 20 g kg^{-1} agar (Fluka, Sigma-Aldrich). Mycelium plugs were transferred aseptically to Kolle flasks, containing the same medium as in Petri dishes, for the wood decay test.

Decay test

Moisture content was determined for treated and untreated sapwood blocks (50 × 25 × 15 mm) of Scots pine (*Pinus sylvestri*s L.). Afterwards specimens were exposed to *Coniophora puteana* and to *Trametes versicolor* for 16 weeks at 22 °C and 70% relative humidity. Before exposure to fungi treated Scots pine wood blocks were leached according to the European standard EN 84 (1997). The decay test procedures were done according to the European standard EN 113 (1996). Eight replicates for each of the fungus were taken. Subsequent to cultivation, blocks were removed from the culture vessels, brushed free of mycelium and oven dried at 103 ± 2 °C. The percentage of weight loss was calculated from the dry weight before and after the test.

The results were processed by mathematical and statistical methods calculating mean values and standard deviations of samples with Microsoft EXCEL 2010 software. The statistical difference between results was calculated using Student t-test. Values in the range of $p<0.05$ were considered statistically significant.

Results and Discussion

In order to ascertain homogeneity among untreated, commercial and impregnated Scots pine wood, the

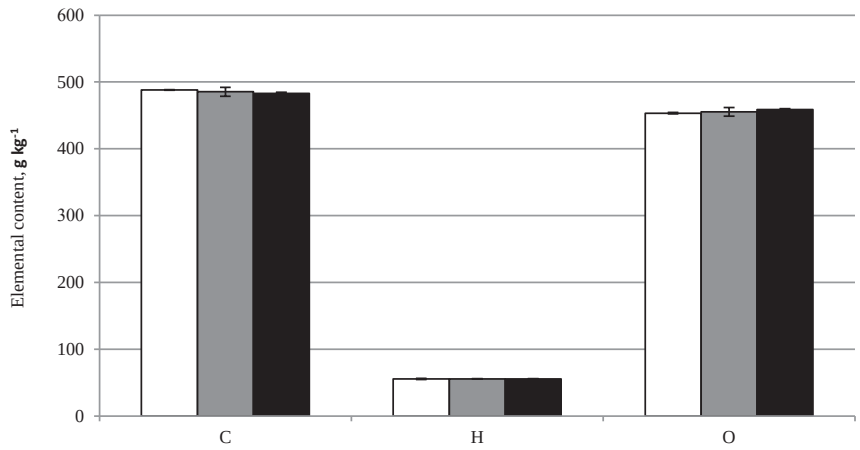

Figure 1. Elemental content of specimens:
□ untreated Scots pine ■ CBA ■ Micro-Cu

elemental analysis was conducted. Figure 1 displays that there is only an insignificant difference among elemental content of all specimens. Scots pine wood contains 48.5 ± 0.25% (485.5 ± 2.5 g kg^{-1}) carbon, 45.6 ± 0.28% (456.0 ± 2.8 g kg^{-1}) oxygen and 5.56 ± 0.01% (55.6 ± 0.1 g kg^{-1}) hydrogen. Student test shows that there are statistically significant differences ($p<0.05$) among nitrogen contents in specimens of all types. The nitrogen content in untreated, commercially treated and impregnated Scots pine wood is 0.18 ± 0.01 % (1.8 ± 0.1 g kg^{-1}), 0.25 ± 0.04% (2.5 ± 0.4 g kg^{-1}) and 0.14 ± 0.02% (1.4 ± 0.2 g kg^{-1}) accordingly. Considering the small amount of nitrogen content in Scots pine wood, variety of wood material itself and the small samples needed for this analysis, the nitrogen content can be considered the same in all samples. H. Matsunaga et al. (2008) has analyzed southern pine boards treated with an aqueos dispersion of Cu carbonate and iron oxide particles (nano-Cu preservative). Energy-dispersive X-ray spectroscopy showed that wood cell walls contain 53% (530 g kg^{-1}) C, 40% (400 g kg^{-1}) O, 65% (65 g kg^{-1}) H and 0.5% (5 g kg^{-1}) N, which coincides quite well with the results obtained in this research.

The Cu content in leachates obtained according to the European standard EN 84 (1997) is shown in Figure 2. For both specimens leaching rates are high initially and decrease significantly over time (after 200 h). This coincides with findings of A. Temiz et al. (2006). The total amount of leached Cu is 0.15 mg g^{-1} absolute dry matter for Scots pine impregnated with micro-Cu. Less than twice the amount of Cu – 0.06 mg g^{-1} absolute dry matter leaches from impregnated wood that belong to group Cu–boron-triazole products

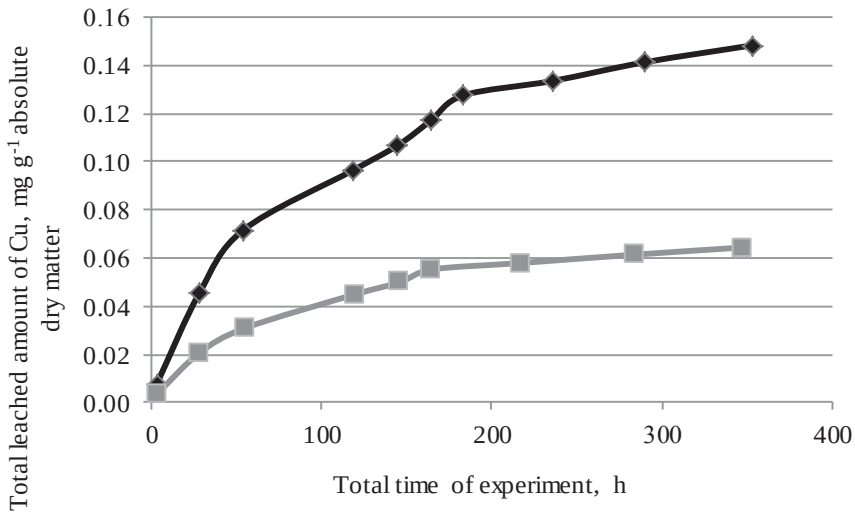

Figure 2. Total leached amount of Cu during artificial ageing:
Micro-Cu CBA

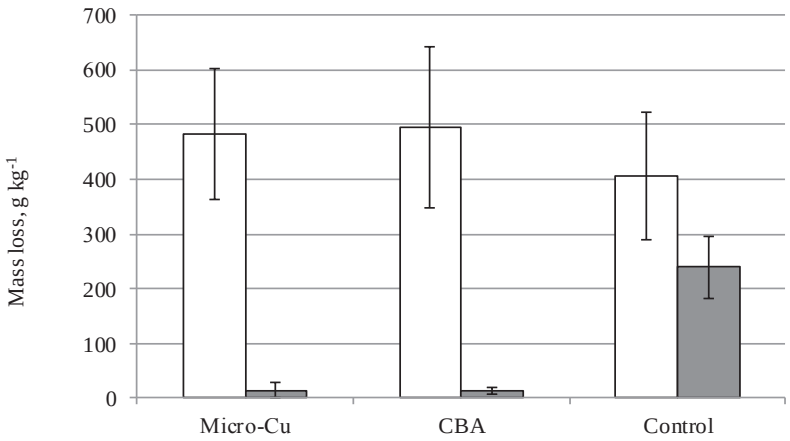

Figure 3. Mass loss of samples after fungi efficacy:
□ *Coniophora puteana* ■ *Trametes versicolor*

(CBA) according to (Salminen et al., 2014). These preservatives form complexes that do not involve cell wall components; they have different fixation mechanisms which leads to high Cu amount leached. Though M. Lupsea et al. (2013) states that Cu release is relatively high with respect to its initial content and Cu is bound on carboxyl and phenolic sites and forms soluble complexes with extractives. According to H. Matsunaga et al. (2008), these complexes aggregate into pits that connect cellular elements in wood and on the cell walls, suggesting that they are too large to penetrate them.

A. Temiz et al. (2014) has conducted a similar research – they reported that the total amount of leached Cu from CBA treated Scots pine wood was 470 mg m^{-2}. Recalculating units from mg g^{-1} to mg m^{-2} it is only 145 mg m^{-2} in the current research. As N. Thaler et al. (2013) state that more intense leaching occurs from specimens with higher Cu content, because Cu deposits on the surface of the specimens and form Cu crystals in cell lumina, the difference between the results obtained by A. Temiz et al. (2014) and results in this research can indicate that initial Cu content was considerably higher in laboratory impregnated specimens than in commercially available ones.

It was expected that because of leached Cu amount there are going to be differences in mass loss of samples due to exposure to *Coniophora puteana* and *Trametes versicolor*. However, in Figure 3 it can be seen that mass loss after *Coniophora puteana* is 48 ± 12% (480 ± 120 g kg^{-1}) for wood impregnated with micro-Cu and 50 ± 15% (500 ± 150 g kg^{-1}) for CBA wood. This indicates that after leaching none of the chemical preservatives provided effective protection against *Coniophora puteana*. Coniophora puteana belongs to brown rot fungi that degrade wood cellulose and hemicelluloses, whereas lignin is modified (Janberga et al., 2013). The mass loss due to exposure to white-rot fungi *Trametes versicolo*r is 1.5 ± 1.5% (15 ± 15 g kg^{-1}) for with micro-Cu impregnated wood and 1.2 ± 0.7% (12 ± 7 g kg^{-1}) for CBA wood. This indicates that both of the chemical preservatives after leaching were effective against *Trametes versicolor*, probably because of non-evaporated ethanolamine in preservatives that causes depolimerisation of lignin (Humar et al., 2008) and prevents the growth of fungi.

A similar phenomenon has been observed previously. Cu leaching data and performance data were not clearly correlated in the experiment (Thaler et al., 2013), where Cu-ethanolamine impregnated Scots pine was exposed to terrestrial microorganisms, besides Cu-ethanolamine preservative exhibits good performance in soil (12% (120 g kg^{-1}) mass loss after 18 weeks with Cu concentration 0.125% (1.25 g kg^{-1})). A. Temiz et al. (2014) also investigated Scots pine wood treated with CBA. Decay test was made according to the European Standard EN 113 (1996) and mass loss due to exposure to *Coniophora puteana* was 0.28% (2.8 g kg^{-1}) for unleached specimens. After accelerated ageing, according to the European Standard EN 84 (1997), mass loss was 0.19% (1.9 g kg^{-1}). These results are considered to fit durability class 3 according to the European Standard EN 350-2 (1994). These results significantly differ from the results obtained in this research, presumably because of the higher initial Cu content in the wood samples, as mentioned before.

Conclusions

As expected, wood impregnation with micro-Cu or Cu-boron-triazole containing wood preservatives does not affect elemental composition of wood.

Both of investigated treatments proved to be inappropriate for wood materials that can be used outdoors (durability class 3, EN 350-2, (1994)) because of its sensitivity to brown-rot fungi C*oniophora puteana.* It is likely that concentrations of preservatives used on wood were too low. It is

recommended to repeat the experiment using higher concentrations in order to provide sufficient protection. However, the treated wood met the requirements for the 3rd durability class due to mass loss after exposure to *Trametes versicolor*. It could be due to the altered structure of lignin after exposure to ethanolamine as lignin is the most affected wood component due to exposure to white-rot.

During leaching micro-Cu impregnated wood releases twice as much Cu than Cu-azole treated wood. However, it is not clearly perceivable, why there are no statistically significant differences between mass losses of both treated specimens, due to exposure to *Coniophora puteana*.

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References

1. EN 113 (1996) *Wood preservatives – Test method for determining the protective effectiveness against wood destroying basidiomycetes – Determination of the toxic values*, 31 p.
2. EN 350-2 (1994) *Durability of wood and wood based products. Natural durability of solid wood. Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe*, 35 p.
3. EN 84 (1997) *Wood preservatives – Accelerated ageing of treated wood prior to biological testing – Leaching procedure*, 7 p.
4. *Commission Directive 2003/2/EC of 6 January 2003* relating to restrictions on the marketing and use of arsenic (tenth adaptation to technical progress to Council Directive 76/769/EEC). Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32003L0002, 13 March 2015.
5. Freeman M.H., McIntyre C.R. (2008) Cu-Based Wood Preservatives: A comprehensive review. *Forest Product Journal*, 58 (11), pp. 1-27.
6. Grantiņa-Ieviņa L. (2013) Jaunākie pētījumi par koksni noārdošām sēnēm (State of art in research of wood decay fungi). Available at: http://priede.bf.lu.lv/grozs/Mikrobiologijas/Daudzveid/Lekcija_3_biodegradacija_2013.pdf, 12 March 2015. (in Latvian).
7. Hasan A.R., Hu L., Solo-Gabriele H.M., Fieber L., Cai Y., Townsend T.G. (2010) Field-scale leaching of arsenic, chromium and Cu from weathered treated wood. *Environmental Pollution*, 158 (5), pp. 1479-1486.
8. Humar M., Bučar B., Pohleven F., Žlindra D. (2008) Influence of ethanolamine on lignin depolymerization and Cu leaching from impregnated wood. *Wood Research*, 53 (4), pp. 85-94.
9. Irbe I., Andersons B., Chirkova J., Kallavus U., Andersone I., Faix O. (2006) On the changes of pinewood (*Pinus sylvestris* L.) Chemical composition and ultrastructure during the attack by brown-rot fungi *Postia placenta* and *Coniophora puteana*. *International Biodeterioration and Biodegradation*, 57 (2), pp. 99-106.
10. Janberga A., Irbe I., Biziks V., Kurnosova Ņ., Asatiani M.D., Andersons B., Andersone I. (2013) Biodegradation of treated softwood and hardwood species by brown rot fungi. *Environmental and Experimental Biology*, 11, pp. 17-22.
11. Love C.S., Gardner B., Morrell J.J. (2014) Metal accumulation in root crops grown in planters constructed from Cu azole treated lumber. *European Journal of Wood and Wood Products*, 72 (3), pp. 411-412.
12. Lupsea M., Mathies H., Schoknecht U., Tiruta-Barna L., Schiopu N. (2013) Biocide leaching from CBA treated wood - a mechanistic interpretation. *The Science of the Total Environment*, 444, pp. 522-530.
13. LVS EN 15104 (2011) *Solid biofuels - Determination of total content of carbon, hydrogen and nitrogen - Instrumental methods*, 18 p.
14. Matsunaga H., Kiguchi M., Evans P.D. (2008) Microdistribution of Cu-carbonate and iron oxide nanoparticles in treated wood. *Journal of Nanoparticle Research*, 11 (5), pp. 1087-1098.
15. Pankras S., Cooper P.A., Wylie S. (2012) Relationship between Cu species in solution and leaching from alkaline Cu quat (ACQ) treated wood. *Holzforschung*, 66 (4), pp. 505-514.
16. Salminen E., Valo R., Korhonen M., Jernlås R. (2014) *Wood preservation with chemicals: Best Available Techniques (BAT)*. Nordic Council of Ministers, Copenhagen, 51 p. Available at: https://books.google.com/books?id=JlJlBAAAQBAJ&pgis=1, 12 March 2015.
17. Shibata T., Solo-Gabriele H.M., Fleming L.E., Cai Y., Townsend T.G. (2007) A mass balance approach for evaluating leachable arsenic and chromium from an in-service CCA-treated wood structure. *The Science of the Total Environment*, 372 (2-3), pp. 624-635.

18. Stirling R., Drummond J., Zhang J., Ziobro R. J. (2008) Micro-Distribution of Micronized Cu in Southern Pine. The international research group on wood protection. Available at: http://www.osmosewood.com/pressroom/images/IRG 08-30479.pdf, 12 March 2015.
19. Temiz A., Alfredsen G., Yildiz U.C., Gezer E.D., Kose G., Akbas S., Yildiz S. (2014) Leaching and decay resistance of alder and pine wood treated with Cu based wood preservatives. *Maderas. Ciencia Y Tecnología*, 16, pp. 63-76.
20. Temiz A., Yildiz U.C., Nilsson T. (2006) Comparison of Cu emission rates from wood treated with different preservatives to the environment. *Building and Environment*, 41 (7), pp. 910-914.
21. Thaler N., Lesar B., Humar M. (2013) Performance of Cu-Ethanolamine-impregnated Scots Pine Wood during Exposure to Terrestrial Microorganisms. *BioResources*, 8 (3), pp. 3299-3308.
22. Vetter L., Depraetere G., Janssen C., Stevens M., Acker J. (2008) Methodology to assess both the efficacy and ecotoxicology of preservative-treated and modified wood. *Annals of Forest Science*, 65 (5), pp. 504-504.
23. Wang W., Zhu Y., Cao J. (2013) Evaluation of Cu Leaching in Thermally Modified Southern Yellow Pine Wood Impregnated with ACQ-D. *BioResources*, 8 (3), pp. 4687-4701.
24. Xue W., Kennepohl P., Ruddick J. (2012) Investigation of Cu solubilization and reaction in micronized Cu treated wood by electron paramagnetic resonance (EPR) spectroscopy. *Holzforschung*, 66, pp. 889-895.

EFFECT OF THERMAL MODIFICATION ON WOOD COLOUR

Dace Cirule[1,2], Edgars Kuka[1]
[1]Latvian State Institute of Wood Chemistry
[2]Latvia University of Agriculture
xylon@edi.lv

Abstract
Colour and colour homogeneity are of special importance for establishing the quality of wood products. In the present study the effect of thermal treatment at 140 °C and 170 °C on colour and its homogeneity was studied for aspen (*Populus tremula* L.), grey alder (*Alnus incana* Moench) and ash (*Fraxinus excelsior*) wood. Wood colour was monitored and evaluated by spectrophotometrical measurements of reflectance spectra and colour parameter calculations using CIELAB colour model with L* as the lightness, and a* and b* as the chromatic parameters. Wood colour changed substantially and all studied types of wood acquired quite similar colour due to the thermal treatment with greater discolouration and almost the same colour detected for treatment at 170 °C. The average colour difference within a board surface as well as among boards of one species was found to be less than 3 DEab units for all thermally treated specimens which can be regarded as hardly perceptible colour difference. However, noticeable differences in colour were detected between the surface and inner layers of thermally treated wood boards. Greater colour heterogeneity throughout the depth of a board was detected for woods treated at 140 °C.
Key words: colour homogeneity, thermal treatment, wood.

Introduction

Thermal wood modification is currently one of the most commercially successful wood treatment methods aimed at production of value-added product (Hill, 2011). There are several thermal modification processes induced in production, differing in modification process parameters (temperature, pressure, duration, oxygen shielding atmosphere) as well as wood material (species, wood moisture content - green, dry). However, all these processes include wood subjection to high temperature in a reduced oxygen atmosphere. Wood properties are permanently changed due to the transformation of wood chemical structure by autocatalytic reactions of the cell-wall constituents during thermal treatment (Tjeerdsma et al., 2005; González-Peña et al., 2009). Chemical changes in wood result in an irreversible improvement of its dimensional stability and enhanced resistance against wood-destroying fungi without using any harmful reacting chemicals, which is an important aspect concerning environmentally friendly management and sustainability (Yildiz et al., 2011). Another consequence of chemical transformations in wood during thermal treatment is the changed wood colour which can be regarded as another benefit of thermally modified wood. Consumers often prefer thermally modified wood just due to its altered colour and sometimes it is even used as an alternative for tropical woods (Ayadi et al., 2003; Esteves et al., 2008; Miklečić et al., 2011; Schnabel et al., 2007).

However, concurrently with above-mentioned benefits, heat treatment commonly results in substantial loss of wood strength. Accordingly, thermally modified wood is mostly recommended for non-structural usage. Therefore, the main use areas of thermally modified wood are garden furniture, flooring, building facades, decking for terraces and similar (Bächle et al., 2010). In all these applications, wood serves as a functional as well as a decorative material. For its decorative function, colour and colour homogeneity are of special significance, since the colour is an important parameter to establish the quality of wood products.

The colour of an object is formed when chemical components named as chromophores absorb certain wavelength of the incident light in a visible range of solar spectrum and the rest part of the light spectrum is reflected which subsequently can be perceived by a human eye. Therefore, the colour characteristics of wood depend on its chemical composition that can interact with light (Hon and Minemura, 2001). A number of chemical reactions, including formation of a range of new chromophoric groups, occur during the thermal modification. Accordingly, wood acquires characteristic lighter or darker brown colour. Colour changes in wood due to thermal treatment have been investigated by several researchers (Menezzi et al., 2009; Mitani and Barboutis, 2013; Chen et al., 2012; Lovrić et al., 2014). It is commonly reported that wood becomes darker when subjected to the heat treatment and the degree of darkening depends on the process conditions. However, these studies have been mainly focused on the average wood colour changes and there is scarce information concerning colour homogeneity of thermally modified wood. Besides, ambiguous results are established regarding colour uniformity in wood due to its thermal treatment. Johansson and Morén (2006) found that colour distribution through the thermally treated boards was not homogeneous. Dubey et al. (2011) established that at lower treatment temperatures there were colour differences between two surfaces of modified boards - decreased when

the treatment temperature was raised, and no visible colour difference was found for boards treated at temperature 180 °C and higher, which denote that the homogeneity of wood colour depends on the treatment conditions. Brischke et al. (2007) observed that there was a higher scattering of colour in thermally modified solid wood compared to milled wood, which implies some colour heterogeneity on surface of the thermally treated board.

The objective of the present study was to investigate the effect of thermal treatment of wood in a water vapour medium at two temperatures on the alteration in wood colour and its homogeneity. Three common hardwood species in Latvia – aspen (*Populus tremula* L.), grey alder (*Alnus incana* Moench) and ash (*Fraxinus excelsior*), were used in the present study.

Materials and Methods

Wood boards of aspen (*Populus tremula* L.), grey alder (*Alnus incana* Moench) and ash (*Fracsinus excelsior*) without any visible defects measuring 1000 × 100 × 25 mm were supplied by sawmill. The thermal mofification of boards were performed in a laboratory experimental wood modification device produced by Wood Treatment Technology (WTT). The modification was carried out in a water vapour medium at super atmospheric pressure (0.6 MPa). Treatments were performed at two operative treatment temperatures – 140 °C and 170 °C, duration of the treatment at the efficient temperature was one hour for both regimes. After modification, the boards were conditioned at 20 °C and 65% relative humidity.

For evaluation of wood surface colour homogeneity, both sides of the conditioned boards wereplaned. In the same way, specimens of untreated boards of the same species were prepared. Whereas, boards intentioned for evaluation of wood colour homogeneity along (throughout) the thickness of the board, were planed prior to the thermal treatment.

A portable spectrophotometer Minolta CM-2500d (standard illuminant D65, d/8° measuring geometry, 10° standard observer, measuring area Ø 8 mm) was used for wood reflectance spectra and colour measurements. Reflectance spectra were recorded against a white optical standard in the wavelength range from 360 to 740 nm with a scanning interval of 10 nm. Colour was expressed in accordance with the CIELAB colour model (introduced by the International Commission on Illumination (Commission Internationale de l'Eclairage), 1976) which is mostly used for objective quantification of colour and colour differences in wood. According to this model, each colour is a point in the three-dimensional colour space with the colour parameters L*, a*, b*, where parameter L* describes the lightness (from zero – black to 100 – white) and parameters a* and b* describe the chromaticity coordinates on the green-red and yellow-blue axis, respectively. From the L*, a*, b* parameter values obtained at two points, the differences of the colour parameters ΔL*, Δa*, Δb* and the total colour difference ΔEab between these two points were calculated according to DIN 6174 2007:

$$\Delta E_{ab} = \left(\left(\Delta L^*\right)^2 + \left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2 \right)^{\frac{1}{2}} \quad (1)$$

The ΔEab value corresponds to the shortest distance in the CIELAB colour space between the two points. Chromaticity change, which characterises change in colour intensity, was calculated according to the equation:

$$\Delta C^* = \left(\left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2 \right)^{\frac{1}{2}} \quad (2)$$

The effect of thermal treatment on colour uniformity of wood was evaluated in three levels:

- *Surface colour homogeneity in a board*. Colour parameters (L*, a*, b*) were measured at 15 points on each board two surfaces and colour differences ΔEab between all possible pairs of measured points (105 combinations) were computed according to the equation (1). The average colour difference, which represented the colour homogeneity of the particular board, was calculated from the colour differences of these pairs. Six boards were used for the evaluation of surface colour homogeneity for each treatment regime.

- *Inter-board homogeneity*. For each surface of six boards, average values of colour parameters (L*, a*, b*) were calculated from measurements at 15 points on the surface. These average values represented the colour parameters of the board in the further calculations. Colour differences ΔEab between all possible pairs of board surfaces were calculated (66 combinations) according to the equation (1). The average inter-board colour difference, which represented colour homogeneity characteristic to the treatment regime, was calculated from the colour differences of these pairs.

- *Homogeneity of colour throughout the board thickness*. Wood layers were planed down from both surfaces of the boards with a step of 2 mm. Colour parameters (L*, a*, b*) were measured at five points on each planed surface and the average values calculated. Colour differences ΔEab between the surface and each of the planed surface were calculated.

In the case of ash wood, boards containing both sapwood and heartwood were used and measurements were performed individually on the sapwood and heartwood parts.

Table 1

Changes in colour parameters and total colour changes (ΔEab) of woods due to thermal treatment

Treatment temperature (°C)	Wood	ΔL*	Δa*	Δb*	ΔC*	ΔEab
140	Aspen	-24.7 (1.8)	7.6 (0.1)	3.6 (0.9)	5.2 (0.9)	26.1 (1.6)
	Grey alder	-10.3 (1.6)	-2.6 (0.2)	-1.9 (0.8)	-2.8 (0.9)	10.8 (1.6)
	Ash-sapwood	-24.5 (0.8)	6.9 (0.5)	5.0 (1.5)	6.9 (1.5)	25.9 (0.5)
	Ash-heartwood	-10.9 (1.6)	2.8 (0.5)	4.1 (0.8)	4.8 (0.8)	12.0 (1.5)
170	Aspen	-64.5 (1.7)	8.3 (0.6)	-0.6 (0.6)	1.6 (1.7)	47.2 (1.6)
	Grey alder	-29.4 (1.6)	-2.2 (0.2)	-6.0 (1.1)	-6.4 (1.0)	30.1 (1.8)
	Ash-sapwood	-49.2 (1.7)	4.1 (0.9)	-8.0 (1.9)	-6.0 (2.1)	50.0 (1.8)
	Ash-heartwood	-35.1 (1.7)	0.5 (0.9)	-8.4 (1.9)	-7.3 (2.1)	36.1 (1.9)

Values in parenthesis are standard deviations
ΔL* - changes in lightness, Δa*- changes in parameter a*, Δb* - changes in parameter b*, ΔEab – total colour changes

Results and Discussion

Spectrophotometrical colour measurements showed that thermal treatment had caused changes in all colour parameters for all woods which resulted in substantial total colour changes ΔEab (table 1) and the magnitude of changes differed on the species. The treatment at a higher temperature (170 °C) facilitated greater colour changes ΔEab.

Woods darkened (negative ΔL* values) at both studied treatment conditions and a greater reduction in lightness was detected for wood treated at the higher temperature which agrees with earlier findings (Esteves et al., 2008; Srinivas and Pandey, 2012). Decrease in lightness indicates that components absorbing visible light were formed during thermal treatment (Yao et al., 2012). Reduction in lightness due to thermal treatment is a well established effect (Brischke et al., 2007; Tuong and Li, 2010; Chen et al., 2012), while different trends have been observed concerning changes in chromaticity parameters, which can be explained by different treatment conditions and durations as well as different wood species used for the experiments. Yao et al. (2012) observed increase in both chromaticity parameters (a* and b*) of wood due to thermal treatment, while Chen et al. (2012) found that the yellowness parameter b* decreased during wood thermal modification in both oxygen and nitrogen atmosphere. In the present study, the changes in the colour parameters a* and b* and consequently in chromaticity C*, evolved differently depending on the treatment temperature. Different effects of treatment conditions on changes in chromaticity were stated also by other researchers (Schnabel et al., 2007; Menezzi et al., 2009; Lovrić et al., 2014). These results indicate that different chromophores are formed during wood thermal treatment at different conditions. Besides, the trends of changes in chromaticity differed for the studied wood species. Chromaticity of grey alder decreased at both treatment conditions and greater reduction was detected at 170 °C. Aspen and ash woods showed increase in chromaticity at 140 °C whereas elevated treatment temperature (170 °C) caused a substantial reduction in chromaticity. Different behaviour of wood during thermal treatment regarding the patterns of changes in chromaticity, implies the formation of diverse chromophoric systems, which may be attributed to variations in the chemical composition of different species.

According to the data recorded in Table 1, the colour of aspen and ash-sapwood was changed more considerably. Analysis of impact of each colour parameter on the total colour change ΔEab, showed that decrease in the lightness (ΔL*) was the dominant contributor to the colour changes of all studied specimens, but for aspen and ash-sapwood the dominance of changes in lightness was more pronounced. These two types of wood, when not thermally treated, are significantly lighter than grey alder and ash-heartwood. Consequently, the greater decrease in lightness of these two types of wood due to thermal treatment resulted in quite similar colour parameters (not shown) of treated wood. It means that during the thermal modification all wood acquired more alike appearance regarding their colour. This is also well illustrated by the reflectance spectra presented in Figure 1. The reflectance spectra of unmodified wood (Fig. 1-a) differ noticeably. Substantial loss in reflectance with concurrent reduction of difference in reflectance among wood was observed after thermal treatment at 140 °C (Fig. 1-b). Moreover, there is only a slight difference among reflectance spectra of all studied wood after modification at 170 °C (Fig. 1-c), which implies that studied wood became quite uniform in colour during the thermal treatment.

It may be an advantage for decorative applications, that pronounced colour difference between ash sapwood and heart wood was substantially reduced during the thermal treatment. Ash colour homogenisation is corroborated by the results of evaluation of colour differences ΔEab between ash-sapwood and ash-heartwood: for unmodified wood

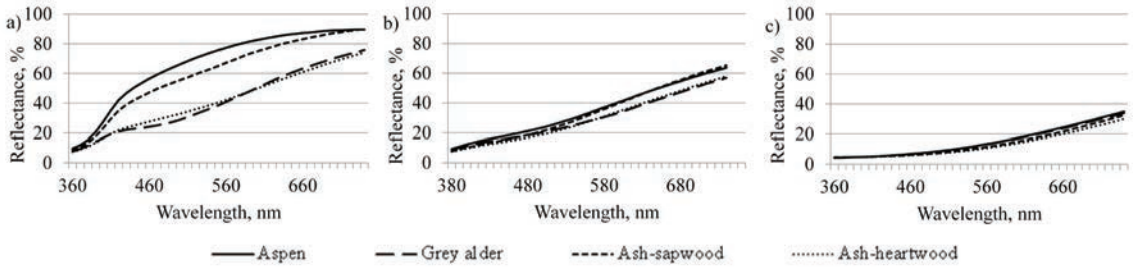

Figure 1. Reflectance spectra of unmodified and thermally modified aspen, grey alder, ash-sapwood and ash-heartwood: a) unmodified; b) modified at 140 °C; c) modified at 170 °C.

-14.7 units, for wood treated at 140 °C – 6.6 units and for wood treated at 170 °C – 1.4 units, respectively. It proves that the treatment at 170 °C ensured uniform colour of ash sapwood and heartwood, as ΔEab = 2-3 units is approximately the limit for human eye to recognize a colour difference (Sundqvist and Morén, 2002). This finding agrees with the observation of Lovrić et al. (2014) who investigated colour changes during thermal treatment of veneers manufactured from poplar species with a pronounced colour difference between sapwood and heartwood. They established that the thermal treatment reduced the colour difference and at a certain temperature it dropped into the category of no perceptible colour difference (ΔEab < 2).

More or less variation in colour is a common feature of all types of wood and the nature and magnitude of characteristic colour difference depends on wood species (Buchelt and Wagenführ, 2012). Extractives are known to be mainly responsible for specific colour of unmodified wood while coloured products formed from extractives and hemicelluloses degradation as well as quinones like products stemmed from lignin have been considered as a reason for wood colour change due to thermal treatment (Yao et al., 2012).

In general, from all analysed homogeneity levels, smaller average differences were detected for colour within the board surface. Unmodified ash-heartwood was the most heterogeneous wood regarding the board surface colour but even in this case the average colour difference was only 3.1 ΔEab units (Fig. 2a).

The average colour differences were between 2 and 3 ΔEab units for all other specimens which allowed to regard their colour as quite homogenous. Besides, these differences were statistically insignificant ($p>0.05$). Thermal modification resulted in an even more uniform colour within the board surface for grey alder and ash wood while aspen wood became less homogenous regarding its colour. However, the colour difference of thermally treated aspen wood still was hardly perceptible (ΔEab = 2.4). Thus, boards with a uniform surface colour were produced during thermal treatment at both studied temperatures.

Among all studied specimens, the highest inter-board heterogeneities were found for unmodified grey alder and ash-heartwood (Fig. 2b) for which the average colour difference reached 3.9 and 3.4 units, respectively. Average colour differences of the other specimens were less than 3 ΔEab units. Similarly as in the case of a board surface, the average colour difference among boards of all studied types of wood decreased during the thermal treatment and the decrease in colour difference was even more pronounced. Similar results were established by Dubey et al. (2011) who examined thermally treated *Pinus radiata* and found that the colour difference between the two board surfaces was smaller for thermally treated than unmodified wood.

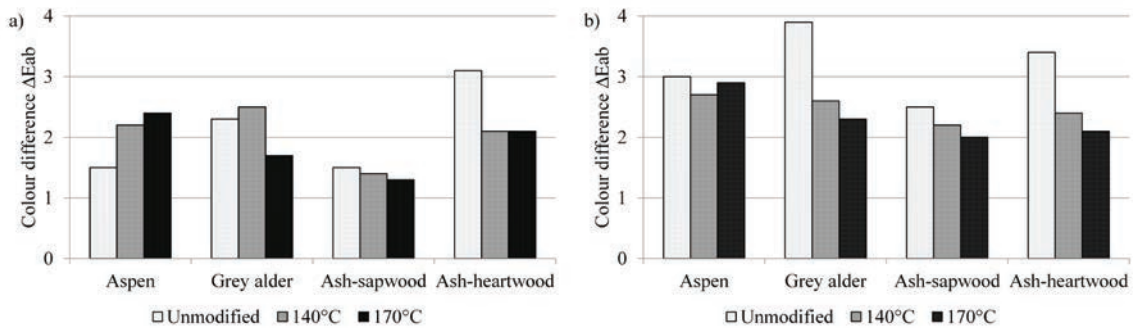

Figure 2. Colour difference ΔEab of thermally modified aspen, grey alder, ash wood and ash-heartwood: a) within a surface of the board; b) among boards.

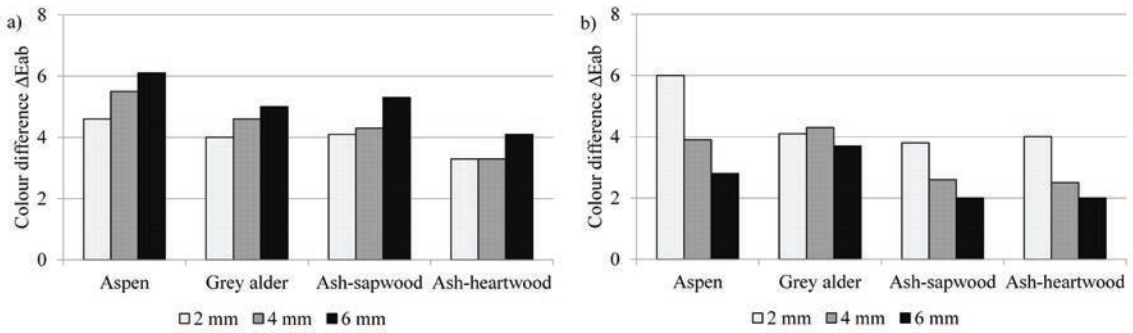

Figure 3. Colour difference ΔEab between the surface and the inner layers of boards of thermally modified aspen, grey alder, ash: a) modified at 140 °C; b) modified at 170 °C.

However, noticeable differences in colour were detected between the surface and inner layers of thermally treated wood boards (Fig. 3). Greater reduction in lightness and increase in chromaticity parameters a* and b* were found for all studied specimens at the board surfaces compared to deeper layers. The statistical analysis showed that the differences between the board surfaces and deeper layers were significant ($p<0.05$). The reason of these colour differences could be an uneven temperature distribution throughout the board thickness during thermal treatment and was lower at the core of the board which subsequently resulted in fewer chemical transformations and fewer colour changes. Besides, the surfaces of boards were exposed to more wet conditions during treatment as the modification was carried out in a water vapour atmosphere. It can significantly contribute to a more intense discolouration as water facilitates chemical decomposition of wood at high temperatures.

For the boards treated at 140 °C (Fig. 3a), a common trend was observed that the colour difference between the surface and the layers underneath the surface became lighter with an increase of the distance between the two planes. The colour differences ΔEab between the surface and all other examined planes throughout the boards exceeded the ΔEab value of 3 units for all types of wood. The greatest colour heterogeneity of wood in various depth from the board surface was observed for aspen wood. During treatment at 170 °C (Fig. 3b), more uniform wood throughout the board was produced. Nevertheless, the colour difference between the surface and the plane of 2 mm underneath the surface, which was the greatest colour difference detected in boards subjected to this treatment conditions, was greater than 3 ΔEab units. Colour of aspen wood was the most heterogeneous among the studied wood also for treatment temperature of 170 °C. Johansson and Moren (2006) and Dubey et al. (2001) have reported a similar trend that during the thermal treatment wood acquired quite a homogeneous surface while colour difference between surface and core was found to be noticeable, though decreased when the treatment temperature was raised.

By contrast, the difference between colour of deeper layers were found to be smaller than 2 ΔEab units (not shown) for all types of wood for both treatment conditions and these differences were statistically insignificant ($p>0.05$). It suggests that the colour of thermally treated wood is homogeneous under the upper layer. As boards, intended for the evaluation of colour uniformity throughout the board thickness, were planed before thermal treatment, the substantial colour difference between the upper and deeper layers might be avoided if rough boards were thermally treated and subsequently the outer layer was planed after the modification.

Conclusions

1. The colour of aspen, grey alder and ash wood changed substantially during the thermal treatment with greater discolouration detected for the treatment at 170 °C. All studied types of wood acquired quite similar colour due to the thermal treatment.
2. The average colour difference within the board surface as well as among boards was found to be less than 3 ΔEab units for all thermally treated specimens which can be regarded as a hardly perceptible colour difference.
3. Noticeable differences in colour were detected between the surface and inner layers of thermally treated wood boards for all studied wood. A greater colour heterogeneity throughout the board was found for wood treated at 140 °C.

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References

1. Ayadi N., Lejeune F., Charrier F., Charrier B., Merlin A. (2003) Color stability of heat-treated wood during artificial weathering. *Holz als Roh- und Werkstoff*, 61, pp. 221-226.
2. Bächle H., Zimmer B., Windeisen E., Wegener G. (2010) Evaluation of thermally modified beech and spruce wood and their properties by FT-NIR spectroscopy. *Wood Science and Technology*, 44(3), pp. 421-433.
3. Brischke C., Welzbacher C.R., Brandt K., Rapp A.O. (2007) Quality control of thermally modified timber: Interrelationship betwee heat treatment intensities and CIE L*a*b* color data on homogenized wood samples. *Holzforschung*, 61, pp. 19-22.
4. Buchelt B., Wagenführ A. (2012) Evaluation of colour differences on wood surfaces. *European Journal of Wood and Wood Products,* 70, pp. 389-391.
5. Chen Y., Fan Y., Gao J., Stark N.M. (2012) The effect of heat treatment on the chemical and color change of black locust (*Robinia pseudoacacia*) wood flour. *BioResources,* 7(1), pp. 1157-1170.
6. DIN 6174 (2007) Colorimetric evaluation of colour coordinates and colour differences according to the approximately uniform CIELAB colour space, 10 p.
7. Dubey M.K., Pang S., Walker J. (2011) Changes in chemistry, color, dimensional stability and fungal resistance of *Pinus radiata* D. Don wood with oil heat-treatment. *Holzforschung,* 66(1), pp. 49-57.
8. Esteves B., Marques A.V., Domingos I., Pereira H. (2008) Heat-induced colour changes of pine (*Pinus pinaster*) and eucalypt (*Eucalyptus globulus*) wood. *Wood Science and Technology*, 42, pp. 369-384.
9. González-Peña M., Curling S.F., Hale M.D.C. (2009) On the effect of heat on the chemical composition and dimensions of thermally-modified wood. *Polymer Degradation and Stability,* 94, pp. 2184-2193.
10. Hill C.A.S. (2011) Wood modification: an update. *BioResources*, 6(2), pp. 918-919.
11. Hon D.N.S., Minemura N. (2001) Color and discoloration. In: Hon, D.N.S., Shiraishi, N. Marcel Dekker (eds) *Wood and Cellulosic Chemistry*, New York, USA, pp. 385-442.
12. Johansson D., Morén T. (2006) The potential of colour measurement for strength prediction of thermally treated wood. *Holz als Roh- und Werkstoff*, 64, pp. 104-110.
13. Lovrić A., Zdravković V., Furtula M. (2014) Influence of thermal modification on colour of poplar (*Populusxeuramericana*) rotary cut veneer. *Wood research*, 59(2), pp. 661-670.
14. Menezzi C.H.S., Tomaselli I., Okino E.Y.A., Teixeira D.E., Santana M.A.E. (2009) Thermal modification of consolidated oriented strandboards: effects on dimensional stability, mechanical properties, chemical composition and surface color. *European Journal of Wood and Wood Products*, 67, pp. 383-396.
15. Miklečić J., Jirouš-Rajković V., Antonović A., Španić N. (2011) Discolouration of thermally modified wood during simulated indoor sunlight exposure. *BioResources,* 6(1), pp. 434-446.
16. Mitani A., Barboutis I. (2013) Heat treatment effect on colour changes of beech (*Fagus sylvatica*) wood. *Pro ligno*, 9, pp. 658-663.
17. Schnabel T., Zimmer B., Petutschnigg A.J., Schönberger S. (2007) An approach to classify thermally modified hardwoods by color. *Forest Products Journal,* 57(9), pp. 105-110.
18. Srinivas K., Pandey K.K. (2012) Photodegradation of thermally modified wood. *Journal of Photochemistry and Photobiology B: Biology,* 117, pp. 140-145.
19. Sundqvist B., Morén T. (2002) The influence of wood polymers and extractives on wood colour induced by hydrothermal treatment, *Holz als Roh- und Werkstoff*, 60, pp. 375-376.
20. Tjeerdsma B.F., Militz H. (2005) Chemical changes in hydrothermal treated wood: FTIR analysis of combined hydrothermal and dry heat-treated wood. *Holz als Roh- und Werkstoff*, 63, pp. 102-111.
21. Tuong V.M., Li J. (2010) Effect of heat treatment on the change in color and dimensional stability of acacia hybrid wood. *BioResources*, 5(2), pp. 1257-1267.
22. Yildiz S., Yildiz U.C., Tomak E.D. (2011) The effects of natural weathering on the properties of heat-treated alder wood. *BioResources*, 6(3), pp. 2504-2521.
23. Yao C., Yongming F., Jianmin G., Houkum L. (2012) Coloring characteristics of in situ lignin during heat treatment. *Wood Science and Technology*, 46, pp. 33-40.

MANUFACTURING AND APPLICATION STUDIES OF SCOTS PINE BARK PELLETS

Kaspars Spalvis[1,2], Uldis Daugavietis[1]
[1]Latvian State Forest Research Institute 'Silava'
[2]Latvia University of Agriculture
Kaspars.Spalvis@silava.lv

Abstract
This paper describes the use of Scots pine (*Pinus sylvestris* L) bark humus and fine fractions for animal litter pellet manufacture, and the efficacy of various additives in improving absorbency. In Latvia is no researge about litter pellet manufacture of pine bark, and possibilities of increasing water absorbency; in internationals research papers there is also no information about the possibilities of improving water absorbency of pine bark pellets with various additives. The additives tested were fresh and fallen leaves, tree needles, dried hogweed and sawdust. Pellets were manufactured with a ZLSP200B granulator at Adazi city, Latvia, in 2014. The results indicated that production of small diameter pine bark pellets could be problematic. Absorbency of the pellets was tested both by rinsing and soaking the pellets, and results were compared to woodchip particle litter pellets. It was found that the best absorbency was achieved with adding up to 30% sawdust, which increased pellet absorbency both by rinsing and soaking. The results indicate that it is possible to manufacture pellets using Scots pine (*Pinus sylvestris* L.) bark humus and fine fraction with good absorbency which can be disposed of in sewerage systems.
Key words: bark pellets, animal litter, absorbency, renewable resources.

Introduction

The study aims to establish a practical use of litter pellets from pine bark fine fraction and humus. There are no pellet quality indicators or guidelines in the regulatory framework for pellets used as animal litter. In Latvia there are no studies about bark pellets, and no research about obtaining bark pellets for litter. There are only general animal welfare requirements - pellets must produce dust, they have to be absorbent, cannot be toxic, or contain compounds harmful to the environment, animals or humans. Used pellets must be easily disposed of. In practice, naturally dry or dried plant biomass - straw, leaves, peat etc. is used for pellet production. To prevent dust, raw plant material can be used.

It is possible to purchase the animal litter sawdust pellets with grass and soft deciduous tree leaf additives, in pet store chains. To investigate the possibilities of to using pine bark pellets as litter, we conducted an experiment on the possibilities of using pine bark for pellet production, manufactured pellet water absorbency, and determined the chemical composition of pine bark. The possibilities of using bark humus and fine fractions as additives to various plant raw materials (tree leaves, needles) was examined. Pine bark is environmentally toxic (Anas et al., 1987), as shown by long-term use of pine bark for mulching. Analysis of the utilised pine bark indicates that it does not contain hazardous substances in dangerous concentrations. Mainly pine bark conteins cellulose, heksozanes and lignin (more than 80%), and it also contains pentazones, pentazones, suberines, sterols, sugars and acids (Громова et al., 1977; 1978) that could not cause harm to animal and human health (Васильева, 1990). Chemical compounds in pine bark are not volatile, and are not released at a temperature of 105 °C; solubility of bark compounds in water, acetone or ethanol is not higher than 8%, solubility in alkaline aqueous solution – not higher than 45% (Корбукова, 1995). Solubility of individual compounds in animal urine has not been investigated in the scientific literature. In addition, in Latvia wood biomass is not contaminated with pesticides and heavy metals, because it is not allowed to use chemical products and fertilizers in forest areas.

Materials and Methods

For pellet production, pine bark mulch fractions and pine bark humus were utilized, which are not suitable for commercial mulch product because of their high flow ability. Pellet size fractionation was performed using a calibrated sieve set (3.15, 20.00, 1.00 and 0.500mm). Moisture content was determined using a Precisia XM 120 moisture analyzer. Ash content of the raw materials was calculated by determining the mass of dry sample, incineration at 500 °C, and then determination of residual ash mass (Table 1)

Studies were conducted in Latvia, Adazi and Salaspils cities in 2014. Pellets were manufactured using a ZLSP200B granulator with an interchangeable matrix. Hole diameters of 8, 6 and 4 mm were used (Ruiz Celma et al., 2012). Water was added during the pellet formation to ensure solid pellet creation (Relova et al., 2009). For determination of moisture content, pellets were placed into closed polyethylene bags prior to cooling, to ensure that the existing moisture content was not altered. Cooled pellets were packed into ventilated bags for further analyses. In order to improve the pellet properties, raw bark materials were added in various proportions (Tore et al., 2011), as well as other plant material additives, which were crushed in an M2 extruder type crusher.

Table 1

Scots pine (*Pinus sylvestris* L) bark humus and fine fraction structure with and without additives

Sample	Moisture, g kg^{-1}	Ash content, g kg^{-1}	Granulometry composition, mm				
			>3.15	3.15-2.00	2.00-1.00	1.00-0.500	<0.500
Bark	206	23	25.4	34.6	24.4	10.9	4.7
Humus	349	339	7.9	25.4	38.2	23.3	5.2
Bark and humus (ratio 1:1)	241	183	14.3	35.2	36.7	9.4	4.3
Bark with sawdust additive (10%)	202	21	38.7	30.1	20.2	6.2	4.9
Bark and humus with sawdust additive (10%)	246	180	20.8	33.9	32.5	10.0	2.8

The absorbency of the manufactured pellets was determined within 24 hours, taking a pre-determined mass of pellets and soaking them in water at a room temperature. After 24 hours, pellets were placed in a sieve, allowing excess water to drain, and reweighed. The increase in mass was the amount of water absorbed by the pellets in 24 hours.

The absorbency of the pellets was also determined by rinsing. Approximately 10 g of pellets were placed in a single layer on a sieve rinsed with 10mL water for approximately 15 s. Excess water was allowed to drain and pellets were reweighed. The increase in mass was the amount of water absorbed by the pellets during rinsing.

The feasibility of disposal of the pellets in sewerage systems was determined by placing water saturated pellets in a tube which conformed with the Construction Standard LBN 221-91. A known mass of saturated pellets was flushed with 5L of water. Pellets were collected at the other end of the tube and weighed. A large mass difference indicated sediment formation

Results and Discussion

The pine bark fine fraction and humus size fractionation was performed 5 times, and the sample average was calculated. Bark fine fraction and humus granulometric structure, moisture and ash content is shown in Table 1.

Various raw material mixtures were prepared in the laboratory using pine bark fine fraction and humus with addition of sawdust, pine needles, fallen leaves, fresh leaves and dried hogweed (*Heracleum Sosnowsky*) (Table 2). The mixtures were dried at the room temperature to 15% moisture content, which is approximately the moisture levels utilised in the pellet manufacturing.

Granulation is done using four, six and eight millimeter diameters. The six millimeter pellets were used for further analyses, as these were the most

Table 2

Additives and properties of bark pellets

Base	Additive	Additive content, g g^{-1}	Absorption by rinsing, mL g^{-1}	Absorbtion (24 hours), mL g^{-1}
Bark	-	0	0	0.326
Bark	leaves	0.05	0.030	0.646
Bark	needles	0.05	0.038	0.517
Bark	withered leaves	0.05	0.028	0.446
Bark	sawdust	0.05	0.029	0.555
Bark	sawdust	0.10	0.039	0.625
Bark	hogweed	0.05	0.029	0.502
Bark	humus	0.50	0.039	0.499
Humus	-	-	0.039	0.500
Bark and humus	sawdust	0.10	0.038	1.112
Bark and humus	sawdust	0.17	0.039	1.732
Bark and humus	sawdust	0.23	0.048	1.825
Bark and humus	sawdust	0.33	0.078	1.837
Bark and humus	sawdust	0.29	0.087	1.849
Bark and humus	sawdust	0.50	0.094	1.932
Commercial litter pellets	-	0	0.162	4.213

suitable for both pellet production and use. 8mm diameter pellet production was equally efficient as for 6mm pellets, but 4mm diameter pellet granulation was highly problematic, as the raw material obstructed matrix openings and the granulation process was halted after a few minutes. As a result, the production of 4mm pellets from the pine bark fine fraction and humus was not technically possible. The raw materials were hydrated according to thr requirement, to promote a better pellet formation. The manufactured pellet optimum moisture content ranged from 15% to 20% of dry mass. Pellets with lower moisture content were looser in form, but pellets with a higher moisture content often disintegrated during drying and cooling.

Water absorbency of pellets was determined by rinsing and soaking them for 24 hours (Table 2). As a comparison, commercial woodchip litter pellets also were tested

Increasing amounts of additives enhance pellet absorbency, with sawdust giving the largest increase of absorbency. The water absorbency of pine bark fine fraction and humus additives was similar, and as the proportion of these two additives in the raw materials obtained was similar, they could be used as additives in the pellet production in equal proportions. Pine bark humus contains a high amount of minerals (high ash content), which indicates the presence of soil and sand particulate matter, so it is not recommended to use only humus as an additive for pellet manufacture, as this would increase wear and tear on granulator mechanisms. To increase the pellet absorbency, we recommend addition of bark mixture (humus and fine fraction) in combination with sawdust, up to a proportion of 0.1 to 0.3 g g^{-1}. Increasing the amount of additives, only slightly improves pellet absorbency, and in addition, a high proportion of additives might reduce pellet mechanical strength, which can be significant during pellet drying and transportation (Monedero et al., 2015).

Flushing of water saturated pellets through a tube indicated that no particles were retained in the tube. Weight measurement results confirmed that pellets and their particles did not accumulate in the tube. During the experiment, 300 to 600 g of saturated pellets were inserted into the tube and rinsed with 5 L of water. Saturated pellets were utilized to exclude the effect of dry pellets, as only saturated pellets could be flushed into municipal sewer systems. The decrease in pellet mass during the flushing experiment did not exceed 10 g of the original mass and it can be assumed that the mass loss resulted because of small particles being rinsed through the sieve or water splashing from the surface of the sieve. Visual examination of the tube confirmed that there were no deposits, and we assume that pellets would be fully flushed through properly assembled sewer pipes.

Conclusions

1. Formation of pellets manufactured using pine bark additives can be problematic, but by utilizing raw materials with a moisture content of 15 - 20%, as well as additionally moistening them during the granulation process, it is possible to obtain mechanically strong pellets with a strong surface.
2. The water absorbency of the pellets manufactured in this study was lower than that of commercial litter pellets. An increase in water absorbency can be achieved by adding sawdust to the raw material mix. Addition of up to 30% sawdust improves the absorbency of pellets manufactured using pine bark fine fraction and humus and other fresh and dried plant material as additives.
3. Pellets manufactured with pine bark additives can be flushed in properly constructed sewerage systems without blocking or forming deposits in sewer pipes.

References

1. Anas E., Ekman R., Holmbom B. (1983). Composition of nonpolar extractive in bark of norway spruce and Scots pine. *Journal of Wood Chemestry and Technology,* Vol. 3, Issue 3. pp. 119-130.
2. Filbakk T., Jirjis R., Nurmi J., Høibø O. (2011) The effect of bark content on quality parameters of Scots pine (Pinus sylvestris L.) pellets. *Biomass and Bioenergy*.Vol.35, Issue 8, pp. 3342-3349.
3. Monedero E., Portero H., Lapuerta M. (2015) Pellet blends of poplar and pine sawdust: Effects of material composition, additive, moisture content and compression die on pellet quality. *Fuel Processing Technology* Vol. 132, pp. 15-23.
4. Relova S., Vignote A., León Y. (2009) Ambrosio. Optimisation of the manufacturing variables of sawdust pellets from the bark of Pinus caribaea Morelet: Particle size, moisture and pressure. *Biomass and Bioenergy*.Vol.33, Issue 10, pp. 1351-1357.
5. Ruiz Celma A., Cuadros F., Lopez-Rodriguez F. (2012) Characterization of pellets from industrial tomato residues. *Food and Bioproducts Processing*, Vol. 90, Issue 4, pp. 700-706.
6. Васильева Н.Е., Гелес И.С. (1990) Экстрактивные вещества коры и древесины ели и сосны. (Extractives of bark and wood of spruce and pine). *Химия и использование экстрактивных веществ дерева: Тез. докл.- Горький.*, с. 98-100. (in Russian).

7. Громова А.С., Луцкий В.И., Ганенко Т.В., Тюкавкина Н.А. (1978) Флаваноиды из коры не-которых видов пихты, ели и сосны. (Flavonoids from the bark of some species of fir, spruce and pine). *Химия древесины*, № 4. с. 90-98. (in Russian).
8. Громова А.С., Луцкий В.И., Тюкавкина Н.А. (1977) Фенолокислоты луба Abies nephrolepis, Pinus sibirica и Pinus sylvestris L. (Bark phenolicacids of Abies nephrolepis, Pinus sibirica and Pinus sylvestris L.). *Химия природных соеди-нений*, №2. с. 277. (in Russian).
9. Корбукова И.В. (1995) *Особенности химического состава корки и луба Pinus sylvestris.* (*The chemical composition of the crust and bark of Pinus sylvestris* L). Дисс.к.х.н. Л. с. 142. (in Russian).

ABSORPTION OF EU FUNDS AND THE DEVELOPMENT OF RURAL AREAS IN LATVIA AND POLAND

Maciej Stawicki
Warsaw University of Life Sciences, Poland
maciej_stawicki@sggw.pl

Abstract
The article presents the findings of research aiming to discover the links between absorption of European funds and the development of rural areas in Latvia and Poland. Based on statistical data and Latvian territorial development index at local level, the value of index for Polish local communities was calculated showing a slightly bigger differences in local development in Poland. Absorption of EU funds was rather concentrated in both countries and its highest level was connected with major infrastructural projects as construction of roads, motorways, etc. The use of EU funds under Cohesion Policy is not correlated with the level of development, neither in Latvia nor in Poland. The only significant negative correlation can be observed between the development and the use of funds under Common Agricultural Policy and Fisheries Policy in Latvia.
Key words: EU funds absorption, local development, rural areas, rural development level, Latvia, Poland.

Introduction

The main aim of the Cohesion Policy (also called regional policy) is to support the process of convergence in selected areas of the EU member states and improve their competitiveness. Regional policy is set to equalize inter-regional differences by supporting development processes in less developed areas, which in the new member states consist mainly of rural areas (European Commission, 2007). Regional Policy in the EU countries is delivered by three main funds: the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF). Additionally, there is a high role of the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF), especially in rural areas, where they improve the quality of life of residents, support agriculture, fishery and contribute to the development on a regional and local scale.

From the new member states, which joined the EU after 2004 the amount of allocated funds (in the period 2007-2013) was the highest in Poland (67 billion EUR), and one of the smallest (4.5 billion) in Latvia, although the amount of funds per capita was higher there (KPMG, 2014). European funds and their role in developing the economies is a common topic of academic studies undertaken by many authors (among others: Tetere V., 2009; Pilvere I., Bulderberga Z., 2009; Wojewódzka-Wiewiórska A., 2012), although not every aspect was a subject to detailed studies. Therefore the goal of this research was to discover links between absorption of EU funds and the development of rural areas in Latvia and Poland. In the first part of the article the differences in development level of municipalities are shown. The second part analyzes the amount of EU funds from the period 2007-2013 absorbed on a local level. At the end, the main goal of the paper is discussed with some final conclusions.

Materials and Methods

Development of rural areas was shown on the second Local Administrative Unit (LAU-2) level, in Latvia rural areas were defined as 110 municipalities (without 9 republican cities), in Poland as 2413 municipalities of all types: rural, urban and urban-rural (without 66 city districts).

The research was conducted using statistical data published in local databank by Polish Central Statistical Office (CSO) and data gathered in Regional Development Indicators Module (RDIM) by Latvian State Regional Development Agency (CSO, 2015; RDIM, 2015). As an indicator of local development level the Latvian territorial development index was used. At local level of counties (in Latvian - *novadi*) it consists of 4 elements: level of unemployment, Personal Income Tax revenues of municipalities, demographic load and population change in previous 5 years (SRDA, 2012). The author, due to data availability and comparability decided to use this indicator with consciousness that it does not include all possible components of local development. The data for Latvia were collected from the Regional development indicators module, but for Poland the source was the CSO, whose data were recalculated using the same methodology as in Latvia. To make the data comparable, score standardization was performed using the Formula 1:

$$y = \frac{x - \bar{\bar{x}}}{s} \tag{1}$$

where:
y – is a specific area indicator characterizing the standardized value,
x – indicator value for territory in their specific units,
$\bar{x}$ – arithmetic mean of the reference area group,
s – standard deviation.

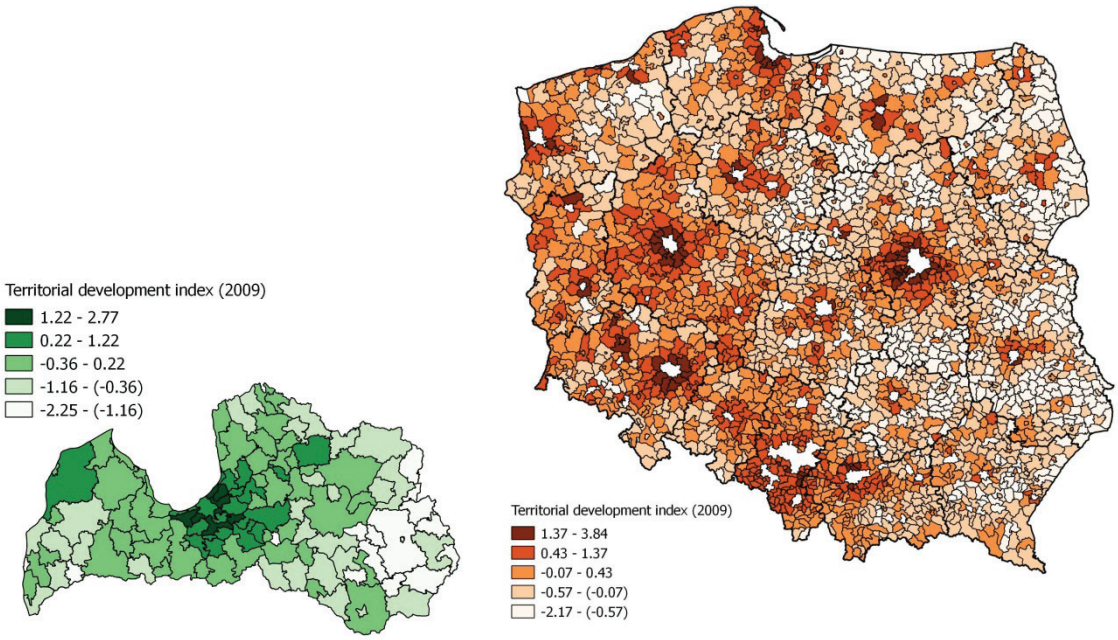

Figure 1. Level of local development in Latvia and Poland.
Source: author's elaboration based on Regional development indicators module data and calculations based on CSO data.

Further, the standardized values of part indicators were summed with the appropriate (same as for Latvia) weighting factors. In this way the territorial development index for Latvia and Poland can be compared, although data for Poland are shown as of 31 December and in Latvia they come from different months during the year. The analyzed variables are normally distributed.

The data of EU funds absorption were also collected from the above mentioned sources: for Latvia it was the sum of ERDF, ESF and CF project funding amount (actually carried out payment amounts). In addition (only for Latvia due do data availability), it was also possible to analyze the EAGGF, EAFRD and EFF funds absorption. In Poland, the total public financing value of completed projects co-financed by the European Union, implemented under the National Strategic Reference Framework 2007-2013 was taken into account. The data of CSO from National Information System (KSI SIMIK 07-13) were used. Polish data refer to projects in a territorial unit, but the designed conversion algorithm causes that the data presented in the reports should be regarded as approximate (in case of projects implemented in many municipalities, their value have equal shares in proportion in each municipality).

The period of analysis covers years 2009-2013, due to the availability of statistical data for both countries at the time of research at the beginning of the year 2015. The data was presented using tables, graphs and maps created using QGIS and Statistica software.

Results and Discussion

Development of rural areas

The level of development of rural communities was analyzed based on the territorial development index prepared by Latvian State Regional Development Agency. As of the beginning of the study period (2009), the development index took a slightly higher spread in Poland, where the highest index value was 3.84, while in Latvia only 2.77. The lowest values were similarly around – 2.2.

Level of development of rural areas in Poland and Latvia has similar spatial differentiation (Fig. 1). It is high around the capitals (Warsaw and Riga) and larger cities (Poznan, Wroclaw, Gdansk in Poland, Ventspils in Latvia). This is mainly caused by high inflow of wealthy population to suburban zones. The less developed areas concentrate in central and eastern Poland (besides surroundings of Warsaw), what was caused by high demographic load in communities located in north-eastern Poland or high unemployment in surroundings of Radom. The analysis leads therefore to conclusions similar to those reached by other researchers of rural development in Poland. In Latvia, similarly, the lowest level of development characterizes the peripheral areas in the eastern and also in south-western part of the country.

Absorption of EU funds

The absorption of European funds among analyzed countries was higher in Poland (67 billion EUR) in comparison to 4.5 billion EUR in Latvia, although the amount of funds per capita and the average

project value was higher there. The mean value of conducted projects per Latvian municipality was 11.2 million EUR and 1085 EUR per inhabitant. In Poland, the average value was two times smaller and amounted 5.01 million EUR and 476 EUR per capita. According to the RDIM data, Latvian municipalities located in rural areas acquired around 1.2 billion EUR from funds implemented under the Cohesion Policy (SRDA, 2015). The largest amount of funds went to municipalities located around Riga: Mārupes nov. (development of infrastructure at the Riga international airport), Inčukalna nov. (establishment of wood pellet manufacturing plant and water system enhancing) and Babītes nov. (reconstruction of motorways A5, A9 and A10) and around Ventspils - Ventspils nov. (reconstruction of motorway A10 and other roads) (Fig. 2). The funds use was quite concentrated: 15% of communities raised the half of all funds.

The EAGGF, EAFRD and EFF funds absorption is clearly connected with the division for central and peripheral areas and employment in agriculture. Higher amount of these funds was acquired in rural communities with lower development level, located not in the vicinity of Riga, mainly in the southern part of Latvia (Fig. 3).

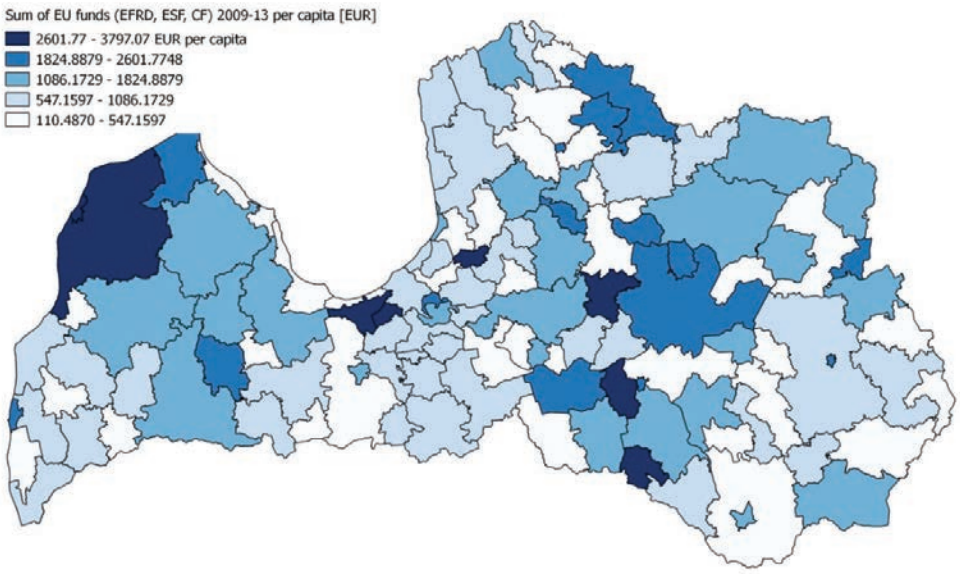

Figure 2. Absorption of EU funds in Latvian communities.
Source: author's elaboration based on Regional development indicators module data.

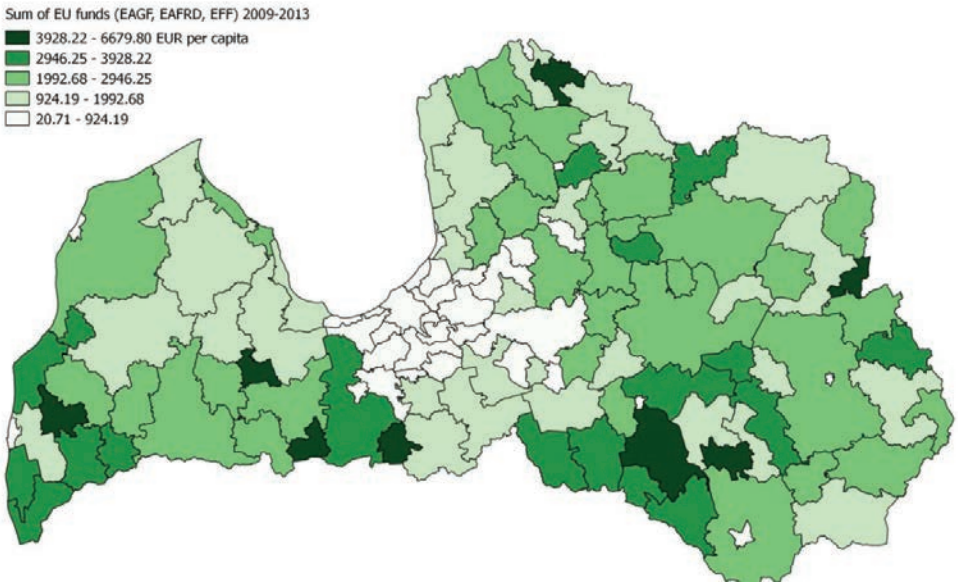

Figure 3. Absorption of EU funds for rural development in Latvian communities.
Source: author's elaboration based on Regional development indicators module data.

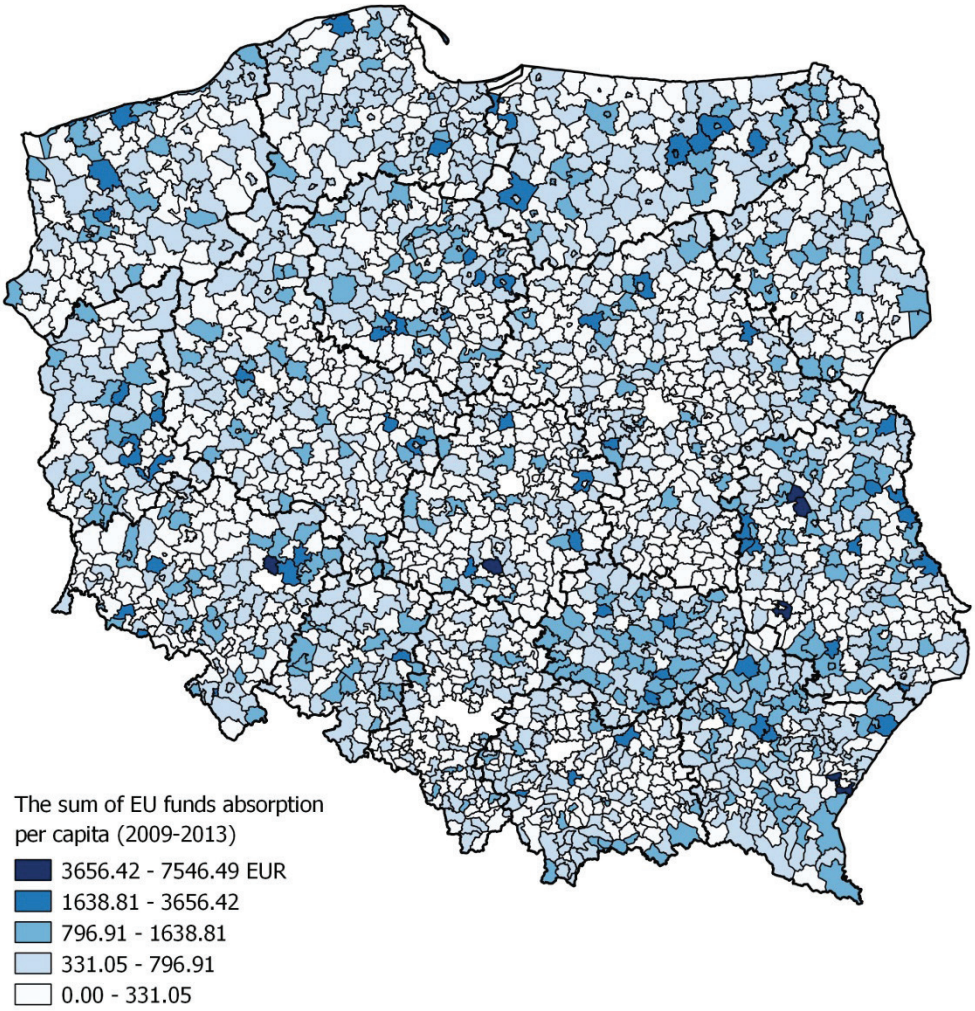

Figure 4. Absorption of EU funds in Polish communities in rural areas.
Source: author's elaboration based on data of local databank of CSO.

In Poland 50% of funds were acquired by 13.5% of communities (Fig. 4). The total amount of conducted projects in Poland amounts 12.1 billion EUR. In Poland, no clear spatial concentration can be seen. The highest amount of funds went to the communities where major infrastructural projects were conducted. These were mainly motorway and other road constructions or railway modernization projects, as the motorway A8 near Wroclaw, express road S19, infrastructure development of Rzeszow-Jasionka airport, construction of sewage or water supply systems (MID, 2015). Other types of projects were investments in wind farms and other industries: flue gas desulphurization installation in Belchatow power plant, installation of solar collectors, waste recycling plants and implementation of other new technologies.

Links between EU funds and rural areas' development

Figures 5 and 6 show the dispersion of communities according to their level of development and the amount of EU funds absorption per inhabitant. Also, linkages between absorption of European funds and the level of development of analyzed communities at the beginning of studied period can be seen.

On the basis of the above placed scatterplots, the use of EU funds under Cohesion Policy (ERDF, ESF, CF) seems weakly correlated with the level of development, both in Latvia and in Poland and it does not have a linear dependence. Although one can see a very slight connection between the territorial development index and the absorption of funds (the higher development, the higher absorption), the correlation coefficients are statistically insignificant. The study does not allow to state clearly if the variables are independent or not, however in Latvian communities a group of better developed units (with territorial development index >1.5) with relatively high absorption can be observed. These are mainly the *novadi* located in the vicinity of Riga, for example Mārupe, Babīte, or Stopiņi. In Poland,

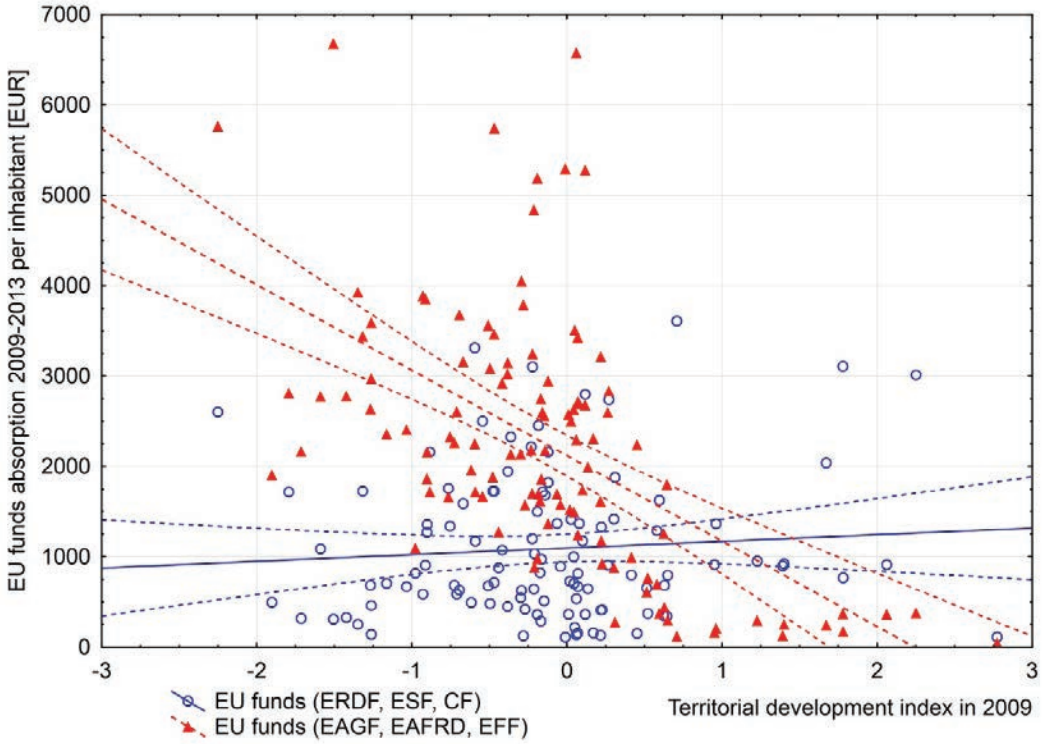

Figure 5. Absorption of EU funds and the development of rural areas in Latvia.
Source: author's elaboration based on Regional development indicators module and data of local databank of CSO.

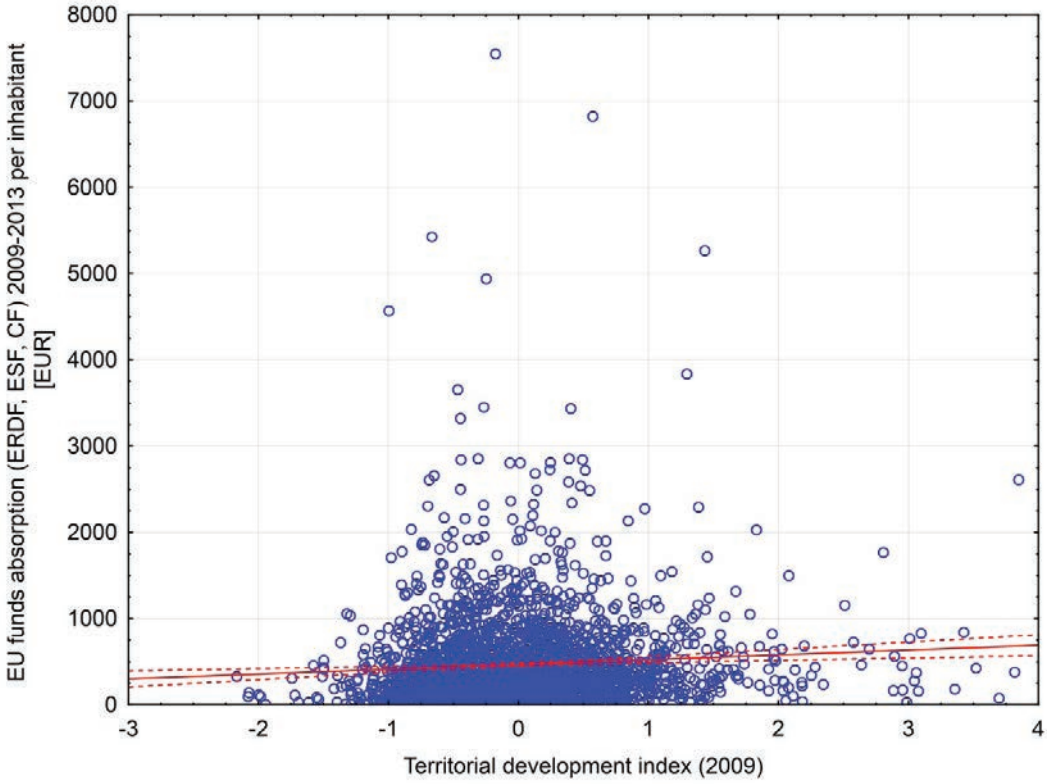

Figure 6. Absorption of EU funds and the development of rural areas in Poland.
Source: Source: author's elaboration based on data of local databank of CSO.

on the contrary, the relatively highest absorption characterized the middle-developed mainly rural communes, which were often located close to middle-size towns or cities. The only significant negative correlation ($p<0.05$) can be observed between the development and the use of funds under Common Agricultural Policy and Fisheries Policy in Latvia. In most cases less-developed communities acquired more funds, which can be seen on Fig. 5. Due to the lack of publication of such data for local level in Poland, it was not possible to compare the situation in both countries.

Conclusions

On the basis of this study, it seems that the level of development of rural areas in both analyzed countries is comparable. The values of territorial development indicator take a similar, although higher in Poland, rate of dispersion. The level of development of rural areas in Poland and Latvia has also quite similar spatial differentiation. It is high around the capitals and larger cities and low in peripheral (mainly eastern) regions. Other conclusions are as follows:

- The definition of rural areas according to the availability of statistical data is comparable in communities in both analyzed countries.
- Latvian territorial development index because of its simplicity and easy availability of statistical data can be used to measure rural development level in other countries.
- The concentration of EU funds absorption is comparable in both countries and slightly higher in Latvia.
- The Cohesion Policy funds (ERDF, ESF and CF) go to the municipalities regardless of their level of development, and the highest amount of conducted projects characterizes the communities where major infrastructure projects were implemented.
- The funds for agricultural, fishery and rural development were (in the case of Latvia) implemented in higher values in less developed areas, a negative correlation was observed.

As the study was quite general in nature, it could be followed by further more detailed studies on differences, factors and dynamics of local development, as well as the in-depth analyses of EU funds absorption and its effects.

References

1. Database of implemented projects 2007-2013, Available at: http://www.esfinanses.lv/lv/a/lapa/es-fondu-projekti, 25 February 2015.
2. European Commission (2007) Territorial Agenda of the EU. Towards a more competitive and sustainable Europe of diverse regions, 25 May 2007. Available at: http://www.eu-territorial-agenda.eu/Reference%20Documents/Territorial-Agenda-of-the-European-Union-Agreed-on-25-May-2007.pdf, p. 11, 17 February 2015.
3. Gorzelak G. (2004) Polish regional policy towards Polish space differentiation, Polska polityka regionalna wobec zróżnicowań polskiej przestrzeni. *Studia Regionalne i Lokalne, No.* 4(18), pp. 37-72.
4. Heijman W., Koch T. (2011) The allocation of financial resources of the EU Structural Funds and Cohesion Fund during the period 2007–2013, *Agricultural Economics – Zemedelska Ekonomika*, 57(2), pp. 49-56.
5. KPMG Central and Eastern Europe Ltd. (2014), EU Funds in Central and Eastern Europe. Progress report 2007-2013, KPMG Central & Eastern Europe Ltd., p. 56.
6. Local Database of Central Statistical Office, available at: http:// http://stat.gov.pl/bdl/app/strona.html?p_name=indeks, 25 February 2015.
7. Main Documentation Centre of Geodesy and Cartography: Polish territorial division shape file http://www.codgik.gov.pl/index.php/darmowe-dane/prg.html, 17 November 2014.
8. Ministry of Infrastructure and Development (MID) (2015) Database of implemented projects 2007-2013, Available at: http://www.funduszeeuropejskie.2007-2013.gov.pl/AnalizyRaportyPodsumowania/Documents/Umowy_wszystko_31_12_2014.zip, 26 February 2015.
9. Pilvere I., Bulderberga Z. (2009) Results of Rural Development Program 2007-2013 Implementation in Latvia, Rural development 2009, The fourth international scientific conference proceedings, Volume 4, Book 1, pp. 252-257.
10. Saktina D., Meyers W.H. (2007) Method and approach for achieving rural development objectives through more targeted and appropriate support policy: case study of a polarized and centralized country, Latvia, *Proceedings of the international scientific conference Economic Science for Rural Development no. 14,* pp. 59-66.
11. Stawicki M. (2011) The use of European funds by communities with different level of development in Eastern Poland, *Electronic Journal of Polish Agricultural Universities* (*EJPAU)* 14(4), #12.
12. State Regional Development Agency (SRDA): Regional development indicators module of Spatial Development Planning Information System, Available at: http://raim.gov.lv/pub/en/, 20 February 2015.

13. State Regional Development Agency (2012) Territory Development Level Evaluation - assessment methodology, (Teritoriju Attīstības Līmeņa Novērtējums. Novērtējuma metodika), Available at: http://www.vraa.gov.lv/uploads/documents/petnieciba/IAT_noteiksana/2012.06.05_tainovertejuma_metodika.pdf, 10 February 2015.
14. Tetere V. (2009) European Structural Funds – Part of Investment in Latvia's Development, *Proceedings of the International Scientific Conference Economic Science for Rural Development*, LLU, Jelgava, pp. 240-245.
15. Wallace H.E., Pollack M.A., Young A.R. (eds.) (2010) Policy-making in the European Union, Oxford University Press, p. 574.
16. Wojewódzka-Wiewiórska A. (2012) Obtaining funds from the EU budget by rural communes of the Masovian voivodeship, *Journal of Agribusiness and Rural Development* 2(24), pp. 273-283.

DEVELOPMENT OF LOCAL FOOD SYSTEMS IN LATVIA

Ligita Melece, **Agnese Krievina**
Latvian State Institute of Agrarian Economics
ligita.melece@lvaei.lv; agnese@lvaei.lv

Abstract
Although there is no consensus among scholars and professionals regarding the definition of the local food system, nevertheless, the local food systems or alternative food networks are no less important and suitable tool for solving environmental, economical (farmers' and rural inhabitants' income increasing) and social issues, and encouraging the further sustainable development of rural areas and communities. The aim of study is to assess the state and recent characteristics of the local food systems and its development in Latvia. The paper presents results of a study of the typology and categorisation of both the producers and distribution channels, and development of the local food systems as a whole, especially in Latvia. Various sources of materials and data have been used: the academic literature, legislation, reports and recommendations, as well as web pages, the internet and data from Food and Veterinary Service (FVS). The typology and categories of local food systems as well as short food supply chains are characterised, and its existence in Latvia is given. Besides, it is essential that the different kind of its merging organizations and projects supporting distribution of local food is implemented. The development of consumer groups for local food purchasing is important. While the requirements for small farmers–food producers are the same as those for large producers, the results suggest that during the recent years an increasing number of home-made food producers is observed.
Key words: local food, chain, farms, home-made.

Introduction

Primary agricultural production plays a decreasing role in rural economy in terms of population and employment (Moreddu, 2013), especially in small farms (Melece, 2014); between 2005 and 2013 there was a reduction by almost one fifth in agricultural labour input in the EU-28 (Eurostat, 2015). These results demonstrate that the population living in rural areas is more likely to be exposed to poverty or social exclusion risk (Eurostat, 2014). Therefore, the diversification of farm activities, multifunctionality and pluriactivity become more significant solution for farms viability (Blad, 2010; Turtoi et al., 2013), especially for semi-subsistence farms (Davidova et al., 2013), where special attention is paid to diversification into non-agricultural activities; supporting the start up and growth of micro businesses. Some of them, which are recommended as a tool for income rising, are revitalizing food traditions and producing artisan or craft foods.

The development of local food systems (hereafter - LFSs), including short food supply chains (hereafter - SFSCs), as an innovation (Coudel et al., 2013; Kellou, 2014; eXtension, 2015), is a widely recognised tool for the further rural development via strengthening of small farm viability and rural population's business, and employment diversification (Kneafsey et al., 2013; Wisser et al., 2013; Melece, 2014; Schmid et al., 2014; eXtension, 2015). Furthermore, LFSs can create wider economic, environmental and social benefits such as transport cost savings, fewer emissions etc. (Wisser et al., 2013; European Network…, 2014). Moreover, the landscape value and quality of life in rural areas, the local food systems are the basis for other agricultural activity such as rural tourism (Sidali et al., 2013; Bessiere and Tibere, 2013) and recreation (e.g. agro-tourism, eco-tourism), supporting economic value for rural development (Schmid et al., 2012) offering opportunities for tourism and further positive associated economic impacts.

Consumers are increasingly interested in the food production/consumption system, which is aware of its individual, economic, social, cultural, environmental and geographical implications (Hernandez, 2009; Albisu, 2014). Recently, the relations between producers and consumers, so-called co-creation (Hoyer et al., 2010), has increased significantly (e.g. Borri et al., 2014), the products are largely determined by the consumers' wishes, the degree of awareness and preferences.

It is acknowledged on the European Union (EU) level, when the Committee of the Regions recognized that the LFSs can boost rural development and highlighted the benefits of LFSs, and proposed suggestions for improving local market access for farmers and food producers (European Network…, 2014). Local farming and direct sales are also supported by the European Parliament and the Council (2012), who stressed the necessity of EC report of new local farming and direct sales labelling scheme; and it is stressed in that stronger connections could be established between local agricultural, tourism and food supply sectors.

Taking into account the above mentioned considerations, the aim of the study was to assess the state and recent characteristics of the local food systems and its development in Latvia. The following tasks of study have been determined: to estimate the recent definitions, meanings and description of LFSs, AFN, SFSCs; to evaluate the typology and categorisation of

LFSs distribution channels and its existence in Latvia; to assess the number and activities (products) of small food producers such as home-made food producers, agricultural cooperatives and individual merchants.

Materials and Methods

This study is part of a broader research aiming at identifying development issues of local food systems in Latvia.

The study proceeds in three stages or phases:

- Firstly, to review the scientific literature, aimed at estimating the recent definitions, meanings and description of local food systems (LFSs), its relationship and differences with alternative food networks (AFNs) and short food supply chains (SFSCs);
- Secondly, to review literature and evaluate the state of typology and categorisation of the local food distribution or food chains, and characterise it in general, and particularly in Latvia by estimating web sites and information on the internet. In addition, it aims at describing new initiatives and activities, regarding local food system development;
- Thirdly, to investigate and analyse the data of Register of Food and Veterinary Service (FVS) for estimating the number and activities (by group of products) of small food producers (farmers), such as home-made food producers, agricultural service providing cooperatives and individual merchants.

Various sources of the materials and data have been used: the academic or scholar literature, legislation, reports and recommendations, as well as web pages, the internet and data from Food and Veterinary Service (FVS).

The appropriate research methods have been used in the study, mainly qualitative and also quantitative: monographic; analysis and synthesis, data grouping, logical and abstract constructive, expert, etc.

The food producers in this paper are both the producers of agricultural non-processed products and the processed food products.

Results and Discussion

The growing popularity of the local food and many studies and publications on it notwithstanding, there is still no academic or professional consensus on the term and definition of 'local food' (Johnson et al., 2013; Wuben et al., 2013). Moreover, there is no consensus what main factors or criteria are in need of defining either.

The scholars have different views, defining and describing the LFSs, Alternative Food Networks (AFNs) and SFSCs. Wuben et al. (2013) explain that the term of SFSC usually is associated with 'local food', alternative food networks and systems. However, Wuben et al. (2013) argue that the definitions of local food seem to emphasise geographical proximity, whereas definitions of SFSCs emphasise social relationships. These arguments are opposed by the opinion of number of scholars (e.g. Visser et al., 2013), who include the social interaction between the producers and consumers, and community, into the LFSs. Moreover, Porro et al. (2014) argue that geographical proximity is only one component of the definition of 'local'; and there are several other features that consumers usually associate with the definition of LFSs, in particular methods of production. But in any case, the central idea of LFSs is a commitment to social co-operation, local economic development, and a close geographical and social relationship between producers and consumers (Karner, 2010). Nevertheless, the main idea of the local food systems is a commitment to social co-operation, local economic development, and close geographical and social relations between producers and consumers, which are the main basis for food re-localisation (Renting and Wiskerke, 2010).

We accept the opinion that the SFSCs is as part of LFSs and relates to the distribution of food products with a regional orientation, short-circuiting the long, anonymous supply chain characteristic of conventional supply chains, and has the intention to generate extra added value; and increase profit for producers.

Table 1

Different types for extending the short food supply chains (SFSCs)

Face-to-face or direct	Proximate	Extended
Farm shops; Farmers markets; Roadside sales; Pick-your-own; Box schemes; Home deliveries; Phone, e-mail order; E-commerce.	Farm shop groups; Regional hallmarks; Consumer cooperatives; Community supported agriculture; Special events, fairs (articulation in time); Local shops, restaurants, tourist enterprises; Retailers (e.g. food or speciality shops); Catering for institutions (canteens, schools).	Brands or labels (certification; approving); Public food procurement; Catering services for institutions; Reputations.

Source: based on Renting et al., 2003; Hernandez, 2009; Galli, Brunori, 2013; Becheva, 2014.

Table 2

Direct sales categories and their existence in Latvia

Category	Description	Latvia
Sales at farm	Point of sale where a producer or a group of producers sells his products to the final consumer on the farm site.	Yes
Pick-your-own	Picking in the farms by the buyers (payment of the amounts collected).	Yes
Sale on the roadside	Sales by the producer of its own products alongside a road.	Yes
Markets (e.g. farmers, "Green")	Markets in which farmers and producers sell their products directly to consumer.	Yes
Ordered delivery	Deliveries of products ordered by phone, the internet at the customer's home or relay points.	Yes
Boxes	Boxes or baskets (individual or collective), e.g. vegetables and fruits, regularly delivered to relay points.	Yes
Fests, fairs	Producer takes part in an event, where he presents and sells his products.	Yes
Collective sale outlet	Retail outlet, managed by several producers who jointly organize the sale of their products.	Not known*

* - authors did not find any information
Source: authors' compilation based on their own research and Karner, 2010; Comps et al., 2011; Kneafsey et al., 2013; Moroney et al., 2013; Becheva, 2014; eXtension, 2015

The types and categories of distribution channels of LFSs and SFSCs

The types and categories of the LFSs and SFSCs (Table 1) are the following: 1) direct sale with several categories; 2) intermediate or proximate distribution, including different categories; and 3) extended territorially with only few categories (Treager, 2007; Renting et al., 2003; Hernandez, 2009; Becheva, 2014).

Apart from these types, there is also one option - self-security, where consumers are as producers, e.g. on allotments or community gardens.

The direct sale can be divided into: 1) sale on the production site; 2) sale outside the production site (e.g. farmers markets, roadside). The categories of the direct sale, its description and existence in Latvia presented in Table 2 demonstrate that practically all categories of the direct sale exist in Latvia.

Intermediate or proximate distribution or marketing channels generally include all marketing opportunities in the local supply chain that are not farmer-to-consumer transactions (Low et al., 2015), including consumers' initiatives (Table 3). Consumers' involvement or activities become apparent in the Community Supported Agriculture (CSA) that emphasises participation, civic responsibility, and volunteerism (Anderson et al., 2014). It is an alliance of concerned consumers and local farmers: the former agree to buy seasonal food from the latter, which are responsible of the delivery at the customers' homes (Hernandez, 2009).

In recent years, particular new types of LFSs (AFN) have developed, i.e. initiatives in which citizens play an active role in the initiation and operation of new forms of consumer – producer relations. Examples of such initiatives are consumer cooperatives and consumer purchasing groups (CPG) of local and organic food, which buy food products directly from primary producers/farmers. These groups are operating in several countries, including Europe, for example: GAS in Italy (Borri et al., 2014), AMAP in France (Lagane, 2015), GASAP in Belgium (Comps et al., 2011), similar initiatives have arisen in other countries European countries (Balazs, 2012; Becheva, 2014); and are supported by governments, RDP and other public or private institutions. For example, "Making Local Food Work" (UK) from 2007-2012, utilising GBP 10 million, has supported over 1,200 community food enterprises, inter alia, CSA, farmers markets, food coops and buying groups as well as country markets (Soil Association, 2012). Renting et al. (2012) these CPG groups as a new type of food chain named as Civic Food Networks (CFN), which go beyond direct-selling and marketing activities operated and initiated by producers, since consumers are the main initiators.

However, several scholars (Kneafsey et al., 2013; Becheva, 2014) argue that CPG (e.g. AMAP, GAS) are equivalent of CSA; other researchers feel that those are only kind of the CAS (e.g. Soil Association, 2012). We distinguish CPG as a separate category of the distribution channels, because there is no any other type or category of CAS in Latvia. Table 3 presents different categories of intermediate or proximate distribution channels of local food and its existence in Latvia. The development of CPG in Latvia is successful; and at present there are more than 15 CPG, which include around 500 members providing approximately 2,000 consumers.

Table 3

Intermediate distribution channels and its existence in Latvia

Category	Description	Latvia
Shops, supermarkets or specialised shops	Selling products to shops.	Approved*
Catering services (e.g. restaurants, rural tourists)	Selling products to another producer who will use them in meals, farm traditional catering.	Yes
Wholesaler	Sales of products through a professional seller who works directly with consumers.	Approved*
Cooperatives	Cooperative purchases members' products and sells them directly to consumers or retail.	Yes
Networks to promote regional products	Associative or public structures gathering local products from producers and organize the sale to consumers.	Not known**
Interdependent networks	Associations of producers and consumers jointly managing sale of food commodities.	Yes
Consumers' purchasing groups	Groups of consumers purchasing local food directly from farmers.	Yes
CSA	Consumers share the risks and rewards of production.	Not known**

* - approved producers; ** - authors did not find any information
Source: authors' compilation based on own research, Comps et al., 2011; Kneafsey et al., 2013; Moroney et al., 2013; Becheva, 2014; Borri et al., 2014; eXtension, 2015.

In Latvia, the CPG or direct purchase groups (Tiešās pirkšanas pulciņi) have formed over the last three years, and more than 15 groups in Riga and other cities (Sigulda, Cēsis, Valmiera, Smiltene, Ikšķile, Ādaži and others) have been established. The total number of involved families is more than 500 with 2,000 consumers, who are now cooperating more with more than 70 organic farmers, including home-made food producers (Tiešā pirkšana, 2014). All activities regarding ordering and distribution of the food products are performed weekly on voluntary basis periodically for each member to guarantee the opportunity to buy organic food at affordable prices. The system operates on the basis of initiatives and does not require financial contributions - merely time. Each group establishes the most suitable arrangements; on average this duty takes about 4 hours once a month or two months.

Furthermore, even some fruitful initiatives and activities, which support local food systems' development in Latvia (Melece, 2014) have been realised. These are associated with: 1) combining the home-made or artisan food producers and craftsmen in the societies or projects at both national and local level, for example, Society „Artisan food producers", the project "Local Identity Product (LIP) – sustainable support systems for communities in Europe" with the brand "Local Identity Product (LIP)", the project created to represent all kinds of farms and companies in the countryside under the brand "Country Goodies"; 2) establishing the cooperatives for marketing and selling of local food, in which smaller food producers and farmers participate. For instance, Agricultural Services Cooperative Society (ASCS) „Saime" (Family) has launched a project for the retail chain „Maxima" (LPKS Saimes galds, 2014).

Producers of local food in Latvia

The producers of local food may be divided into several groups by ownership: farms, farmers' cooperatives and individual merchants (mainly fishermen in Latvia). However, the small food processing enterprises in the status of Limited Liability Company are also involved on SFSC; they are not included in this study, because the main accent of study is put on farmers as potential and aimed receivers of added value.

Latvia lacks national rules or regulations, and it has only guidelines that define and regulate the home-made production, and it falls under the same EU Regulations as large-scale producers. Moreover, the recommendations of Guidelines of Good Hygiene Practice are interpreted by FVS officials differently. It means that development of small local food producers, such as home-made producers, occurs contrary to the current regulatory framework. There is another practice in several EU countries and, moreover, the Latvian practice differs from EU recommendations. For example, in Hungary, in 2006 there were regulations for the small-scale producers adopted to ease food hygiene conditions for natural persons producing and selling products in small quantities; and in the 2010 amendment to the regulation increased the quantities for selling and allowed small-scale producers living in any part of the country to sell their products in the capital (Balazs, 2012). In spire of that,

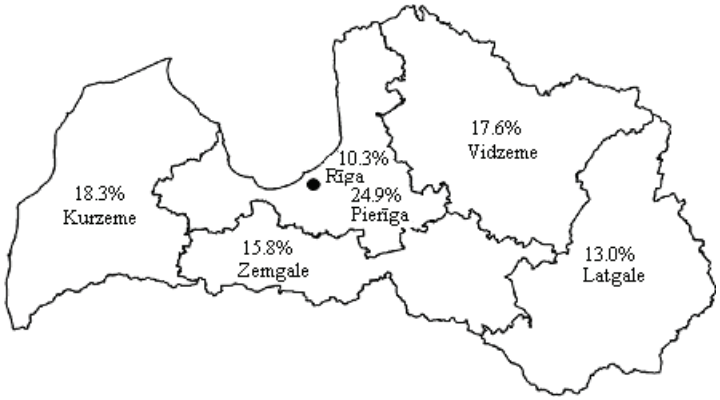

Figure 1. The share (%) of registered home-made food producers in the Latvia's regions.
Source: authors' compilation based on data of the Register of FVS, 2015.

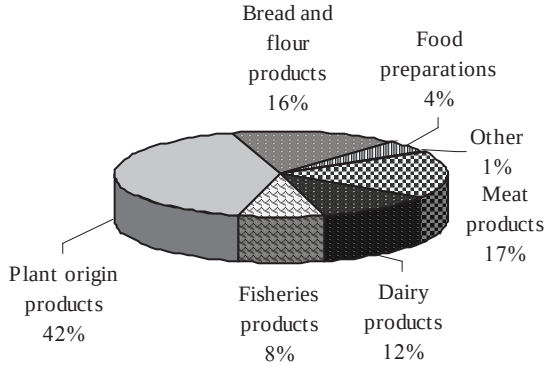

Figure 2. The share (%) of main home-made food producers by the product group.
Source: authors' compilation based on data of the Register of FVS, 2015.

the EU regulations hamper development of short food supply chains, in many cases it has been shown that it is possible to carry out an adaptation of regulations at the level of EU Member States within the same European regulatory framework (Galli and Brunori, 2013).

The total number of home-made food producers and processors (hereinafter – producers) was 1,287 in the beginning of 2015. Majority of them are located near the capital Riga (Pierīga region – 24.9%) and in Riga (10.3%) (Figure 1).

Even though this is due to the proximity to reach consumers, it generally does not contribute to the diversification and income generation of the small farmers in marginal regions, particularly Latgale. Therefore, it does not stimulate interaction between the producers and consumers and the involvement of communities and consumers into development LFSs and SFCSs, especially CAS. Besides, there is a very high proportion (about 70%) of unregistered home-made producers due to legislative requirements (Latvijas lauku..., 2009).

The main part of home-made producers is involved in production of plant origin products and bread and flour products, 42% and 16%, respectively, but the smaller part produces animal origin products (Figure 2).

In our opinion, the plant origin products are less regulated and it is easier to receive permission to sell products in the retail chain, including public catering.

The numbers of food producing farms, individual merchants and cooperatives have been approved by the FVS (Table 4). This allows receiving the permit to sell the products to retail (shops, supermarkets, restaurants and catering).

Table 4

Number of approved producers by producers' ownership and main products' group

Group of products	Farm	Cooperative	Merchant
Meat of domestic ungulates	18	2	0
Plant origin products	15	3	1
Milk and milk products	7	34	0
Packed honey	5	0	0
Meat products	3	1	1
Fisheries products	3	4	6

Source: authors' compilation based on data of Register of FVS, 2015.

Despite the high consumers' preference of local products (Melece, 2012; Bikernieks and Eglite, 2014), there is a lack of supporting policy or programming document for local food and SFSCs further development. It is especially true about supporting the CAS initiatives, including the consumers' groups and cooperatives.

Conclusions

1. The development of LFSs, including SFSCs, as an innovation, is a widely recognised tool for the further rural development via strengthening of small farm viability and diversification; creating income and diversifying employment. Furthermore, LFSs can create wider economic, environmental and social benefits such as transportation cost savings, fewer emissions; and are the basis for other agricultural activity such as rural tourism and recreation, supporting economic value for rural development.
2. The types with corresponding categories of the LFSs and SFSCs are the following: 1) direct sale with several categories; 2) intermediate or proximate distribution, including different categories; 3) extended territorially with only few categories. Practically all categories of distribution types exist in Latvia, except Community Supported Agriculture (CSA), in which consumers' active involvement is provided.
3. Some fruitful initiatives and activities, which support local food systems' development in Latvia, out of which the most significant are two: 1) branding, e.g. brand "Country Goodies", which promotes rural tourism and recreation, including farm visits, food and culinary services; 2) active and successful participation of consumers in the LFSs development, organising the consumer purchasing groups (CPG) have been realised. Some scholars single these groups out as a new type, named Civic Food Networks (CFN), in which consumers are the main initiators.
4. The development of local food producers, which are connected with agricultural production (e.g. farmers and agricultural cooperatives), shows that the total number of home-made food producers is 1,287. Majority of them are located in the capital Riga and its region (Pierīga), due to the proximity to reach consumers. In general, it does not contribute to the diversification and income generation of smaller farms in marginal regions, particularly Latgale; it does not stimulate interaction between the producers and consumers, including involvement of the communities and consumers into development of CAS.

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References

1. Albisu L.M. (2014) From Local Markets to International Trade: Logistics and Debate on the Food Miles Concept. *Mediterra 2014*, pp. 417-429.
2. Anderson C.R., Brushett L., Gray T.W., Renting H. (2014) Working together to build cooperative food systems [Editorial]. *Journal of Agriculture, Food Systems, and Community Development*, 4 (3), pp. 3-9.
3. Balazs B. (2012) Local Food System Development in Hungary. *International Journal of Sociology of Agriculture and Food*, 19 (3), pp. 403-421.
4. Becheva S. (2014) Short food supply chains: value for agro-ecology. Available at: http://organic-congress-ifoameu.org/wp-content/uploads/2014/03/8EOC_Becheva.pdf, 3 December 2014.
5. Bessiere J., Tibere L. (2013) Traditional food and tourism: French tourist experience and food heritage in rural spaces. *Journal of the Science of Food and Agriculture*, 39 (14), pp. 3420-3425.
6. Bikernieks A., Eglite A. (2014) The Consumer's Choice of Branded Products Conformity to National Identity: Case of the Baltic States. Research for Rural Development 2014, 2, pp. 215-222.
7. Blad M. (2010) Pluriactivity of farming families - old phenomenon in new times. *Rural Areas and Development*, 7, pp. 155-160.
8. Borri I., Borsotto P., Aguglia L. (2014) A meeting point between agricultural producers and consumers: the Italian Solidarity Purchasing Groups case study. Available at: http://ifsa.boku.ac.at/cms/fileadmin/Proceeding2014/WS_2_8_Borri.pdf, 7 March 2015.
9. Comps S., Claustriaux J-J., Vandercammen M., Horge E., Lebailly P. (2011) Local food systems in Walloon Region (Belgium): definition and trends in supply and demand. Available at: http://www.gembloux.ulg.ac.be/eg/publicationseconomieagricole/doc_download/179-local-food-systems-in-walloon-region-belgium--definition-and-trends-in-supply-and-demand, 17 December 2014.
10. Coudel E., Devautour H., Soulard C.T., Faure C.T.G., Hubert B. (2013) *Renewing Innovation Systems in Agriculture and Food: How to Go Towards More Sustainability*? Wageningen Academic Publishers, Wageningen, 240 p.

11. Davidova S., Bailey A., Dwyer J., Erjavec E., Gorton M., Thomson K. (2013) *Semi-subsistence farming: value and directions for development*. European Union, Brussels, 115 p.
12. European Network for Rural Development (ENRD) (2014) Local Food and Short Supply Chains. http://enrd.ec.europa.eu/enrd-static/themes/local-food-and-short-supply-chains/en/local-food-and-short-supply-chains_en.html, 4 March 2015.
13. European Parliament and Council (2012) Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs. *Official Journal of the European Union*, L 343, pp. 1-29.
14. Eurostat (2014) *Living conditions in Europe.* Publications Office of European Union, Luxembourg, 129 p.
15. Eurostat (2015) *Agriculture, forestry and fishery statistics: 2014 edition*. Publications Office of the European Union, Luxembourg, 200 p.
16. eXtension (2015) An Evolving Classification Scheme of Local Food Business Models. http://www.extension.org/pages/70544/an-evolving-classification-scheme-of-local-food-business-models#.VP7Y_468q2B, 18 February 2015.
17. Food and Veterinary Service (FVS) (2015) Register. Available at: http://www.pvd.gov.lv/, 3 March 2015.
18. Galli F., Brunori G. (2013) *Short Food Supply Chains as drivers of sustainable development*. Laboratorio di studi rurali Sismondi, Pisa, 93 p.
19. Hernandez J.L.S. (2009) Alternative Food Networks: Concept, Typology and Adaptation to the Spanish Context. *Boletin de la A.G.E. N.,* 49, pp. 375-380.
20. Hoyer W.D., Chandy R., Dorotic M., Krafft M., Singh S.S. (2010) Consumer Cocreation in New Product Development. *Journal of Service Research*, 13 (3), pp. 283-296.
21. Johnson R., Aussenberg R.A., Cowan T. (2013) The Role of Local Food Systems in U.S. Farm Policy. Congressional Research Service. Available at: http://fas.org/sgp/crs/misc/R42155.pdf, 3 February 2015.
22. Karner S. (ed) (2010) *Local Food Systems in Europe: Case Studies from Five Countries and What They Imply for Policy and Practice*. Graz: IFZ publisher, 52 p.
23. Kellou I. (2014) Alternative Food Systems: The Case of Agri-food SMEs. In: *Proceedings in System Dynamics and Innovation in Food Networks 2014*, pp. 155-160.
24. Kneafsey M., Venn L., Schmutz U., Balazs B., Trenchard L., Eyden-Wood T., Bos E., Sutton G., Blackett M. (2013) *Short Food Supply Chains and Local Food Systems in the EU. A State of Play of their Socio-Economic Characteristics*. Publications Office of the European Union, Luxembourg, 125 p.
25. Lagane J. (2015) When students run AMAPs: Towards French model of CSA. *Agriculture and Human Values*, 32 (1), pp. 133-141.
26. Latvijas Lauku Sieviešu apvienība (2009) Lauku mājražotāju uzņēmējdarbību kavējošo un veicinošo faktoru izpēte un veicinošo aktivitāšu apzināšana un ierosināšana (Research of hindering and facilitating factors of the home-made entrepreneurship, and identification of contributing activities and its initiation). LLS, Rīga, 39. lpp. (in Latvian).
27. Low S.A., Adalja A., Beaulieu E., Key N., Martinez S., Melton A., Perez A., Ralston K., Stewart H., Suttles S. et al. (2015) *Trends in U.S. Local and Regional Food Systems: A Report to Congress*. U.S. Department of Agriculture, Washington, D.C., 86 p.
28. LPKS Saimes galds (2014) Saimes galds (Family Table). Available at: http://www.saimesgalds.lv/, 19 December 2014. (in Latvian).
29. Melece L. (2012) Local food systems for sustainable rural development. *Economic Science for Rural Development,* 27, pp. 152-158.
30. Melece L. (2014) Local Food Systems and their Development in Latvia. *Management Theory and Studies for Rural Business and Infrastructure Development*, 36 (2-3), pp. 588-598.
31. Moreddu C. (2013) Factors and Policies to Favour Diversification of Rural Economy: OECD Experience. Policies to Enhance Agricultural Innovation and Productivity - Workshop, Beijing, 24 October 2013. Available at: http://www.oecd.org/agriculture/agricultural-policies/Moreddu-Session%20I%20Factors%20and%20Policies.pdf, 25 January 2015.
32. Moroney A., O'Shaughnessy M., O'Reilly S. (2013) *Facilitating and Encouraging Short Food Supply Chains*. National Rural Network, Ireland, 40 p.
33. Porro A., Ferrazzi G., Spigarolo R., Corsi S., Bocchi S. (2014) Local Food Systems: Opportunities and Threats in creation of local model in Lombardy (IT). In: *Proceedings of 11th European IFSA Symposium on Farming systems facing global challenges: Capacities and strategies*, 1- 4 April 2014, Berlin, Germany, pp. 1622-1630.

34. Renting H., Shermer M., Rossi A. (2012) Building Food Democracy: Exploring Civic Food Networks and Newly Emerging Forms of Food Citizenship. *International Journal of Sociology of Agriculture and Food*, 19 (3), pp. 289-307.
35. Renting H., Marsden T.K., Banks J. (2003) Understanding alternative food networks: exploring the role of short food supply chains in rural development. *Environment and Planning*, 35 (3), pp. 393-411.
36. Renting H., Wiskerke H. (2010) New Emerging Roles for Public Institutions and Civil Society in the Promotion of Sustainable Local Agro-Food Systems. In: *Proceedings of the 9th European IFSA Symposium on Building sustainable rural futures*, Vienna, Austria, 4-7 July 2010, pp. 1902-1912.
37. Schmid O., Padel S., Levodow L. (2012) The Bio-Economy Concept and Knowledge Base in a Public Goods and Farmer Perspective. *Bio-based and Applied Economics*, 1 (1), pp. 47-63.
38. Sidali K.L., Kastenholz E., Bianchi R. (2013) Food tourism, niche markets and products in rural tourism: combining the intimacy model and the experience economy as a rural development strategy. Journal of Sustainable Tourism. Available at: http://dx.doi.org/10.1080/09669582.2013.836210, 27 February 2015.
39. Soil Association (2012) Buying Groups: A Viable Supermarket Alternative? Soil Association, Bristol, 12 p.
40. Tiešā pirkšana (2014) Kas ir tiešās pirkšanas pulciņi (Direct Purchase. What is direct purchase groups? Available at: http://tiesapirksana.lv/kas.html, 9 March 2015. (in Latvian).
41. Turtoi C., Toma C., Gavrilescu C. (2013) Opportunities for Other Gainful Activities in Small and Very Small Farms. *Bulletin UASVM Horticulture*, 70 (2), pp. 390-398.
42. Visser J., Trienekens J., van Beek P. (2013) Opportunities for Local for Local Food Production: A Case in the Dutch Fruit and Vegetables. *International Journal on Food System Dynamics*, 4 (1), pp. 73-87.
43. Wubben E.F.M., Fondse M., Pascucci S. (2013) The importance of stakeholder-initiatives for business models in short food supply chains: the case of the Netherlands. *Journal on Chain and Network Science*, 13 (2), pp. 139-149.

IMPLEMENTATION OF MANAGEMENT FUNCTIONS: BASED ON THE EXAMPLE OF NON-GOVERNMENT ORGANISATIONS IN KAUNAS DISTRICT

Lina Marcinkevičiūtė, Jan Žukovskis
Aleksandras Stulginskis University, Lithuania
Lina.Marcinkeviciute@asu.lt; Jan.Zukovskis@asu.lt

Abstract
This article deals with conception and particularity of management process and functions of non-governmental organisations (hereinafter referred to as NGO), as well as peculiarities of management functions of NGO.
Empirical research results of implementation of NGO management functions in Kaunas District have been presented, the major advantages and disadvantages of implementation of NGO management functions in Kaunas District have been pointed out. With reference to the data of theoretical analysis and empirical research, the directions towards development of problematic areas of NGO management functions have been indicated and justified, highlighting the elimination of drawbacks to the implementation of management functions.
Key words: management functions, non-governmental organisations, directions towards activity development.

Introduction

For the purposeful performance of the system of every organisation, its members and elements, there is a need for a specific activity that can be treated as the entirety of specific actions: management. The content of management as a specific activity depends on various features of an organisation: large or small, informal or regulated, local or international, etc.

In the scientific literature, there is a wide range of classifications of management functions. The authors of the article hold the opinion that the functions of goal formation and motivation have not been distinguished in the classical classification of management functions. These functions are highly significant to the process of management. Goal formation is the initial and final point of the process of management, while the function of motivation is important for the staff of the organisation to carry out productive work, having impact on their material well-being and psychology.

Non-governmental organisations are a part of Lithuanian civil society. They can provide great benefit with little finances as NGO is based on the principle of voluntarism and attracts financing from various funds. More and more social-cultural associations occur in the rural areas (community centres, youth centres, unions of the disabled, gyms, etc.), which are concerned about the support for the people, who experience social exclusion, families at social risk, individuals who are not able to fend for themselves, etc. That is why this article aims at analysing the most common type of NGO in the rural areas: an association (in this case, associations in Kaunas District), focusing on community centres, youth centres, unions of the disabled, Kaunas District Local Action Group, etc.

The object of the research: implementation of management functions in the NGO

The aim of the research: to identify and justify the directions towards the development of NGO management functions in Kaunas District

The objectives of the research:

1. To theoretically analyse the implementation of management functions in the NGO activity.
2. To determine advantages and disadvantages of implementation of NGO management functions in Kaunas District.

The methods of the research: analysis and synthesis of scientific literature, analysis and synthesis of documents, survey of NGO managers and members.

Materials and Methods

Theoretical analysis of the implementation of NGO management functions

Management functions in various organisations are implemented in different ways. These functions should be properly adapted for NGO as their nature of activity is specific, based on voluntary principle. In the scientific literature (C. Rees (2008), L. Sheal (2004)), it is manifested that NGO is characterised by its particularity of management and distinctive means of management.

Goal formation can be indicated as the first management function in any organisation. L. Marcinkevičiūtė and J. Žukovskis (2007) state that a goal is a guide of organisational activity, the achievement of which all present activities of the organisation depend on. In order to achieve goals of the organisation, there is a need for purposeful activity, concentration on the actions. *The main assumption of the goal formation is that people will work better and more if they know clear and understandable goals to be achieved.*

Involvement of employees into the process of goal setting should be emphasised. Especially NGO, where the activity of members is based on voluntarism. The managers of the organisation should be aware of the conditions for the involvement of members in the goal setting that would ensure the involvement of members when forming goals. Personal goals of members

should be integrated into general organisational activity with the support of collective efforts of members and managers.

The Code of Ethics and Conduct for NGOs was initiated by the World Association of Non-Governmental Organisations (WANGO) in 2008. It focuses on setting NGO goals higher than personal goals. The interests of the organisation should be put ahead of individual desires. This is especially accentuated for the members of the Board, working in the body of NGO management. For volunteers working for an organisation, personal goals should not be more important than organisational goals. Carrying out duties as volunteers, they should strive for the benefit for the society but not themselves. On the other hand, every member joining the organisation tries to achieve personal goals as well: to actualise professional capabilities, find friends and peers, etc. As a result, integration of personal goals into organisational activity is particularly important. Having integrated personal goals of members into organisational activity, the pursuit of organisational goals will evoke the pursuit of personal goals.

In rural areas, there are rural communities, youth centres, as well as other NGOs, the activity of which is oriented towards the satisfaction of needs for a specific target group of residents and representation of their interests. As it has been already mentioned, the establishment is based on the principle of voluntarism. The goals are formulated with regard to the problems of the area and needs of residents. However, the goals are not always achieved successfully. Certain obstacles come across that raise difficulties to achieve organisational goals successfully. According to the data of the scientific literature, (Park et al., 2009) the goals are not often achieved due to the lack of financial resources, scarce competences of members or manager, and lack of knowledge. One more important aspect is lack of specialists. Non-governmental organisations, especially rural communities, are lacking qualified specialists that would advise community members on topical issues. It is also challenging to attract new members: volunteers involved into community activity as there is no pay for the participation.

The second function of management is *planning*. J. Pakhare (2011) points out that planning is an endless course of actions. For the managers it is necessary to evaluate the activity stage that an organisation takes place and where it will be next year. For this reason, an action plan is formed and implemented to make an organisation achieve its goals. In order to analyse how the function of planning is implemented in the organisation, it is necessary to find out how the goals are set and means are chosen to achieve these goals. If the goals are achieved by implementing the means, determined in the plan, the system of planning can be evaluated as affective, if not, the system of planning should be changed or improved.

NGO action plan helps managers focus on the main ideas, indicate the most effective methods to achieve organisational goals and plan resources. In *the Management Quality Standard of NGO and Social Non-profit Partners* (2003) it is stated that all individuals involved in the organisational activity should participate in the planning process. It is really important to involve members of the organisation in the planning process because this will ensure successful performance of tasks and working towards goals. When planning organisational activity, it is essential to foresee whether there is a connection between the goal, set tasks and determined activities, whether members support the implementation of the plan or not. *Another important step is advertising the plans of NGO activity in public places such as websites, information board of the organisation, etc. The more people know about NGO activity, the more chances that it will attract more volunteers. The members of the organisation should know about the prospects for organisational activity as well.* E. James (2011) suggests that members of the society would easier become financial supporters and volunteers and would be involved in the significant NGO activity if the organisation was more visible and known.

Taking into account planning process of the activity, it should be pointed out that it is impossible to foresee all unexpectancies of the planned activity. Certain obstacles occur that consistently interfere the planning of the organisational activity. In non-governmental organisations, planning obstacles often occur due to external factors of organisation environment (political, economic, etc.), unexpected events, time, costs, etc. Insufficient communication between managers and members of the organisation is also an important aspect. In *the Management Quality Standard of NGO and Social Non-profit Partners* (2003), it is stated that consistently described and well-known procedure of information spread for all people conditions the exchange of necessary and general information among the members of the organisation on what is going on in the organisation and its planned activities.

Taking into account *organising*, Y. Olum (2010) observes that the purpose of organising, as a management function, is to describe the role of every element in the organisation, to determine their relationships so that there would be favourable conditions to achieve goals. According to D. Valentine (2011), organising covers the delegation of powers, allocation of rights for employees, formation of duty descriptions, rules and procedures to regulate the work, etc.

The Code of Ethics and Conduct for NGOs (2008) suggests that NGO should have organisational documents, executive board, and managers, regularly arrange meetings and perform its activity. There is clear distribution of work, described responsibility areas, tasks and a responsible person. The organisational documents, i.e. statues or establishment agreement, should clearly describe the mission, goals, management structure, membership rights and liabilities (if any) and rules of internal procedure of the organisation. The documents should fully describe the structure of management in the organisation and be available to all interested groups.

Considering distribution of work for NGO members, it should be pointed out that job specialisation is important as it enhances efficiency of the organisational activity because the performed tasks are not duplicated. *The Management Quality Standard of NGO and Social Non-profit Partners* (2003) highlights that proper distribution of work in the organisation prevents from leaving tasks that do not belong to any of its members and tasks performed by several employees of the organisation. Distribution of work in the organisation optimises the load for the organisation members and enhances the efficiency of the performed work. Therefore, it is essential to clearly describe the distribution of tasks and responsibility areas for an individual member. *It should be noted that job descriptions, describing functions of certain positions and responsibility areas, contribute to this.*

L. Marcinkevičiūtė (2010), T. Mullern, A. Styhre et al. (2011) describe *motivation* as an activity stimulation process between one and others, when achieving personal or organisational goals. The results of work will be better when employees are not only explained what they are expected to do, but they are given what they desire. As L. Antic, V. Sekulic (2009) state, a motivated employee is proud of his/her work, he/she does not show negative attitude towards organisation, he/she is dedicated to his/her job and satisfied with it. According to U. Eriksson-Zetterquist, T. Mullern and A. Styhre (2011), employees' motivation and satisfaction with the job influences the culture of organisation, identifies the quality of its results and effectiveness of management.

Members-volunteers work in rural communities and other NGOs. People assume certain duties and perform beneficial work for community without receiving any pay for it. M. Binder and A. Freytag (2013) (according to Wilson, 2000)) assume that volunteering is any activity, which is performed in one's free time pursuing benefit for other person, group or organisation. L. Marcinkevičiūtė (2010) believes that volunteering motivates to continue such activity if the activity is likeable, clear structured and a volunteer feels a part of it. It should be pointed out that motivation of volunteers should not be left "on their own", voluntary work should be constantly motivated.

In order to keep motivation for NGO members, mutual relationships of members and a manager are extremely significant. If the interaction between members and a manager is not satisfactory, there is a huge possibility that members will avoid interaction and become passive. Constant communication and open relationship are particularly important to maintain motivation of volunteers.

Taking into account a *management function*, R. Tijūnaitienė and B. Neverauskas (2009) suggest that governance is one of the most important functions of a manager, which is related to interpersonal aspects of management, allowing employees to understand the goal of organisation and stimulating to achieve them effectively. A manager transforms the totality of individuals into a group working purposefully and effectively. Management is especially important as it helps the group keep together and focus on the achievement of goals.

NGO management should be democratic, although, in exceptional cases, management can have non-democratic features as well if it is related to the activity which requires strict hierarchical structure. It is important to ensure that the management structure of NGO and indication of member's rights and duties would not prevent him/her from voluntary exit from organisation.

In the scientific literature Y. Stukalina (2010) a *control function* is treated as a systematic process, which ensures the achievement of goals in the organisation. The goal of control is to evaluate the carried out work and correct work process (if needed), trying to ensure effective achievement of organisational goals and implemented plans. Control allows managers to monitor the effectiveness of planning, organising and management functions, as well as take actions to correct something during their implementation.

Certain features help to determine whether the control in the organisation is effective or not. As A. Stoner, R. Freeman (2006) state, they are: strategic purposefulness, orientation towards results, correspondence, suitable control time, flexibility, and simplicity. Non-governmental and other organisations both should control their employees in moderation; otherwise, there is a possibility that employees will suffer from high tension and dissatisfaction about work.

According to the data of the researches, there is a tendency that management of non-governmental organisations notably shows resemblance to the management of small or medium business companies. NGO follows the same principles of planning, management and accountability, applied in the

business sector. NGOs that provide services compete against service providers of business and budgetary sector. Within the employment relationship, more professionalism is noticeable, work processes become more formalised and standardised, the activity of NGO is oriented towards measurable results.

Results and Discussion

Empirical research results of implementation of NGO management functions in Kaunas District

In order to determine how management functions are implemented in NGO activity in Kaunas District, 24 managers and 34 members of associations have been questioned.

When analysing participation of NGO members in goal formation, it has been found out that the Chairman and the Board (70%) are those who usually participate in goal formation. The crucial obstacles interfering goal formation in the organisation such as lack of financial resources, lack of different specialists, lack of competence and knowledge, as well as insufficient number of new members, have been identified.

Note that rural communities and other NGOs run projects and receive funding, however, the data of the research have proved that it is simply not enough. It is necessary to look for opportunities to attract additional funding. One of the possibilities is promotion of social entrepreneurship. A part of received financing could be intended for NGO goal implementation. When implementing projects or preparing organisational strategy, there is a lack of knowledge and competence regarding certain issues. As respondents point out, *the courses organised by the specialists are very general, they do not focus on specific problems. Classical examples provided by the specialists are hardly adapted in particular situations of organisational activity.* Therefore, rural community centres are often advised by other organisations, for instance, a local action group, administration of the municipality, etc. Insufficient number of new members is also a very significant obstacle, which interferes the implementation of desirable goals. It is difficult to attract volunteers as there is no pay for voluntary activity.

When analysing problems related to activity planning, it has been indicated that 50% of organisations participating in the survey plan their activity according to the existing situation. *The assumption can be made that managers of the organisations do not prepare strategic plans.* As they state, the main planning obstacles remain lack of time and high costs for social services.

Analysing the organising of NGO activity, it has been found out that most of organisations (80%) have organisational management structure, which is officially drawn in the organisational documents. Work cooperation and acquisition of qualification as well as its development, schedule of work and leisure and good working conditions are in respondents' favour.

Answering to the question whether they are satisfied with the work in the organisation, 82% of respondents responded positively. Having evaluated their work personally, volunteers improve themselves and activities are performed more effectively.

50% of NGO managers indicated non-monetary means of motivation, including evaluation of work, freedom to make decisions, possibilities for self-expression, qualification improvement and other.

The survey enquired about the means of motivation that would motivate members most. The answers have been divided as follows: 38% of members indicated freedom to make decisions as the priority, 37% of members highlighted the relationship with the manager and other members, 36% of respondents that manager's praise for a good performance of activity is also very important. The fourth place belongs to organisation of member leisure. This statement has been indicated by 34.3% of respondents. Certificates of appreciation take the fifth place. Certificates of appreciation express gratitude for cooperation and participation in various events. By receiving certificates of appreciation volunteers feel evaluated. Both managers and members evaluated mutual relationship positively.

The question on whether the members in the organisation are provided with opportunities for personal growth and development has been answered as follows: 50% of managers state that, according to their needs, members are provided with opportunities for personal growth and development, *21% of managers noticed that no opportunities for personal growth and development exist in their organisation. It can be assumed that the members of the latter organisations have no opportunities for development. Disregard of opportunities for personal growth and development may cause members professional degradation.*

When analysing implementation of a management function in the organisation, it has aimed at types of essential management principles. Among underlying principles of management, principles of orientation balance, personal independence and orientation towards the goal have been mentioned.

When evaluating the implementation of control function, it has been determined that the main control functions in the organisations are correction, diagnosis, encouragement, and spread of experience. The main disadvantage is that organisations lack orientation and evaluation control functions. These functions are especially important as the controlled activity of a member has greater meaning.

Table

Directions towards the implementation development of NGO management functions

Directions towards the implementation development of NGO management functions		Responsible persons
Development directions towards goal formation	***Clear and motivating formulation of organisational goals*** Presentation of organisational goals for existing and new members to make goals comprehensible ***Purposefulness of goals and orientation towards plans*** Goal formation, taking into account the mission of organisational activity ***Search of financial sources for successful implementation of organisational goals*** Search of sponsors, fund-raising in the streets, during events, requests to donate in media, on the radio, etc.	Manager, board, members
Development directions towards activity planning	***Preparation of strategic activity plans*** Formation of a strategic planning group and acquisition of necessary skills and knowledge. ***Formalisation of organisational activity and publication in public places*** Preparation and approval of activity plans, publication on the website, on the noticeboard of the organisation, etc. ***Reduction of costs by using the time of work intended for planning.*** Determination of activity priorities and personal time planning	Manager and board
Development directions towards activity organising	***Clear and concrete distribution of work for members of the organisation*** Appropriate selection of work, considering health condition, age, competence of a member ***Determination of rational ways when coordinating members' work*** Indication of crucial instructions, supervision of executable tasks ***Organising regular meetings and taking the minutes of their process*** Constant organisation of meetings by writing and approving the minutes ***Preparation and formalisation of organisational documents*** Archiving of organisational documents	Manager and board
Development directions towards motivation of members	***Constant opportunities for personal growth and development*** Participation in various trainings, seminars during a rotary period ***Application of various forms of leisure inside and outside the organisation*** Organising business trips and travels, commemoration of traditional festivals	Manager
Development directions towards management of members	***Application of principles of control and orientation towards the goal*** Implementation of principles of control and orientation towards the goal in the organisation	Manager
Development directions towards control maintenance	***Employment of orientation, assessment and feedback control functions*** Implementation of orientation, assessment and feedback control functions in the organisation	Manager

Directions towards the development of NGO management functions in Kaunas District.

Based on the theoretical analysis of NGO management functions and empirical results of the research on implementation of NGO management functions in Kaunas District, the directions towards implementation development of NGO management functions have been mentioned (Table).

Development directions towards goal formation.

Members will work efficiently and try to achieve better results if they perceive organisational

goals. Existing and new volunteers both should be acquainted with organisational goals. Otherwise, a member will be disappointed with volunteering and will perform tasks without any motivation if he/she does not understand the purpose of the organisation and his/her level of responsibility.

Financial resources for NGO should be found through sponsors; fund-raising should be performed during various events; media, radio or television should request people to donate, to sell various handicrafts, postcards, souvenirs, etc. Search of financial resources should be considered strategically. A positive effect would be: successful implementation of organisational goals and achieved desirable results.

Development directions towards activity planning.

When preparing strategic plans, it is necessary to form a strategic planning group that would set long-term goals and would choose the ways of how to achieve these goals. Importantly, a strategic planning group should have knowledge and skills in management of communal organisations. A positive effect would be: forecast of future plans, consolidated effort of members to achieve mutual NGO goals, reasonable distribution of resources by determining priorities of activity, indication of crucial issues and their effective solution. It is not enough only to prepare and formalise an action plan. Publication of NGO action plan in public places: on the website (if such exists), organisational noticeboard, billboard, etc. A positive effect would be: more efficient work of NGO members, more opportunities to attract volunteers.

Development directions towards activity organisation.

Work specialisation should be purposeful as the effectiveness of works performed in the organisation depends on it. Work of NGO members should be coordinated properly. Purposeful coordination of work allows forming substantial instructions: what, who and when should be done. A positive effect would be: to assure continuous work.

In order to make activity of NGO formal, it is necessary to prepare organisational documents and formalise them appropriately. A volunteer joining the organisation should receive all necessary information about the organisation: its mission, goals, present activity, etc. Moreover, the manager of the organisation should introduce a new member with working place, his/her duties, and rules of internal procedure. A positive effect would be: a positive image of the organisation, more productive activity of the organisation.

Development directions towards motivation of members.

Increasing number of members in the organisation can be treated as constant exercising of competences and skills to achieve common organisational goals. It is necessary to arrange various trainings so that members had a possibility to acquire proper competences and skills. These trainings and seminars should be arranged during a rotary period. Consistent personality education of NGO members would provide further basis to improve work results. A positive effect would be: greater motivation to work, better work results.

Organising leisure for NGO members provides opportunities to actualise self-expression and needs for communication, educate cultural consciousness through artistic, intellectual or other activity. Regular leisure organisation reduces the feeling of alienation, fosters discovery of sociality, common interests and concerns. Managers of NGO should practice different forms of leisure organisation: sport activities, art events, extreme activities and other forms. Furthermore, business trips and travels should be organised, traditional festivals should be celebrated to enhance interests and benefit for volunteers. A positive effect would be: increased sociality and reduced feeling of alienation among members, development of common interests and hobbies.

Development directions towards management of members.

Principle of control signifies continuous yet not one-time control. Proper behaviour of employees should be ensured in the organisation, property of the organisation should be protected, any activity area should be controlled, etc. Orientation towards goal principle means that the orders of the manager should not be alienated from the main goal. Implementation of these principles would stimulate effective management in the organisation. A positive effect would be: more successful management and decreased number of mistakes.

Development directions towards control maintenance.

Orientation and evaluation control function highlight the control of members' work. Usually, the controlled work of members is more effective than less controlled; without any control it becomes less meaningful. Feedback is the drive of the organisation. Members exchange the information and learn whether they carry out their tasks properly. If no feedback is received, a member does not know what a manager thinks about his/her work and what the expectations are. The most effective way to ensure feedback in the organisation is to arrange constant meetings for

members and managers, during which different issues would be considered. A positive effect would be: effective implementation of tasks and set goals, better mutual relationships between members and managers.

Conclusions

1. NGO management notably shows resemblance to the management of small or medium business companies. NGO follows the same principles of planning, organisation and management, applied in the business sector. NGO that provides services competes against service providers of business and budgetary sector. Within the employment relationship, more professionalism is noticeable, work processes become more formalised and standardised, activity of NGO is oriented towards measured results.
2. NGO management functions in Kaunas District are implemented incompletely as the implementation of each of them has crucial disadvantages. *The following NGO management disadvantages are distinguished:* inappropriate goal formation, absence of organisational activity oriented towards future, unclear specialisation of work, control functions of evaluation and feedback are ignored.
3. Six problematic areas of implementation development of NGO management functions, focusing on the elimination of disadvantages of management functions implementation have been identified and justified (oriented towards goal formation, planning, organising, motivation, management and control).

References

1. Antic L., Sekulic V. (2009) Organizing as the phase of management process and management accounting. *Journal of Economics and Organization*, 2, pp. 237-245.
2. Binder M., Freytag A. (2013) Volunteering, subjective well – being and public policy. *Journal of Economic Psychology,* 34, pp. 97-119.
3. Eriksson–Zetterquist U., Mullern T., Styhre A. (2011) Organization Theory: A Practice-Based Approach. New York, Oxford: Oxford University Press, pp. 12-16.
4. James E. (2011) The Non-profit Enterprise in Market Economics. Harwood Academic Publishers, pp. 23-24.
5. Marcinkevičiūtė L., Žukovskis J. (2007) *Teoriniai ir praktiniai vadybos aspektai* (Theoretical and Practical Aspects of Management). Kaunas: Lithuanian Agriculture University, pp. 9-13. (in Lithuanian).
6. Marcinkevičiūtė L. (2010) Darbuotojų motyvavimo modeliai: teoriniai ir praktiniai aspektai (Employee motivation models: theoretical and practical aspects). Monograph: Kaunas: Lithuanian Agriculture University, pp. 47-56. (in Lithuanian).
7. Olum Y. (2010) Modern management theories and practices. Department of Political Science and Public Administration Makerere University, pp. 35-40.
8. Pakhare J. (2011) Management Concepts - The Four Functions of Management. *Journal Management,* 5, pp. 49-50.
9. Park M., Chu Y., Lee H. (2009) Evaluation Methods for Construction Projects. *Journal of Civil Engineering and Management,* 15, pp. 349-359.
10. Rees C.J. (2008) Organizational Change and Development: Perspectives on theory and practice. *Journal of Business Economics and Management,* 9, pp. 87-89.
11. Sheal L. (2004) Systems Organization: The Management of Complexity. Milton Keynes: Open University Press, pp. 56-58.
12. Stukalina Y. (2010) Using Quality Management Procedures in Education: Manading the Learner-Ventered Educational Environment. *Technological and Economic Development of Economy*, 16, pp. 75-96.
13. Tijunaitiene R., Neverauskas B. (2009) Expression of Collectivistic Motives of Lithuanian Citizens Participation in Civil Society Organizations. *Engineering Economics*, 3, pp. 67-74.
14. Valentine D. (2011) Maintaining Organization Culture Through Leadership Succession Planning. *Franklin Business & Law*, 4, pp. 103-109.
15. World Association of Non-Governmental Organisations (WANGO) (2008) Code of ethics and conduct for NGOs. NGO Transparency Primer. Vilnius: Eugrimas, pp. 7-9. (in Lithuanian).

THE IMPACT OF PLOT SPATIAL PROPERTIES ON THE CONVERSION OF ARABLE LAND INTO BRUSHWOOD

Siim Maasikamäe, **Merit Mandel**
Estonian University of Life Sciences
siim.maasikamae@emu.ee

Abstract
Land use change has caught scientist's attention all over the world and in the perspective of globalisation the pressures on agricultural land are increasing. However, the agricultural land abandonment is still evident. This phenomenon has no single definition and its driving forces are varying among different regions and countries. In this paper agricultural land is considered as abandoned while there is evidence of shrub and bushes on agricultural land according to the orthophoto and Estonian base map comparison. The aim of this paper was to test the impact of arable land plot spatial properties: plot area, ratio of arable land area in the surrounding of plot and plot compactness. General hypothesis is that brushwood will more likely occur on the arable land plots with poor spatial properties than on arable land plots with good ones. The study was conducted in 15 rural municipalities across Estonia. Results are showing some impact of the spatial properties on the arable land plots conversion into brushwood. In nine municipalities out of 15, there was an arable plot area without brushwood larger than plots with brushwood and the percentage of arable land area surrounding plots without brushwood was higher in other 9 studied municipalities. As expected, the uncompact arable land plots tend to have more likely brushwood on them than the compact ones. Study results show that the impact of plot area and the ratio of arable land in surroundings of plots on the conversion of arable land plots into brushwood need further studies.
Key words: plot area, shape of the plot, land abandonment.

Introduction

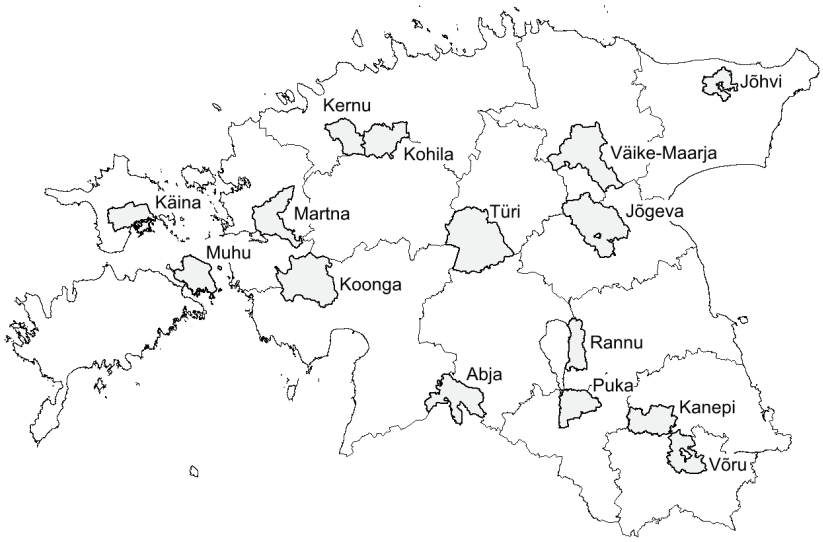
The conversion of arable land into brushwood often occurs if the plot is not cultivated for a certain period of time. It means that land is not used and one can say that land is abandoned. Therefore, the conversion of arable land into brushwood can be studied from the land abandonment point of view. The land abandonment is complicated phenomenon and has been studied in different scales. Some of land abandonment studies are conducted in European scale (Keenleyside and Tucker, 2010; Pointereau et al., 2008) while other studies focused on the smaller problematic areas in different countries: Spain (Zaragozi, et al. 2012), Austria (Silber and Wytrzens, 2006), Poland (Szostak et al., 2013), Latvia (Ruskule et al., 2012), European Russia (Prishchepov et al., 2013).

Abandonment of arable land has manifold character and may be caused by socio-economic, ecological or political factors (Rey Benayas et al., 2007; Zaragozi et al., 2012; Pointereau et al., 2008; Prishchepov et al., 2013; Silber and Wytrzens, 2006; Mander and Kuuba, 2004). Such land abandonment in remote areas may be associated with declining subsidies, low accessibility (distance from roads, farming centres and markets), demographic factors (population density, farmer age and the labour market) and ecological aspects (Baumann et al., 2011; Gellrich and Zimmerman, 2007; Pointereau et al., 2008; Prishchepov et al., 2013; Rey Benayas et al., 2007). In addition, it has been one topic in political discussions (Gellrich and Zimmerman, 2007).

The knowledge about the processes of land abandonment is needed in order to take the right measures at the national or local level (Keenleyside and Tucker 2010). This knowledge is also important because of the pressure from other land use types that affects the future use of agricultural land (Benjamin et al., 2007). The need for agricultural land is increasing worldwide. N. Alexandratos and J. Bruinsma (2012) pointed out that worldwide the area of arable land per capita in 1960 was 0.44 hectare; in 2010 this figure was 0.23 hectare; the projection for the 2050 is 0.181 hectare. J. Bruinsma (2011), B. R. Döös (2002) and FAO (2002) made similar prognoses and projections. All mentioned above refers to the need to study the land abandonment questions. At the same time Keenleyside and Tucker (2010) pointed out that it is difficult to measure and study land abandonment and it is difficult to obtain land abandonment data (Land abandonment..., 2004).

There are few studies about land abandonment in Estonia. Large-scale abandonment was evident in the country in the early 1990 when the major driving force behind this process was socio-economic changes (Mander and Kuuba, 2004). The rate of abandoned arable land was about 32% at this time (Peterson and Aunap, 1998). The study of M. Mandel and S. Maasikamäe (2013) showed that the distance of plots from roads have an impact on the conversion of arable land into brushwood. However, this is not sufficient in order to understand all aspects of arable land abandonment in Estonia.

The aim of this study was to test if there was an impact of spatial properties of arable land plots on the conversion of those plots into brushwood. The general hypothesis of the study is that the occurrence of brushwood on the arable land is more likely on the



Source: author's construction on the basis of Estonian Land Board data.

Figure 1. The location of studied municipalities (study area).

arable land plots with poor spatial properties than on the arable land plots with good spatial properties. The study focuses on the area of plots, the ratio of arable land in surroundings of plots and the shape of plots as the indicators that describe the spatial properties of arable land plots.

The results of the study showed that the spatial properties of arable land have some impact on the processes of conversion of arable land into brushwood. However, this study showed also some methodical problems of such kind of studies and the need to continue the researching the issue.

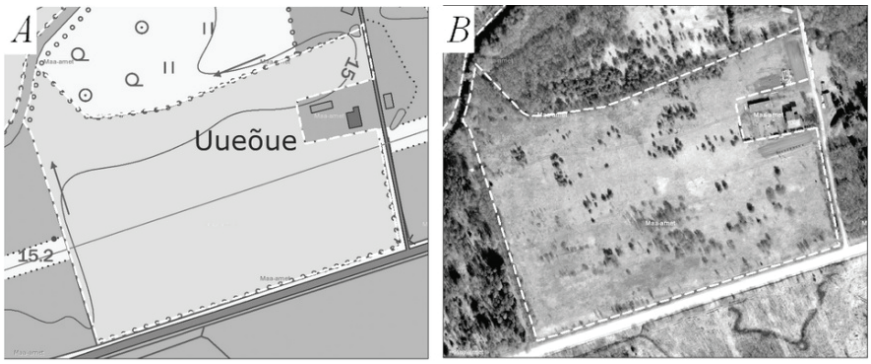
Materials and Methods

According to the administrative division, there are 15 counties in Estonia and one rural municipality from each county was selected for the study. The location of those municipalities is presented in Figure 1. The percentage of arable land of municipalities was the criterion for selection them for the study. The average percentage of arable land in the selected municipalities was the closest to the average percentage of arable land in the respective county. This way different regions of Estonia were included in the study.

The study consisted of the following tasks:

- formation of study units (arable land plots);
- checking the occurrence of brushwood on the arable land plots;
- determination of arable land plots spatial properties;
- testing the hypotheses of the study.

Formation of study units was carried out in the ArcGIS environment and the Estonian National Topographic Database (ENTD) (digital topographic



Source: author's construction on the basis of Estonian Land Board data (http://xgis.maaamet.ee/xGIS/XGis).

Figure 2. Example of brushwood determination process on arable land. There is no brushwood on the arable land according to the topographic map of Estonia (Picture A). The ortophoto map shows the brushwood on the arable land (Picture B). Such arable land plots (marked with a dotted white dashed line) were classified as arable land with brushwood.

map) was used for that purpose. The content of the ENTD is updated continuously and some arable land areas were from the year 2006 while some of them were from the year 2011. The arable land of investigated municipalities was split into undivided and complete pieces (plots). Undivided and complete study units are contiguous areas that are delimited by other types of land (e.g. forest), by roads, ditches, or other linear objects. Study units with the areas less than 0.2 hectares were excluded from the study because small arable land plots are usually a part of small landholdings and not important for contemporary agriculture. Different ArcGIS overlay procedures were implemented for the study unit's formation.

The ortophoto maps of Estonian Land Board geoportal (http://xgis.maaamet.ee/xGIS/XGis) were used for checking the occurrence of brushwood on the arable land plots. Ortophoto maps were available from the period of 2007 to 2011 in geoportal. All arable land plots were divided into two groups: arable land without brushwood and arable land with brushwood. Figure 2 illustrates the case if the study unit was classified as arable land with brushwood. The trees and bushes are clearly visible on the formerly cultivated land.

Three indicators were used to characterize the spatial properties of arable land plots. The area of plots was the first parameter. It is the most common parameter to characterise any piece of land. The second parameter to characterize the spatial properties of arable land plots was determination of arable land ratio (percentage) in the circle with the radius of 700 meters. Figure 3 illustrates that procedure.

Firstly, the centroid was determined for all plots and then the circles with the constant radius R were constructed around all centroids. Figure 3 shows only one circle as an example. Actually, the circles were constructed for all plots and they overlap with each other. Finally, the ratio of arable land inside of each circle was calculated. To do so, the area of arable land inside of each circle was determined by ArcGIS intersect procedure. Then, the area of arable land inside of each circle was divided by the area of circle with 700 metre radius (153.9 hectares).

The third parameter to characterize the spatial properties of plots was the coefficient of compactness. This parameter characterises the shape of plots and it is calculated as the ratio of perimeter of plot to circumference of square whose area is equal to the area of that plot. Thus, the coefficient of compactness for the square equals to one. The value of the coefficient of compactness increases if the shape of the plot becomes more uncompact. More compact shapes of the plots are preferred from land cultivation point of view.

Testing the study hypotheses was the last task of the study. The average values of the spatial properties indicators were calculated for both groups of arable land plots (without brushwood on arable land and with brushwood on arable land). The comparison of average values of above mentioned indicators in two groups allows us to assess if there is difference between them. The Mann-Whitney test was used in order to check the statistical significance (p-value) between the average values of indicators describing the spatial properties of arable land plots. One can conclude that there is an impact of the spatial properties of plots on the occurrence of brushwood on the arable land if the group averages of the indicators describing the spatial properties of those plots are statistically significant. The Mann-Whitney test was used because of non-normal distribution of the indicators describing the spatial properties of investigated arable land plots.

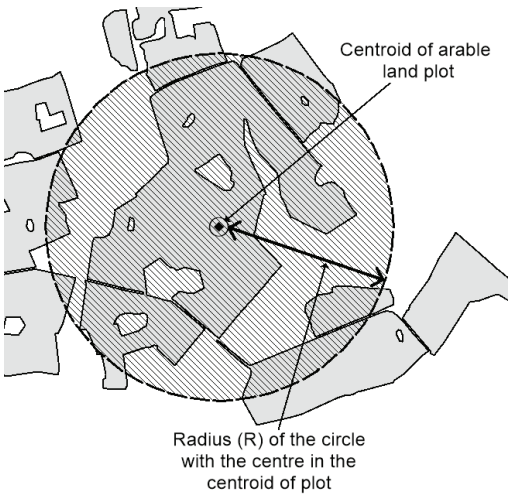


Figure 3. Example of determination of the arable land area inside the circle whose centre coincides with the centroid of an arable land plot. Grey areas are arable land plots, hatched area is the circle whose centre is coinciding with the centroid of arable land plot.

Results and Discussion

The main results of the study are presented in Table 1 and Table 2. The average area of plots (study units) is 12.4 hectares but it ranges from 5.4 hectares (Võru municipality) to 24.3 hectares (Väike-Maarja municipality), see Table 1. The difference is 4.5 times. The minimum area of studied plots (study units) in all investigate municipalities was 0.2 hectares. The reason for that is the elimination of all plots with areas less than 0.2 hectares from the study. The maximum area of plots in Väike-Maarja municipality was 424.4 hectares while in Kanepi municipality this area was 100.6 hectares. The difference is 4.2 times which is similar to the difference of average areas of plots.

The data of Table 1 show that the number of plots without brushwood is greater than the number of plots with brushwood in 12 municipalities out of 15. The number of plots with brushwood is greater than the number of plots without brushwood in Muhu, Puka and Võru municipality. In general, the number of plots with brushwood is about 1.8 times smaller than the number of plots without brushwood. It means that about 35.6 percent out of all investigated plots had in some extent brushwood on them. However, this figure varies among the investigated municipalities. In Martna municipality this figure was only 16.7 percent while in Puka municipality - 54.0 percent. It is necessary to emphasise that the area of brushwood on the investigated plots was relatively small in some cases. For example, on some large plots (100 and more hectares) the area of brushwood was only some hectares.

The comparison of the average areas of plots with and without brushwood shows some unexpected results. In total, the average area of plots without brushwood was less (11.4 ha) than the average area of plots with brushwood (14.2 ha). At the same time in nine municipalities the situation was contrary. For example, in Muhu municipality the average area of plots without brushwood was 2.8 times bigger than the average area of plots with brushwood. The possible explanation for that might be the varying land use conditions in different areas.

Data in Table 2 characterise the impact of two spatial properties on the likelihood of occurrence of brushwood on the arable land. The p-values in this table show whether the spatial properties of plots without and with brushwood are significantly different or not. The ratio of arable land in surrounding of the centroids (the circle with the radius of 700 meters) of the plots is the first spatial property described in Table 2. For all investigated municipalities the average ratio of arable land in the surrounding of the centroids of plots without brushwood is 47.4 percent and the same figure for plots with brushwood is 40.0 percent. The difference is statistically significant. The mentioned difference was not statistically significant for five municipalities (Abja, Jõhvi, Muhu, Puka and Rannu). Also, it came out that the situation among municipalities is different even if the difference

Table 1

Areas of investigated arable land plots

Municipality	Number of arable land plots	Area of plots (ha)			Number of arable land plots by groups		Area of plots by groups (ha)	
		mean	minimum	maximum	plots without brush-wood	plots with brush-wood	plots without brush-wood	plots with brush-wood
Abja	614	13.7	0.20	158.6	376	238	19.4	10.1
Jõgeva	891	15.5	0.20	289.2	711	180	13.7	22.6
Jõhvi	187	14.4	0.21	221.8	132	55	8.6	28.2
Kanepi	994	7.0	0.20	100.6	604	390	4.6	10.6
Kernu	444	9.1	0.21	108.2	303	141	9.9	8.7
Kohila	555	11.1	0.20	114.2	293	262	13.6	8.9
Koonga	497	15.7	0.20	193.1	376	121	12.8	24.9
Käina	449	10.8	0.20	112.8	331	118	11.5	10.5
Martna	436	13.3	0.20	102.5	363	73	14.0	13.2
Muhu	653	7.3	0.20	127.5	306	347	10.4	3.7
Puka	742	6.9	0.20	140.7	341	401	3.9	9.5
Rannu	259	23.7	0.21	193.8	197	62	28.4	22.2
Türi	1147	17.9	0.20	226.1	841	306	18.0	17.9
Võru	1043	5.4	0.20	143.3	501	542	7.2	3.5
Väike-Maarja	664	24.3	0.20	424.3	494	170	22.0	30.8
All investigated municipalities	9575	12.4	0.20	424.3	6169	3406	11.4	14.2

Table 2

The impact of the percentage of arable land in surrounding of plots and compactness coefficient of arable land plots on the likelihood of brushwood occurrence on the arable land

Municipality	Number of plots by groups		Average percentage of arable land in surrounding of plots			Average compactness coefficient of arable land plots by groups		
	plots without brush-wood	plots with brush-wood	plots without brush-wood	plots with brush-wood	p-value	plots without brush-wood	plots with brush-wood	p-value
Abja	376	238	42.5	42.3	0.918	1.26	1.41	0.000*
Jõgeva	711	180	51.6	43.0	0.000*	1.34	1.46	0.000*
Jõhvi	132	55	57.3	53.5	0.463	1.29	1.50	0.000*
Kanepi	604	390	43.1	39.6	0.000*	1.27	1.49	0.000*
Kernu	303	141	34.1	38.6	0.017*	1.25	1.32	0.001*
Kohila	293	262	40.5	45.4	0.001*	1.21	1.35	0.000*
Koonga	376	121	48.7	44.4	0.034*	1.49	1.63	0.000*
Käina	331	118	38.6	45.1	0.002*	1.24	1.40	0.000*
Martna	363	73	44.1	50.6	0.010*	1.36	1.45	0.017*
Muhu	306	347	35.6	35.4	0.613	1.20	1.44	0.000*
Puka	341	401	39.0	36.6	0.086	1.24	1.45	0.000*
Rannu	197	62	57.7	63.6	0.061	1.35	1.50	0.002*
Türi	841	306	45.0	53.7	0.000*	1.33	1.46	0.000*
Võru	501	542	34.2	40.3	0.000*	1.26	1.53	0.000*
Väike-Maarja	494	170	56.3	50.1	0.002*	1.32	1.44	0.000*
All investigated municipalities	6169	3406	47.4	40.0	0.000*	1.30	1.46	0.000*

* - the difference between groups of plots without brushwood and with brushwood is significant at a confidence level of 95% ($p < 0.05$)

between the two compared groups (plots with and without brushwood) is statistically significant. In five municipalities (Kernu, Kohila, Käina, Türi and Võru) the ratio of arable land in surroundings of plot centroids was higher for the plots with brushwood compared with plots without brushwood. The result could be explained with the local differences, but this result needs deeper investigations. The similar difference that is not easy to explain was observed in the study of impact of distance of plots from the roads on the conversion arable land into brushwood (Mandel and Maasikamäe, 2013).

There is a clear impact of the plots' shape on the likelihood of brushwood occurrence on the arable land plots. The uncompact arable land plots tend to have brushwood more likely than compact plots. The difference between average coefficients of compactness for plots without brushwood and with brushwood is statistically significant for investigated municipalities and in general.

One of the problematic aspects of this study is the selection of the radius for circles surrounding the plot centres in order to calculate arable land ratio inside those circles. The problem can be divided into two parts (or questions). The first question is: should the radius be the same for all plots? If so then what is the right radius? The example on Figure 4 clearly illustrates that the ratio of arable land in the circle surrounding the plot centroid will change in some cases if the radius of the circle will change (see Picture A on the figure 4). In some cases (see Picture C and Picture D on figure 4) the change of the radius of the

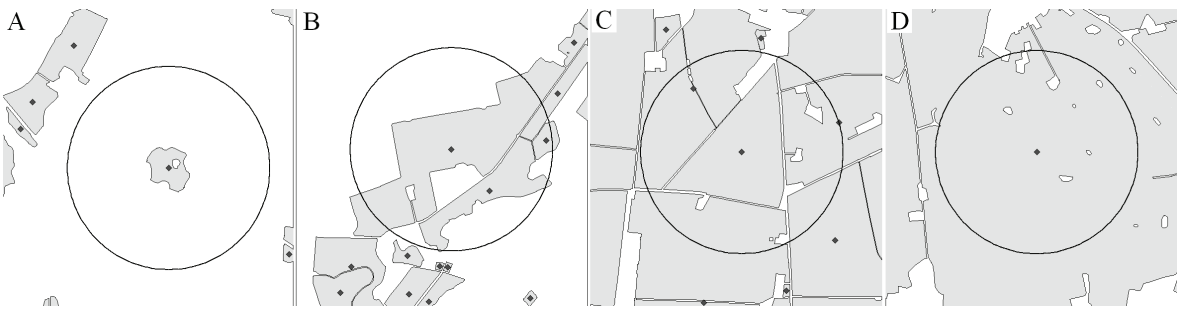


Figure 4. Examples of arable land plots inside the circle surrounding the centroid of plots.

circle surrounding the centroid of the plot will not have an impact on the ratio of arable land in this circle. The arable land ratio in such cases will be close to 100 percent anyway. However, if the radius of the circles will increase, there will be a situation that the ratio of arable land inside the circles is definitely less than 100 percent.

The second question arises if selection is in favour of the different radiuses of the circles surrounding the plot centroids. The question in this case will be: what is an argument for determination of varying radiuses? Should one keep in mind the spatial properties of the particular plot or is it necessary to consider a wider area? The average ratio of arable land in different regions varies. For example, the arable land ratio in Rannu municipality is about 40 percent while in Koonga municipality that figure is only 20 percent. The average area of arable land plots is also varying: in Rannu municipality that figure is almost 24 hectares while in Võru municipality only 5.4 hectares. The implementation of different radiuses for the circles surrounding the plot centroids allows taking into consideration the local conditions. At the same time it will be difficult, if not impossible, to compare the figures of different regions.

It is necessary to note that the result of the study does not mean that plots with the poor spatial properties will definitely be abandoned and converted to brushwood. The results of the study show that if the land abandonment and conversion of arable land into brushwood occur, it will more likely happen on the plots with poor spatial properties. It is somehow controversial that land abandonment occurred simultaneously with the situation when the area of arable land per capita in the world is decreasing. On the other hand, it shows that the land abandonment and conversion of arable land into brushwood is a complicated phenomenon.

The treatment of all plots in the same manner is the limit of the study. The problem is that small arable land plot, for example five hectares, is likely a part of one parcel and it is managed by one owner. The large arable land plot, for example 150 hectares, is probably divided among many owners and if one of them does not use his/her land then the whole plot was classified as arable land with brushwood. In this respect, the methodology of the study on the conversion of arable land into brushwood needs elaboration.

In this study, the study area of arable land plots was not considered. Small plots, for example less than five hectares, were treated in the same way as large plots, for example more than 100 hectares. Also, the area or the ratio of brushwood on the plot was not considered. The treatment of all plots in the same way can be considered as a limitation of the study. This aspect needs special attention in further studies.

Conclusions

1. The results of the study show that spatial properties of arable land plots can have the impact on the conversion of arable land into brushwood. There are clear indications that uncompact arable land plots tend to have more likely brushwood on them than the uncompact plots.
2. The impact of the ratio of arable land in surroundings of the plots centroids is different among investigated regions. In general, the ratio of arable land plots in surroundings of the plots without brushwood is higher (47.4 percent) than in surroundings of the plots with brushwood (40.0 percent).
3. There are no clear relations between the plot area and the likelihood of brushwood occurrence on arable land. The results of the study are contradicting in this respect.
4. The contradicting results of the present study indicated that local conditions (spatial properties land) of the regions must be investigated more deeply.

References

1. Alexandratos N., Bruinsma J. (2012) World Agriculture Towards 2030/2050: The 2012 Revision. ESA Working Paper No. 12-03. Rome, FAO, 147 p.
2. Baumann M., Kuemmerle T., Elbakidze M., Ozdogan M., Radeloff V.C., Keuler N.S., Prishchepov A.V., Kruhlov I., Hostert P. (2011) Patterns and drivers of post-socialist farmland abandonment in Western Ukraine. *Land Use Policy* (28), pp. 552-562.
3. Bruinsma J. (2011) The Resources Outlook to 2050: by How Much Do Land, Water and Crop Yields Need to Increase by 2050? In: Looking Ahead in World Food and Agriculture: Perspectives to 2050, Edited by Piero Conforti, pp. 233-278.
4. Döös B.R. (2002) Population Growth and Loss of Arable Land. *Global Environmental Change* (12), pp. 303-311.
5. FAO (2002) World Agriculture: Towards 2015/2030. Summary Report. Food and Agriculture Organization of the United Nations, Rome, 97 pp.

6. Gellrich M., Zimmerman N. (2007) Investigating the regional-scale pattern of agricultural land abandonment in the Swiss Mountain, a spatial statistical modelling approach. *Landscape and Urban Planning* (79), pp. 65-76.
7. Keenleyside C., Tucker G.M. (2010) Farmland Abandonment in the EU: an Assessment of Trends and Prospects. Report prepared for WWF. Institute for European Environmental Policy, London, 93 p.
8. Land abandonment, biodiversity and the CAP (2004) Land abandonment and biodiversity, in relation to the 1st and 2nd pillars of the EU's common agricultural policy; outcome of an international seminar in Sigulda, Latvia, 7-8 October, 2004. Utrecht, 2005 DLG, Service for Land and Water Management Available at: http://www.ieep.eu/assets/197/land_abandonment_Final_report.pdf., 10 February 2015.
9. Mandel M., Maasikamäe S. (2013) Correlation between Conversion of Arable Land into Brushwood and Distance of Plots from Roads. The Sixth International Scientific Conference Rural Development 2013; Aleksandras Stulginskis University, Akademija, 28–29 November, 2013. Kaunas, Lithuania, (3), pp. 343-348.
10. Mander Ü., Kuuba R. (2004) Changing landscapes in Northeastern Europe based on examples from the Baltic countries. – The New Dimensions of the European Landscapes./Jongman, R.H.G (ed.). Dordrecht, Springer, pp. 123-134.
11. Peterson U., Aunap R. (1998) Changes in agricultural land use in Estonia in the 1990s detected with multitemporal Landsat MSS imagery. *Landscape and Urban Planning* (41), pp. 193-201.
12. Pointereau P., Coulon F., Girard P., Lambotte M., Stuczynski T., Sánchez Ortega V., A. Del Rio A. (2008) Analysis of farmland abandonment and the extent and location of agricultural areas that are actually abandoned or are in risk to be abandoned. Institute for Environment and Sustainability, Joint Research Centre, European Commission. Available at: http://www.jrc.ec.europa.eu/, 3 February 2015.
13. Prishchepov A.V., Müller D., Dubinin M., Baumann M., Radeloff V.C. (2013) Determinants of agricultural land abandonment in post-Soviet European Russia. *Land Use Policy* (30), pp. 873-884.
14. Rey Benayas J.M., Martins A., Nicolau J.M., Schulz J.J. (2007) Abandonment of agricultural land: an overview of drivers and consequences. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2, No 057, 14 pp. Available at: http://www3.uah.es/josemrey/ Reprints/ ReyBenayasetal_Landabandonment_Perspectives_07.pdf., 10 February 2015.
15. Ruskule A., Nikodemus O., Kasparinska Z., Kasparinskis R., Brumelis G. (2012) Patterns of afforestation on abandoned agriculture land in Latvia. *Agroforestry Systems* 85(2), pp. 215-231.
16. Silber R., Wytrzens H.K. (2006) Modelling the probability of land abandonment at parcel level, Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie 15, pp. 55-63.
17. Szostak M., Wezyk P., Tompalski P. (2013) Aerial Orthophoto and Airborne Laser Scanning as Monitoring Tools for Land Cover Dynamics: A Case Study from the Milicz Forest District (Poland). *Pure and Applied Geophysics* (171), pp. 857-866.
18. Zaragozi B., Rabasa A., Rodriguez-Sala J.J., Navarro J.T., Belda A., Ramon A. (2012) Modelling farmland abandonment: A study combining GIS and data mining techniques. *Agriculture, Ecosystems and Environment* (155), pp. 124-132.

RURAL COMMUNITY PUBLIC PROJECT VALUATION APPLYING TOPSIS MULTI-CRITERIA METHOD

Jurgita Baranauskienė[1], Gunita Mazure[2], Vilija Aleknevičienė[1]
[1]Aleksandras Stulginskis University
[2]Latvia University of Agriculture
jurgita.baranauskiene@asu.lt

Abstract
The primary goal of public projects is to create social benefits for the community. The prepared public project usually has more than one option. In order to choose the most efficient option, it is necessary to take into consideration all social benefits. For this reason multi-criteria methods may be applied since they provide a possibility to assess quantitatively social benefits which are measured in many different quantitative and qualitative indicators. The problem of the research stems from a variety of social benefits indicators of public projects, the problematic establishment of their value and the need of their complex valuation. The paper presents a methodology for TOPSIS multi-criteria method adapted for the valuation of public projects in order to select investment option and the empirical research makes it possible to look at the problems of public project valuation from the practical approach. The research of the paper is aimed at revealing the advantages and limitations of TOPSIS multi-criteria method used for public projects valuation.
Key words: rural community, public project, social benefits, TOPSIS multi-criteria method.

Introduction

Public projects are implemented in order to satisfy the needs of the society, which are taken care by the country, through state institutions, non-profit organisations and associations. The goals of public projects are related with the implementation of state functions: health, improvement of social security, education and employment of children and youth, decreasing the unemployment, ensuring the environmental safety, development of state engineering network etc. Implementation of public projects allows reducing social exclusion, promotion of economic and regional development. Investment projects, specifically aimed at reducing poverty, are related to the aspects of welfare, but not to income. Benefits derived from such projects are difficult to quantify (Van De Walle, 2002). Benefits brought by public projects are intended to satisfy public needs and they are generally referred to as social benefits. Investments in the public sector have to comply with the social, economic and political criteria (Medaglia et al., 2008).

Every investment option should be evaluated and substantiated before the right investment decision is made. The valuation of public projects is complicated due to complexity of valuation of social benefits. Social benefits of public project should effectively satisfy the needs of society. When making the investment decision, it is appropriate to assess the efficiency of the projects. The cost-benefit analysis method is usually used for valuation the public projects: investment and operating costs of the activity is evaluated as well as the benefits created by the public project, which may be expressed in monetary measures during the life-time period of the project.

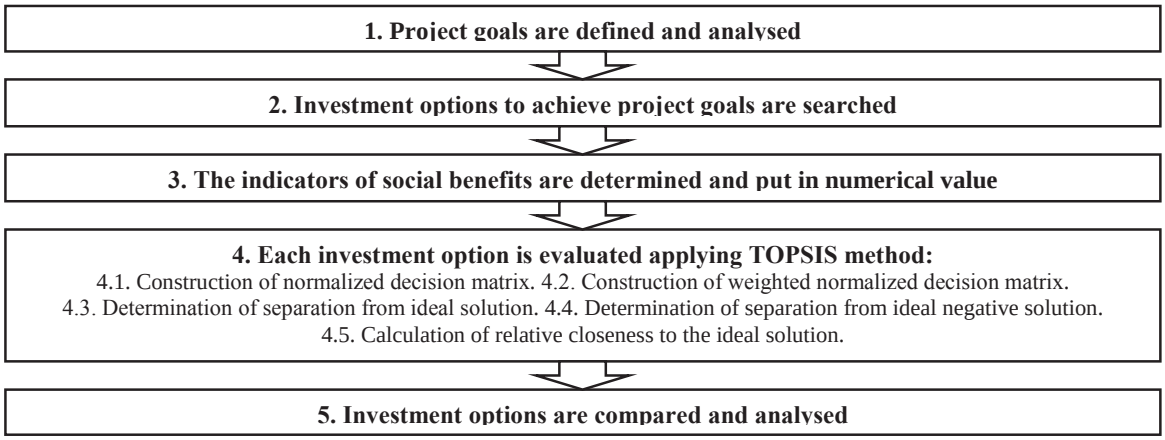
The theoretical principles of cost-benefit analysis were detailed by Boardman et al. (2006), Pearce (2006), Guide to Cost-Benefit Analysis of Investment Projects (2008), Rosen, Gayer (2008); Baranauskiene, Aleknevicienе (2013) and other authors.

Evaluation in monetary measures is important when it is necessary to make final decision in the ranking of public projects, but no less important in providing understandable information for the society about the public project which often determines how many members of the society will receive social benefits created by the project. In this perspective the cost-benefit analysis loses its attractiveness. The information obtained from cost-benefit analysis is not suitable for society debates about public projects' implementation. Still, a set of non-monetary indicators has to be prepared for the society (Nyborg, 2000).

Cost-benefit analysis is usually used for valuation of public projects in order to choose the best investment option, but it is criticized for two main features: 1) theoretical value substantiation: if the priorities are not correctly chosen, the main values – ecology, durability, fair allocation, social welfare – are not always indicated; 2) problematic assessment of social benefits. Due to this reason a question is raised – can the right decision be made using the method of cost-benefit analysis? (Aleknevicienе and Baranauskiene, 2013).

Public projects can also be evaluated using the cost-effectiveness analysis which covers the analysis of project goals, search for option ways to achieve the goals, estimation of the costs incurred and benefits generated by investment options and the comparison of investment options (Ernst, 2006; Simic et al., 2011).

The main limitations of cost-effectiveness analysis is that selected indicators do not always express the entire social benefits created by a public project; therefore, a large number of evaluated indicators produce a complex combination which



Source: compiled by the authors.

Figure 1. The steps of TOPSIS method applied for evaluation of public project.

is incomparable with another relevant option and no ways of how to combine benefit indicators are presented (Alekneviciene and Baranauskiene, 2014).

Scientists raise the question: how to measure social benefits of public projects and what indicators have to be used to evaluate them? Another important problem is the monetary measurement of social benefits: how to quantify non-market goods, such as human life, environmental impact on human health, etc. (Hansjugen, 2004; Almansa and Calatrava, 2007; Hepburn and Koundouri, 2007; Sáez and Requena, 2007; Greenberg and Robins, 2008; Nooij, 2011; Firini et al., 2012; Parks and Godway, 2013) Scientific problem can be formulated: how to quantify and evaluate social benefits provided by public projects for the public?

Multi-criteria valuation methods could be used for solving the mentioned problems. The main advantage of mentioned methods is that one summarized indicator can include several maximizing and minimizing indicators expressed in various dimensions, i.e. indicators which cause the improvement of analyzed phenomenon in one case and worsening in another case. Such combining is possible due to normalization while all the indicators are turned into non-dimensional, i.e. are comparable with each other. Multi-criteria valuation methods provide a possibility to combine indicators of social benefits expressed in either qualitative or quantitative measures, thus the measurement of social benefits in monetary terms becomes unnecessary. These methods provide a possibility to rank several projects (Guitouni and Martel, 1998; Zopounidis, 1999; Bisdor, 1999; Hites et al., 2006; Mendoza and Martins, 2006; Tamosiuniene et al., 2006; Ginevicius, 2006, 2009; Ginevicius and Podvezko 2008; Shmelev et al., 2009; Frini et al., 2012).

The object of the research is valuation of public projects.

The aim of the research is to reveal the methodology of TOPSIS method and evaluate investment options for a rural community public project by the TOPSIS method.

Research tasks: 1) to present a methodology for TOPSIS multi-criteria method applied for the evaluation of public projects; 2) to evaluate investment options for a rural community public project by the TOPSIS method; 3) to determine the advantages and limitations of TOPSIS method used for public project evaluation.

Scientists use different Multi-criteria evaluation methods: SAW (Simple Additive Weighting), MOORA (Multi objective optimization on the Basis of Ratio Analysis), TOPSIS (Technique for order Preference by Similarity to Ideal Solution), COPRAS (Complex proportional Assessment), ELECTRE (Elimination and Choice Expressing Reality), PROMETHEE (Preference Ranking Organisation Method for Enrichment Evaluation) and other methods. TOPSIS method is chosen for this theoretical and empirical research to justify combining different social benefits and costs indicators.

Materials and Methods

TOPSIS (Technique of Order Preference by Similarity to Ideal Solution) method considers three types of attributes or criteria: qualitative and quantitative benefit attributes/criteria and cost attributes or criteria.

Two artificial options are hypothesized in TOPSIS method:

1. Positive ideal option: the one which has the best level for all attributes considered.
2. Negative ideal option: the one which has the worst attribute values.

TOPSIS selects the option that is the closest to the positive ideal solution and farthest from negative ideal option. The steps of TOPSIS method applied for

public project evaluation are presented in Figure 1.

1-3 steps are the preparation for public project evaluation using TOPSIS method. The qualitative indicators of social benefits put in numerical value using the scale. The evaluation scale reveals the impact of investment options on the project's target group according to the selected evaluation indicators for project effects.

Numerical value	**1**	**2**	**3**	**4**
Description of the effects of investment option on the evaluated indicator	No effects	Weak effects	Medium effects	Strong effects

The solution received using the TOPSIS method is the best one (the investment option is assessed by creating the biggest social benefits to the society), which is the closest to the ideal solution and farthest from the worst solution (Olson, 2004).

Vector normalization is applied in the TOPSIS method (Ginevičius and Podvezko, 2008):

$$\tilde{r}_{ij} = \frac{r_j}{\sqrt{\sum_{j=1}^{n} r_j^2}} \qquad \text{(i=1,...,m; j=1,...,n);} \qquad (1)$$

Where: $\tilde{r}_{ij}$ - i -th indicator, j -th option normalised value.

The best investment option V* and the worst investment option is calculated using the following formulas (Lofti at al, 2007; Ginevičius, Podvezko, 2008):

$$V^* = \{V_1^*, V_2^*, ..., V_m^*\} = \{(\max_j \omega_i r_j \ / i \in I_2), (\max_j \omega_i \tilde{r}_j \ / i \in I_2)\} \qquad (2)$$

$$V^- = \{V_1^-, V_2^-, ..., V_m^-\} = \{(\max_j \omega_i r_j \ / i \in I_2), (\max_j \omega_i \tilde{r}_j \ / i \in I_2)\} \qquad (3)$$

Where: I_1 – a set of maximised indicator indices, I_2 – a set of minimised indicator indices.

The total distance of every compared option from the best decisions and from the worst decisions is calculated according to the formulas.

$$D_j^* = \sqrt{\sum_{i=1}^{m} (\omega_i \tilde{r}_j - V_i^*)^2} \qquad (4)$$

$$D_j^- = \sqrt{\sum_{i=1}^{m} (\omega_i \tilde{r}_j - V_i^-)^2} \qquad (5)$$

TOPSIS method criterion C_j^* is calculated using the formula:

$$C_j^* = \frac{D^-}{D_j^* + D_j^-} \qquad \text{(j=1,...,n)} \qquad (6)$$

The value C_j^* of such criterion may vary from 0 to 1 ($0 \le C_j^* \le 1$). The best investment option is expressed by the biggest C_j^* value.

Combining various social benefit indicators of public projects in one measurable indicator, all options of public projects can be compared with each other.

Results and Discussion

In order to justify methodology for public projects evaluation using TOPSIS multi-criteria method, the empirical research was carried out. The rural community public project was evaluated seeking to choose the best investment option regarding investment costs, operating costs and social benefits.

The rural community has approximately 450 residents, while approximately 30 percent of them are young people. One of the main goals of the community is to gather the residents of Gudeliai and neighbouring villages in searching for the most appropriate decisions to raise economic and social well-being and to create safe and convenient living environment. There are two main problems raised in a village: unemployment and the lack of public infrastructure, resulting in decrease of population, when young people are leaving to work in the biggest cities of the country or abroad, while the village is disappearing. The remaining residents,

Table 1

Goal of rural community project and investment options

Project goal	**Investment options**		
	I Option	**II Option**	**III Option**
To improve living conditions for members of rural community, create public infractructure for leisure	To equip a sports court, where people could play basketball, volleyball, badminton and mini football.	To equip a library with a computerised reading room.	To create a modern beach near a pond that is close to the village.

Table 2

Valuation of indicators for investment options of rural community project

Indicators of social benefits	Valuation of social benefit indicators based on the investment options			Description of the assessment applied to the indicator
	I	II	III	
1. Increase of the variety and quality in the leisure time for the residents	4	4	3	Village residents of different age will be able to spend their leisure time in the equipped sports court. There will be an opportunity created to engage in all kinds of sports: basketball, volleyball, tennis and badminton. The library will provide an opportunity not only to read the literature, but also to find out the necessary information on the internet. The beach is less attractive because it can be used only during a particular season.
2. Improved possibilities for self-education, development of hobbies and talents	3	4	3	The best conditions for self-education are created by equipping a library. The sports court and beach create a possibility to discover and educate the sports talents.
3. Improvement of residents' health.	3	1	3	The created infrastructure will encourage people to do sports outdoors, be healthier, get fit, everything that increases health and helps to rehabilitate the ability to work helps to develop a healthy lifestyle. Sports and water procedures are essential both for kids and young people as well as working residents.
4. Decrease of destructive activities of the youth.	4	3	2	The inappropriate behaviour of children and teenagers is usually encouraged by lack of measures devoted to their favourite activities. Upon the appearance of a possibility to do sports in the qualitative manners, to read their favourite literature, the youth will be directed away from destructive activities - smoking, consuming alcohol and vandalism. The attractive infrastructure will motivate children to take up sports and reading activities appropriate for their age, to find out their hobbies and develop them, leaving behind the waste of time or destructive activities.
5. Encouraging the sense of community for the residents.	4	3	4	Even the idea of the project itself encouraged the village community to cooperate when implementing this project. The created infrastructure will serve as a common place for rural people, where they will be able to spend their leisure time. In such a way the sense of community is encouraged among the residents.
6. Decrease of depopulation in the village.	3	3	3	One of the reasons why people emigrate from the village and move to the cities are social and cultural factors. Upon implementing the project and creating the infrastructure to spend the leisure time purposefully, the village will become a more attractive place to live. Considering the positive effect of the project to the social environment and the initiative of the residents when preparing and implementing the activities of the project, it is possible to state that the project will have a positive effect in reducing the depopulation of the village.
7. The natural diversity of the environment is harmed.	1	1	2	Preservation of natural environment is considered when implementing the project. When improving the beach, the low value bushes are removed from the shore and the accumulated sludge is cleaned. Upon cleaning the shore near the pond, the natural flora and fauna may be harmed.

Source: compiled by the authors

especially young people do not have any place where they can spend their leisure time. In order to solve the mentioned problem, it was decided to prepare and implement the investment project and perform the investigation of the needs of residents. Three optional investment projects were prepared, which are briefly described in Table 1.

The social benefit indicators are formulated to compare the investment options, assessing of which is based on a scale, considering the expected effect of the project (Table 2).

It should be noted that the presented indicators reveal not only the benefits created by the public project, but also its harm (negative impact on the natural environment). When normalising the values of the indicators, the indicators of social benefits are maximised (the more the better), while the harm indicators are minimised (the less the better). In order to take into account the investment costs and the maintenance costs for the established infrastructure, they are also included into the multi-criteria valuation by giving them a numeric value in the range of 1-3 and comparing the investment options with each other.

The main goal of public project is to create social benefits for the society; therefore, social benefits are more important than investment and operating costs. Due to this reason the presumption is made that all indicators of social benefits are equally important and

Table 3

Evaluation of investment options applying TOPSIS method

Investment options	Number of social benefit indicators							Operating costs in EUR per year	Investment costs (EUR)
	1	2	3	4	5	6	7		
I option	4	3	3	4	4	3	1	900	40547
II option	4	4	1	3	3	3	1	4800	28962
III option	3	3	3	2	4	3	2	900	57924
Construction of normalized decision matrix									
I option	0.67	0.50	0.75	0.80	0.67	0.60	0.50	0.18	0.53
II option	0.67	0.67	0.25	0.60	0.50	0.60	0.50	0.97	0.38
III option	0.50	0.50	0.75	0.40	0.67	0.60	1.00	0.18	0.76
Construction of the weighted normalized decision matrix									
I option	0.67	0.50	0.75	0.80	0.67	0.60	0.50	0.09	0.27
II option	0.67	0.67	0.25	0.60	0.50	0.60	0.50	0.49	0.19
III option	0.50	0.50	0.75	0.40	0.67	0.60	1.00	0.09	0.38
Determination of separation from ideal solution									
I option	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01
II option	0.00	0.00	0.25	0.04	0.03	0.00	0.00	0.16	0.00
III option	0.03	0.03	0.00	0.16	0.00	0.00	0.25	0.00	0.04
Determination of separation from ideal negative solution									
I option	0.03	0.00	0.25	0.16	0.03	0.00	0.25	0.16	0.01
II option	0.03	0.03	0.00	0.04	0.00	0.00	0.25	0.00	0.04
III option	0.00	0.00	0.25	0.00	0.03	0.00	0.00	0.16	0.00
Calculation of relative closeness to the ideal solution									
I option	**0.8251**								
II option	0.4741								
III option	0.4816								

have weights 1, and investment and operating costs have weights 0.5.

Considering the importance of indicators, the indicators of each investment option are combined into one comparative indicator using TOPSIS multi-criteria method. The numeric and normalised values of social benefits indicators of the rural community project investments options are provided in detail in Table 3. After relating to the normalised indicators, considering the coefficients of their importance, it is possible to compare the expected social benefits of the village community project investment options.

Applying TOPSIS, multi-criteria method can be stated that the 1st investment option of rural community project is the most effective considering social benefits, investment and operating costs.

In summary, the valuation of the public project using TOPSIS multi-criteria method made it possible to incorporate into valuation various indicators of social benefits, compare investment options and make the right investment decision.

Conclusions

1. TOPSIS multi-criteria method allows combining the social benefits, harm as well as investment and operating costs, which are expressed in the public projects by measurable and non-measurable indicators in monetary units. Cost-benefit analysis usually allows only the assessment of social benefits of public project measurable in monetary units. After defining project goals, investment options and indicators of social benefit, TOPSIS method could be applied for valuation of each investment option. Main steps of TOPSIS method consist of construction of normalized decision matrix, determination of weight to each indicator, determination of separation from ideal solution and ideal negative solution and calculation of relative closeness to the ideal solution.
2. The valuation of rural community public project applying TOPSIS method was carried out. Project goal is to improve living conditions for members of rural community, creating public infractructure for leisure. Three investment options were evaluated in order to reach the goal of the project. Seven social benefit indicators were identified for the project, which are related to the improvement in the quality of rural people spending leisure time, the possibilities of self-expression, health

promotion possibilities, decrease of destructive habits in youth, depopulation in the village, etc. The social benefit indicators as well as investment and operating costs will be combined using the TOPSIS method and selecting the most efficient investment option.

3. Upon performing all of the steps in assessment of the public project in practice, when applying the TOPSIS method, it is possible to summarise the advantages and limitations of the method. The main advantages: 1) enables to evaluate the indicators measured in monetary and non-monetary units; 2) enables to evaluate the chosen indicators that do not have a qualitative expression; 3) the indicators can be chosen and combined depending on specific situation, project or evaluation purposes. The limitations of TOPSIS method used for public project valuation: 1) separate options are not evaluated; the method allows to rank the options; 2) it is not clear how to evaluate the impact of public projects on social welfare when the investment horizon is long; 3) the final result is highly determined by the weight of indicators; 4) the objectivity of valuation is highly impacted by the qualification, logical reasoning and creativity of the expert. However, due to the mentioned advantages it can be successfully applied for the evaluation of public projects.

References

1. Aleknevicienе V., Baranauskiene J. (2013) Rural Communities Public Project Valuation Using Cost-Benefit Analysis. *Rural development 2013: the 6th international scientific conference proceedings*. Vol. 6, book 1, pp. 25-31.
2. Aleknevičienė V., Baranauskienė J. (2014) Valuation of public projects by the method of cost-effectiveness analysis. *Economic Science for Rural Development: Proceedings of the International Scientific Conference: Integrated and Sustainable for Rural Development*. Jelgava. 36, pp. 118-128.
3. Almansa C., Calatrava J. (2007) Reconciling sustainability and discounting in Cost–Benefit Analysis: A methodological proposal. *Ecological economics*, 60: pp. 712-725.
4. Bisdor R. (1999) Cognitive Support Methods for Multi-criteria Expert Decision Making. *European Journal of Operational Research*, 119, pp. 379-387.
5. Boardman A., Greenberg D., Vining A., Weimer D. (2006) Cost-Benefit Analysis: Concepts and Practice. Upper Saddle River, NJ: Prentice Hall, 576 p.
6. Ernst R. (2006) Indirect Costs and Cost-Effectiveness Analysis. *Value in Health*, 9(4), pp. 253-261.
7. Frini A., Guitouni A., Martel J.M. (2012). A general decomposition approach for multicriteria decision trees. *European Journal of Operational Research*, 220: pp. 452-460.
8. Ginevicius R. (2006) Daugiakriterinio vertinimo rodikliu svoriu nustatymas, remiantis ju tarpusavio saveika // Multicriteria Evaluation of the Criteria Weights Based on Their Interrelationship. *Verslas: teorija ir praktika // Business: theory and practice*, 7(1): pp. 3-13.
9. Ginevicius R. (2009) Socioekonominiu sistemu bukles kiekybinio ivertinimo problematika // Some Problems of Quantitative Evaluation of the State of Social-economic Systems. *Verslas: teorija ir praktika // Business: theory and practice*, 10(2): pp. 69-83.
10. Ginevicius R., Podvezko V. (2008) Daugiakriterinio vertinimo taikymo galimybes kiekybiniam socialiniu reiskiniu vertinimui // A Feasibility Study of Multicriteria Methods' Application to Quantitative Evaluation of Social Phenomena. *Verslas: teorija ir praktika // Business: theory and practice*, 9(2) pp. 81-87.
11. Greenberg D.H., Robins P.K. (2008) Incorporating Nonmarket Time into Benefit-cost Analyses of Social Programs: An Application to the Self–sufficiency Project. *Journal of Public Economics*, 92: pp. 766-794.
12. Guide to Cost-Benefit Analysis of Investment Projects. Structural Funds, Cohesion Fund and Instrument for Pre-Accession. (2008) Final Report. 255 p.
13. Guitouni A., Martel J.M. (1998) Tentative Guidelines to Help Choosing an Appropriate MCDA Method. *European Journal of Operational Research*, 109: pp. 501-521.
14. Hansjugen B. (2004) Economic Valuation through Cost-benefit Analysis – Possibilities and Limitations. *Toxicology*, 205: pp. 241-252.
15. Hepburn C.J., Koundouri P. (2007) Recent Advances in Discounting: Implications for Forest Economics. *Journal of Forest Economics*, 13, pp. 169-189.
16. Lofti F.H., Allahviranloo T., Jondabeh M.A., Kiani N.A. (2007) A New Method of Complex Decision Making Based on TOPSIS for Complex. *Applied Mathematical Sciences*. Vol.1; 60, pp. 2981-2987.
17. Medaglia A.L., Hueth D., Mendieta J.C., Sefair J.A. (2008) A Multiobjective Model for the Selection and Timing of Public Enterprise Projects, *Socio-Economic Planning Sciences* 42, pp. 31-45.
18. Mendoza G.A., Martins H. (2006) Multicriteria Decision Analysis in Natural Resource Management: A Critical Review of Methods and New Modelling Paradigms. *Forest Ecology and Management*, 230: pp. 1-22.

19. Nyborg K. (2000) Project Analysis as Input to Public Debate: Environmental Valuation Versus Physical Unit Indicators. *Ecological Economics*, 34, pp. 393-408.
20. Nooij M. (2011) Social Cost-benefit Analysis of Electricity Interconnector Investment: A Critical Appraisal. *Energy Policy*, 39: pp. 3096-3105.
21. Olson D.L. (2004). Comparison of Weights in TOPSIS Models. *Mathematical and Computer modeling*; 40, pp. 721-727.
22. Parks S., Gowdy J. (2013) What Have Economists Learned About Valuing Nature? A Review Essay. Ecosystem Services, 3: pp. 1-10.
23. Pearce D.W., Atkinson G., Mourato S. (2006) Cost-Benefit Analysis and the Environment: Recent Developments. Paris: Organisation for Economic Co-operation and Development (OECD), 318 p.
24. Rosen H.S., Gayer T. (2008) Public Finance. New York: McGraw-Hill, 336 p.
25. Saez C.A., Requena J.C. (2007) Reconciling Sustainability and Discounting in Cost–Benefit Analysis: a Methodological Proposal. *Ecological Economics*, 60, pp. 712-725.
26. Shmelev S.E., Rodrkguez-Labajos B. (2009) Dynamic Multidimensional Assessment of Sustainability at the Macro Level: The Case of Austria. *Ecological Economics*, 68: pp. 2560-2573.
27. Simic N., Vratonjic V., Beric I. (2011) Methodologies for the Evaluation of Public Sector Investment Projects. Megatrend Review 8(1), pp. 113-130.
28. Tamosiuniene R., Sidlauskas S., Trumpaite I. (2006) Investiciniu projektu efektyvumo daugiakriterinis vertinimas // The Multicriterial Evaluation Method of the Effectiveness of the Investment Projects. *Verslas: teorija ir praktika //Business: theory and practice*, 7(4): pp. 203-212.
29. Van de Walle D. (2002) Choosing Rural Road Investments to Help. *World Development*, 30(4): pp. 575-589.
30. Zopounidis C. (1999) Multicriteria Decision Aid in Financial Management. *European Journal of Operational Research*, 119, pp. 404-415.

SOCIAL DIMENSION OF THE MEASUREMENT FOR REGIONAL DEVELOPMENT

Līga Rasnača, Baiba Bela
University of Latvia
liga.rasnaca@lu.lv, baiba.bela@lu.lv

Abstract
The article addresses the problem of social dimension measurement of for regional development. Authors' discus approaches of definition of social dimension. There is some discord how social dimension could be understood in more broader or narrowed sense and how it is characterized in international and national social policy documents. Authors focus attention on contiguity of social dimension and social security. The measurement of social dimension demands multidimensional approach. The authors use theoretical analysis and document analysis, as well as analysis of statistical data on key elements of social dimension of regional development (differences of employment rate; GINI coefficient, and the number of people at risk-of-poverty threshold). The main conclusions are that social dimension is more or less covered in development planning documents, but the progress indicators are inadequate. Especially disparities in social dimension of regional development are formally addressed and closer analysis of key indicators shows necessity to elaborate both – policy instruments as well as policy progress measurement.
Key words: social dimension, social security, regional development, social policy.

Introduction

Uneven regional development and high income inequality are recognized as serious threats to successful development in Latvia (Saeima, 2010; VARAM, 2013). The economic disparities result in sharp differences in working and living conditions. There are also considerable differences in provision of social security between regions and municipalities (National Social Report of Latvia, 2014). Are these problems addressed in the policy documents? Are adequate progress indicators developed, especially for monitoring of social dimension of regional development? The aims of the article are: 1) to discuss the definition of the social dimension and to analyze the coverage of social dimension in the policy documents of development planning; 2) to illustrate social security problems by analysis of statistics in order to substantiate the necessity of regular monitoring of social dimension indicators at regional level.

Latvia has elaborated the long-term development planning document "Sustainable Development Strategy of Latvia until 2030 (Latvia 2030)" and the medium-term planning document "National Development Plan 2014-2020 (NDP 2020)". NDP 2020 is closely related to Latvia 2030 and the National Reform Programme for the Implementation of the EU 2020 Strategy. Because one of Latvia's strategic goals is to join the OECD, the authors of this article will pay particular attention to the measures of social dimension covered by mentioned documents in the context of strategic goals for social security and social sustainability of OECD. Social security plays a key role in provision of well-being and as a base for sustainable growth and development. The social dimension contains elements directly and indirectly connected with social security provision.

The research is done as a part of the project "Elaboration of innovative diagnostic instruments for regional development", funded by the European Social Fund (No 2013/0057/1DP/1.1.1.2.0/13/APIA/VIAA/065), where the task of authors was to develop the social security index as innovative instrument to measure the coverage of social security provision at different territorial units (national, regional, local).

Materials and Methods

Authors apply theoretical analysis and document analysis. The documents analysed are policy documents of the UN, EU, OECD, ILO and Latvia. The aim is to stress importance of social dimension of development and simultaneously to find contemporary understanding of key elements for social dimension of regional development. Descriptive statistics are used in order to throw light on the regional disparities within key elements of social dimension of regional development. However, during the research the broader range of indicators were analysed in order to develop complex and holistic approach to social dimension of sustainable development, the limitations of article allow to pay attention only to key elements. Even analysis of few key indicators show considerable regional differences and allows substantiate the importance of regular measurements for monitoring and development of better targeted and more efficient social policy.

Results and Discussion

However, the central concept of the article is that of social dimension of development, it is very closely linked to more concrete concept of social security. Social security is a key to secure social dimension of sustainable development. However, there is no real consensus even on the social security concept, as it is

reflected in conceptual documents of the international organizations. Therefore, it needs to be clarified. Social Security is a value that includes a broad view of the human right to dignity and free development, but in a narrower sense it means security in the labour market, income security, health protection, and high quality of social services for all. The United Nations Universal Declaration of Human Rights, Article 22 defines that everyone has the right to social security and the maintenance of self-esteem of their personality and the free development of the necessary rights in the economic, social and cultural fields. The Declaration is also made to ensure legislation for the implementation of international cooperation and support for State Aid pursuant to its resources (UN Universal Declaration of Human Rights, 1948). However, a clear definition of the concept of social security is not given. Also, the scientific literature has a rather descriptive approach, including social security within the meaning range of policy areas, such as employment, health, education, welfare, social inclusion, in tune with the Declaration of Human Rights. Broad approach contains the link between social security, human dignity and free development. Often, however, social security is understood very narrowly based on the income replacement in social risk situations, as defined by the International Organization (ILO) Convention 102 on minimum standards of social security (International Labour Organization, 1952). Employment researcher Wouter Van Ginneken indicates that from a narrow view of social security as income replacement, there is a return to the broader perspective of social security, which is fundamentally linked to human rights (Van Ginneken, 2009). Social security is a human right and a social and economic necessity. It is empirically proven that unfair and unequal societies have slower economic growth, lower gross domestic product, greater instability and mutual distrust (Stiglitz, 2012; Vilksinsons and Pikita, 2009).

Modern understanding of social risk and their content is not sealed and requires a review of the assumptions that formed in the middle of the previous century. The researchers also point out that main internationally recognized social risks referred to in the 1952 ILO definition of social security (health care, income security, protecting from social risks in old-age, unemployment, sickness, occupational diseases, disability, work accidents, maternity or survivors' case) are nowadays changing as a result of the traditional system of social protection no longer fully conformed with its mission (Beck, 2000; Bauman, 2007). Global change actuality acquires new risks, such as elderly care at home and in institutions or a new relationship in the labor market (for example, agreements of micro-enterprises) (Phillips, 2008; Daly, 2011). Therefore, researchers should not be confined to the narrow understanding of social security, its regulatory role, but to analyze it in the context of global, international, national, regional and local processes of social change, which is done only with complex, flexibly adapted research tools. ILO recognizes this and is working on the recommendations of the social policy in order to cover new risks and review the existing security system coverage (ILO, 2010). European Union social policy level has been established to the new concept of 'flexicurity', which is embedded in the EU resolution, shifting the emphasis from social security to flexible security, a framework for security in the labor market (EU Commission, 2007).

For analysis of social dimension of regional development the very important is its conceptual link developed by OECD, especially in the context of Latvia's aim to join OECD. Latvia's Road Map to OECD covers a broad range of economic and social policy topics. Regional development is on the front lines of many challenges faced not only by Latvia, but also by many OECD countries today. The guidelines of OECD are valuable for Latvia's regional development measurement. The OECD have elaborated a Framework for Measuring Well-Being and Progress, which proposes to measure well-being through a multi-dimensional approach expanding on capability concept of Amartya Sen's and ideas about social progress of Joseph Stiglitz's (Sen, 1993; Stiglitz et al.,.2009). Well-being and social dimension of development are not completely overlapping concepts. Well-being is more individual-centered concept, whereas social security is more policy-centered concept, but their constitutive elements almost overlap (especially with elements of broad understanding of social security and social dimension of development). The OECD conceptual framework for measurement of well-being in regions consists of seven distinctive features: income, health, safety, housing, access to services, civic engagement, education, jobs, environment (OECD, 2014). OECD offers to measure regional differences by seven dimensions, constructing an index with the seven constituents. Each dimension could be measured by 1-2 indicators (for example: jobs: employment rate and unemployment rate; housing: number of rooms per person; health: life expectancy and age adjusted mortality rate; education: share of labour force for people who have, as a minimum, secondary education; safety: homicide rate, etc.). The indicators are selected for measurements by focusing on individual and location based characteristics. OECD concentrates on well-being outcomes as direct information rather than on inputs and outputs, material and non-material dimensions; it looks at the dynamic of well-being over time (OECD, 2014). The OECD measurement framework includes different dimensions of well-

being; it is broader than social security, which is a contested concept.

When selecting the dimensions for measurement of social security of territories, it is important to pay attention to the development of objectives and performance indicators included in Latvia basic planning documents. The authors are eager to find a reasonable balance between the theoretical principles and policy objectives for measurement of social dimension in regional development. The Ministry of Environmental Protection and Regional Development recognizes: "Latvian regional development disparities are still significant and the existing measures have failed to achieve a decisive change in the territorial development indicators in reducing adverse distinction" (VARAM, 2013).

Sustainable Development Strategy of Latvia until 2030 is a key tool for long term development planning in the country (Saeima, 2010). The idea of happy people in the prosperous country is central in this document, security and possibility to attain goals, a person has a reason to value - are mentioned among main strategic objectives. However, among progress indicators the inequality is measured by GINI and regional differences are measured by regional dispersion of GDP. The indicators for employment and unemployment level are not included at all. The OECD recommends focusing attention on employment possibilities as base for social security and unemployment level as a threat for it. The focus of National Development Plan 2020 is on the idea about the necessity of a breakthrough, the establishment and development of businesses that are creative and generate high added value that constitute preconditions for increasing competitiveness to create the effective growth model for Latvia (Cross-sectoral Coordination Centre, 2010). Among priorities there is human security and growth of territories. Social dimension of development and set of progress indicators is better developed in this document. However, the weak point is that authors of NDP 2020 assume that economic growth will automatically resolve social problems. Also, employment, education and health are treated rather instrumentally, as means for economic growth, not as basic human rights and elements of social security.

Latvia 2030 and NDP 2020 constitute the strategic development settings, but do not show the way to reduce the high poverty rates and significant regional differences in income, as well as unequal distribution at the level of local governments. The strategic objectives in social security area have a declarative character, and there is lack of adequate progress indicators.

The next problem is the fragmented responsibilities for social dimension at governmental level. The responsibility for social security matters is divided between ministries at the national level and local governments at the local level. The Ministry of Welfare is responsible for the social policy planning, for social insurance, social assistance and social services and demographics. The Ministry of Education is competent in the issues of inclusive education, but the Ministry of Economy - in employment. The social integration and anti-discrimination field refers to the Ministry of Culture, but health care policy - to the Ministry of Health. The Ministry of Justice and Ministry of Finance are involved in solving financial and legislative problems of social dimension. Six ministries are involved in division of the responsibility for social dimension in Latvia. It is difficult to harmonize the understanding of social security and elaborate universal instrument for measurement of regional differences in social security. Local governments provide social assistance and social services, pre-school, general and basic services, access to health care, as well as assistance to people in resolving housing issues (National Social Report of Latvia, 2014). The problem is that each local government can decide to increase the minimal level of assistance. Certainly, the local governments with higher income levels are able to provide higher levels of social security and measures for social inclusion. The Ministry of Welfare of the Republic of Latvia recognizes disparities in amount and availability of social services in different local municipalities – „two persons with identic needs receive very different services according to the place of living" (National social report of Latvia, 2014). Here again regional disparities come to the forefront.

Authors offer to substantiate the importance of social dimension for regional development by selecting and analyzing here just key elements of social security: employed population, inequality (GINI) and persons at risk of poverty (%). Employment serves as basis for social security expenses, and work is one of the most important values in life, as well as an element of basic human rights. The social inequality shows the distribution of income differences in Latvia regions. Higher GINI coefficient value means not only higher income inequality, but also higher risk of insufficient social security for lower income groups and greater sense of social injustice in the larger part of population. The proportion of people at risk of poverty constitutes less protected and more vulnerable part of population. The problem is especially serious in the context that the local governments operate in diverse socio-economic environments and are rather autonomous in solving social issues. Social inequality is a crucial factor for sustainable social development according to guidelines adopted in the UN, OECD and EU. That is why authors have chosen

Table 1

Difference of employed population (15-64) by labour status in statistical regions against average % in Latvia

	2009	2010	2011	2012	2013
Riga region	+2.4	+1.8	+3.3	+4.1	+4.5
Pieriga region	+2.3	+1.2	+1.1	+2.1	+1.7
Vidzeme	− 2.9	−0.7	−0.6	−3.9	−3.3
Kurzeme	− 0.4	+1.0	−1.6	−0.9	−0.6
Zemgale	−1.4	−2.9	−1.3	−1.1	−1.1
Latgale	−3.7	−3.2	−5.6	−7.2	−7.4
Urban	+0.9	+1.1	+1.8	+1.5	+1.7
Rural	−1.7	−2.4	−2.9	−3.1	−3.5

Source: CBS, recalculation according to Employment rate in Latvia statistical regions, CSB (2015).

differences of employment rate in different regions as key components; GINI coefficient, and the number of people at -risk-of-poverty threshold (60% of the national median equalized disposable income %). The importance of reduction of social inequality as major challenge is pointed out in Sustainable Development Strategy of Latvia until 2030.

The authors consider employment differences (as calculation of employment rate against Latvia average) show outcome of labour market trends and are clear and illustrative, There are clear differences between employment rate against Latvia average in rural (only negative values) and urban areas (only positive values). Employment differences show distinct trends in Latvia regions in 2009-2013. The employment rate in Riga (capital city), Pieriga (Riga metropolitan area) are higher than in other regions. The fluctuations of employment rate in the interval are high (−3.9; +4.5). An employment possibility, the number of work places is the basis for economic and social stability and security. And it is the source of resources for social security implementation. Low level of employment means that a large part of population is unemployed or even economically inactive.

Gini coefficient is broadly used for international comparison and is recommended by OECD and EU advisors. It is proposed as an indicator in Sustainable Development Strategy of Latvia until 2030. Sustainable Development Strategy of Latvia until 2030 has defined strategic indicators for 2030 - Gini coefficient must decrease below thirty (<30). At present, Gini coefficient is above defined limit in all regions. Latgale and Zemgale regions are the only areas where social inequality has evidence of decrease after crises and in 2013 is lower than in 2009. Both regions have rather large part of population living and working in rural areas (agriculture).

The fluctuations of Gini coefficient size in different regions show lack of clear progress in elimination of social inequality. The Gini coefficient was slightly higher in 2013 in Riga and Pieriga region. It is higher than in the EU on average (Eurostat, 2013).

In 2013, each fifth of the Latvian population were subjected to the risk of poverty, which is more than in 2012. There are evident differences between regions (Latgale >30%; Riga < 15%). The higher proportion of people below threshold of poverty is in Latgale – the Eastern, mostly rural part of Latvia.

Table 2

Gini coefficient in Latvia regions (%)

	Rīga	Pierīga	Vidzeme	Kurzeme	Zemgale	Latgale
2009	34.9	36.0	32.8	33.4	36.3	34.5
2010	34.9	34.3	33.4	32.3	33.6	33.4
2011	34.2	38.1	33.6	34.9	34.8	31.6
2012	33.7	36.9	35.2	33.2	32.1	31.9
2013	34.3	37.1	33.7	33.6	32.0	31.9

Source: authors' calculations based on CSB data (CSB,2015a).

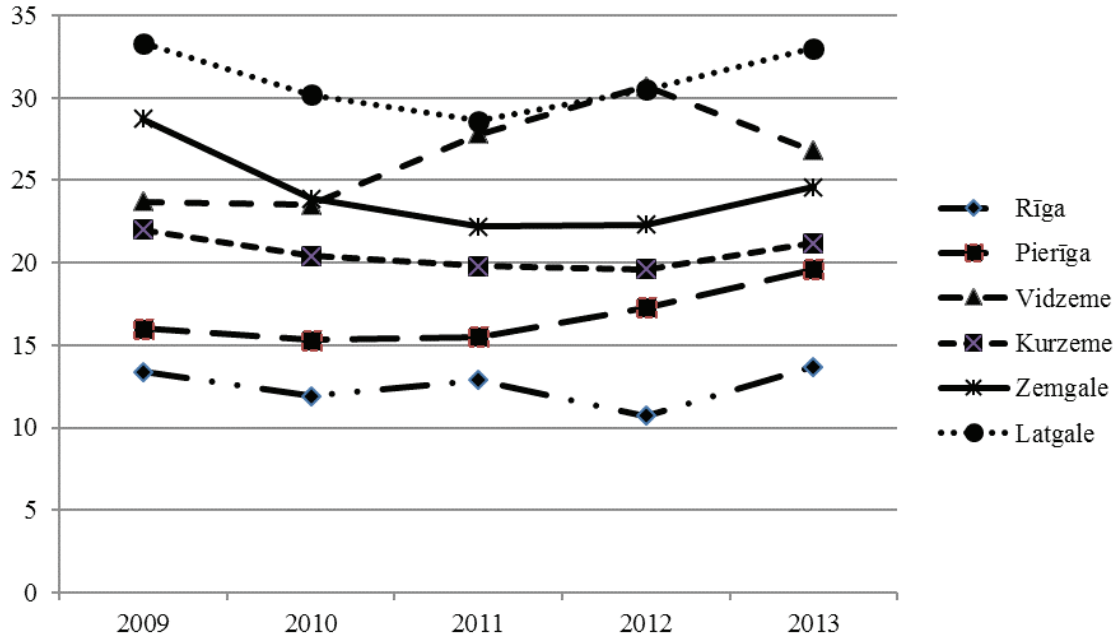


Figure 1

Figure 1. At-risk-of-poverty (persons with disposable income below at risk-of-poverty threshold - 60% of the national median equalized disposable income %).

Source: authors' calculations based on CSB data (EU-SILC survey) (CSB, 2015b).

But less people below poverty line are in Riga and Pieriga regions where employment and income levels (Table 1) are higher (Bela and Rasnača, 2015). However, the relatively successful economic growth does not guarantee social development for all (in Riga and Pieriga, numbers of persons under risk poverty are still high, and these districts have the most unequal income distribution in Latvia). In five years (2009-2013), the number of people at risk of poverty or social exclusion has slightly risen in three regions (Riga, Pieriga, Vidzeme), but slightly diminished in others (Kurzeme, Latgale, Zemgale). The authors suggest that particularities of local political initiatives could be at the bottom of such changes.

Conclusions

Latvian government should establish a clear social policy that would strengthen Latvian move towards a welfare state functions and purposes. 'The Sustainable Development Strategy of Latvia until 2030' and 'National Development Plan 2014-2020' have designed more general regional and social development aims, but complex and networked implementation is necessary. Welfare policy actors see the social security in narrow and fragmented perspective. The analysis of regional disparities and inequality indicators, which do not show tendencies toward decline, substantiate a great need for a unified social policy planning document as a mid-level document (between Latvia 2030, the NDP 2020 and the lower level planning documents), which would help to improve coordination between different policy implementation levels and sectors. The extent to which income inequality varies within regions and districts is very relevant for policy decisions and monitoring. The economic growth without social security coverage failed to ensure well-being and social security for all population.

The contribution of this paper is to show the importance of social dimension in context of international perspective on social security measurement for regional development evaluation. Latvia must seriously work on complex solutions for social inclusion, reduction of poverty and inequality, as well as on other social security issues, including more equal living and working conditions in all local governments. The innovative instrument for measurement of social dimension of regional development is a necessary precondition for regular monitoring of policy objectives for sustainable social development in all regions.

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References

1. Bauman Z. (2007) *Liquid Times: Living in an Age of Uncertainty.* Cambridge, Malden: Polity Press, pp. 128.
2. Beck U. (2000) *The Brave New World of Work*. Cambridge, Malden: Polity Press, pp. 202.
3. Bela B., Rasnača L. (2015) Social sustainability and social security of territories: methodology of analysis and relevance for development. *ECONOMIC SCIENCE FOR RURAL DEVELOPMENT. Integrated and Sustainable Regional Development*. Nr. 38. Jelgava, pp. 71-80.
4. Central Statistical Bureau (2015) Employment rate in Latvia statistical regions. Available at: http://data.csb.gov.lv/pxweb/lv/Sociala/Sociala__ikgad__nodarb/NB0030.px/table/tableViewLayout1/?rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0/, 14 February 2015.
5. Central Statistical Bureau (2015a) Gini coefficient of equalized disposable income in Latvia regions. Available at: from: http://data.csb.gov.lv/sq/0558819d-bb5a-4935-ac95-3fc548b95d09, 1 February 2015.
6. Central Statistical Bureau (2015b) Share of population below the poverty threshold. Available at: http://www.csb.gov.lv/en/notikumi/large-share-population-still-risk-poverty-41760.html, 11 February 2015.
7. Eurostat. European Commission (2009) Sustainable development in the European Union. Luxembourg: Office for Official Publications of the European Communities. Available at: http://ec.europa.eu/environment/eussd/, 28 February 2015.
8. National Social Report of Latvia (2014) Available at: http://www.lm.gov.lv/upload/sociala_aizsardziba/sociala_ieklausana/nsr_2014_latvia_fin2.pdf, 14 February 2015.
9. OECD (Organization of Economic Cooperation and Development) (2014) OECD Regional Well-Being: A user's guide. Available at: http://www.oecdregionalwellbeing.org, 11 February 2015.
10. (ES Komisija) (2007) ES Komisijas paziņojums. Ceļā uz kopīgiem elastīguma un sociālās drošības principiem: vairāk un labākas darba vietas, izmantojot elastīgumu un drošību (Report of EU Comission: Way to Common Goals of flexicurity). Available at: http://eur-lex.europa.eu/legal-content/LV/TXT/?uri=CELEX:52007DC0359, 7 February 2015. (in Latvian).
11. Eurostat (2013) Gini coefficient of equivalised disposable income. Available at: http://epp.eurostat.ec.eu, 4 January 2015.
12. ILO (International Labour Organization), Social Security Department (2010) Extending social security to all. Geneva: International Labour Office. Available at: http://www.ilo.org/public/english/protection/spfag/knowledge/publ.htm, 12 December 2014.
13. International Labour Organization (1952) Convention concerning Minimum Standards of Social Security (Entry into force: 27 Apr 1955). Adoption: Geneva, 35th ILC session (28 Jun 1952). Available at: http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::p12100_instrument_id:312247, 6 January 2015.
14. Phillips J. (2007) *Care*. Cambridge: Polity Press, pp. 224.
15. Saeima of the Republic of Latvia (2010) Latvijas ilgtspējīgas attīstības stratēģija līdz 2030.gadam (Sustainable Development Strategy of Latvia until 2030). Available at: http://www.latvija2030.lv/upload/latvija2030_saeima.pdfLR Saeima, 5 February 2015. (in Latvian).
16. Sen A. (1993) Capability and Well-being. In Nusbaum M., Sen A. (eds). *The Quality of life*. Oxford: Oxford University Press, pp. 9-30.
17. Stiglitz J.E. (2012) *The Price of Inequality*. New York, London: W.W. Norton &Company, pp. 306.
18. Stiglitz J., Sen A., Fitoussi J. (2009) Report by Comission on the Measurement of Economic Perfomance and Social Progress. Available at: http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf, 12 February 2015.
19. Report of the Social Protection Floor Advisory Group (2011) Social protection floor for a fair and inclusive globalization. Geneva: International Labour Office. Available at: http://www.ilo.org/public/english/protection/spfag/download/background/bachrep_en.pdf, 12 January 2015.
20. Van Ginneken W. (2009) Social Security and Global Socio-economic Floor. doi: 10.1177/1468018109104627 Global Social Policy August 2009 vol. 9 no. 2 228-245. Available at: http://datubazes.lanet.lv:2232/content/9/2/228.full.pdf+html, 20 January 2015.
21. VARAM (2013) Reģionālās politikas pamatnostādnes 2013.-2019. gadam. Ministru kabineta 2013.gada 29.oktobra rīkojums Nr. 496 (Regional policy guidelines for 2013-2019). Rīga, Available at: http:// www.vraa.gov.lv/uploads/espon/i.goba.pdf, 10 January 2015.
22. Vilkinsons R., Pikita K. (2009) *Līmeņrādis. Kāpēc mums ir nepieciešama vienlīdzīga sabiedrība? (Ne) laimīgas sabiedrības analīze* (The Spirit Level: Why More Equal Societies Almost Always Do Better?). Rīga: Zvaigzne ABC, pp. 336. (in Latvian).

GEOGRAPHICAL TENDENCIES OF MAIN PRODUCE EXPORTS OF LATVIA 2000-2013

Antons Berjoza[1], Juris Paiders[2]
University of Latvia
antons.berjoza@inbox.lv; jpaiders@inbox.lv

Abstract
Recently economic development has been an issue of intense research and discussion in an academic society. Many facets of countries' economic development were examined, including foreign trade. As a foundation of international cooperation, this indicator is relevant in observing one's internal development and external ties. In case of Latvia, this topic is heavily influenced by economists, and the geographical perspective is quite underdeveloped. In this research, the economic ties of Latvia were explored through the analysis of its main export groups in sectors of agriculture, forestry and fisheries throughout the first decade of the 21st century.
With the aim of establishing clear ties between Latvia and its major export markets, the statistics of foreign trade was analysed using frequency analysis. It can be reported that in general Latvian export markets are closely located and consist of the Baltic Sea Region countries such as Denmark, Germany, Russia and others. Despite the differences in commodity group destinations, it can be clearly stated that a division of trade flow still exists, separating it into two directions - Eastern and Western, where the former allocates the majority of Latvian processed commodities and more sophisticated goods, and the latter consumes raw materials and less transformed materials. This arguably shows a difference in demand in Western and Eastern markets, where the first mostly requires materials for its own industry, while the latter procures them for consumption on the local market, again pointing to a complexity of reforms required for the Latvian economic focus turning towards Western markets.
Key words: foreign trade, frequency analysis, agriculture, forestry, fisheries.

Introduction

Following the economic crisis of 2007-2009, the debate about the economic development in Latvia and many other countries has taken a big turn towards more sustainable and continuous economic policing than ever before. Due to a fast and fluctuating nature of the crisis, where the fall or stagnation of economies resembled a domino effect, the mechanisms of stabilisation used on previous occasions were not very effective; however, the heavy-handed interventions by state financial institutions in many cases led to quick or moderate recovery times. In case of Latvia, the damage was too great for it to recover on its own, so the international financial assistance was sought.

This is one of the few great background events that highlight the research field of the economic development of Latvia. In the last 20 years, Latvian economy has undergone a profound transformation from a post-socialist economy based on the production of agricultural and industrial goods to a more liberal economy, where services dominate production. Another aspect is the restructurization of its production sectors, where the agricultural part grew and the industrial one decreased considerably, with only few heavy industries surviving and the majority shifting to light industries, such as textiles, furniture and raw material re-processing. These changes, made to accommodate the Latvian economic transition to one closer to the European Union (further EU), were made prior to the 2004 enlargement of the EU, and continued even after, but at a faster, more optimistic speed, which led to an unprecedented growth rate. In few years between the Latvia's accession to the EU and the economic crisis, the economy of Latvia developed very actively and sometimes with very unreasonable and hypertrophied ambitions, which led to intensive borrowing of free EU capital available on financial markets. As a result, industries had to bear the greatest toll when the crisis became a reality in Latvia. Stagnation, a sharp drop of Gross Domestic Product, recession and growing unemployment made it hard for many enterprises to continue their functioning, and many of them went bankrupt.

All these events made economists and those in the research field shift their attention to perspective development targets, evaluations of the existing trading patterns and connections, and to a more sustainable planning of economic development. In this scientific research, however, geography and spatial research has been secondary, priority being given to economic parameters and variables. Still, space and its structure are important since they are crucial in economic theories on good flows and production chains as noted by A. Smith and many others (Mažirina, 2007).

This research aims to analyse the spatial development of foreign trade of Latvia in particular, its export markets of major commodity groups using frequency analysis. This is achieved by:

- evaluating the existing extent of research in the field and completing a statistical overview in the period of interest;
- gathering export data of main commodity groups and using frequency analysis to pinpoint the major and continuously stable markets;
- analysing the results of the frequency analysis and interpreting them with additional qualitative data to explain a positive or negative trend, without relying on pure empirical data.

Before starting to analyse the statistics, it was crucial to observe the current trends in this research. On the local level, the research concentrated on international connections and trade (Karnups, 2004; Mažirina, 2007; Rupeika, 2010; Žuravļovs, 2012), foreign trade development as a major economic development element (Vasiļjeva, 2007; Privalova, 2008; Svilāns, 2008; Ovčiņņikova, 2011), foreign trade as a descriptor of international integrity and a tool for further European/World integration (Būmane, 2007; Lagune, 2007; Kolesnikova, 2008; Fadejeva and Meļihovs, 2009). On the other hand, in the international scientific community, the research of foreign trade as an economic development component was mostly concentrated on the largest trading partners (Berentsen, 2012; Bērtaite and Liepa, 2011; Kantar et al., 2011), commodity turnover (Birzins, 2004; Keišs et al., 2009; Devaeva, 2006), and the analysis of traded commodity type or group (Berentsen, 2012; Gingrich, 2011; Devaeva, 2006).

Materials and Methods

The data used in this research were taken from the Central Statistical Bureau of Latvia. The data from the year 2000 to 2013 were collected for all foreign trade transactions in the selected groups, which represented the major sectors of the Latvian economy such as agriculture, fisheries and forestry. The data from the whole data set were selected based on four digit international goods nomenclature:

02 – Meat and its processed goods;
03 – Fish and its processed goods;
04 – Milk and its processed goods;
10 – Grains;
11 – Grain processed goods;
16 – Prepared foodstuffs and conserves;
44 – Forestry goods;

The mentioned groups were further processed to fit the preliminary analysis criteria by being sorted by a year, month, and country in one matrix. The preliminary analysis involved the preparation of a binary matrix, by substituting any positive trade instance for 1 and the rest for 0. Using the formula below, a frequency of export can be calculated:

$$P = \sum(N1+N2+N3+ \dots +Nx)/X, \quad (1)$$

Frequency calculation formula

Where – P is frequency,

X – is a number of months in the observed period,

and N – is a value for every month in the matrix. Thus, the analysis gives a string of frequencies that describe the export frequency for any export position of goods to a given state. For further analysis, the data were transformed again combining all the data into 5 major groups: 02 – meat products, 03 – fish products, 04 – milk products, 10 – grains and its products and 44 – forestry products. Further some countries were excluded (Yugoslavia and its succession states, Sudan and ex-Dutch colonies in the Caribbean), as they were in the periods of transition, and these might have caused serious misinterpretations and heterogeneities in the matrixes.

The transformed data of 5 columns were used in calculating a function from the relative frequency that would give an opportunity to determine whether the H_0 could be dismissed. H_0 was formulated as follows: export to any selected country/market at any selected time is random in nature. For that purpose, R. Fisher φ-function is the best (See Formula 2) (Krastiņš and Ciemiņa, 2003, 161).

$$\varphi = \frac{2\pi}{180}\arcsin(\sqrt{p}) \quad (2)$$

Fisher φ calculation formula, where p- is frequency

Then, using formula in Figure 3, t-empirical can be calculated, and using formula in Figure 4 t-theoretical can also be obtained:

$$t_a = \frac{|\varphi_1 - \varphi_2|}{\sqrt{\frac{n_1 + n_2}{n_1 \times n_2}}} \quad (3)$$

T_{emp} calculation formula

$$\upsilon = n_1 + n_2 - 2 \quad (4)$$

T_{theo} calculation formula

Formula 4 shows the calculation for the degrees of freedom, where n_1 is the number of observations in the general set, but n_2 the number of observations for one country, φ_1 is Fisher transformation for indicator frequency for the general set, φ_2 is Fisher transformation for indicator frequency in the general for one country: *V* – Number of the degrees of freedom; T- theoretical is based on the T- distribution (T-tables) according degrees of freedom.

As a result, it is possible to obtain T_{emp} value that can give a relative frequency from which it is possible to speculate a possibility of export occurring in any randomly selected month into the country under observation. Hence, all countries can be divided into 3 groups, after the calculation of t-statistics of significance:

1) Export markets – where the export occurrence probability is statistically high – where T_{emp} is greater than 2, and the average frequency of the export group is smaller than that of the observed country;

2) Export markets – where the export occurrence probability is statistically low - T_{emp} is greater than 2,

and the average frequency of export group is greater than that of the observed countries. This group also includes all the countries with no export records;

3) Export markets – where export has eventual character - T_{emp} is less than 2, and H_0 cannot be dismissed.

Results and Discussion

The analysis shows a significant geographical differentiation of export markets for different commodity types and significant shifts that occurred in these markets due to different economic or political events, such as Latvia's accession to the EU and the economic recession in 2007-2009, as well as the new economic policy following the crisis management policies.

Analysing the mentioned groups in a successive order, it can be noted that the first (i.e. meat and its products) group has a relatively small geography; it is mainly restricted to the Baltic Sea region and encompasses mostly the immediate neighbours and historical trade partners of Latvia such as Germany, Poland, Denmark and the Czech Republic. Subsequently, further markets such as Austria and Cyprus, and even the Netherlands are also significant. The UK and Ireland being in the range of significant export markets can also indicate a previously noted 'goods follow people effect' mentioned in other studies (Berjoza and Paiders, 2013), where it appeared as an explanation for sustainable and constant export of Latvian processed fish to Western European countries with significant ex-Soviet expatriate communities. Few significant markets at a considerable geographical distance were also noted, for instance Panama and Liberia. Export to these countries can be explained by the fact that many ships in Latvian ports are registered in 'cheap flag nations' such as the mentioned ones, meaning this export does not describe the trade relations between Latvia and these countries, but mostly order preferences of a ship crew.

Looking into detail on the data of the fish and fish products group, a wider geography was observed. It covered not only Europe, but also North American and Central Asian countries, making it one of the most geographically diverse export networks in this study. The export markets are generally focused on particular commodity types, for example, live and fresh fish were majorly exported around the Baltic Sea, predominantly to Lithuania and Estonia, while fresh processed fish and processed red fish were exported to Western Europe and the rest - to Eastern Europe. Canned fish, usually sprats or mackerels, smoked, salted and differently processed fish were the dominating Latvian products exported to the Eastern European and Asian countries.

In this group, the internal differentiation of the market played a great role in distinguishing trade flows as noted in Berjoza and Paiders (2013) work on fisheries, but this did not give away a stable market disposition. It should be noted that a largest volume of export in this major group consists of such processed fish as canned sprat, so in many aspects any volume analysis would give the major markets a pattern consistent wit this groups export. On the other hand, in this study, the method of binarisation was applied, so the total volume had no significant impact, proving that even less significant export groups, such as fresh fish, frozen fish, fish fillets and others, were equally subject to a wider differentiation of export, which was similar to that of canned fish.

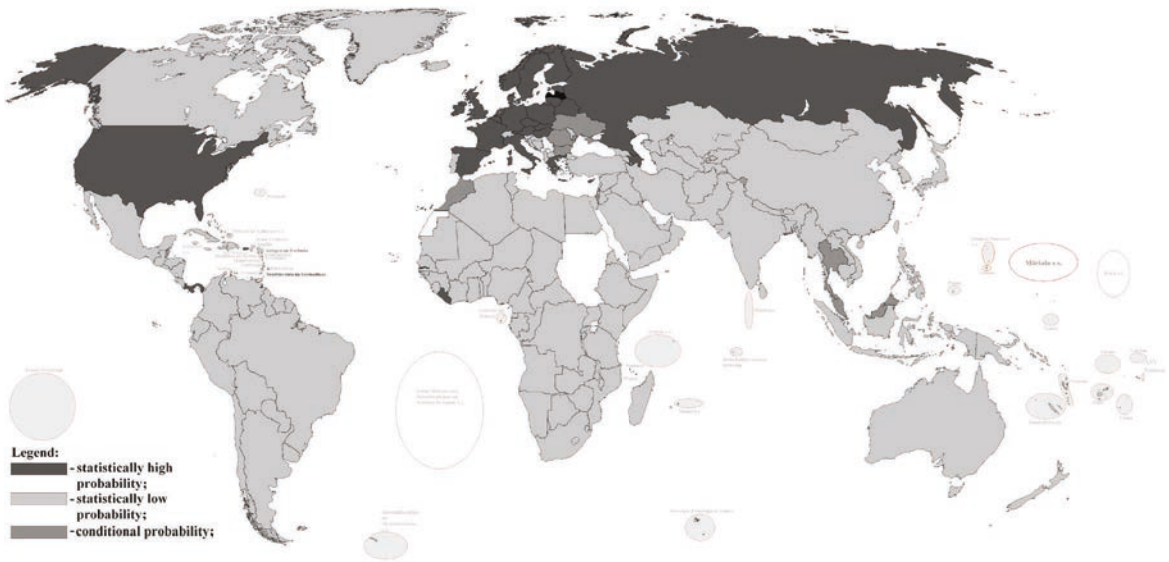

Figure 1. Export markets by probability for dairy and dairy products in the observed period.

Table 1

Cheese and cottage cheese export volumes by major export markets in the period from 2000 to 2013 (in million Euros, country names given in ISO codes)

State	00	01	02	03	04	05	06	07	08	09	10	11	12	13
DE	1.19	2.96	1.57	2.8	5.01	12.24	12.82	15.3	19.11	7	10.53	9.52	8.62	12.36
DK	0.17	0.05	1.13	1.95	3.72	3.35	1.51	0.96	0.26	0.1	0	0.51	0.38	0.88
EE	0.54	0.85	1	1.04	1.18	1.17	1.06	2.38	5.01	3.77	3.26	4.33	4.64	5.52
FI	0	0	0	0	0	0.46	0.79	2.64	2.48	0.26	0.02	0.06	0.01	0
GB	0.1	0.01	0.01	0.12	1.09	0.64	0.09	0.60	1.01	0.57	0.26	0.36	0.53	0.98
IT	0.06	0	0.03	0.23	0.59	7.99	9.10	4.13	2.44	2.89	5.3	4.57	1.81	1.13
LT	0.15	0.19	0.3	0.81	1.02	1.03	1.73	1.24	1.72	2.16	2.39	5.62	6.92	6.96
NL	2.27	5.43	4.89	6.57	2.65	0.56	1.80	1.03	0.76	0.13	0.43	2.65	7.42	5.94
PL	0.04	0	0	0.01	0.60	0.23	0.35	0.3	0.16	0.29	2.02	0.96	2.16	1.45
RU	0.28	0.054	0.13	0.10	0.55	1.32	3.43	5.65	7.53	4.72	13.3	18.04	15.67	15.24

Analyzing dairy and dairy products, it was noted that the geography of export is extensive. Figure 1 shows a chart of the frequency analysis results, which indicate that stable and significant markets were concentrated in Europe. Detailed insight into a distribution of export market shares amongst different export positions reveal a significance of two general groups – fresh milk and cream and cheese and cottage cheese exports. So, it can be noted that the extent of the geographical export market can be determined by the 'expiration date' of the product, hence a relatively narrow geography for fresh milk and cream and wider - for cheese and cottage cheese. Similarly to the previous group, an additional transformation of input data managed to annul the effect of larger group shares in total volume statistic. So, it can be stated that frequency analysis can effectively distinguish and show stable export markets, without a distortion caused by greater or smaller values of total export, its general shares and volumes of exported goods.

Another important aspect disclosed by the analysis of the 3rd group can be seen in Table 1, where export dynamics for all significantly large export markets is shown. It is seen that prior to 2004, the dominating export market was the Netherlands, which imported a large portion of Latvian cheese and cottage cheese, but after the accession of Latvia to the EU and its inclusion in the common European economic space, the significance and volumes of export to Germany and Italy grew significantly, effectively tripling in a span of just few years. Consequently, during and after the economic crisis of 2007-2009, it can be seen that the export to Germany and Italy fell dramatically, while the export to Russia and Lithuania developed at a steady progressive pace.

The 2012-2013 showed a new decline, which might indicate a worsening international economic situation, despite recovery signs in some economies. A general trend for a recess in the major economies can indicate wider dispersion of Latvian export amongst several significant and new markets that were not included in this chart due to a low total volume in the span of a decade, although, the scenario of potential differentiation of Latvian export markets was mentioned before (Svilāns, 2008; Vasiļjeva, 2007). This can ask for further research in the future for more accurate evaluations.

Figure 2 provides an illustration of the frequency analysis results of grain and its product exports, in which the geographical extent is similar to that of meat groups, but general diversity of export is similar to that of fish and diary groups. As it can be seen, the stable markets are once again localised in the nearest vicinity of Latvia. Countries can be divided in two groups: ones with a potential shortage of examined commodities due to harsher environment (Spain, Greece, Austria, Uzbekistan and Kazakhstan) or extreme rates of consumption (Thailand, the USA and Belize).

The Results of this group are also significant because they are the best illustration of the essence of the method used for the research. Figure 3 provides the information on the main export markets in terms of sheer volume for the most significant portions of this export niche. In comparison to Figure 2, many significant export markets of this group are not shown as stable by the frequency analysis, thus proving the hypothesis that there is some strong interrelation between the frequency analysis results and the sheer volume analysis results.

In the end, it is important to observe some export patterns in forestry commodity export. The range of stable markets for this group is tremendous. It includes all major European markets, Chinese and Japanese markets, North American markets, Central Asian markets, even relatively exotic Egyptian and Guinea markets. It proves that wide nomenclature of goods with long preservation time can be exported further and stored longer for best realisation price,

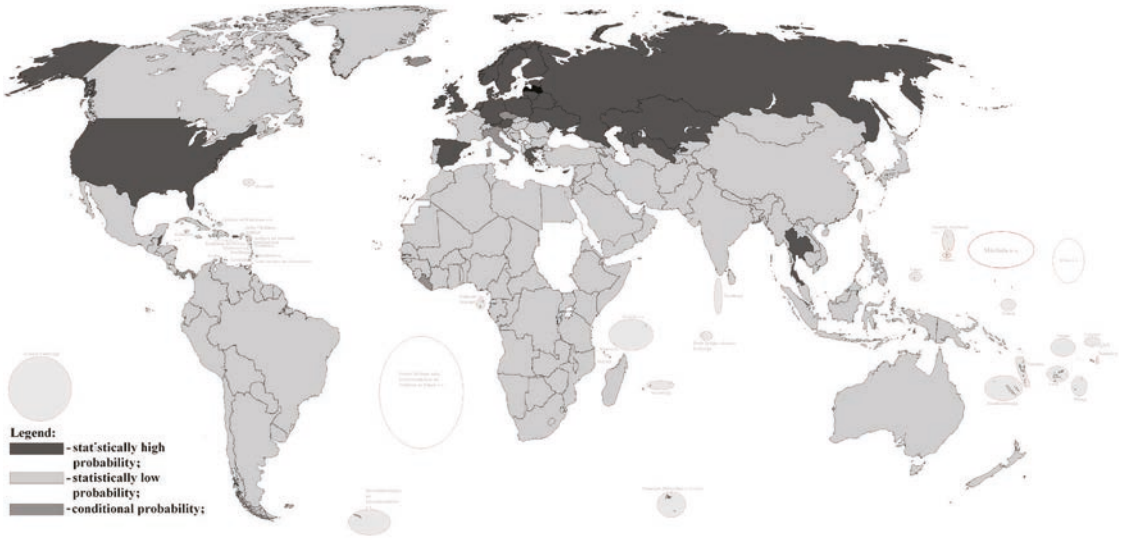

Figure 2. Export markets by export probability for grain and its products in the observed period.

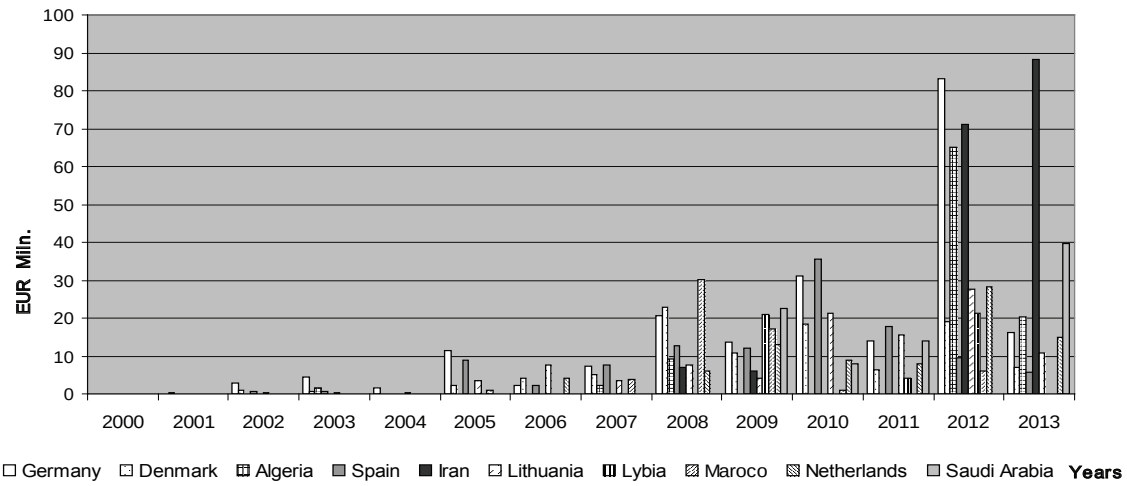

Figure 3. Wheat and wheat-rye mixture export volumes by major export markets in the observed period.

compared to perishable goods observed in the previous groups.

As it has been mentioned above, theoretical studies have strong economic inclination, that is, the main emphasis of the research is on economic impact, the parameters relevant for the field of academic or practical economy. Spatial information and data are used scarcely and only as vague illustration, despite the fact that it can be an important addition or facet, if appropriately used, as demonstrated by this research. Unlike economic variables, spatial ones often require additional insight and are able to provide in-depth information on processes and conditions, otherwise unnoticed or unexplained by simple numbers. Despite that this kind of data is often overlooked in research, even when its use could greatly improve the results.

On the other hand, some researchers such as Haibo (2004) and Kantar et al. (2011) stress that spatial and particularly geographical information is one of the most crucial elements in the research of economic development and is instrumental in assisting the evaluation of possible future prospects. They came to these conclusions by analysing Chinese geo-economics in one case and Turkish foreign trade change in a period of a decade between the 20th and the 21st centuries. Others (Hall, 2006; Herkenrath, 2007; Kaminski and Raballand, 2009; Gingrich, 2011) also note the importance of spatial data in the research of economics, which provides additional parameters and explanations to some existing connections in economic interrelations. Hence, it is important to widen the scope of geographers' presence in the filed of export studies and contribute to it by providing some geographical materials and insights into the problems and questions posed.

Conclusions

Export studies are internationally recognised subject of scientific interest. It is being ascertained by the range and the amount of papers and other works that research these flows not only in space, but also time. Unfortunately, in case of Latvia these studies are largely concentrated in the field of economics and their diversity is determined by a range of economic theories applied to their study, not by the prospects and possibilities of the multiple research angles of the phenomena. That calls for wider and deeper studies of trade flows in scientific fields other than economy.

By analysing Latvian export markets of agriculture, fisheries and forestry and observing the differences between the data acquired through two different empirical methods, it can be said that Latvian major export area is the Baltic Sea region (including Estonia, Lithuania, Finland, Sweden, Russia, Belarus, Poland, Germany, and Denmark) and adjoining nations (such as the Czech Republic, Norway, Slovakia, the Netherlands, Austria). The USA can also be mentioned as a stable trading partner for Latvia, but it is largely insignificant in terms of volumes.

The Analysis in this study confirms some findings from the previous work (Berjoza and Paiders, 2013) such as 'goods follow people', which specify a distribution of particular goods in terms of population migration and the demand for recognised and trusted brands (e.g. canned sprats); 'export variety is determined by time', which indicates the shrinkage of geography in proportion to the time the goods can be preserved unspoiled, giving advantage to non-organic/non-perishable goods (e.g. fresh food stuffs and forestry commodities).

The Applied methodology has successfully assisted in finding stable export markets of Latvian major economic sectors and has been effective in comparison with other less reliable methods, such as export volume analysis and others. The method could efficiently separate stable markets (i.e. markets with statistically significant probability being an export market) from unknown or rare markets (i.e. markets with statistically insignificant probability being an export market), as well as determine markets with random probability, which signify complex underlying processes and connections that make export to these markets possible in different cases.

References

1. Berentsen W.H. (2012) The Change in European Foreign Trade from 1960 to 2010: A Geography of Leading Merchandise Exporting Partners. *Eurasian Geography & Economics*, pp. 380-399.
2. Berjoza A., Paiders J. (2013) Geographical trends in export market of Latvian Fisheries production. *Research for Rural Development - International Scientific Conference*, 2, pp. 208-214.
3. Bērtaite L., Liepa I. (2011) Analysis of tree felling, regeneration, import and export dynamics in Latvia. *Research for Rural Development - International Scientific Conference*, 2, pp. 13-16.
4. Birzins A. (2004) Bilateral diplomatic and economic relations between East Asia and the new EU members: The case of Latvia. *Asia Europe Journal*, 2, pp. 221-235.
5. Devaeva E. (2006) Foreign Trade Flow Structure of the Russian Far East. *Far Eastern Affairs*, 34(3), pp. 93-105.
6. Fadejeva L., Meļihovs A. (2009) Latvijas Tautsaimniecības nozaru kopējās faktoru produktivitātes un faktoru izmantošanas novērtējums. (General sectoral factor productivity and use of factor assessment of Latvian national economy). Available at: http://80.233.167.45/public_files/images/img_lb/izdevumi/latvian/citas/pet_2009-3_fadejeva-melihovs.pdf, 21 April 2011. (in Latvian).
7. Gingrich S. (2011) Foreign trade and early industrialisation in the Habsburg Monarchy and the United Kingdom — Two extremes in comparison. *Ecological Economics*, 70(7), pp. 1280-1288.
8. Haibo L. (2004) Geoeconomics at Work. *Beijing Review*, 47(45), pp. 3.
9. Hall N. (2006) The Liverpool Cotton Market and Cotton Re-exports, c. 1815–1914. *Northern History*, 43(2), pp. 257-271.
10. Herekenrath M. (2007) Introduction: The Regional Dynamics of Global Transformations. *International Journal of Comparative Sociology (Sage Publications, Ltd.)*, 48(2/3), pp. 91-105.
11. Kaminski B., Raballand G. (2009) Entrepôt for Chinese Consumer Goods in Central Asia: The Puzzle of Re-exports through Kyrgyz Bazaars. *Eurasian Geography & Economics*, 50(5), pp. 581-590.
12. Kantar E., Deviren B., Keskin M. (2011) Hierarchical structure of Turkey's foreign trade. *Physica A*, 390(20), pp. 3454-3476.
13. Keišs S., Grišins A. (2011) Innovation Opportunities of Export - Oriented Latvia's Forestry and Wood Processing Industry. *Economic Science for Rural Development Conference Proceedings,* 25, pp. 89-100.
14. Krastiņš O., Ciemiņa S. (2003) Statistika (Statistics). LR Centrālā statistikas pārvalde, Riga, Latvia, 267. lpp. (in Latvian).

15. Mažirina J. (2007) *ES ārējā tirdzniecība ar Ķīnu: priekšnosacījumi un perspektīvas: Bakalaura darbs.* (EU foreign trade with China: advantages and perspectives: Bachelor thesis) Riga, Faculty of Economics and Management, University of Latvia, 72. lpp. (in Latvian).
16. Karnups V. (2004) *Latvijas ārējā tirdzniecība ar Skandināvijas valstīm: Promocijas darbs.* (Latvia's foreign trade with Scandinavian countries: PhD thesis) Riga, Faculty of Economics and Management, University of Latvia, 207. lpp. (in Latvian).
17. Rupeika D. (2010) *Latvijas arējā tirdzniecība ar Japānu un tās perspektīvas: Bakalaura darbs.* (Latvia's foreign trade with Japan and its perspectives: Bachelor thesis) Riga, Faculty of Economy and Management, University of Latvia, 69. lpp. (in Latvian).
18. Žuravļovs A. (2012) *Latvijas ārējā tirdzniecība ar Slovākiju un tās perspektīvas lauksaimniecībā un pārtikas nozarē: Maģistra darbs.* (Latvia's foreign trade with Scandinavian countries and its perspectives in fields of agriculture and foodstuffs: Masters thesis) Riga, Faculty of Economics and Management, University of Latvia, 85. lpp. (in Latvian).
19. Vasiljeva S. (2007) *Latvijas ārējās tirdzniecības attīstības tendences: Bakalaura darbs.* (Latvia's foreign trade development tendencies: Bachelor thesis) Riga, Faculty of Economics and Management, University of Latvia, 86. lpp. (in Latvian).
20. Privalova J. (2008) *Ārējā tirgus iekarošana kā uzņēmuma eksportspējas paplašināšanas nosacījums metalurģijas nozarē: Maģistra darbs.* (Foreign market conquest as the facet of export volume enlargement in the sector of metallurgy: Masters thesis) Riga, Faculty of Economics and Management, University of Latvia, 85. lpp. (in Latvian).
21. Svilāns I. (2008) *Ārējās tirdzniecības attīstības veicināšana, kā svarīgs Latvijas ārējā makroekonomiskā līdzsvara nodrošināšanas nosacījums: Maģistra darbs.* (Foreign trade development as important factor in stabilizing Latvian outer macroeconomic balance: Masters thesis) Riga, Faculty of Economics and Management, University of Latvia, 125. lpp. (in Latvian).
22. Ovčiņņikova J. (2011) *Arējā tirdzniecība un Latvijas ekonomikas izaugsme: Maģistra darbs.* (Foreign trade and Latvian economic development: Masters thesis) Riga, Faculty of Economics and Management, University of Latvia, 106. lpp. (in Latvian).
23. Būmane I. (2007) *Latvijas ārējās tirdzniecības raksturojums no 2000.-2005. gadam: Bakalaura darbs.* (Latvia's foreign trade overview from 2000 to 2005: Bachelor thesis) Riga, Faculty of Economics and management, University of Latvia, 65. lpp. (in Latvian).
24. Lagune S. (2007) *Latvijas ārējā tirdzniecība pēc iestāšanās Eiropas Savienībā: piena produktu tirgus izpēte: Bakalaura darbs.* (Latvia's foreign trade after accession to European Union: case of dairy market: Bachelor thesis) Riga, Faculty of Economics and Management, University of Latvia, 71. lpp. (in Latvian).
25. Kolesnikova J. (2008) *Ārējā tirdzniecība Latvijā un tās vieta Eiropas Savienībā: Maģistra darbs.* (Foreign trade in Latvia and its place in European Union: Masters thesis) Riga, Faculty of Economics and Management, University of Latvia, 133. lpp. (in Latvian).

ROLE OF LOCAL ACTION GROUPS IN ADDRESSING REGIONAL DEVELOPMENT AND SOCIAL PROBLEMS IN LATVIA

Agnese Krieviņa, **Ieva Leimane**, **Ligita Melece**
Latvian State Institute of Agrarian Economics
agnese@lvaei.lv; ieva@edo.lv; ligita@lvaei.lv

Abstract
The objective of the paper research is to assess the role of the implementation of the local development strategies (LDS) elaborated by the local action groups (LAGs) in the regional development and addressing social problems in Latvia. The paper examines the role and place of LDS in territorial development planning in Latvia, carries out thematic analysis of the projects implemented under the LDS as well as tries to assess the LEADER approach impact on regional development and addressing of social issues on the local level. The authors use unpublished data on LEADER projects and apply quantitative and qualitative analysis methods. Most of LEADER projects have been implemented to facilitate the development of infrastructure related to recreation and quality leisure time as well as culture and sports. Rural inhabitants have noticed positive changes in their local territory introduced by the LEADER approach. Though, in order to enhance the role of LAGs and LDS in addressing regional development and social problems at local level, it is advisable that the potential interaction of the activities provided by all regional planning documents is observed when determining priorities at regional level (presently the place and role of the LDS has not been formally defined), while implementation of the LDS should pay more attention to long-term effects and even accomplishment of target priorities.
Key words: LEADER, local action group, local development strategy, rural development.

Introduction

Awareness of resources, opportunities and their optimal utilisation without depletion throughout Latvia, including rural areas, is a prerequisite for sustainable and balanced territorial development. In policy planning documents, rural area is defined as a sphere of national interests with outstanding value and significance for a sustainable development of the state, for preserving the identity, which includes strategic resources critical for the national development. However, in recent years the most typical trends in spatial development in Latvia are depopulation of rural areas and low density of population. This reduces the socialising opportunities as well as becomes a reason for limited availability of services: the distance to the places where services are provided increases, government funding for healthcare, transportation and education infrastructure is reduced, and rural areas are subject to unbalanced and uneven development.

With Latvia joining the European Union (EU), EU funds have become the most important financing source for territorial development. Latvian Rural Development Programme 2014-2020 stresses the importance of the LEADER approach to address such socio-economic problems as maintaining the rural areas populated, improvement of living standards by providing employment and availability of services, and encouraging the social activity of population, including education, culture, sports and recreation (MoA, 2014). The idea of LEADER is to improve living standards in the countryside, along with economic and social improvements and preserving the environment. It is being applied since 1991 in the EU as an instrument for addressing rural development problems and encouraging development on the level of local rural communities. Contrary to other public measures, LEADER seeks for solutions possibly close to the local territory (bottom-up approach).

In Latvia, LEADER approach is being applied since 2000; however, only starting from 2007 it covers the whole country. LEADER approach is based on the local development strategies (LDS) developed by the local action groups (LAGs). In Latvia, under RDP 2007-2013 the LEADER approach was applied by 40 LAGs.

The objective of the paper research is to assess the role of the implementation of the local development strategies elaborated by the local action groups in the regional development and addressing social problems in Latvia. To reach the objective, the tasks have been set: 1) to evaluate the role and place of LDS in territorial development planning in Latvia, 2) to carry out thematic analysis of the projects implemented under the LDS and 3) to assess the LEADER approach impact on regional development and addressing of social issues on the local level.

Materials and Methods

The study analyses LEADER projects implemented within the Latvian RDP 2007-2013 under Measure 4.1.1. 'Improving Competitiveness of Local Development Strategies in the Territory' (data on 387 projects obtained on July 22, 2014), and Measure 4.1.3. 'Diversification of Rural Economy and Quality of Life for the Promotion of Local Development Strategies in the Territory' (data on 3216 projects obtained on January 30, 2014). The main sources of data for the study are unpublished data of the Rural Support

Service (RSS), territorial development planning documents (regional development programmes, local action group strategies etc.), research papers and reports of institutions, LAG survey data (evaluation of project dead-weight; survey carried out during May-September, 2014), CSB of Latvia data etc. Considering various impact directions of LEADER projects, all projects were grouped in three main thematic groups according to their purpose: rural economy; development and growth of society; and rural infrastructure and basic services. This grouping allowed to analyse similar projects and to evaluate and compare the results as well as determine the thematic focus of the LEADER projects in Latvia. Classification system was based on the European Commission methodological materials for the assessment of the impact of LEADER measure on the quality of life (DG Agri, 2010a; DG Agri, 2010b). For this paper part of the results of LSIAE study 'LEADER Measure and Measure 3.2.1 - Results and their Impact on Business Development in Latvian Rural Area' (with the participation of the authors) have been used.

The suitable qualitative and quantitative research methods have been used in the study: monographic; analysis and synthesis, concepts of Meta - analysis; survey; correlation, data grouping, logical constructive analysis etc.

Results and Discussion

Many researchers welcome the LEADER approach as a tool to deal with rural development challenges; however, the conclusions about its practical implications tend to be contradictory. It has been noted that the LEADER, unlike other public funding measures, values the role of social capital and focuses on the enhancement and use of its potential at the local level (Buller, 2000; Shortalls 2008), allowing to maintain the regional diversity in the EU - local traditions, lifestyle, cultural, historical and natural values (Becerra and Lastra-Bravo, 2010) and contributing to the learning of new skills, exchange of experience and improvement in cooperation, and reducing the indifference and passivity (Bruckmeier, 2000; Wellbrock et al., 2013). LEADER approach contributes to the endogenous development of the territory based on local resources and the bottom-up approach to planning (Kis et al., 2012) as well as contributes to the cooperation among entrepreneurs (Ploeg, 2006).

LEADER approach is based on the local development strategies, implemented by LAG, intended to solve the local problems and determine priorities for local development of the area. Some researchers emphasize the role of LAGs by naming them a territorial organizing force and the institution which on the local level implements and coordinates the rural development process (Kis et al., 2012; Falkowski, 2013). However, in practice surveys of rural population indicate that people are ill-informed about the activities of LAG and are not familiar with the LDS developed by them. Also, the European Court of Auditors criticises the contents of the LDS (2007-2013) - concrete and territory-specific goals are missing in the documents, the results to be attained have been defined incompletely. As a document, LDS is expected to justify the existence of the LAG, reflecting its specific contribution to addressing the rural development issues, it should also offer arguments for the role planned for he LEADER approach in this process, yet the evaluation concludes that LDS are rather a formality in order to make the LAG territory eligible to public financing under LEADER (European Court of Auditors, 2010). RDP 2007-2013 mid-term evaluation report, in its turn, criticises the long-term impact of the activities implemented within the LDS: in short-term certain movement is triggered in the territory; however, these projects have no long-term contribution to the development of the territories (LSIAE, 2010a).

The place and role of LDS in Latvia in territorial development planning

Within the RDP 2007-2013 public financing of 39.2 mln EUR was available to the implementation of LEADER projects through LDS. A number of requirements have been set for the LDS development process and contents: they should have a vision, priorities and concrete actions towards facilitating development of rural areas, promoting innovation, strengthening the rural economics, providing quality of life to rural population (MoA, 2010). The local population and a variety of stakeholders should be involved in the development of LDS, and at the same time they should be coordinated with other planning documents binding on the LAG territory.

In Latvia, a strictly regulated territorial development planning system is in place, comprising policies and development planning and assuring their linking with financial planning as well as coherence and hierarchy of the decisions made by central and local government authorities. Given the requirements set out for the LDS contents, it can be perceived as a medium-term territorial development planning document. However, this is not so from the legal aspect, since 1) LAG, as public-private partnerships, are not subjects of the *Development Planning System Law*, 2) there is no place allotted to LDS in the Latvian territory development planning system hierarchy, 3) according to the *Territorial Development Planning Law* the local level development planning documents shall be drafted only by local governments. Thereby, the LDS exist and are being implemented parallel to other regional and local territorial planning documents, contributing to attaining their goals (LSIAE, 2010b).

However, neither the planning region nor the local government development documents specify the role of the LDS towards reaching of strategic goals, defined either on regional or local level (though in practice local governments take active part in the implementation of LEADER projects).

In order to identify the contribution and coherence of the LDS priorities and actions on the level of planning regions, the LDS have been compared with the priorities and actions in the development programmes of five planning regions. The comparison reflects how frequently the priorities and actions defined in regional level have been mentioned in the LDS. Such analysis enables to have a quality evaluation of the significance of each individual action in LDS as well as to judge on the expected implementation impact on the regional level.

While evaluating the mutual coherence, it has been observed that the priorities and subordinated directions of actions in the planning regions development documents comprise all aspects of quality of life. Conversely, in the LDS intended actions, an emphasis on promotion of entrepreneurship, facilitation of employment, development of education, sports and culture infrastructure and improvement of availability of services dominate (see Table 1).

The Vidzeme planning region is the only region where rural development (including development of agricultural and non-agricultural activities, encouraging the initiative of local population and development of agriculture-related research and support institutions) has been elevated to the level of strategic priorities. Considering that the very idea of LDS actions is addressing the problems in rural areas, one can conclude that in the Vidzeme region LDS are conducive to the development process selected by the region.

As to the Latgale region LDS, the intention to *master knowledge and use it at work and in everyday life, local government administration and company*

Table 1

Comparison of the priorities in planning regions development documents with those in the LAG LDS

	Priorities in regional development programme	Emphasis of regional priorities and actions in the LDS actions*
Pieriga	-high quality and development of human capital -region conveniently reached -competitive economy, diversified and active business -high quality environment for living -increase of the role and influence of the region	-availability of health care, social, education and culture infrastructure and services (38;2.5) -diversified activities in rural areas (31, 2.1) -enhanced urban environment quality 21, 1.4) -intensification of entrepreneurial activity (28; 2.1) -expanding of innovations in business (14; 0.9)
Vidzeme	-development of infrastructure and services -development of economy and competitiveness, targeting towards knowledge-intensive economy -development of human capital and employment -rural development	-development of education, culture and sports infrastructure (12; 1.5) -intensification of entrepreneurial activity (19; 1.9) -development of life-long learning (8; 1.0) -development of non-agricultural activities (12; 1.5) -development of agriculture (10; 1.2)
Kurzeme	- to promote and diversify regional economy and to develop production - to enhance transport and infrastructure possibilities in the region - to invest in human capital and develop innovation culture -to create a high quality environment for living, to preserve nature environment and enhance the development of remote areas	- to facilitate the viability of populated areas and rural areas (27; 4.5) - to develop an infrastructure in support to businesses, to promote business and encourage innovations (11; 1.8) - to promote employment and improve the competitiveness of the labour force in the region (11; 1.8) - to create a favourable basis to investment and facilitate the development of high value added sectors and knowledge-based entrepreneurship (11, 1.8)
Zemgale	- an educated, creative and competitive individual - development of knowledge and economy - quality environment for living	- development of business environment (14; 2.8) - development of culture and sports infrastructure and development of services (14; 2.8) - development of cultural and historical heritage and development of recreational environment (12; 2.4)
Latgale	- connections -efficient companies -skills -smart management	-availability of services (21; 3.5); -increase of company productivity and export potential, development of technologies and infrastructure (14; 2.5); -mastering knowledge and application at work and in everyday life, local government administration and company management (14; 2.5)

*the first figure in the brackets denotes the number of instances when a regional level priority action has been mentioned in the regional LDS, while the second figure denotes how frequently on average the action has been mentioned in one LDS
Source: Riga planning region, 2011; Vidzeme Development Agency, 2007; Kurzeme planning region, 2004; Zemgale planning region, 2008; Latgale planning region, 2010; 40 LAG local development strategies

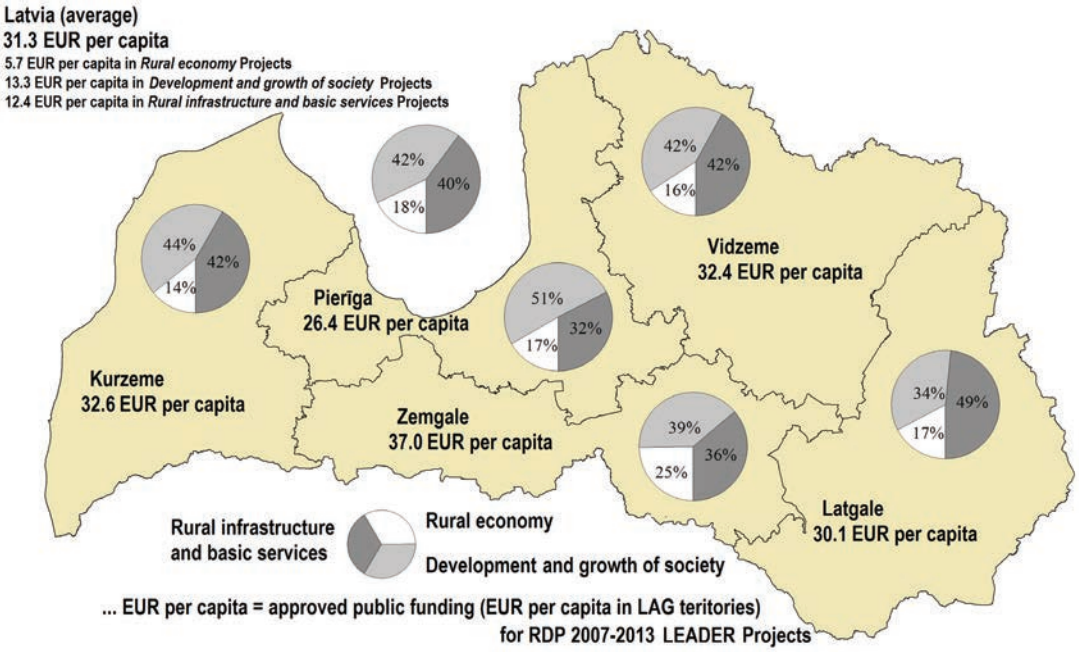

Figure 1. The structure of approved LEADER public financing in the breakdown by thematic groups in the regions of Latvia.

Source: compiled by the authors based on the RDS project database and OCMA.

management, has been mentioned more frequently than in the LDS of other regions, possibly suggesting that this issue is more topical in the Latgale region compared to other regions.

Thematic scope of the LEADER projects

A summary on the projects implemented in Latvia under LEADER approach shows that the largest number of implemented projects, both in terms of quantity and approved public financing, are towards *development and growth of society.* In the regional breakdown, approved financing is rather evenly dispersed, except for project financing prevalence in Pieriga and a notably smaller share for Latgale (see Figure 1). According to the classification developed in the study, the projects directed towards the development of an individual's mental and physical capacities fall under projects *development and growth of society*, which includes also the development of the necessary infrastructure and facilities. In territorial development planning documents, the development of human resources and knowledge-based development is a target priority on the state, regional and also local level; therefore, the LEADER approach is a contribution towards bringing this priority to life.

In total, for the project group *development and growth of society* public financing in the amount of 12.9 mln EUR has been approved (see Table 2). Most of projects, both in terms of quantity and financing, are directed towards enhancing human capital by widening the possibilities to spend leisure time meaningfully and productively (investment in activity centres and sports infrastructure and purchase of equipment) - sub-group *development of society*. Some other projects in this sub-group promote hobby activities (hunting, equestrian sports), education/training and information dissemination as well as strengthen capacities of associations and societies. More than 2.5 mln EUR from the approved public financing have been channelled towards support to amateur performance-related projects. National costumes and stage costumes have been purchased (74% of the financing for the sub-group) as well as musical instruments (17%), and premises have been equipped to enable quality amateur performance activities.

Rural infrastructure and basic services is the second important thematic group of LEADER projects, covering projects towards improvement of living standards of population and enhancing the attractiveness of the environment. In the breakdown by region (see Figure 1), the public financing for the approved projects in the group *rural infrastructure and basic services* indicates that in the Latgale region this issue is more topical, while in Pieriga it is comparatively lower. Compared to other thematic groups, these projects are more capital-intensive in terms of public financing investment per project (9.9 EUR). The largest number of projects approved under LEADER RDP 2007-2013 *rural infrastructure and basic services* group are towards enhancement of recreational environment – in the

Table 2

RDP 2007-2013 LEADER project investment and result indicators by main directions

Thematic group/subgroup	Approved projects		Approved total public financing		Average publ.fin. per project, thsd EUR
	number	**%**	**thsd EUR**	%	
Development and growth of society	**1,577**	100	**12,942**	100	**8.2**
development of society	1,184	75	10,402	80	8.8
amateur performances	393	25	2,540	20	6.5
Rural infrastructure and basic services	**1,225**	100	**12,102**	100	**9.9**
rural infrastructure	345	28	3,257	27	9.4
healthcare and social services	253	21	2,414	20	9.5
recreational environment	427	35	4,474	37	10.5
cultural and historical heritage	200	16	1,956	16	9.8
Rural economy	**801**	100	**5,464**	100	**6.8**
entrepreneurship	591	74	3,422	63	5.8
social entrepreneurship	27	3	227	4	8.4
support to entrepreneurship	183	23	1,815	33	9.9
Total	**3,603**		**30,508**		**8.5**

Source: compiled by the authors based on the RDS project database.

sub-group *recreational environment* (see Table 2), including more than 140 projects related to setting up playgrounds for children (outside pre-school educational establishments); for this purpose total financing in the country exceeds 1.2 mln EUR (29% of total financing for the sub-group). Other popular projects include establishing of recreation places (29%), places for activities and sports (20%), also projects related to improvement of open-air stages (9%), nature trails (7%) and swimming places (4%). Considering the fact that well-maintained recreational environment as well as investment in preservation of cultural heritage (200 projects have been approved with total financing EUR 1.96 mln) has an important role for development of tourism, a function of indirect promotion of entrepreneurship can be attributed to these projects.

In the sub-group *rural infrastructure* majority of projects (99 or 29%) are related to purchase of sound and light equipment for stages, which is to some extent innovative, because it allows organising cultural events and enjoying them in a new quality. Investments in improvements to community halls and centres is the second most popular in the sub-group *rural infrastructure* (26% of approved projects in terms of quantity and 28% of public financing). Also, investment was made to improve the availability of utility services and transport infrastructure (streets, pavements, bicycle lanes). In *healthcare and social services* sub-group, 2.4 mln EUR of public financing has been approved, including 76% for improvement of social services (social support, care/support/social centres) and 13% for improvement of rehabilitation services and 6% for health care services.

The share of approved *rural economy* projects and public financing is about one fifth of the total number of approved projects and financing in Latvia. These include projects which are directly related to entrepreneurship, development of business infrastructure, availability of consultations and training helpful to businesses. Though promoting economic activities is often not a priority goal of the LEADER approach, it is an important aspect in Latvia, because the availability of jobs and a possibility to earn income is directly related to addressing the population and sustainability problems of rural areas (Krieviņa et al., 2012). Most of *rural economy* projects (73%) cover commercial activities, where investments to develop agricultural production (including forestry, craftsmanship, primary processing, home production) dominate (see Table 2). Other *entrepreneurship* projects pertain to services (recreation (14%), utility (7%), territory improvements (7%) and commercial services (7%)).

Considering that the idea of social entrepreneurship in Latvia is a new and topical phenomenon, the projects in the sub-group *social entrepreneurship* should count as innovations. In the social entrepreneurship theme, the issue of the availability of utility, healthcare or social services (in terms of service price and availability) to people from different risk groups has been addressed. Most of public financing has gone to laundries/showers (30% of total financing for the sub-group), healthcare services (25%), babysitting (13%) and preparing firewood (11%). In total, 27 projects were attributed to the sub-group *social entrepreneurship*, with total approved public financing 227 thsd EUR.

The projects in the sub-group *support to entrepreneurship* directly promote business, including

cooperation, business infrastructure, professional development and industry promotion). In 26% of cases (in terms of both number of projects and approved public financing within this sub-group) cooperation of entrepreneurs to reduce production costs can be observed; 35% of the public financing relates to sales promotion (mainly setting up market-places), 33% to development of business infrastructure and 6% to professional training.

The impact of the LEADER approach on addressing regional development and social issues

Some of the LAG self-assessments summarize diverse opinions about the implementation of the LEADER approach and its practical role in the regional development. Thus, according to the survey carried out in 2014 by LAG 'No Salacas līdz Rūjai', more than half of local respondents believe that the LEADER projects are very significant and available to all people; the survey carried out by LAG 'Cēsu rajona lauku partnerība' more than half (52%) of the respondents partly agree and 19% entirely agree that since 2009 the opportunities to start and diversify business in agriculture, fishery, tourism etc. have improved in the LAG's area, and also most of the respondents (71%) have noticed that children playgrounds; places for assembly and sport activities have been improved (60%); and the environment has been improved - nature, cultural and other historical objects (65%). Conversely, the interviews with people in the Carnikava municipality carried out in 2012 reveal that people do not associate the terms LEADER, LAG and partnership with the development of their municipality.

In their self-assessment reports about the implementation of LEADER approach, LAGs report the following contributions towards addressing social problems in the countryside:

- people are motivated to be more active in social life, new non-government organisations are being founded, people are more motivated to do volunteer work to the benefit of local community;
- as a result of the LEADER projects, a number of innovations have been introduced, especially as to addressing social problems as well as in respect of organisational solutions, and social exclusion has been reduced;
- opportunities have been created allowing people to develop their skills and lead healthy lifestyles;
- the supported activities have contributed to improving the quality of the infrastructure for leisure, public areas and development of new services. Taken together, this has improved the quality of life.

In order to evaluate the topicality of the implemented LEADER projects and the significance of support, project dead weight has been identified in the breakdown by thematic subgroup. The information has been obtained from the LAG surveys, and it is assumed that the project dead weight is 100% if the project would be implemented at full scope without public financing; 0% if the project would not be implemented without public financing; and 50% if the project would be partly implemented (including over a longer period). Average dead weight has been obtained by weighing the dead weights of individual projects with eligible costs.

The calculation results in the breakdown by the project thematic sub-groups show that the *rural infrastructure* and *entrepreneurship* projects have the highest dead weight - 47 out of one hundred rural infrastructure projects (45 in case of entrepreneurship) would have been implemented also without public financing (see Table 3). The lowest project dead weight is in the projects *support to entrepreneurship, cultural and historical heritage and amateur performances,*

Table 3

Dead weight of implemented RDP 2007-2013 LEADER projects in the breakdown by thematic group in surveyed LAGs

Thematic group/subgroup	Dead weight, % (100%=pure dead weight)
Entrepreneurship	45
Support to entrepreneurship	22
Development of society	33
Amateur performances	29
Rural infrastructure	47
Healthcare and social services	41
Recreational environment	32
Cultural and historical heritage	27
Total	36

*social entrepreneurship included in the entrepreneurship group

Source: calculations based on the LAG survey data (cover 44% of public financing).

22%, 27% and 29% respectively. Consequently, these projects are unlikely to be implemented without public financing. Project dead weight, apart from allowing to make judgements about the role of support, also suggest the innovation level in the projects. Since innovative projects have a higher failure risk, a low dead weight of the project (i.e., the project would not get implemented without public financing) suggests a higher innovation level (Ekosgen, 2011). In case of Latvia, a higher project dead weight might also indicate that the project is related to addressing the basic needs of people and businesses.

The authors also performed a correlation analysis in order to find out the correlation between the analysed LEADER project public financing per capita impacts on the dynamics of the number of population. Given the existing depopulation tendencies in the country as well as in an attempt to ignore the varied development levels across the areas, for the purpose of the study an index of the change in the number of population, which describes the dynamics of the number of population between 2009 and 2013 compared to that between 2004 and 2008 was introduced. The calculation shows a weak link (r=0.424, p=0.01) between LEADER project public financing and changes in the population in the countryside.

Conclusions

1. The place and role of the LDS developed by LAGs has not been formally defined by the regional or local territorial development documents, though, at the level of targeted priorities and activities, LDS are coherent with the main emphasis of the regional level development.
2. In practice, the implementation of the LDS in the framework of LEADER RDP 2007-2013 is not balanced: at the planning level, priorities and activities of LDS widely cover entrepreneurship development, though among the implemented projects economy related projects account for only about 18% of the total approved financing. Most of LEADER projects have been implemented to facilitate the development of infrastructure related to active recreation and quality leisure time as well as culture and sports.
3. The implementation of the LEADER RDP 2007-2013 projects attributed to the thematic group *development and growth of society* has facilitated to the widening of the possibilities to spend leisure time productively, contributed to the improvement of the quality of educational services as well as skills related to local administration and cooperation. Only 1/3 of these projects would have been implemented without public support.
4. Project group *rural infrastructure and basic services* has mainly contributed to the improvement of the availability and quality of public infrastructure and services (mainly healthcare and social services). This group is characterized by comparatively high project deadweight indicating on high necessity of these projects as well as low innovation level (the basic needs of rural population are being addressed).
5. In relation to *rural economy* mainly commercial projects regarding agricultural and home production, recreational and utility services have been implemented, including some social entrepreneurship projects. Almost half of them would be implemented also without public support, suggesting a high need for these projects.
6. According to surveys conducted by LAGs in 2013 and 2014, inhabitants have noticed and positively evaluate changes taking place in their local territory introduced by the implementation of the LEADER approach.
7. Self-assessment reports of LAGs also highlight qualitative gains from the implementation of LDS: enhanced cooperation, active participation in addressing local issues, possibility to develop new skills and to lead a healthy lifestyle, to develop local cultural heritage and natural values. This evaluation is coherent with the opinions expressed about the LEADER approach in other countries – it values the role of social capital and focuses on the enhancement and use of its potential at the local level.
8. In order to enhance the role of LAGs and LDS in addressing regional development and social problems at local level, it is advisable that the potential interaction of the activities provided by all regional development documents is observed when determining priorities at regional level; while implementation of the LDS should pay more attention to long-term effects and even accomplishment of target priorities.

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References

1. Becerra A.T., Lastra-Bravo X. (2010) Planning and Neo-Endogenous Model for a Sustainable Development in Spanish Rural Areas. *Int. Journal of Sustainable Society*, Volume 2, Issue 2, pp. 156-176.
2. Bruckmeier K. (2000) Leader in Germany and the Discourse of Autonomous Regional Development. *Sociologia Ruralis*, Volume 40, Issue 2, pp. 219-227.

3. Buller H. (2000) Re-creating Rural Territories: LEADER in France. *Sociologia Ruralis*, Volume 40, Issue 4, pp. 190-199.
4. DG Agri (2010a) Approaches for Assessing Impacts of the Rural Development Programmes in the Context of Multiple Intervening Factors: *Working Paper*. Available at: http://enrd.ec.europa.eu/enrd-static/evaluation/library/evaluation-helpdesk-publications/en/evaluation-helpdesk-publications_en.html#guidance, 20 December 2014.
5. DG Agri (2010b) Capturing Impacts of Leader and of Measures to Improve Quality of Life in Rural Areas: *Working Paper*. Retrieved: http://enrd.ec.europa.eu/enrd-static/fms/pdf/EB43A527-C292-F36C-FC51-9EA5B47CEDAE.pdf, 20 December 2014.
6. Ekosgen (2011) National Impact Assessment of LEADER: Impact Report – FINAL (UK). Retrieved: http://randd.defra.gov.uk/, 20 October 2014.
7. European Court of Auditors (2010) *Implementation of the Leader Approach for Rural Development. Special Report, No 5/2010*. Luxembourg: Publications Office of the European Union. p. 100.
8. Falkowski J. (2013) Political Accountability and Governance in Rural Areas: Some Evidence from the Pilot Programme LEADER in Poland. *Journal of Rural Studies*, Volume 32, pp. 70-79.
9. Kis K., Gil J., Veha A. (2012) Effectiveness, Efficiency and Sustainability in Local Rural Development Partnerships. *Applied Studies in Agribusiness and Commerce*, Volume 06, Issue 3-4, pp. 31-38.
10. Krieviņa A., Leimane I., Miglavs A. (2012) The Role of Agribusiness in Maintenance of Future Rural Employment in Latvia. *Proceedings of Latvia University of Agriculture*, Volume 28 (323), pp. 29-38.
11. LSIAE (2010a) National Rural Development Programme 2007-2013 – Latvia. *Mid-term Evaluation Report*. Available at: http://ec.europa.eu/agriculture/rurdev/countries/lv/mte-rep-lv_lv.pdf, 30 October 2014.
12. LSIAE (2010b) VRG stratēģiju analīze. *Pētījuma atskaite*. (Analyses of LAGs strategies. *Research Report*). Available at: http://www.lvaei.lv/upload/LEADER_strat_anal.pdf, 16 October 2014.
13. Ministry of Agriculture (MoA) (2010) Latvia – Rural Development Programme 2007-2013. Available at: http://www.lad.gov.lv/veca-versija/files/lap_7_versija_04_06_2010.pdf, 21 January 2015.
14. Ministry of Agriculture (MoA) (2014) Latvia – Rural Development Programme 2014-2020 (draft). Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/49/66/LAP2014-2020_121214.pdf, 18 January 2015.
15. Shortall S. (2008) Are Rural Development Programmes Socially Inclusive? Social Inclusion, Civic Engagement, Participation, and Social Capital: Exploring the Differences. *Journal of Rural Studies*, Volume 24, pp. 450-457.
16. van der Ploeg J.D. (2006) Rural Development and the Mobilisation of Local Actors. *Discussion Paper*. Retrieved: http://ec.europa.eu/agriculture/events/salzburg/panels/ploeg.pdf, 27 December 2014.
17. Wellbrock W., Roep D., Mahon M., Kaiyte E., Nienaber B., Garcia M.D.D., Kriszan M., Farrell M. (2013) Arranging Public Support to Unfold Collaborative Modes of Governance in Rural Areas. *Journal of Rural Studies*, Volume 32, pp. 420-429.

THE ROLE OF EU FUNDS IN DIVERSIFICATION OF RURAL ECONOMY IN LATVIA

Jānis Ozoliņš[1], Armands Vēveris[2], Elita Benga[2]
[1]Corporate Management Experts Bureau, Latvia
[2]Latvian State Institute of Agrarian Economics
armands@lvaei.lv

Abstract
Promotion of non-agricultural activities in Latvian rural areas is highly important for diversification of rural economy due to decrease in agricultural and forestry employment. So far too little attention has been paid to this aspect. Although EAFRD is the only EU fund directly supporting rural development, only 14% of its public financing for projects in 2007-2013 was invested in non-agricultural entrepreneurship, half of this in financially demanding energy production projects. By total eligible accepted project expenses, approximately 60% of rural entrepreneurship projects were financed by EAFRD. ERDF was also important in which a smaller number of higher value investment projects was implemented. Although EU funds have some importance in activating rural entrepreneurship, so far the direct impact on creation of jobs and value added has been small. The impact could be increased by setting forth specific job creation requirements for the beneficiaries. It is also suggested to avoid supporting expensive projects which do not create a substantial number of jobs. In view of rural entrepreneurs improvements in entrepreneurial environment, including taxing policy are more important than direct support. It especially concerns operation of small companies. Development of small companies in rural areas is of high importance because in many territories there is no capacity and rationale to develop large projects.
Key words: entrepreneurship, support, rural areas, diversification.

Introduction

Economic development in Latvia is increasingly territorially unequal. Such situation promotes not only depopulation of broad territories but also of the whole country. Furthermore, depopulation is associated with increased infrastructure costs and lower attractiveness for entrepreneurship in the future.

Survey of Latvian rural population indicates that one of the most important factors to promote population density is employment possibility (Zobena and Lāce, 2011). Just 26% of rural respondents consider their territory a good place to work. Statistical analysis reveals that agriculture and forestry are still key branches of economy in Latvian rural areas. The branches create 22% of rural jobs which are rapidly decreasing in number: by 14 thousand or 19% within 2008-2013 time period according to the data of Central Statistics Bureau of Latvia (CSB). The traditional branches of economy are especially significant in places distant to development centres. For example, in municipalities whose centres are in excess of 50 km from Riga and 20 km from other large towns, 50% of economically active market sector statistical units work in primary branches and their number shows a decreasing trend. It means that promotion of entrepreneurship is critically important to avoid further depopulation of rural territories. In addition, the priority should be creation of new jobs with a goal to attract people who are forced to leave primary sectors (agriculture, forestry and fisheries) due to increases in production efficiency.

As indicated in the discussion material prepared by several institutions (Latvijas lauku…, 2012), the productivity in agriculture and food processing is still low, but it is gradually increasing concurrently with decreases in the number of jobs in the respective areas. In the absence of considerable investments in improving employment possibilities a more unfavourable situation can be expected. The discussion material forecasts that within a decade 60% of primary sector employees of agrarian branches will leave anyway and without a purposeful activity on the part of the state the number will reach 70%. According to calculations made by authors of the discussion material, each employee in the real production of goods or services creates a basis for an additional employee in services, government or trade. Thus, the total depopulation risk reaches 40%. It follows that the effect of decreased employment in Latvian rural areas can be severe, because the territories will not be able to fulfil even 2 of the 3 basic functions – place of work and place for socialisation.

Research carried out in the EU and other countries points out that it is possible to considerably improve the entrepreneurial environment, even in territories located remotely to larger urban centres (Esparcia, 2014; Horlings, 2014; McAreavey and McDonagh, 2011; Čingule-Vinogradova, 2011; Rural entrepreneurship…, 2011; Smallbone, 2009; Stimulating the…, 2010; Study on…, 2010; The future…, 2003). It is supported by observations in Latvia because, especially at the level of rural territories, the situation varies highly. For example, from 2006 to 2013 the total number of employees decreased by 11.8%. However, according to the data of Latvian State Revenue Service in 168 of 584 Latvian rural territories (parishes) and towns, the number of employees increased (in 35 rural territories even by

more than 50%). These rural territories are located in all regions of Latvia.

Latvian sustainable development strategy Latvia 2030 sets a goal to create equal life and work conditions for all inhabitants irrespectively of their location of living by promoting entrepreneurship in regions, developing quality transports and communication infrastructure and public services (Sustainable development…, 2010). Several support programmes promote entrepreneurship both in the previous (2007-2013) and current (2014-2020) EU budget planning period.

The aim of the paper is to evaluate the effect of the most important EU funds on rural economy diversification in Latvia. The following tasks have been carried out to achieve this aim: (1) analysis of Latvian 2007-2013 RDP rural entrepreneurship diversification measure characteristics and results; (2) evaluation of availability and use of ERDF and other EU funds for development of rural entrepreneurship. Due to format limitations the paper includes concise analysis of results of the respective funds and measures, including only the key indicators and refrains from detailed reviews of supported branches.

Materials and Methods

Results of research carried out in OECD, Latvia and other EU countries on development of non-agricultural entrepreneurship in rural territories, data of Central Statistics Bureau of Latvia, Rural Support Service (RSS), State Revenue Service (SRS), Latvian Investment and Development Agency (LIDA) and a focus group discussion have been used in the paper.

Correlation, synthesis, constructive calculations, graphical analysis, focus group discussion and monographic analysis methods have been used to carry out research tasks.

EAFRD RDP 2007-2013 impact assessment is comprised of analysis of measure 3.1.2. (3.1.1.) Business creation and development (including diversification into non-agricultural activities) and measure 3.1.3. Encouragement of tourism activities. The analysis is based on RSS data on 1474 projects of 1308 beneficiaries (data as of 28.03.2014). The economic impact has been evaluated for those projects which have received public support payments and which have submitted annual reports to SRS.

In line with EU evaluation guidelines (Guidelines for…, 2014), the main economic indicators being evaluated for the 3rd axis of the RDP were gross value added (GVA) and number of jobs created. Data on creation of jobs have been obtained from RSS database and have been subjected to logical control.

GVA cannot be calculated directly from the RSS database information. Several approaches to calculate the GVA from annual report data were considered. The chosen approach includes annual report data from profit and loss statements, information on the number, remuneration and taxes of employees from SRS as well as information from company income tax statements. ERDF support data was obtained from LIDA and is limited to information on eligible expenses of contracted projects, branch and implementation address. Due to space limitations only the most important fund by amount of investments, the ERDF has been analysed.

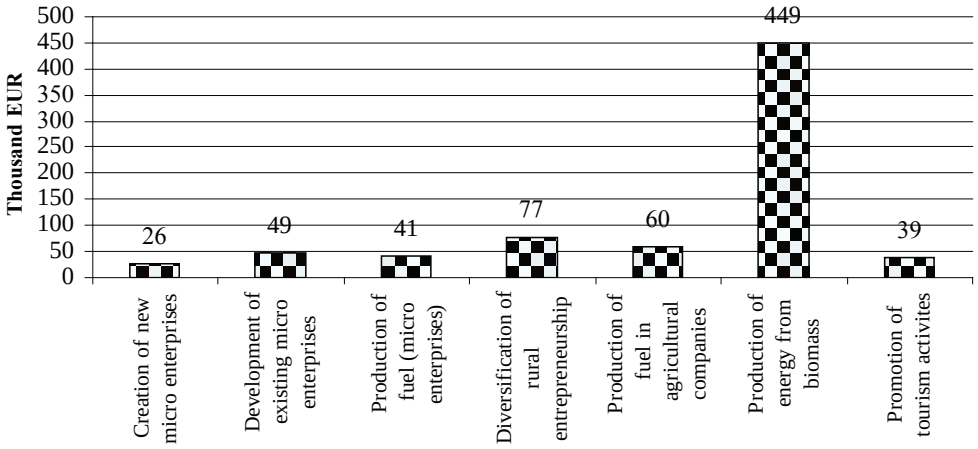
A focus group discussion was conducted involving existing and potential rural entrepreneurs from various regions of Latvia. This allowed obtaining direct insights and opinion about possibilities to develop non-agricultural entrepreneurship in the rural territories of Latvia. Cartographic material was prepared to demonstrate and analyse several key indicators at levels of municipalities and rural territories.

Results and Discussion

Characteristics and results of Latvian RDP 2007-2013 entrepreneurship diversification measures

Just a part of RDP 2007-2013 3rd axis support was directed at activities, which are not related to agriculture and forestry. They include measure 3.1.2. (3.1.1.) Support to creation and development of enterprises (including diversification of activities not connected to agriculture) and measure 3.1.3. Promotion of tourism activities. By the end of 2013, public financing of 96 million EUR was disbursed in these measures which was only 14% of the total RDP financing for investment projects. It means that entrepreneurship diversification was not an RDP priority. The measure 3.1.2. (3.1.1.) pursued several aims: creation and development of rural micro enterprises; diversification of agricultural enterprises; energy production from agricultural and forestry origin biomass. The aim of the measure 3.1.3. was to support and improve the existing Latvian rural tourist facilities. Measure 3.1.2. (3.1.1.) was separated into creating new microenterprises and development of existing ones, but both first and second sub-measure included a separate activity – production of fuel. As a result, in measure 3.1.2. (3.1.1.) there were 6 activities and only one in measure 3.1.3.

The public financing for energy production from biomass activity comprises 45% of total public financing while the number of projects (41) was the smallest. The part of financing directed at development of existing microenterprises (538 implemented projects) formed 24% of total, whereas 11% (359 projects) were received by newly created micro enterprises. The share of other activities did not exceed 10% of total. Data on mean public financing per newly created job has been summarised in Figure 1.



Source: Calculations of authors based on RSS data.

Figure 1. Mean public financing per newly created job, 2007-2014.

The highest number of newly created jobs (501 and 420, respectively) is in the activities of development of existing microenterprises and creation of new microenterprises. It must be noted that the mean financing per newly created job at level of EUR 25.7 thousand is the lowest in the creation of new microenterprises. To the opposite the highest public financing amounting to EUR 449.4 thousand per newly created job is in the energy production from biomass. Only 101 jobs were created in this activity.

The investment of such a considerable part of financing in large biomass energy production projects (the average project and public support amount in the activity is respectively EUR 3 and 1.1 million) contradicts rationale of the measure. The substantiation states that the support is needed for small rural farms in order to maintain rural population, allow for starting an alternative business as well as to increase the quality of services for rural population (Latvijas lauku…, 2014). The substantiation of submeasure 3.1.2. (3.1.1.)/3 states that the need to develop processing of biomass stems from utilisation needs of animal husbandry by-products (manure). It means that support should have been provided only to such projects as opposed to those in which energy is produced from specially grown agricultural products (grain, corn etc.).

The second financially largest activity (in relation to the number of newly created jobs) was

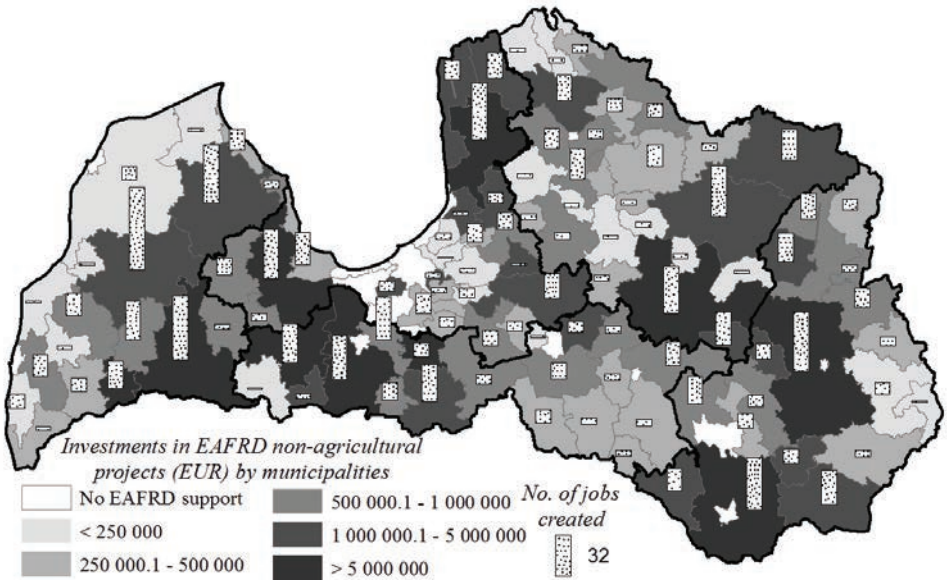


Figure 2. Support and newly created jobs in RDP measures 3.1.2. (3.1.1.) and 3.1.3. in Latvian municipalities, 2007-2014.

diversification of agricultural enterprises. It is suggested by the authors that further support to such activities must be more tightly connected to the number of jobs created and their sustainability. The discussion with entrepreneurs supports a conclusion that entrepreneurs are not inclined to increase the number of jobs – it is in their interest to produce higher value with the same or smaller number of employees. Therefore, support can be an important stimulus to attract new employees.

According to RDP 2007-2013, the measure 3.1.2. (3.1.1.) implementation territory is whole Latvia except large cities and territorial units of municipalities – towns with more than 5 thousand inhabitants. In measure 3.1.3., in addition to the above-mentioned, projects from municipalities bordering with the city of Riga were not eligible. Moreover, the selection criteria favoured projects from territories with lower development indices.

Graphic analysis of support at the level of municipalities (Figure 2) shows higher concentration of support in Pieriga and the central part of Zemgale, whereas much smaller financing has reached territories further from Riga – eastern part of the country and western Kurzeme. Largely it is determined by dependency of entrepreneurship development on the local market demand – focus group discussion showed that one of the main factors is position within 100 km from Riga. However, research carried out in other countries indicates that successful entrepreneurship is possible elsewhere further from major urban areas (Study on..., 2010).

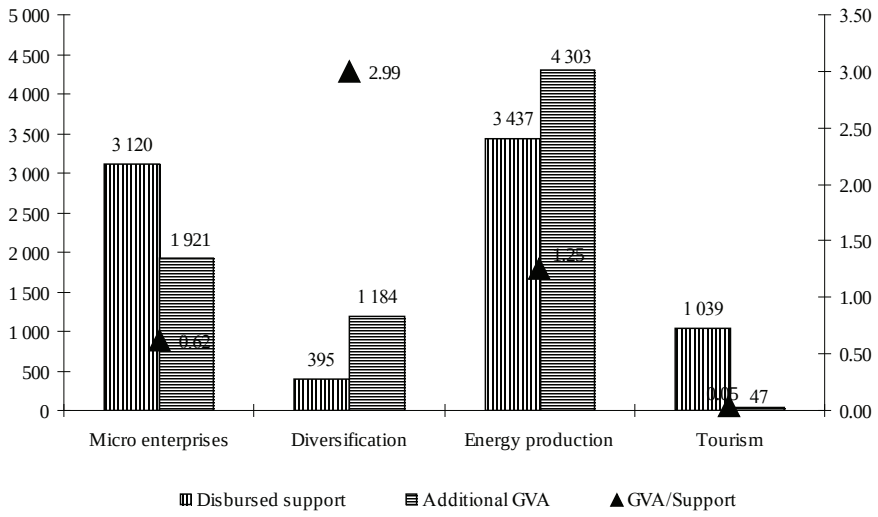
Correlation analysis for connection between the number of jobs created and financing was carried out. A panel of 584 Latvian territories and cities with variables newly created jobs and financing of 3rd axis received was used for calculations. The results show that funding and new jobs are moderately positively correlated (r = 0.44). Correlation is significant at 0.01 level (2-tailed).

Although the intensity of job creation in various activities obviously varies, statistical analysis shows that the support is connected to increases in employment. At the same time it can be seen that the connection is not very strong, thus other factors such as branch of implementation are important.

Additional GVA during the whole period was calculated as a total of annual GVAs starting from 2008, by subtracting the result of 2007 (thus the additional GVA of each year was calculated). The additional GVA created in the analysed period (2008-2012) was estimated at EUR 7.4 million for measure 3.1.2. (3.1.1.) and EUR 0.05 million for measure 3.1.3. (Figure 3).

It should be emphasized that the results refer only to the projects included in the evaluation. It can be calculated that in the period of 2008-2012 each euro of support has increased the GVA on average by 1.1 EUR in measure 3.1.2. (3.1.1.) and only by EUR 0.05 in measure 3.1.3. The submeasure analysis reveals that the most effective has been 3.1.2. (3.1.1.)/2 (diversification), which has brought 2.99 EUR per each euro of public support although this activity is the smallest by the amount of financing.

Assuming that the same results would be reached by the other companies which receive support in the abovementioned measures, each euro of public support would yield EUR 0.93 additional GVA. Thus, the total



Source: Calculations of authors using SRS data.

Figure 3. Additional GVA in 2008-2012 period and paid public support comparison (thousand EUR), additional GVA per euro of paid public support by submeasures in beneficiaries which have received support by the end of 2010.

additional GVA in both measures would exceed EUR 100 million which exceeds the initially expected EUR 35.9 million several times. It is not much though when compared to the total amount of investment in these measures (almost EUR 300 million).

The impact potential of EAFRD on the unique set of factors determining development of rural economy and entrepreneurial environment is not substantial. The focus group discussion indicated that entrepreneurial environment is of highest importance to rural entrepreneurs. Road infrastructure quality, workforce availability, administrative and tax burden related to any legal entrepreneurial activity were mentioned as the key aspects. The focus group participants, Latvian rural entrepreneurs, unanimously expressed an opinion that even a very high support rate would not help to create sustainable rural companies in territories with adverse entrepreneurial environment. RDP 2007-2013 financing was not sufficient to ensure entrepreneurial environment appropriate for starting new business. Furthermore, many factors such as natural resources, position relative to major urban centres and transport routes, set of local population attitudes and values cannot be changed or it may be complicated and costly.

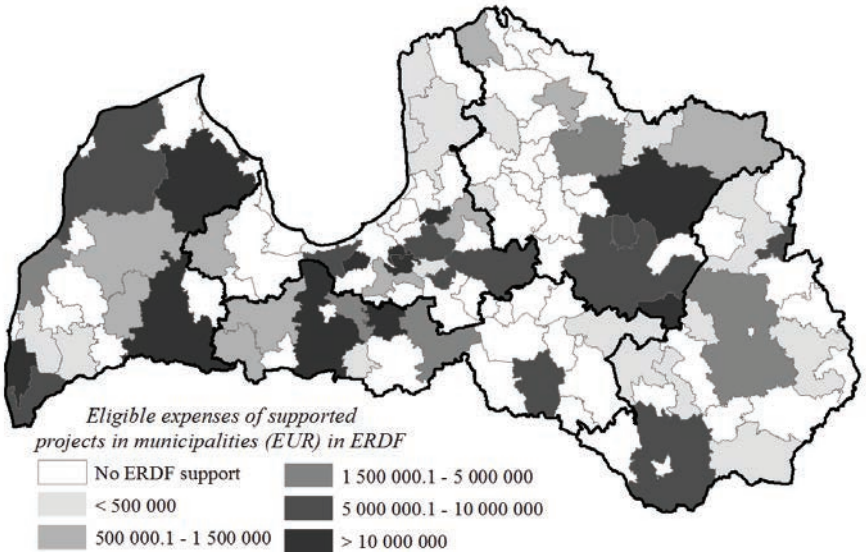
Availability and use of other EU funds for rural entrepreneurship development

Apart from EAFRD the most important EU fund for promotion of non-agricultural entrepreneurship in Latvia in 2007-2013 was European Regional Development Fund (ERDF). The aim of ERDF was to promote social and economic cohesion by decreasing regional disparities. The most important measures by the amount of financing for rural territories were high value investment (HVI), development of new products and technologies – support for introduction of new products and technologies (NPT) and support to development of micro and small companies in specially supported territories (SST). The territorial spread of ERDF support of the three measures is shown in Figure 4. Most of support has been attracted in municipalities, which have one or several economically strong, viable companies which have implemented large projects in the HVI programme. Companies from approximately 50% of the municipalities did not receive any support at all because in a large part of Latvia there were no strong applicants to qualify. There were no specific privileges to rural companies; therefore, in HVI and NPT they had to compete for project financing with the most advanced and largest companies located in urban areas.

The support of SST measure was more available to rural areas because it was intended for companies located in specially supported territories, which are mostly rural. The eligible expenses included preparation of construction projects, purchase of equipment, construction costs, software, licences and patents. The required financing exceeded the available financing almost tenfold and 101 projects were implemented, EUR 7.6 million in public support was disbursed. Approximately 52% of the eligible expenses were in projects implemented in rural areas, in 29 municipalities. Lower territorial development index provided a major advantage in project competition.

HVI support has been granted to investment in fixed assets (construction, equipment) and credit institution guarantee costs, the rate of support being at 35-45% level. Advantage in project selection was to companies in which high value added per employee is created, there is an adequate capital supply, who work in prioritised sectors of economy, are able to export, can prove their economic viability and research and development capacity. The application and implementation process in the measure was time-consuming and complicated, but it allowed receiving substantial support for large projects, part of them in rural territory. The total planned financing for this activity was EUR 201 million. According to the eligible expenses of contracted projects, 33% of the financing in the measure was intended for rural territories. Contracts with 30 companies have been signed who have implemented or are still implementing projects in 19 rural municipalities. A considerable part of these projects by the share of eligible expenses (45%) are being implemented in the municipalities close to the capital city of Latvia - Riga (Stopini, Salaspils and Marupe). The projects are mostly implemented in various branches of processing industry: wood, fuel, construction materials, meat, vegetables, chemicals and production of electronic components. A relatively large share of investment in rural territories can be a result of availability of land for developing medium or large projects outside boundaries of cities or towns.

NPT was a financially important measure in which support was provided to initial investment in equipment as well as in patents and licences necessary to start production of a new product or to implement a new technology. The maximum rate of support was 35%. Project selection criteria provided advantage to projects with higher level of innovation, those in prioritised sectors of economy, in which the company together with related persons has high turnover or provable sales network as well as in cases of high export intensity in the branch of project implementation. Similarly to HVI, the administrative burden in the project life-cycle was high. Minimum and maximum public financing for projects in this activity was considerably lower – beneficiaries with smaller projects could take part. Therefore, mostly small or medium sized projects were implemented



Source: Calculations of authors using LIDA data

Figure 4. Eligible expenses of supported projects implemented in Latvian rural territory in HVI, NPT and SST measures of ERDF, 2007-2014.

in urban territories to improve existing production infrastructure.

A part (26%) of contracted project eligible costs in NPT measure was intended for implementation of projects in rural territories in branches of construction materials, furniture, vegetable processing, metal processing and chemicals. In total, 31 contracts on project implementation in rural territories with 30 beneficiaries were signed. Project implementation takes place in 19 municipalities, 25% of planned investment being in those which directly border the territory of Riga city.

Support in SST measure was received by companies of various traditional rural non-agricultural branches because no high-level requirements were set forth for applicants and expected project results. In HVI and NPT activities, to the contrary, the requirements for project applicants, project quality and results predetermined that support was received by the economically and technologically strongest, most promising companies. Although some beneficiaries implemented projects both in HVI and NPT measures, in the latter case rural projects were implemented to a larger extent by local capital small and medium enterprises.

The total eligible contracted rural project expenses of the analysed ERDF measures exceed EUR 176 million. It is close to 40% of the total eligible expenses of projects implemented to develop rural economy in EAFRD and ERDF. A conclusion can be made that the ERDF and EAFRD support is mutually complementary. Nevertheless, ERDF activities were not specifically targeted at development of rural territories but rather whole regions. Although no data for evaluation of support impact is available, it can be assumed that the ERDF measures analysed had a considerable positive impact on development of non-agricultural entrepreneurship in Latvian rural areas. It can be substantiated by relative to EAFRD strict requirements for reaching project results in HVI and NPT activities and amount of public financing. It should be noted that in HVI measure support was given to projects with higher value added per employee. The beneficiaries of NPT measure were not motivated to create additional jobs either. Thus, the support applicants were encouraged to develop highly productive, internationally competitive production with a minimal number of employees while the provision of rural jobs is of key importance in countering rural depopulation.

Conclusions

1. Whereas EAFRD is the most important EU fund for development of rural entrepreneurship, diversification of rural economy is not its priority because only 14% of its public financing has been paid in projects directly promoting this goal.
2. Almost one-half of EAFRD resources intended for rural entrepreneurship diversification were invested in one activity – energy production from renewable energy resources in which a small number of expensive projects were implemented, resulting in very high costs per newly created job.
3. Creation of new microenterprises has been the most successful activity from job creation viewpoint while the most effective in the value added formation was diversification of rural entrepreneurship.

4. Creation of new jobs, as a result of RDP 3rd axis measures in Latvian municipalities and towns, depends on the amount of financing.
5. Support of the ERDF promoted development of the economically strongest rural non-agricultural companies but it was not specifically targeted at increasing rural employment.
6. The financing of both EAFRD and ERDF was more actively attracted in the central part of Latvia. However, it is positive that in case of EAFRD the support was rather equally territorially distributed which was achieved by project selection criteria.
7. Entrepreneurial environment aspects such as availability of road infrastructure, workforce, administrative and tax burden are more important to rural entrepreneurs than direct support.
8. EAFRD projects whose implementers have assumed responsibility to create new and to preserve existing jobs should be prioritised in the future in order to achieve the goal of increasing support efficiency in maintenance of rural population and employment.

Acknowledgements

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References

1. Čingule-Vinogradova S. (2011) Dienvidlatgales potenciāla izvērtējums un attīstības virzieni (Evaluation of Dienvidlatgale Potential and its Development Directions). Available at: http://llufb.llu.lv/dissertation-summary/economics/Sanda-CinguleVinogradova_promocijas_d_kopsavilkums_2011_LLU_EF.pdf, 23 February 2015. (in Latvian).
2. Esparcia J. (2014) Innovation and networks in rural areas. An analysis from European innovative projects. *Journal of Rural Studies*. Vol. 34, pp. 1-14.
3. Guidelines for the ex-post evaluation of 2007-2013 RDPs (2014) Available at: http://enrd.ec.europa.eu/enrd-static/app_templates/enrd_assets/pdf/evaluation/epe_master.pdf, 07 March 2015.
4. Horlings L. (2014) Exploring the "New Rural Paradigm" in Europe: Eco-economic strategies as a counterforce to the global competitiveness agenda. *European Urban and Regional Studies*, Vol. 21, no. 1, pp. 4-20.
5. Latvijas lauku attīstības programma 2007.-2013. gads 12. versija (Latvian Rural Development Programme 2007-2013. Version 12). (2014) Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/37/56/LAP_12_versija_13012014.pdf, 25 February 2015. (in Latvian).
6. Latvijas lauku telpas attīstība un tās iespējamie nākotnes scenāriji. Informatīvs materiāls diskusijām. (Development of Latvian Rural Space and Its Possible Future Scenarios. Informative Discussion Material). (2012) Available at: http://www.laukutikls.lv/sites/laukutikls.lv/files/informativie_materiali/latvijaslaukutelpasattistibauntasiespejamienakotnesscenarijipetijumslr.pdf, 06 March 2015. (in Latvian).
7. McAreavey R., McDonagh J. (2011) Sustainable Rural Tourism: Lessons for Rural Development. *Sociologia Ruralis*. Vol. 51, Issue 2, pp. 175-194.
8. Rural Entrepreneurship in Selected EU Member States (2011) Available at: http://enrd.ec.europa.eu/enrd-static/fms/pdf/A502C17B-B074-2913-E9E0-F1AC79AE55C0.pdf, 25 February 2015.
9. Smallbone D. (2009) Fostering entrepreneurship in rural areas. In: Potter J. and Hofer, Andrea R., (eds.) Strengthening entrepreneurship and economic development in East Germany: lessons from local approaches. Paris, Organisation for Economic Co-operation and Development. pp. 161-187.
10. Stimulating the Agricultural and Rural Economy Through the Rural Development Programme. (2010) Available at: http://www.nrn.ie/wp-content/uploads/2010/12/stimulatingtheagriculturalandruraleconomythroughtherdp1.pdf., 19 February 2015.
11. Study on Employment, Growth and Innovation in Rural Areas (SEGIRA) (2010) Available at: http://ec.europa.eu/agriculture/analysis/external/employment/full-text_en.pdf, 28 February 2015.
12. Sustainable Development Strategy of Latvia until 2030 (2010) Available at: http://www.varam.gov.lv/in_site/tools/download.php?file=files/text/dokumenti/pol_doc//LIAS_2030_en.pdf, 20 February 2015.
13. Zobena A., Lāce I. (2011) Lauku attīstības programmas 2007.-2013. gadam 3. un 4. ass pasākumu ietekme uz Latvijas lauku iedzīvotāju dzīves kvalitāti (Impact of Latvian Rural Development Programme 3rd and 4th Axis Measures on the Quality of Life of Latvian Rural Inhabitants). Available at: http://www.lvaei.lv/images/Nacionalie_projekti/2011/Petijums%20par%20soc_datiem.pdf, 06 March 2015. (in Latvian).
14. The Future of Europe's Rural Periphery, the Role of Entrepreneurship in Responding to Employment Problems and Social Marginalization. (2003) Available at: http://cordis.europa.eu/documents/documentlibrary/100124141EN6.pdf, 20 February 2015.

AGRICULTURAL DEVELOPMENT IN LATVIA AFTER JOINING THE EUROPEAN UNION

Kristaps Zdanovskis, **Irina Pilvere**
Latvia University of Agriculture
kristaps.zdanovskis@gmail.com

Abstract
Since 1990 significant structural changes have taken place in Latvia. First of all, the reestablishment of an independent state in 1991 and the accession to the European Union (EU) in 2004. Joining the EU provided free flow of goods, finances and individuals, a single system of legal acts as well as a trustful image of the state for foreign investors. In Latvia, 60% of the EU funds are allocated for agriculture and rural development, thus achieving the objective of producing food adequate for consumers' purchasing power and ensuring agricultural commodities are available for their processing. Financial aid for primary industries also results in support for the whole society and other industries from which necessary resources and commodities are purchased. After joining the EU, the growth of the agricultural industry was observed owing to support payments. As a result of the EU policy, the size distribution of farms changed in Latvia, the output and exports of food increased as well as agricultural productivity rose. The research aim is to analyse the changes in and gains for Latvia's agriculture after the accession to the EU. The following research methods were employed: the monographic and descriptive methods, analysis and synthesis and the logical and constructive methods.
Key words: Latvia; agricultural development; European Union; support; planning period.

Introduction

The preparation and adjustment process to join the EU started in Latvia already in 1995 by signing the Europe Agreement establishing an association between the European Communities and their Member States, of the one part, and the Republic of Latvia, of the other part. This process ended on 1 May 2004 when Latvia became a full member of the EU. The views and opinion on joining the EU were diverse, yet, the majority of people voted in favour of the accession and Antuža (2003) noted that Latvia would be a gainer, contributing to its wellbeing and development. The effects of the EU were felt already before the accession, as Latvia being a candidate country received funds under various EU programmes. Before joining the EU, the most popular one in agriculture was the SAPARD programme (Special Accession Programme for Agriculture and Rural Development). In the EU Member States, the development of agriculture and rural areas depends to a great extent on the future Common Agricultural Policy (CAP). The CAP has been among the main drivers for change in farmers' behaviour as well as the main instrument to address the viability of rural areas and to support the profitability of the agricultural sector (Bartolini et al., 2015). The CAP is constantly being reformed every three to seven years. In 2013, the process of adoption of a new CAP regulation was completed, which includes a re-definition of policy objectives, instruments and budget distribution for a further seven years (2014–2020) (Erjavec and Erjavec, 2015). Therefore, an assessment of how and whether agriculture in Latvia has developed after joining the EU owing to the Common Agricultural Policy (CAP) needs to be performed. In a number of countries, scientists have positively assessed a country's agricultural development after its accession to the EU. For instance, Tomšik and Rosochatecka (2007) emphasised that the "adoption of the CAP rules meant really radical changes for Finnish farmers. With regard to rapid cut in producer prices caused by the introduction of the new rules, the competitiveness of the Finnish agrarian sector had to be improved". Poczta et al. (2012) pointed that the process of Poland's integration with the European Union has had a positive effect on an increase in the volume of agricultural output and income. In the Czech Republic, "it can be assumed that the CAP subsidies have had an effect on the stabilization of the livelihoods of rural inhabitants. In general, there is a positive shift of valuation of the CAP among farmers in the Czech Republic" (Lapka et al., 2011).

Antuža (2003) pointed out that Latvia is a small country with a limited domestic market and limited resources, as well as the country had insufficient finances for its development. Consequently, economic growth and wellbeing in Latvia directly depend on its foreign trade, investment, capability to compete and produce high value-added products. At the same time, one has to note that approximately 80% of Latvia's foreign trade goes to the EU Member States and candidate countries. The main gains from joining the EU are as follows: the free movement of goods, services, individuals and financial capital, a single legislation, single tax and regional policies, a customs union, etc. (Ārlietu ministrija, 2014).

The EU aims to contribute to social and economic equality in its Member States, and Latvia is one of the 16 Member States whose annual receipts from the EU budget are greater than contributions to it, and

this fact applies to all economically less developed EU countries. With such a policy, the EU stimulates production in developed Member States, ensuring new sales markets. The authors suppose that Latvia's accession to the EU allowed its economy, including its agriculture, to develop, as this industry receives a considerable share – on average, 60% - of the total EU funding for Latvia. Yet, one has to agree with Rivza et al. (2010) who stress that any country, when joining the EU, partially loses its freedom of action, and its activity is partially limited and regulated. One has to take into account that there are both gains and losses, and one of the main gains is an increase in foreign trade and investment.

The research aim is to analyse the changes in and gains for Latvia's agriculture after the accession to the EU.

To achieve the aim, the following research tasks were set:

1. To analyse the agricultural structural changes in and the main indicators of Latvia before and after the accession to the EU.
2. To examine the EU's financial contribution to Latvia's agriculture.

Materials and Methods

To carry out the present research, the authors used topic-related research papers and information available on the websites of the Central Statistical Bureau (CSB), the European Commission (EC), the National Rural Network and the Ministry of Agriculture (MoA). The research methods employed: the monographic and descriptive methods, analysis and synthesis and the logical and constructive methods. Since data availability was limited, the research findings do not apply to the same period.

Results and Discussion

Structural changes in and main characteristics of agriculture in Latvia

Over recent decades, significant changes in the rural environment have taken place in Europe owing to agricultural intensification and a change of land boundaries. It might be particularly observed in Central and East European countries, including Latvia, where radical political and socio-economic changes occurred in the 1990s. In Latvia, after regaining the independence, a land reform or privatisation was carried out in 1991, which aimed to replace soviet period collective and state farms with individual farms – economic entities of Latvia's first independence. Thus, more than 50000 small farms with an average size of less than 20 ha emerged. The privatisation process was chaotic and uncoordinated and farms lacked investment during the period of change, which reduced their productivity, the area sown and large-scale agricultural production. The reform contributed to the fragmentation of farms, a large share of rural people moved to cities, renting out, selling or leaving unfarmed their privatised land (Vanwambeke et al., 2012).

In 2013, Latvia's total land area was 64.6 thou km^2, of which 37% was used in agriculture and 46% in forestry, which was 6% more than on average in the EU. Of the 37% of the agricultural area (AA), 65% was arable land, 35% was pastures and meadows and 9.5% was an overgrown area (Zemkopības ministrija (Ministry of Agriculture), 2014). According to the CSB, the AA reached 2.5 mln ha in Latvia in 1991, while over next years the AA gradually decreased if measured against the previous year and against 1991 as the base year (Augkopība (Crop farming), 2013). Keller (2000) points that rural territories decrease in size in the world because of the urbanisation of population and the expansion of cities. Until 2000, the AA decreased in Latvia by 37.4% or 947 thou ha in comparison with 1991. The key reasons for the decrease in the AA were an increase in the area unfarmed and overgrown with shrubs, the expansion of urban territories as well as a slight increase in the forest area (Mežsaimniecība (Forestry), 2013). From 2001, the AA was slowly reintegrated into agricultural production along with an increase in national support for agriculture and the introduction of first agricultural support instruments in Latvia (SAPARD was available from 2001). The next increase in the AA was observed from 2004 to 2007 when an economic crisis slowed down this increase, which also affected agriculture. Joining the EU considerably increased agricultural output, as various CAP support instruments were available, for instance, the EU Structural Funds and direct payments. In the programming period 2014-2020, the strategic target of the MoA is to retain 2 mln ha in agricultural production, while the AA level of 1991 is not going to be reached (Zemkopības ministrija (Ministry of Agriculture), 2015).

The number of small-size farms declined, whereas the number of farms with an area of more than 100 ha rose (Figure 1). In 2013, compared with 2003, the number of farms in all size categories with an area less than 99.9 ha declined, whereas the number of large farms having more than 100 ha rose by 3% and the area farmed by these farms was greater by 23%. After joining the EU, small and low-profitability farms in the leading agricultural industries were not competitive, and the introduction of and compliance with new EU standards did not contribute to the financial profitability of farms. These arguments may not be attributed to high value-added agricultural industries, for example, vegetable farming, fruit farming, non-traditional agriculture, etc.

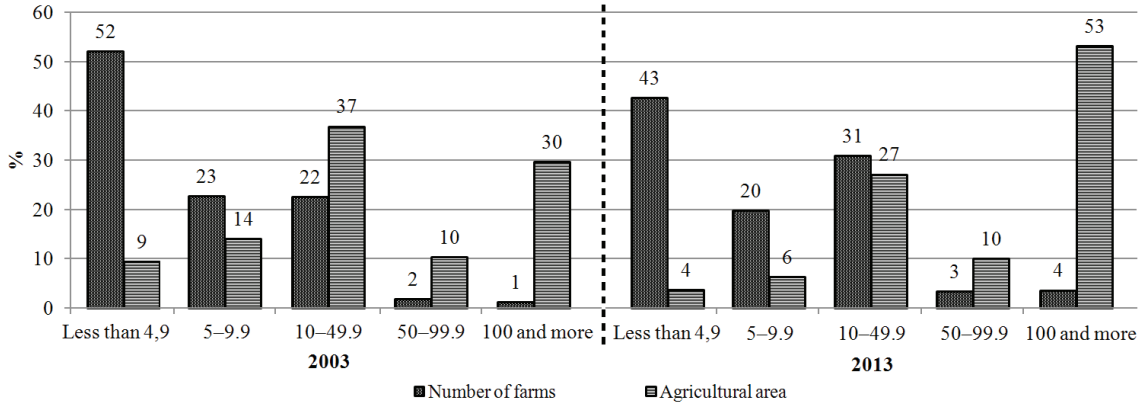

Figure 1. Percentage distribution of the number of farms and the AA by size of land owned by farms in Latvia in 2003 and 2013.

Source: authors' construction based on Lauku saimniecību struktūra, 2007 and Lauku saimniecību struktūra, 2013.

Already since 1991 in the crop sector, the dominant crops have been feed and green forage crops, permanent grasses and cereals, while since 1995 the main crop group in Latvia has been cereals, occupying 44% of the total sown area; in 2013 this area accounted for even 51%. The total sown area has decreased since 1991. Yet, since EU financial support has been available, this area has increased, but the base-year level has not been reached until 2014 (Augkopība, 2013).

Over this period, the crops being grown have changed; after joining the EU, in 2007, the sugar industry was liquidated in Latvia, and sugar producers and farmers were paid compensations. As a result, sugar beets were grown in small quantities for feed, and a former sugar beet area of 11.3 thousand ha was sown with rapeseed (Ministru kabinets, 2008).

The EC ambitious target to produce 20% of energy from renewable energy sources in 2020 has affected Latvia, too, for which the target is 40% of energy from renewable energy sources (European Parliament..., 2009). This, in its turn, has contributed to an increase in the area sown with energy and oil crops that are used to produce biofuel as well as biogas for electricity generation. The area sown with maize rose by 19.5 thousand ha in 2013, compared with 2004 (Augkopība (Crop farming), 2013).

An analysis of the vegetable and fruit industries showed that the largest area was sown with potatoes, 27.3 thousand ha in 2013, comprising 63.7% of the total vegetable area. The smallest area was sown with permanent crops such as bilberries, cranberries, fruit trees, berry bushes, etc., which do not generate any return and income in the first year. A specific of the fruit and vegetable industries is their small sown area, whereas the gain from and the value added of such crops are higher than for traditional crops. Given the fact that this area is small, a significant focus has to be placed on market demand when planning to plant fruits and vegetables, so that this will not result in overproduction, thus reducing producer revenues.

Analysing the livestock industry's development, it has to be taken into consideration that the number of livestock is not the determinant factor, as livestock productivity has considerably increased, according to Atsbeha et al. (2012), and significant investments have been made in livestock selection and herd management. In the livestock sector, the leading industries are dairy, pork, poultry and beef production. In 2013, compared with 1991, the average milk yield per cow increased from 3.2 to 5.6 tonnes (Lauksaimniecības dzīvnieku…, 2013). The Agricultural Data Centre has reported a few farms having high-quality herds with an average milk yield of more than 12 tonnes per cow per year (Diedziņa, 2014). The decrease in the number of livestock also indicates the increasing productivity; in 1991 in Latvia, the number of milk cows reached 532 thousand, while in 2013 their number was only 165 thousand. After joining the EU, dairy farming in Latvia developed and was modernised owing to the EU support available for this industry. According to Bouamra-Mechemache et al. (2008), the quota system in the EU Member States limited the output of milk, and the cancellation of quotas would indicate the real production capabilities of a Member State.

Since joining the EU, the number of cow herds has decreased, whereas the number of livestock has increased, which indicates that farms with large herds have expanded; the reason was the EU animal welfare and sanitary standards, which small farms were not able to meet because it was too expensive. Complying with the standards that were supported by the EU funds, the eligibility criteria to be met and the expected outcomes to be achieved during the years of project implementation were the reasons for the decrease in the number of herds (Latvijas Holšteinas…, 2011; Popluga, 2009).

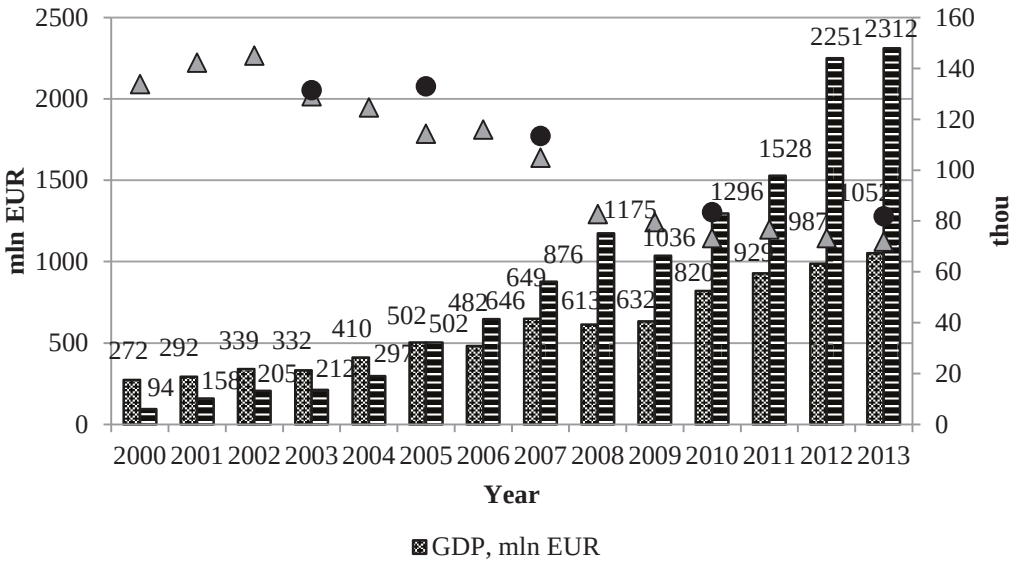

Figure 2. GDP and agricultural exports, mln EUR, the number of agricultural employees, thou, in the period 2000-2013 and the number of farms, thou, in 2003, 2005, 2007, 2010 and 2013 in Latvia.

Source: authors' construction based on Pilvere, Pilvere, 2010, Lauku saimniecību struktūra, 2007 and Lauku saimniecību struktūra, 2013.

Like in dairy farming, the number of livestock in pig and poultry farming does not indicate production quantities. By using the EU's financial support for farm modernisation and livestock selection, many breeds of fast-growing poultry and pigs, which reach the slaughter-weight within a shorter period, have been created; this results in a shorter life-cycle of livestock on farms. For instance, the productivity of laying hens in 2013, compared with 1991, rose by 35.8% or from 201 to 273 eggs per year, while broiler chickens reached the slaughter-weight, on average, within 42 days instead of 90 days earlier (Michael, s.a.).

The authors suppose that joining the EU and free trade opportunities have fostered agricultural exports to European markets, as well as the high EU sanitary and hygiene standards create a trustful and safe image of products for trade with third countries in the world.

After 1991, Latvia's agriculture gradually developed, thus contributing to GDP and exports (Figure 2). As noted by Mazūre (2007), in contributing to these indicators, an essential role was played by financial support available for agriculture (Figure 3), which rose by 585% after joining the EU in 2004.

The EU funding has positively affected the development of agriculture, and in 2006 agricultural exports exceeded the industry's contribution to GDP. Over the decade, agricultural exports rose almost eight times, reaching EUR 2.3 bln in 2013, while agriculture's contribution to GDP rose more than twice, reaching EUR 1.05 bln. In 2014, agriculture's contribution to GDP was only 4.6% of the total, while agricultural exports were 21.2% of the total exports, which leads to a conclusion that higher value-added agricultural products were produced, and the national and EU financial support contributed to higher profitability (Zemkopības ministrija (Ministry of Agriculture), 2014).

In 2013 in terms of final agricultural output, Latvia's leading agricultural industries were cereal farming with 26.6%, dairy farming 22.4%, feed crops 9.6% and rapeseed 8.9%, followed by pork, poultry and beef production. In 2013, Latvia exported 1.9 mln t of grain and was the third largest grain exporter in the EU (Zemkopības ministrija (Minitry of Agriculture), 2014). After the accession to the EU, agricultural cooperation in primary agricultural industries and the education level and experience of farmers have significantly increased.

The EU's financial support and free trade have contributed to the competitiveness of agriculture both in the EU and at global level, changing the percentage distribution of agricultural products according to market conditions. Competitiveness means the introduction of new and precision agricultural technologies, which results in lower prices and higher quality of products, but it reduces the demand for labour force owing to increases in technological productivity. Modern innovative technologies significantly affect the size distribution of farms, as such technologies raise labour productivity, but only comparatively large and developed farms can afford to buy such technologies owing to their high prices. Technological development and price level increases lead to decreases in the numbers of small farms and agricultural employees. Consequently, a greater value of agricultural products is generated by employing

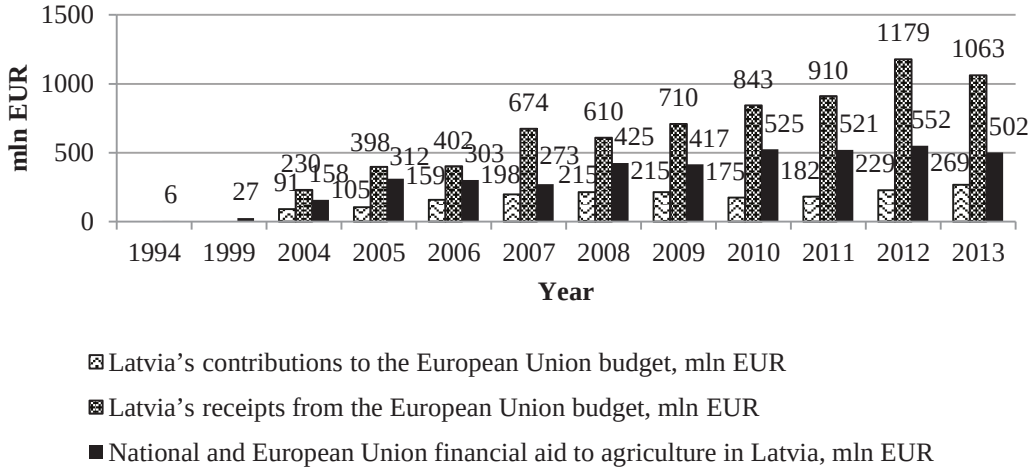

Figure 3. Latvia's contributions to and receipts from the European Union budget in the period 2004-2013 and the national and EU financial aid to agriculture in Latvia in 1994, 1999, 2004-2013, mln EUR.

Source: authors' construction based on Mazūre, 2007 and DG BUDG, 2013.

a smaller number of employees. The number of employees in agriculture in 2013, compared with 2003, decreased by 45%; yet, given the fact that the value-added of agricultural products rose 3.2 times, labour productivity in the agricultural industry increased significantly – 5.6 times – in the same period (Figure 2).

EU Financial Aid to Latvia's Agriculture

Balaceanu (2013) points that agriculture is the industry, the performance of which is not possible without government financial support, especially due to changeable weather and market conditions. Upīte (2010) has the same opinion, noting that the main problems of the agricultural industry are due to a market economy, as it is constrained by limited natural resources and changeable weather conditions. The specifics of use of labour force have to be also considered, as any rural enterprise is also the place of work and residence. Agricultural activity may be characterised as a lifestyle; it is featured by slow development, its share in GDP declines and it is less flexible, reacting on market changes. Therefore, subsidising agriculture was historically and objectively determined. The first kind of support to farmers in Latvia was a national financial assistance of EUR 6 mln allocated in 1994 (Figure 3). Over the next years, this assistance rose and reached EUR 39.3 mln in 2003; yet, after joining the EU, in eight months of 2004, the size of national and EU assistance for agriculture reached EUR 158 mln – four times more that in the previous year – and accounted for 68.7% of the total EU funding for Latvia.

In 2013, on average, 40% of the EU budgetary expenditures were allocated for agriculture (European Commission, 2013). Compared with 1991, the EU budgetary expenditures on agriculture, on average, declined by 27%, but the greatest expenditures were reported in 1995, comprising 74% of the total budget (DG Agri, 2014). A similar trend was observed in the other Member States, while in Latvia, on average, 60% of the total EU financial assistance was spent on agriculture in the analysis period, reaching the highest level, 75%, in 2006. It has to be taken into account that agriculture is a producer of primary products; for this reason, the industry produces low value-added products that are subsidised, which contributes to prices adequate for consumers' purchasing power.

Latvia is one of the Member States that totally receives, on average, 3.7 times greater funds from the EU than it contributes to the EU budget. The receipts of all less developed countries of the EU are greater than their contributions. On the one hand, it is a paradoxical situation; yet, it has to be taken into consideration that the economies and exports of large EU Member States are fostered in this way, as the new EU Member States have poorly developed manufacturing sectors, and the materials, technological resources, machinery, equipment, fertilisers, plant protection products, etc. are imported from the large Member States that produce the mentioned products (Mileiko, 2013).

According to calculations performed by Mileiko (2013), in the programming period 2014-2020, Latvia will receive four euro of EU funding on every euro paid to the EU. This period's EU budget is reduced; yet, despite this fact, Latvia succeeded in getting greater receipts, compared with the pervious programming period, and this budget is estimated at EUR 7.5 bln.

In the period 2014-2020 in Latvia under the CAP, funding for agriculture is composed of two parts: Pillar 1 – direct payments totalling EUR 1.717 bln and Pillar 2 – funding for rural development, amounting

to EUR 966 mln (Mileiko, 2013). In addition, EU funding will be available for research, development of technologies, innovation, employment, education, etc. Agricultural nongovernmental organisations regard direct payments for farmers as the greatest achievement in negotiations with the EC on funding for agriculture, as the funding will be two times greater than that in the period 2004-2013. From 2019, the funding will be equal in all the Baltic States if measured per ha of agricultural land, 196 EUR/ha, and in order to get the maximum financial assistance, the corresponding criteria will have to be met, depending on the size of farmed land (Zemkopības ministrija (Ministry of Agriculture), s.a.). In the period 2014-2020, support will be available to farmers from two funds: the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD) (European Parliament..., 2013).

An analysis and comparison of the use of EU funds in the programming period 2007-2013 shows that, according to data as of the end of 2014, the situation in Latvia was not as successful as in the other Baltic States. Project submission activity in Latvia was the highest among the Baltic States and the number of approved projects exceeded the available EU funding by 4.9%. Nevertheless, the projects were implemented at an extent of 85.6% of the available funding, which means that the projects were implemented at a slower pace than in Estonia and Lithuania. However, the funding received from the European Commission was 81.2%, which showed that national funding was invested in part of the projects (ES fondi, 2015).

Conclusions

1. In Latvia, since the restoration of its independence in 1991, agriculture has undergone structural changes, which were determined by the privatisation of agricultural land. Growth in agricultural production was observed at a faster rate after the accession to the EU, as the proportion of farms with a small area of agricultural land considerably declined, whereas the proportion of farms with an area of more than 100 ha increased.
2. Joining the EU and free trade opportunities have significantly increased the potential of agricultural exports, as the value of agricultural exports in 2013 was 11 times greater than that in 2003, and in 2013 Latvia was the third largest grain exporter in the EU. This was possible because the value of agricultural goods rose 3.2 times in that period. Since the number of agricultural employees declined in the analysis period, labour productivity in agriculture rose 5.6 times.
3. Latvia is one of the Member States that totally receives, on average, 3.7 times greater funds from the EU than it contributes to the EU budget. Until 2013, agriculture received, on average, 60% of the available EU funding for Latvia. So, every euro paid by Latvia into the European Union budget allows getting back approximately 4 euro.
4. In the period 2014 - 2020, a financial assistance of EUR 1.7 bln will be available for agricultural production under Pillar 1, which is twice as much as in the period 2004 - 2013; furthermore, EU financial assistance totalling almost EUR 1 bln will be available for rural development from the EAFRD, which allows predicting further stabilisation of agricultural production in Latvia.

References

1. Antuža D. (2003) Eiropas Savienībā Latvija iegūs (Latvia will Gain from Being in the European Union). Available at: https://www.makroekonomika.lv/eiropas-savieniba-latvija-iegus, 18 February 2015. (in Latvian).
2. Atsbeha D.M., Kristofersson D., Rickertsen K. (2012) Animal Breeding and Productivity Growth of Dairy Farms. *American Journal of Agricultural Economics*, Vol. 94 Issue 4, pp. 996-1012.
3. Central Statistical Bureau (2013) Augkopība (Crop Farming). Available at: http://data.csb.gov.lv/pxweb/lv/lauks/lauks__ikgad__03Augk/?tablelist=true&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0, 12 February 2015. (in Latvian).
4. Ārlietu ministrija (2014) Argumenti par Latvijas ieguvumiem no iestāšanās ES (Arguments in Favour of Latvia's Gains from Joining the EU). Available at: http://www.mfa.gov.lv/arpolitika/eiropas-savieniba-arpolitika/arhivs/integracija-es/iestasanas-es-sarunas/sarunu-pozicijas/argumenti-par-latvijas-ieguvumiem-no-iestasanas-es, 20 February 2015. (in Latvian).
5. Balaceanu C. (2013) A historical analysis of the common agricultural policy. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* Vol. 13, Issue 3, Bucharest: University of Agricultural Sciences and Veterinary Medicine, pp. 25-30.
6. Bartolini F., Angelini L.G., Brunori G., Gava O. (2015) Impacts of the CAP 2014-2020 on the Agroenergy Sector in Tuscany, Italy. *Energies* (19961073), vol. 8, no. 2, pp. 1058-1079. Available at: http://web.a.ebscohost.com.ezproxy.llu.lv/ehost/detail/detail?vid=5&sid=c94a88f8-256e-4e8e-ba23-b40388a104c5%40sessionmgr4002&hid=4104&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#db=a9h&AN=101064859, 2 March 2015.

7. Bouamra-Mechemache Z., Jongeneel R., Réquillart V. (2008) Impact of a gradual increase in milk quotas on the EU dairy sector. *European Review of Agricultural Economics* 35 (4) Oxford: Oxford University Press, pp. 461-491.
8. DG AGRI (2014) European Commission: CAP expenditure in the total EU expenditure. Available at: http://ec.europa.eu/agriculture/cap-post-2013/graphs/graph1_en.pdf, 3 March 2015.
9. DG BUDG (2013) European Commission: EU expenditure and revenue. Available at: http://ec.europa.eu/budget/figures/interactive/index_en.cfm, 3 March 2015.
10. Diedziņa S. (2014) Ražotājiem piena rekordi (Producers Report Milk Production Records). Available at: http://www.db.lv/laikraksta-arhivs/lauksaimnieciba/razotajiem-8211-piena-rekordi-410242, 12 February 2015. (in Latvian).
11. Eiropas Līgums par asociācijas izveidošanu starp Eiropas Kopienām un to Dalībvalstīm, no vienas puses, un Latvijas Republiku, no otras puses (1995) The Europe Agreement Establishing an Association between the European Communities and Their Member States, of the One Part, and the Republic of Latvia, of the Other Part. Available at: http://www.mfa.gov.lv/data/file/l/01_Eiropas_Ligums_txt.pdf, 28 February 2015. (in Latvian).
12. Erjavec K., Erjavec E. (2015) Greening the CAP' – Just a fashionable justification? A discourse analysis of the 2014–2020 CAP reform documents. *Food Policy*, Volume 51, February 2015, pp. 53-62.
13. ES fondi (2015) ES fondu apguves salīdzinājums starp Baltijas valstīm 2007-2013.g. (Comparison of the Use of EU Funds Among the Baltic States in 2007-2013) Available at: http://www.esfondi.lv/page.php?id=1025, 12 February 2015. (in Latvian).
14. European Commission (2013) The Common Agricultural Policy and Agriculture in Europe – Frequently Asked Questions. Available at: http://ec.europa.eu/agriculture/faq/index_en.htm#5, 18 February 2015.
15. European Parliament and the Council (2009) Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:lv:PDF, 12 February 2015.
16. European Parliament and the Council (2013) REGULATION No 1306/2013 on the financing, management and monitoring of the common agricultural policy. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:EN:PDF, 15 February 2015.
17. Keller W.J. (2000) The Importance Of Rural Development In The 21st Century - Persistence, Sustainability, And Futures. *First National Conference on the Future of Australia's Country Towns*. Available at: http://regional.org.au/au/countrytowns/keynote/keller.htm, 14 February 2015.
18. Latvijas Holšteinas šķirnes lopu audzētāju asociācija (2011) Piena nozares analīze (Analysis of the Dairy Industry). Available at: www.laukutikls.lv/system/files.../piena_nozares_analize_2011.g.pdf, 14 February 2015. (in Latvian).
19. Lauksaimniecības dzīvnieku produktivitāte (2013) Central Statistical Bureau (Agricultural Animal Productivity). Available at: http://data.csb.gov.lv/pxweb/lv/lauks/lauks__ikgad__05Lopk/LL0120.px/?rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0, 12 February 2015. (in Latvian).
20. Lauku saimniecību struktūra (2007) Central Statistical Bureau (Percentage Distribution of Agricultural Holdings). Available at: http://data.csb.gov.lv/pxweb/lv/lauks/lauks__ikgad__laukstrukt/?tablelist=true&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0, 12 February 2015. (in Latvian).
21. Lauku saimniecību struktūra (2013) Central Statistical Bureau (Percentage Distribution of Agricultural Holdings). Available at: http://data.csb.gov.lv/pxweb/lv/lauks/lauks__ikgad__laukstrukt_13__1.visp/?tablelist=true&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0, 12 February 2015. (in Latvian).
22. Lapka M., Cudlķnovį E., Rikoon J.S., Pģlucha M., Kvetoņ (2011) The Rural Development in the Context of Agricultural "Green" Subsidies: Czech Farmers' Responses. Agricultural Economics, Volume 57, Issue 6, pp. 259-271.
23. Mazure G. (2007) Effective use of financial resources for rural development of Latvia. Economics and Rural Development 3 (2) Vilainiai: Lithuanian University of Agriculture, 2007, pp. 7-15
24. Central Statistical Bureau (2013) Mežsaimniecība (Forestry). Available at: http://data.csb.gov.lv/pxweb/lv/lauks/lauks__ikgad__mezsaimn/?tablelist=true&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0, 12 February 2015. (in Latvian).
25. Michael J.D. (s.a.) Everything You Need to Know About Raising Broiler Chickens. Available at: http://www.uvm.edu/newfarmer/production/livestock/Growing%20Broilers-Darre.pdf, 12 February 2015.
26. Mileiko E. (2013) Kā veido un starp dalībvalstīm sadala ES budžetu (How the EU Budget is Formed and Distributed Among the Member States). Available at: http://www.lvportals.lv/print.php?id=257759, 12 February 2015. (in Latvian).

27. Ministru kabinets (2008) Ministru Kabineta 2008.gada 17.jūlija noteikumi Nr. 556: *Kārtība, kādā piešķir, administrē un uzrauga valsts un Eiropas Savienības atbalstu cukura rūpniecības restrukturizācijas skartajam reģionam* (Procedure for How to Grant, Administer and Control National and European Union Assistance for the Region Subject to the Restructuring of the Sugar Industry). Available at: http://likumi.lv//ta/id/178369?&search=on, 12 February 2015. (in Latvian).
28. Pilvere I., Pilvere A. (2010) Evaluation of National and the EU Support for Agriculture in Latvia. *Human Resources: The Main Factor of Regional Development,* Issue 3, pp. 44-51.
29. Rivza B., Cingule S., Latviete I. (2010) Acquisition of EU Structural Funds in Ireland and Latvia. *European Integration Studies*, Issue 4, pp. 116-126.
30. Poczta W., Pawlak K., Czubak W. (2012) Production and income situation in Polish agriculture after accession to the European Union. Berichte uber Landwirtschaft, Volume 90, Issue 1, April 2012, pp. 133-158.
31. Popluga D. (2009) Beef Consumption Trends in Latvia. In: Treija S., Skuja I. (eds.) *Proceedings of International Scientific Conference "Research for Rural Development 2009"*, Latvia University of Agriculture, Jelgava, pp. 241-247.
32. Tomšik K., Rosochatecka E. (2007) Competitiveness of the Finnish Agriculture after ten years in the EU, *Agricultural Economics (AGRICECON),* Czech, Issue 53, 10, pp. 448-454.
33. Upīte I. (2010) Ieguldījumu atbalsta izmantošana Latvijas lauksaimniecībā (Use of Investment Support in Latvia's Agriculture). Promocijas darba kopsavilkums, Latvijas Lauksaimniecības universitāte, Jelgava, 96. lpp. (in Latvian).
34. Vanwambeke S.O., Meyfroidt P., Nikodemus O. (2012) From USSR to EU 20 years of rural landscape changes in Vidzeme, Latvia. *Landscape and Urban Planning* 105 (3) Oxford: Elsevier Ltd, 2012, pp. 241-249.
35. Zemkopības ministrija (2014) Latvijas lauksaimniecība 2014 (Latvian Agriculture 2014). Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/45/84/LAUKSAIMNIECIBAS ZINOJUMS_2014.pdf., 12 February 2015. (in Latvian).
36. Zemkopības ministrija (2015) Latvijas lauku attīstības programma 2014. - 2020. gadam (Rural Development Program 2014 - 2020). Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/51/78/LAP2014-2020_projekts.pdf, 12 February 2015. (in Latvian).
37. Zemkopības ministrija (s.a.) Tiešie maksājumi 2015-2020 (Ministry of Agriculture. Direct Payments 2015 - 2020). Available at: https://www.zm.gov.lv/public/ck/files/ZM/tirgus/Tiesie%20maksajumi%20no%20 2015.pdf, 28 February 2015. (in Latvian).

IMPACT OF THE NATURA 2000 NETWORK ON SOCIAL-ECONOMIC DEVELOPMENT OF RURAL COMMUNES IN POLAND

Iwona Cieślak, Katarzyna Pawlewicz, Adam Pawlewicz, Karol Szuniewicz
University of Warmia and Mazury in Olsztyn, Poland
isidor@uwm.edu.pl

Abstract
The study deals with issues related to the impact of Natura 2000 sites on local development of rural communes in Poland. The purpose of the study is an attempt at comparing the level of social-economic development of rural communes in which Natura 2000 sites are located within their borders against other communes where there are no such sites, based on an analysis of selected indices. The selected indices of social-economic development were analysed in 424 rural communes in six Polish provinces. The study uses statistical data from the Central Statistical Office from the years 2000-2013. The analysis indicates that rural areas with Natura 2000 network sites do not differ from other units of local government as far as the level of social-economic development is concerned and in some cases show even better results. In the 'Natura' communes – compared to units where there are no such sites – the level of total income is higher, along with the commune's own income, and there is a higher level of investment expenditure. The conducted analysis allows for the statement that the presence of Natura 2000 sites does not hinder economic development of communes and only modifies the manner of preparation and implementation of an investment. It does not constitute a barrier to human activity on the condition that any such activity complies with the principles of sustainable development. This testifies to the higher economic activity of inhabitants in comparison to other units.
Key words: environmental network Natura 2000, social-economic development, rural communes.

Introduction

The concept of development is complex and multidimensional. It is most often determined as a process of positive changes, encompassing a quantitative increase and qualitative progress in a given area in the life of its inhabitants and operations of its economic entities (Parysek, 2001; Cieślak et al., 2013). It may be stated that social-economic development on a local level takes place in the economic, social, political and environmental dimensions (Takamori and Yamashita, 1973; Potoczek and Stępień, 2008). These dimensions are not uniformed and they are closely interconnected. These dependencies contribute to the creation of new, durable development potential that should result in more complete satisfaction of the needs of the local community and also prevent a negative impact on the environment (Szewczuk et al., 2011; Goraj et al., 2014). Natural resources and environmental quality have a direct influence on the dynamics and development of rural territories (Sánchez-Zamora et al., 2014).

However, it is necessary to draw attention to the fact that intense economic development has led to the loss of numerous ecosystems, and thus to a significant deterioration of biological diversity. For the purpose of protecting threatened parts of the natural environment, the Natura 2000 environmental network was designed for the EU. Within the scope of the programme it is possible to undertake activities that efficiently protect natural habitats and species. The Natura 2000 programme in Poland was officially implemented in 2004, i.e., at the moment of Poland's accession to the European Union. The designation of Natura 2000 sites is based on the distribution and population size of threatened species and habitats. Other components do not play an important role when designating sites encompassed by the programme. Thus, economic or social determinants cannot constitute an argument preventing the inclusion of a given site in the Natura 2000 network (Brînzan, 2006).

In Poland, this relatively new form of nature preservation is usually located in areas with a high forestation rate, low number of inhabitants, and weaker soils, and in areas where infrastructure is underdeveloped and entrepreneurship is slight (Bołtromiuk, 2012), which are characteristic features of rural areas. Thus, the basis for discussion and analyses is the purported thesis that rural communes with Natura 2000 sites develop more slowly and their level of development is lower in comparison to other local government units that do not have such sites. The authors can confirm the accuracy of this thesis via an analysis of the basic indices testifying to the low level of social-economic development. However, the fact that no visible differences between these indices for communes with or without the Natura 2000 sites may prove that the designation of valuable natural sites does not have a direct impact limiting development and in some cases may even stimulate it in such areas (Getzner and Jungmeier, 2002; Pawlewicz et al., 2011).

The objective of the study is an attempt to compare, through an analysis of basic indices, the level of social-economic development of rural communes with Natura 2000 sites and other rural communes in the same provinces without Natura 2000 sites.

Materials and Methods

The examined communes are located in six provinces in Poland (Lower Silesia, Lubuskie, Podkarpackie, Podlaskie, Warmia and Mazury, and Western Pomerania). These are provinces where the degree of coverage with Natura 2000 sites is much higher than in other regions of the country and exceeds 20% of the province's surface area. The analysis encompassed 424 rural communes, including 294 communes with Natura 2000 sites within their borders. In the study, statistical data from the Central Statistical Office (Bank …, 2015) was used, allowing for a determination of the indices of social-economic development along an x-axis (years 2000-2013) and one y-axis (divided by groups of local government units, i.e., 'Natura' communes and other communes from the area analysed, as well as the average values for communes in Poland as a control). Data regarding financial values was adjusted and presented in the form of fixed prices; the base period is the year 2000. This allowed for the elimination of the impact of current prices on the dynamics of the examined categories and enabled them to be compared, taking into account changes in their physical sizes in various periods. In the case of certain indices, the analysis refers to a shorter period as a result of a lack of data for the years 2000-2001. The indices selected for analysis referred to the finances of the communes (total income and own income, investment expenditure), technical infrastructure (water network and sewerage), entrepreneurship and the activity of the inhabitants (number of economic entities).

Results and Discussion

Commune Income

The basis for the operation of communes is their income, thanks to which these units of local government may implement tasks that aim to satisfy the collective needs of their inhabitants. Therefore, the financial policy of a local government unit should rely on the procurement of sufficient funds to enable the implementation of the tasks imposed on it. The amount of total income shows the 'affluence' of a commune and provides basic information about the financial standing of a local government unit. On the other hand, a commune's own income testifies to its financial independence as well as the prudence of local authorities and the economic activity of its inhabitants and their assets (level of taxes and local fees). The amount of its own income ensures independence in the decision-making process and creates opportunities for a more complete satisfaction of the needs of the community and an increase in the standard of the services provided (Sobczyk, 2009). Especially important is the fact that an increase in the total income of a commune does not have to be related to an improvement in financial standing. This is the result of a higher authority mandating a task for the commune to implement. The local social and economic situation, the economic standing of a commune and the dynamics of a commune's development are better reflected by own per capita income. If the level of income increases, the local economic base grows along with the development potential. However, it is necessary to note that environmental protection, via the introduction of Natura 2000 sites, raises fears among some with respect to rapid economic development. However, there are numerous premises that may testify to a positive relation between the existence of Natura 2000 sites and the level of social-economic development of local government units in areas where such sites are located (Russo et al., 2011; Kurowska et al., 2014).

In the communes analysed between 2000 and 2013, it is possible to observe an increase in actual total income and their own income per inhabitant. It may be concluded that in the examined local government units where the Natura 2000 network is functioning, the situation is better with respect to income in comparison to the situation of other communes, as well as the average value for rural communes in Poland. These determinants were present both before and after the year 2004. Additionally, after 2004, the gap between the income of local government units with Natura 2000 sites and other communes started to increase, to the advantage of the former (Figure 1). The influx of European CAP and structural funds greatly influenced an improvement in these indices.

Investment Expenditure

One factor signalling the level of local development is the start of investment activities as reflected in the amount of a commune's investment expenditures. These outlays are used to develop new infrastructure in a commune and to restore and extend the existing infrastructure. Investment projects are necessary for the implementation of commune's tasks. Undertaking projects allows these units of local government to provide their inhabitants with access to services, possibly offered at the highest level. Apart from that positive benefit, investment, in particular the extension of technical infrastructure is one of the most important factors influencing the further investment attractiveness of a commune and its future 'affluence' (Markowski, 2001).

The analysis has shown that the level of investment expenditures between 2000 and 2013 in the area studied and across Poland varied. Until 2004, it was possible to observe an increase in such outlays; subsequently, the years 2005 and 2007 were marked by stagnation, whereas in 2008 growth was noticed, lasting until 2010. After this period, the growth rate

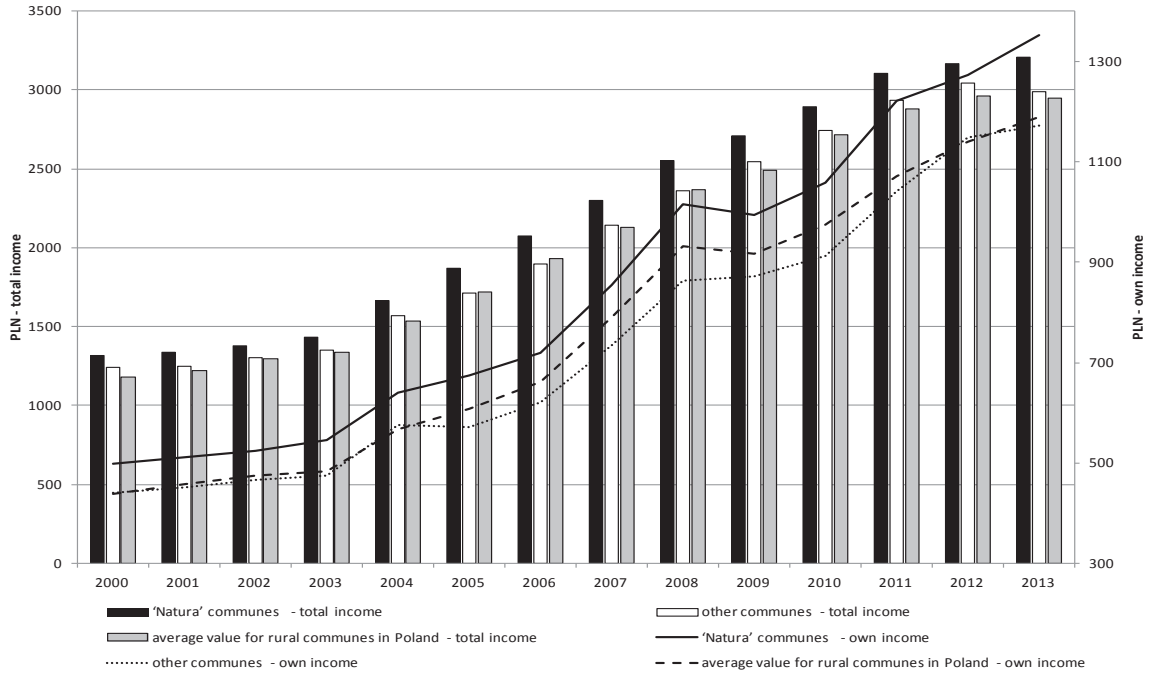

Figure 1. Actual total income and own income per inhabitant in the communes analysed between 2000 and 2013 (PLN, constant prices).

Source: authors' calculations based on Bank Danych Lokalnych, Access: 20.01.2015.

of investments started to decline (Figure 2). On the one hand, this is a result of the use of finances near the end of the then-current EU budget period; on the other hand, it is saturation of investments. Subsequent investments may generate unnecessary costs, overburdening the budget of the local government and forcing it to incur credit. At the same time, they may not significantly improve the quality of life of the inhabitants, and infrastructure should be extended by taking their needs into account.

A review of the collected information has indicated that for investment expenditures in communes with Natura 2000 sites, the index between 2000 and 2012 was higher than in other analysed communes. It was only in the year 2013 when a reverse trend was observed. On the other hand, comparing the value of the expenditures by local governments assigned to investments against the average in Poland, it is possible to state that in 'Natura' communes, these expenditures were lower (Figure 2). This results from the dominance of agricultural and nature in such communes, which may not require the extension of technical infrastructure.

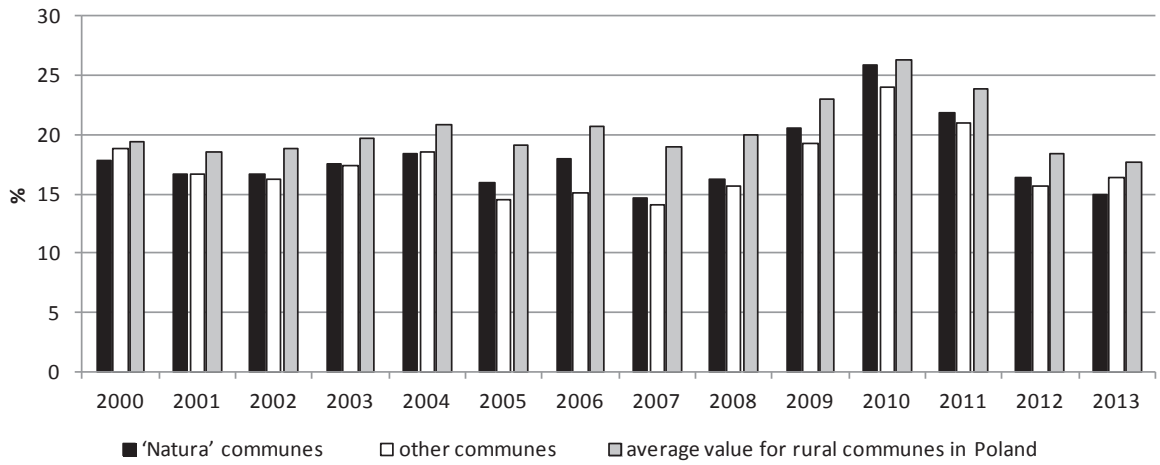

Figure 2. Investment expenditure in total expenditure in the communes analysed between 2000 and 2013 (%).

Source: authors' calculations based on Bank Danych Lokalnych, Access: 20.01.2015.

Technical Infrastructure (Water and Sewage Networks)

Technical infrastructure plays an important role in the shaping of settlements and the social-economic development of every area. Its significance increases especially in non-urbanized areas, not only on account of development of the rural sector but primarily due to the creation and solidification of other forms of activity, enabling so-called multi-functional development of rural areas. In this respect, it is necessary to attach particular importance to water and sewage management, which not only influences the quality of life of the inhabitants but also the quality and the condition of the natural environment. Access to infrastructure of this type creates development conditions for other forms of non-agricultural activity and the management of rural areas, thereby increasing not only investment attractiveness but also the level of competitiveness between regions (Kłos, 2012).

Although infrastructure plays such an important role in the economy, the condition, range and devices incorporated in such infrastructure are greatly insufficient. This is particularly noticeable in rural areas. The need to construct or extend network infrastructure in such areas is common but satisfied gradually, in line with the funds held by a commune and its priorities as determined by local authorities and the communities themselves (Piszczek and Biczkowski, 2010). This tendency is observable in the analysed area. For 'Natura' communes and other communes, there is constant, systematic growth in coverage of water and sewage infrastructure, even though, as was mentioned earlier, it is still insufficient. With respect to local government units where Natura 2000 sites are located, these delays were and are much greater both before and after 2004. This is primarily caused by the fact that investments in valuable natural areas pose many difficulties (Kistowski, 2008). Additionally, it is important to note that in these areas the increase in the water supply network is greater than for the sewage network (Figure 3). This may be influenced by the fact that the development of the water supply network has always had greater significance in the hierarchy of people's needs. On the other hand, investments related to sewerage have been perceived by the public as an additional financial burden, not as an element increasing the quality of life or limiting the degradation of the natural environment (Świątek, 2003). Another premise for this is provided by economic issues, namely that the cost of constructing a sewage network is three times higher in comparison to a water supply network (Piszczek, 2008).

Economic Operation

A very important element of social-economic development is the activity of economic entities in a given region. It is possible to indicate a certain dependency related to this: a large number of economic entities registered in a commune report

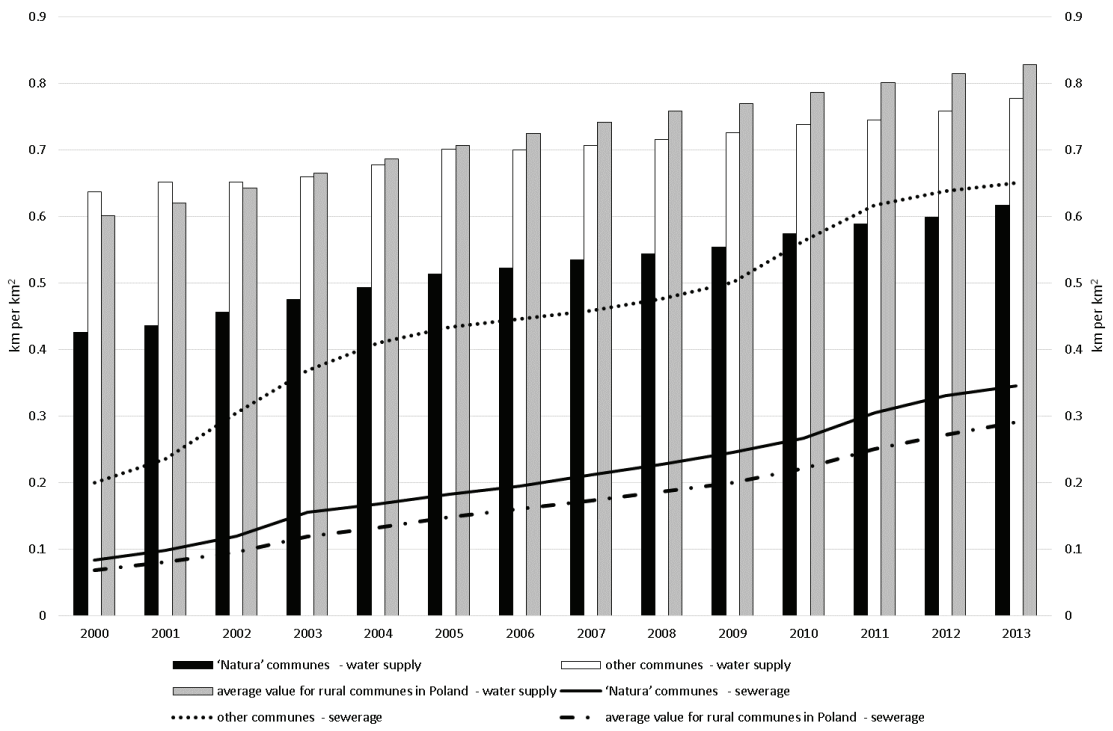

Figure 3. The length of the water supply system and the length of the sewerage network per 1 km² in the communes analysed between 2000 and 2013 (km per km²).

Source: authors' calculations based on Bank Danych Lokalnych, Access: 20.01.2015.

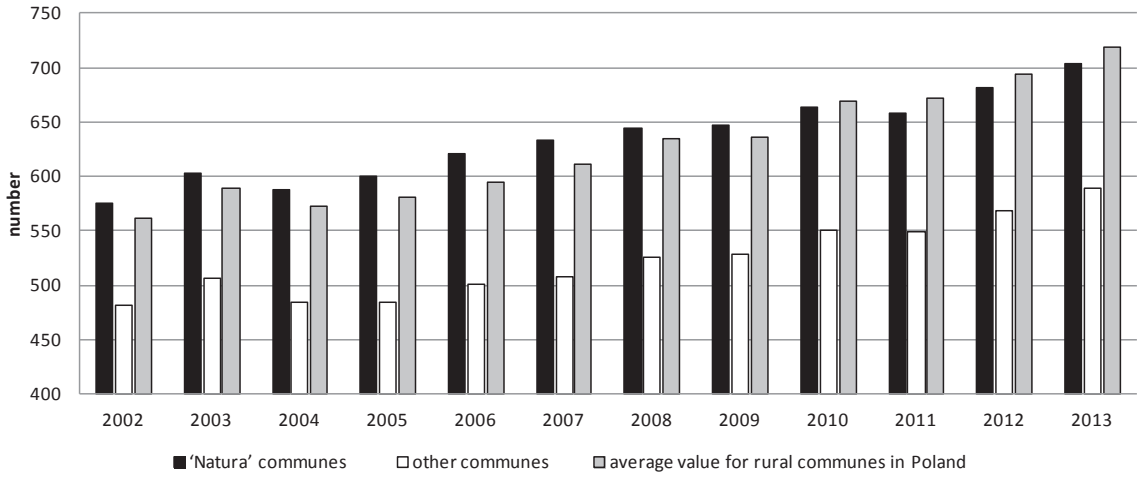

Figure 4. The number of registered economic entities per 1000 inhabitants in the communes analysed between 2000 and 2013 (number of entities).

Source: authors' calculations based on Bank Danych Lokalnych, Access: 20.01.2015.

have high economic activity among its inhabitants and there exist good conditions for the development of entrepreneurship (Karmowska, 2011) in the area. Social and economic conditions of local government units in the area where there are protected sites are usually characterized by limited advantages. This is the result of the low level of urbanization, small population density, insufficient number of non-agricultural economic entities and high unemployment related to the lack of opportunity.

It is possible to encounter an opinion that for the majority of local communities, Natura 2000 is yet another site encompassed by environmental protection policy that limits the free management of an area and, at the same time, is associated with a natural barrier to development (Weber and Christophersen, 2002; Mouro and Castro, 2010). In the public's opinion, the development of economic activity in communes with Natura 2000 sites means numerous barriers that exclude local economic development or significantly limit it. Such a limitation may be quantitative (slowing down the pace of development) as well as qualitative (reduction of possible paths of development). Meanwhile, new possibilities which may be, under certain conditions, used for the purpose of developing economic activity are often overlooked (Kettunen et al., 2009; Dan et al., 2012; Chmielewski et al., 2014). The most obvious for such areas is the development of tourism or the production of organic food. Changing consumer consumption preferences and a rise in 'green' tourism and recreation have created opportunities for many rural areas, particularly areas with high quality natural assets. Despite the economic crisis, the stability of this factor is currently being reinforced becoming a key element linked to the resilient nature of rural areas. The increased awareness of the importance of environmental sustainability is now a booming reality (Kocur-Bera, 2012; Sánchez-Zamora et al., 2014).

The results of the analyses indicate a growing trend in the number of registered economic entities, both in units with Natura 2000 sites and in other units. Between 2002 and 2013, the index of registered companies per 1,000 inhabitants in 'Natura' communes did not differ from the average for all of Poland and fluctuated around 570 in 2002, rising to 710 in 2013. It is worth noting that the number of registered companies in other communes in the analysed area was much lower, reaching 481 in 2002 and almost 570 in 2013. A dynamic increase in the number of registered new economic entities, comparable to the average in Poland indicates that operating in areas that include a part of the Natura 2000 network does not constitute a barrier to the economic activity of inhabitants. It is possible to note that economic activity in the analysed areas is systematically improving, which is evidenced by the increasing number of economic entities. This tendency is noticeable in 'Natura' communes and in other communes, yet to the advantage of the former. A slight drop could be observed in 2014, which could have been caused by Poland's accession to the European Union and entrepreneurs' difficulties with adjustment to new requirements (Figure 4).

Conclusions

The analysis has shown that rural communes with Natura 2000 sites do not differ with respect to the level of social-economic development from other units of local government. This is visible by the fact that in the 'Natura' communes, compared to communes without such sites, a higher level of total income and their own income of communes was observed overall, along with

a higher level of investment expenditures. On account of the characteristics of the area of the examined units, i.e., low degree of urban development and low population density, a smaller index for water supply and sewage networks was noticed in these communes. Therefore, it can be stated that the presence of Natura 2000 sites does not hinder the economic development of communes and only modifies the manner of preparation and implementation of investments.

Investments have to be conducted in a manner that least interferes with the environment and has the least negative impact on it. Natura 2000 sites are not a barrier to human activity, on the condition that the activity complies with sustainable development tourism. This is confirmed by the communes' higher economic activity than other units in the examined area, analysed on the basis of the number of registered economic entities per 1,000 inhabitants.

The use of financial assistance from the EU budget is also significant, and which is intended to improve the social and economic situation of these areas. It is necessary to remember that in the current financial period, EU funds intended for environmental protection are going to be reinforced. This calls for the inclusion of the environment and landscape as one of the basic axes of development policy in rural areas. Thus, the conclusion that the natural environment is perceived as a barrier by the local community may be a reason for increasing EU assistance to specific regions and which, in turn, may contribute to an improvement of local living and management conditions for the inhabitants of rural areas.

Summing up, the results of the studies confirm the lack of a correlation between the presence of a Natura 2000 site and a weaker economic situation for a rural commune. The results of the analysis presented above only show the direction and scope of changes in the social-economic development of local government units on the basis of basic indices over the course of several years. In order to determine clearly the causes of such changes, in-depth studies are necessary. It is possible to conclude that the article is a starting point for subsequent, broader analyses.

References

1. Bank Danych Lokalnych. Główny Urząd Statystyczny. (Local Data Bank. Central Statistical Office). Available at: http://stat.gov.pl/bdl/app/strona.html?p_name=indeks, 20 January 2015. (in Polish).
2. Bołtromiuk A. (2012) Natura 2000 – the Opportunities and Dilemmas of the Rural Development within European Ecological Network. *Problemy Ekorozwoju – Problems Of Sustainable Developmen*. Vol. 7, No. 1, pp. 117-128.
3. Brînzan O. (2006) Natura 2000 network an opportunity for rural space sustainable development. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Agriculture*, 62, pp. 179-183.
4. Chmielewski W., Głogowska M., Wrana K. (2014) Modele rozwoju gospodarczego w gminach z obszarami Natura 2000 (Models of Economic Development in Municipalities with Natura 2000 Areas). *Woda-Środowisko-Obszary Wiejskie*. Vol. 14. Book 2 (46), pp. 17-34. (in Polish).
5. Cieślak I., Szuniewicz K., Gerus-Gościewska M. (2013) Evaluation of the Natural Value of Land Before and after Planning Procedures. In: Rural Development 2013. *The Sixth International Scientific Conference Proceedings*. Aleksandras Stulginskis University, Akademija, Kaunas. Vol. 6, Book 3, pp. 228-233.
6. Dan R., Lucius I., Todorova M., Martini M., Piazzi A., Koukos I. (2012) *Guidance on assessing socio-economic benefits for better access to structural funds for biodiversity*. INTERREG IVc SURF Nature project. 52 p.
7. Getzner M., Jungmeier M. (2002) Conservation policy and the regional economy: the regional economic impact of Natura 2000 conservation sites in Austria. *Journal for Nature Conservation*. 10/1, pp. 25-34.
8. Goraj S., Nowak M., Gwiaździńska-Goraj M. (2014) Functional changes in rural areas in North-Eastern Poland. In: Research For Rural Development. *Annual 20th International Scientific Conference Proceedings.* Vol. 2. pp. 140-146.
9. Karmowska G. (2011) Badanie i pomiar rozwoju regionalnego na przykładzie województwa zachodniopomorskiego (Research and the Measurement of Regional Development on the Example of Zachodniopomorskie Province). *Roczniki Nauk Rolniczych, Seria G*, Vol. 98, Book 2, pp. 85-93. (in Polish).
10. Kettunen M., Bassi S., Gantioler S. Brink P. (2009) *Assessing socio-economic benefits of Natura 2000 – a toolkit for practitioners* (September 2009 Edition). Output of the European Commission project Financing Natura 2000: Cost estimate and benefits of Natura 2000. Institute for European Environmental Policy (IEEP), Brussels, Belgium, 191 p.
11. Kistowski M. (2008) Problemy lokalizowania inwestycji na terenach cennych przyrodniczo (Problems Locating Investments in Environmentally Valuable Areas). In: Gwiazdowicza M. (eds), *Ochrona przyrody (Nature protection)*. Studia Biura Analiz Sejmowych Kancelarii Sejmu, Vol. 10, Wyd. Sejmowe Kancelarii Sejmu, Warszawa, pp. 139-163. (in Polish).

12. Kłos L. (2012) Wpływ infrastruktury technicznej na atrakcyjność obszarów wiejskich (Influence of Technical Infrastructure on Attractiveness of Rural Areas). *Studia i Prace WNEiZ.* Vol.25, pp. 179-192. (in Polish).
13. Kocur-Bera K. (2012) Uwarunkowania inwestowania na obszarach Natura 2000 (Conditions for Investing in Natura 2000 Areas). *Studia i Materiały Towarzystwa Naukowego Nieruchomości (Journal of the Polish Real Estate Scientific Society*), Vol. 19, nr 4, pp. 83-95. (in Polish).
14. Kurowska K., Kryszk H. Marks-Bielska R., Kietlińska E. (2014) Spatial Analysis of Afforestation in Poland under Rural Development Programme 2007-2013. In: Research For Rural Development. *Annual 20th International Scientific Conference Proceedings.* Vol. 2. pp. 14-21.
15. Markowski K. (2001) Zarządzanie finansami gminy w aspekcie inwestycji komunalnych w Polsce w latach 1996–1999 (The Financial Management of The Municipality in Terms of Municipal Investments in Poland in 1996-1999). In: Zarzycki D. (eds) *Zarządzanie finansami: cele, organizacja, narzędzia.* Wyd. Fundacji Rozwoju Rachunkowości w Polsce, Warszawa, pp. 335-348. (in Polish).
16. Mouro C., Castro P. (2010) Local Communities Responding to Ecological Challenges – A Psycho-social Approach to the Natura 2000 Network. *Journal of Community & Applied Social Psychology. Vol* 20. pp. 139-155.
17. Parysek J.J. (2001) Podstawy gospodarki lokalnej (Basics of the Local Economy). *Poznań. Wyd. Naukowe Uniwersytetu Adama Mickiewicza*. pp. 240. (in Polish).
18. Pawlewicz A., Pawlewicz K., Kościńska J. (2011) Funkcjonowanie gospodarstw rolnych na obszarach 'Natura 2000' w opinii rolników z terenu powiatu olsztyńskiego (The Functioning of the Farms in Natura 2000 Areas of the District Olsztyn in the Opinion of Farmers). In: Andrzej Graczyk (eds) *Kryzys a rozwój zrównoważony rolnictwa i energetyki.* Prace Naukowe UE we Wrocławiu, Vol 231, pp. 113-124. (in Polish).
19. Piszczek S., Biczkowski M. (2010) Infrastruktura komunalna jako element planowania i kształtowania rozwoju obszarów wiejskich ze szczególnym uwzględnieniem terenów chronionych (Municipal Infrastructure as a Part of Planning and Designing of Rural Development With Particular Emphasis on Protected Areas). *Infrastruktura i ekologia terenów wiejskich*. Vol 14, PAN, Kraków, pp. 41-56. (in Polish).
20. Piszczek S. (2008) Rozwój sieci wodno-kanalizacyjnej na obszarze Krajeńskiego Parku Krajobrazowego (The Development of the Water-sewage System in the Krajna Landscape Park). In: Świątek D., Bednarek M., Siłka P. (eds) *Współczesne problemy badawcze geografii polskiej – geografia człowieka.* PAN. IGiPZ. Polskie Towarzystwo Geograficzne. pp. 115-121. (in Polish).
21. Potoczek A., Stepień J. (2008) *Podstawy strategii rozwoju lokalnego i regionalnego (Basics of Local and Regional Development Strategies)*. Bydgoszcz. Wyd. Uczelniane Wyższej Szkoły Gospodarki. 207 p. (in Polish).
22. Russo P., Carullo L., Riguccio L., Tomaselli G. (2011) Identification of Landscapes for Drafting Natura 2000 Network Management Plans: A Case Study in Sicily. *Landscape and Urban Planning*. Vol 101, pp. 228-243.
23. Sánchez-Zamora P., Gallardo-Cobos R., Ceña-Delgado F. (2014) Rural Areas Face the Economic Crisis: Analyzing the Determinants of Successful Territorial Dynamics. *Journal of Rural Studies*. Vol. 35. pp. 11-25.
24. Świątek D. (2003) Infrastruktura obszarów wiejskich województwa mazowieckiego (Rural Infrastructure Mazowieckie Voivodship). In: Śmigielska M., Słodczyk J. (eds) *Geograficzne aspekty globalizacji i integracji europejskiej*, PTG. Opole. pp. 463-469. (in Polish).
25. Szewczuk A., Kogut M., Zioło M. (2011) *Rozwój lokalny i regionalny. Teoria i praktyka (Local and Regional Development. Theory and Practice).* Wyd. CH Beck. 432 p. (in Polish).
26. Takamori H., Yamashita Sh. (1973) Measuring Socioeconomic Development: Indicators, Development Paths, and International Comparisons. *The Journal of the Institute of Developing Economies.* Vol. 11, pp. 111-145.
27. Weber N., Christophersen T. (2002) The Influence of Non-governmental Organisations on the Creation of Natura 2000 During the European Policy Process. *Forest Policy and Economics.* Vol 4 (1), pp. 1-12.

THE ROLE OF RURAL COMMUNITY ENHANCING RURAL SOCIAL INFRASTRUCTURE CHANGES

Gintarė Vaznonienė
Aleksandras Stulginskis University
gintarej@gmail.com

Abstract
This article presents analysis of the role of rural community in enhancement and implementation of changes in rural social infrastructure. Rural social infrastructure is a key part of rural social and economic system, the development level of which predetermines satisfaction of needs of rural residents, fulfilment of their range of choices and alternatives. The main objective of this article is to deploy the fact that application of "bottom-up" approach could stimulate rural community to make decision intended for promotion of positive changes when straining after the attractiveness of their locations through the rational development of social infrastructure facilities, supply of target, high-quality and multiple services. The following research question has been addressed – what is the potential contribution of rural community towards promotion of changes in social infrastructure of rural areas. The research aim is to disclose the role of rural community in enhancement of rural social infrastructure changes. An anonymous survey using questionnaire was implemented in five pilot rural areas and the summary of results is presented.
It has been determined that activity and citizenship of rural community in assumption of liabilities for the wellbeing of all rural residents predefines the relevancy of their decisions and opinions before the local authorities and other concerned local or regional institutions. Consequently, the challenge for mentioned rural development actors is to identify or recognise the constraints on rural community participation in forming social infrastructure at local level, and to develop and enable specific initiatives in their favour.
Key words: rural community, community needs, rural social infrastructure, rural development.

Introduction

Structural changes in Lithuanian society are directly related to changes faced by rural residents and rural areas, which, in turn, are contingent on the rural social infrastructure development level and on the demand of residents for services provided by different segments. Rural social infrastructure comprises various, mostly public, services, provided by different SI actors: e.g., educational institutions, medical authorities, police forces, domestic service providers, post offices, suppliers of transportation services, etc. (Atkočiūnienė et al., 2015). It shall be noted that changes in rural areas based on population ageing problem influence the importance of RSI services and their perception as being the essential factor of rural area viability. This statement could be supplemented by the research results, performed by G.Kuliešiaus ir D.Vidickienės (2008) concerning the dependence of the availability of all services without any exceptions on the increasing population densities in rural areas. It is certain that structure of rural community plays the main role in forming rural social infrastructure services which influences the functioning of them as well. Development of rural social infrastructure increases choices, sustains positive attitudes, improves the function of institutions, creates better conditions and enhances quality of life (Cavaye, 2001; Paslaugų…, 2007). B.V. Gopalakrishna, D.S. Leelavathi (2011) pointed out that social infrastructure directly and most efficiently impacts rural issues like poverty, social exclusion and the whole human development within the living areas of such people. If the existing rural social infrastructure complies with the needs and expectations of rural community – the higher quality of life of rural residents is achieved; if social infrastructure does not satisfy needs of residents or create choice range – particular social and economic issues influencing the wellbeing of the community occur. In terms of sustainable development of rural areas, the wellbeing of current and future rural residents could not be distinguished from the satisfaction of comprehensive needs which are generally preconditioned by the rural social infrastructure. The need to provide basic amenities of life has now become essential thing while improving humans' wellbeing. Contribution of local community to forming rural social infrastructure and rural development on the whole is significant though not always evaluated properly. Accordingly, the *scientific problem* solved in this article is described as whether the active rural community promotes changes in rural social infrastructure. *The research object* is to examine the features of rural community in enhancement of rural social infrastructure changes. *The research aim* is to disclose the role of rural community in enhancement of rural social infrastructure changes. *The research tasks* are as follows: 1) to reveal the importance of rural community's activity promoting rural social infrastructure changes; 2) to explore rural community's needs and attitudes for rural social infrastructure changes.

The major part of scientific works (Flora and Flora, 1993; Suharto et al., 2010; Gopalakrishna and Leelavathi, 2011; Planning…, 2012) disclose the necessity of revealing rural areas changes to be initiated by the rural community, i.e., local residents.

Initiatives promoting the development of rural areas in Europe such as "Leader" (The bottom-up approach) acknowledge relevancy of the "bottom up" approach while reaching after the social progress maintained by the involvement of society in rural area changes initiation processes as well as encouraging process of local participation in every aspect of development. Participation was considered to be a basic human right (Chifamba, 2013). Rural community participation in decision making is important for local democracy and for the quality of decisions taken in regard the development affecting the life and future of rural communities and economies (Women..., 2000). Rural community's activity or vitality, as J.M. Cavaye (2001) pointed out, also relies on communities "rethinking" assets, developing networks, building local cooperation and acting on local passion and motivation. It is known that community – driven development in rural development context is the key factor which influences improvements in all life domains (social, economic, cultural, and political, etc.). However, the case of paradox appears in this case – on the one hand, activity of rural community is deemed as a key factor in reaching the enhanced wellbeing, on the other hand, sometimes opinion of local residents remains unknown to local authorities and main actors are not able to encourage or join the initiative to change present situation. Such kind of a duality leads rural communities to strengthening their opinions or conversely, detracts their role in initiation of urgent changes. It is considered that, advanced communities could direct other communities that could not attract sufficient attention of the authorities or other actors concerned. According to B.V. Gopalakrishna, D.S. Leelavathi (2011), public action is an important component of any strategy to achieve higher levels of human development.

Community participation is considered as an imperative feature for success and prosperity of rural development (Chifamba, 2013), therefore the RSI development demand is based on the activity of rural residents in employing SI services. It could be said that needs of active, smart, engaged in recent development, conscious in activities of different social groups community are generally satisfied by favourably developed SI. G. Kuliešis ir D. Vidickienė (2008) stated that small local market shall be perceived as a vital factor preventing business initiatives to develop service sector in rural areas. Accordingly, rural residents are subjected to less favourable conditions comparing to those, living in bigger cities, and, as a result, the entire community, showing passive attitude towards changes, innovations, omitting needs of its members for RSI services could hardly achieve positive result, namely, the required SI services.

Community usually is defined as a group of people who has something in common, so understanding active rural community in broader terms, it can be characterized by various features. Scientific literature based on various reports and researches (Flora and Flora, 1993; Cavaye, 2001; Suharto et al., 2010; Gopalakrishna and Leelavathi, 2011) reveals that active rural community is the community, satisfying or implementing the following socially determined roles:

- innovative (generate initiatives);
- integrating or empowering (respect ideas and people, recognise the existence of diverse needs);
- flexible;
- smart;
- emphatic;
- socially sensitive;
- socially responsible (socially safe);
- enabling reliance upon members of rural community and neighborhood;
- best organisation of development players/actors;
- creating attractive living environment (place shaping).

If it is required to highlight the fact that active community shall be responsible for its activities and reached changes in full, the following evidences undermining and limiting rural communities struggle to enhance changes revealed by Cavaye J.M. (2001) shall be provided:

- they cannot change an issue because it is outside their influence, or they do not have the resources or assistance, etc.;
- they do not want to change – have enough;
- they do not know how to change – they lack the direction, organisation or expertise to take action;
- they think they cannot change.

Following above mentioned, the activity of rural community is usually restricted not for its own reasons, but also by others. J.M. Cavaye (2001) and E. Chifamba (2013) discussed one more issue – what if the community sees only constraints, not the opportunities? One of the dangers of any community assessment is the tendency to look only at a community's problems or deficiencies. Problem-oriented assessments tend to ignore resources and solutions that may be found within a community. Previous ideas confirm that rural communities while providing their active role also in forming rural social infrastructure must be strong and positive thinking. In order to be active or effective, rural community assessments should be systematic, involve a wide variety of community members, and engage people in a meaningful way. Accordingly, community participation is therefore an active engagement of individuals and groups to change problematic conditions and to influence policies and

programmes that affect the quality of their lives or the lives of others (Skinner, 1997; Chifamba, 2013).

Summarizing the above-mentioned, it can be noted that when emphasizing the rural community role in enhancement of rural social infrastructure major part of steps are related to the achievement of pre-determined goals. Various problems and restrictions that obstruct the activity of rural community should strengthen capabilities of rural people and create greater self-reliance finding out new ways for rural social infrastructure changes and improvement.

Materials and Methods

This article is based on implementing analysis and synthesis of scientific literature, logic and systematic analysis, applying questioning method. A growing number of international organisations and scientists emphasises advantages of subjective assessment along with the assessment of objective conditions (Veenhoven, 2009; Vaznonienė, 2011; Durand, 2011; OECD, 2013; National..., 2013). Rural community wellbeing depends on the opinion of its members, their needs and objectives raised. In this context the most considerable role is played by the subjective assessment of rural community able to disclose individual point of view regarding the behaviour of the community when achieved better life and enhancing rural social infrastructure.

The objective evaluation of rural social infrastructure sectors (education, training, consultancy; communications and telecommunications; utilities and municipal services; transportation; culture, sports, recreation; trade and public catering services; health and social security; personal and property protection) was done in five points scale (1 means very bad evaluation; 5 means very good evaluation). Each sector included a particular number of social infrastructure indicators which characterise the sector‘s situation (Atkočiūnienė et al., 2015).

Subjective opinion of the individual, its assessment and needs declares both current conditions and preconditions the future state irrespective of the assessment object (Stiglitz et al., 2009). It could be stated that subjective opinion involves the assessment of life and life conditions performed by individuals themselves, assessment of their perception of persons living nearby, and their feelings about the place they are living in. Advantages and importance of rural community subjective assessment in achieving RSI changes are based on the following reasons (Compendium..., 2011; Durand, 2013; OECD, 2013; Atkočiūnienė et al., 2015):

- they not only assess objective conditions, but also help in determining things important for rural residents;
- they disclose varying level of community needs development and their satisfaction directions;
- they highlight attitudes of various social groups towards RSI assessment;
- they reveal opinion of rural residents being the consumers about the demand for RSI services;
- they discover priorities of residents involved in enhancement of standards of living and wellbeing;
- they emphasise the important role of social relations in meeting the needs, promote social integration and involvement;
- they point out priorities of existing and future solutions related to RSI development;
- they assist in finding of innovative decision making processes when solving existing problems and enable the determination of particular means to be applied for problem solving;
- they supplement the data of already performed qualitative researches;
- they promote social cohesion and concentrate efforts of actors from various sectors in enhancement of SI.

Needs of rural residents as well as opportunities to satisfy them are one of the most important factors, affecting the demand and supply of RSI services. Needs of rural community being the social determinants of higher wellbeing could motivate, stimulate or limit SI development.

In order to determine needs of residents and RSI conditions, we have drafted the anonymous questionnaire (50 questions), which was used to generalise collected data without mentioning specific answers of respondents. Main diagnostic blocks of the questionnaire have been developed to identify respondents' opinion regarding current RSI conditions and existing deficiencies of RSI facilities as well as to clarify the attractiveness of residential area for living, working, investment, and indicate relevant problems of various areas in terms of local residents' opinion. Involvement of local residents in the query has enabled us to form a foresight and decide on active participation of rural community in straining after RSI changes. Some social demographic characteristics of respondents (e.g., including themselves to a particular social group), identification of local community peculiarities, answers to open questions regarding RSI changes enabled it to glimpse a level of activity shown or to be showed by participants when initiating RSI projects, creating a favoured rural area.

This research performed applying probability (random) selection methodology, to be more exact, we have applied a cluster analysis. Since the key role was dedicated to rural communities, the selection of geographical regions as a type of cluster analysis has been selected. Selected pilot areas (5 of them: Alytus

Table 1

Subjective and objective evaluation of rural social infrastructure sectors in Lithuania, 2014, in scores

Evaluation method	Social infrastructure sectors							
	Education, training, consultancy	Communications and tele-communications	Utilities and municipal services	Transportation	Culture, sports, recreation	Trade and public catering services	Health and social security	Personal and property protection
Average of respondents subjective evaluation in pilot areas	3.39	3.82	3.38	3.05	3.09	3.07	3.14	2.95
Average of objective evaluation	2.56	3.36	2.57	2.44	2.68	2.33	2.39	2.28

distr., Kedainiai distr., Kaisiadorys distr., Pasvalys distr. and Rietavas municipality) complied with specified criteria of applied method and showed the following distinctions: there are particular differences in rural residents, they are in different regions, and districts consist of townships, some of them of small towns and villages. In terms of the present research, selection of respondent from pilot areas was set as N=1023 (Atkočiūnienė et al., 2015). Data and calculations gained in the course of this research have been processed by using IBM SPSS Statistics Version 20 and Ms Excel programmes.

Results and Discussion

Performed research of the need of rural communities for rural social infrastructure services has revealed a wide range of results. Rather broad selection (N-1023) enabled to make particular assumptions regarding both the areas of high importance to individual rural residents and rural communities in terms of enhancement of rural social infrastructure. Since the research task of the article has been related to the determination of the role of community in achieving rural social infrastructure changes, several research aspects shall be provided.

Most of mentioned above authors acknowledge that there are many challenges to promoting active changes in a rural area. When we discuss how rural community can provide and be proud of its activity, we mean different possibilities to explore the power of local people. Doing field research in order to develop evidence-based ideas about rural community activity for social infrastructure progress, it disclosed some interesting remarks on it. Community development initiatives should prove the need of essential services. Some scientific works (Cavaye, 2001; Planning…, 2012) revealed that community activity development starts with its members fundamentally considering, how they imagine the living environment based on social infrastructure in the future. Determination of SI services needs shall be relevant due to the fact that SI services shall serve as the main force directed towards enhancement of community activity, its focus or integration abilities and enabling the satisfaction of both phisiological and higher spiritual needs, e.g. expression (personal fulfillment) needs).

In order to know the opinion of local residents about RSI sector, we have compared objective and subjective evaluation results. Evaluation of RSI conditions has shown that scores of subjective RSI sector assessment are higher than scores of the objective one KSI (Table 1).

Gained results has provided us with the opportunity to assume the application of different evaluation methods to subjective and objective evaluation of RSI sector, i.e., only several factors (objects) (selected by the research team members and prioritised by experts) have been subjected to objective evaluation of each RSI sector; moreover, residents of pilot areas have provided their general opinion about these sectors. The subjective evaluation has shown that rural communities have sufficient information about current conditions of social infrastructure at local level and are able to decide on priorities and aspects to be improved at once. It has been determined that lower evaluation of RSI sector (e.g., personal and property protection sector's evaluation is until 3 scores) causes higher attention and requires greater efforts of rural community to be paid in order to improve existing situation.

Research results highlighted particular characteristics of local communities (Fig. 1). It shall be emphasised that communities of pilot areas are described rather positively. Consequently, it could be assumed that rural communities are in progress, prosperous enough with their activity and able to

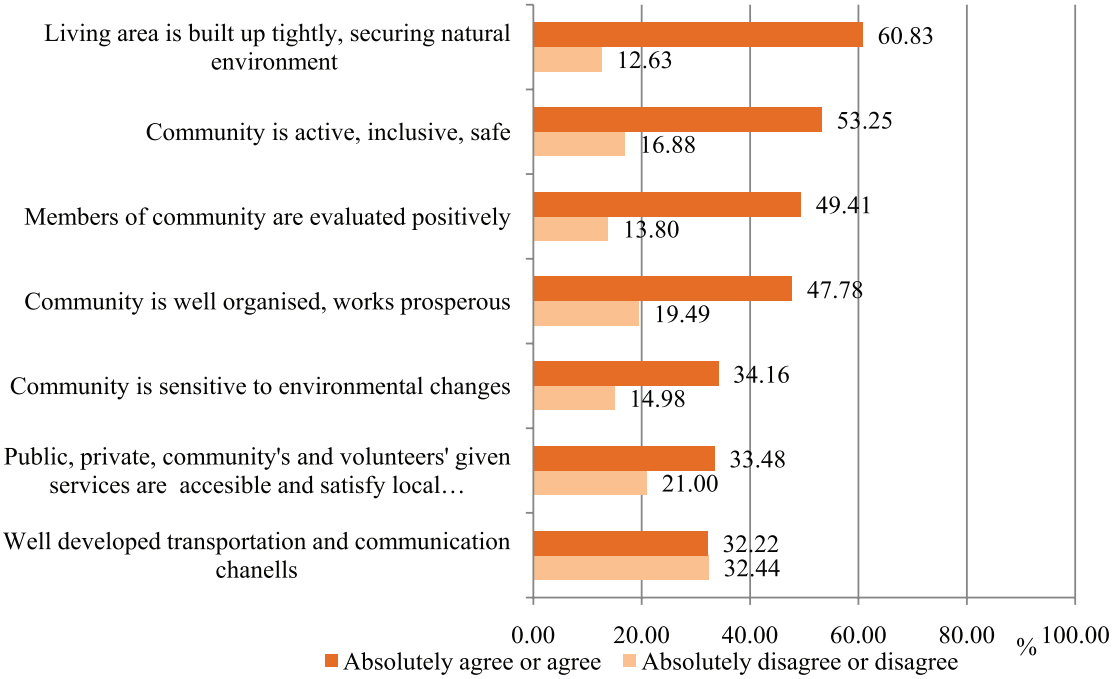

Figure 1. Pilot areas respondents opinion about rural community key features, 2014, percentage.

ensure enhanced wellbeing for existing and future generations. On the other hand, results disclose that different agents from public, private and volunteering sectors still have to put bigger attention and support to local communities' efforts for changes while improving and making attractive living in rural area. The key feature of social infrastructure ensuring communities' viability and activity is transportation and communication channels. Improvement of these elements could help in stimulation of rural communities for innovations and more active role in society.

Considering social status of respondents, it was revealed that rural community shall pay additional attention to groups of residents that describe themselves as "barely can survive" or "live poorly", because their evaluation of RSI sectors was lower than the evaluation of group of residents that describe themselves as "live well or live very well". The same situation occurred when respondents were asked about

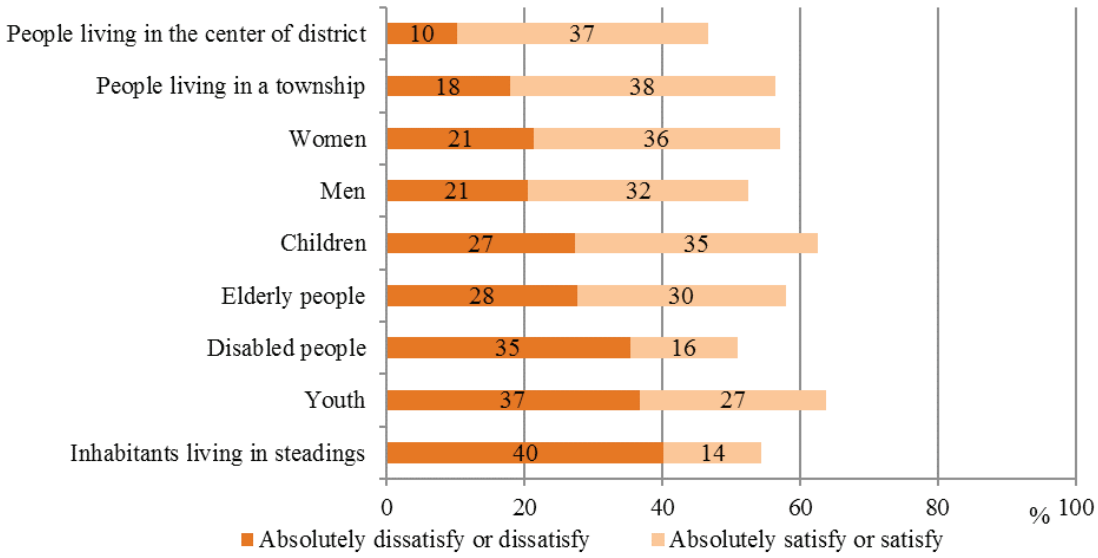

Figure 2. Distribution of pilot areas respondents' opinion about how rural social infrastructure services quality satisfies social groups' needs, 2014, percentage.

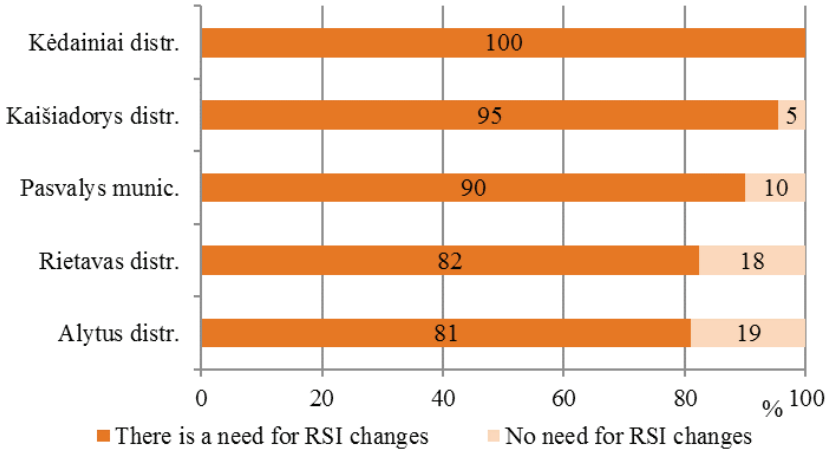

Figure 3. Pilot areas respondents‘ opinion about the need for rural social infrastructure changes, 2014, percentage.

the compliance of existing rural social infrastructure quality with the need of particular social groups (Fig. 2).

In the Figure it is shown that people living in township and the centre of district evaluate RSI services best, but inhabitants living in steadings and disabled people evaluate them the worst. It means that in order to achieve social infrastructure progress in rural areas, needs of various social groups shall be met, since RSI serves are deemed as an empowerment instrument which enables rural inhabitants' integration into local community.

In the course of research we have determined the attitude of respondents towards rural social infrastructure changes on the whole and in separate sectors (Fig. 3).

Determination of the need of social infrastructure changes could relatively reflect rural inhabitants intentions or willingness for action. Need for innovations varies depending on the social infrastructure sector development level in different pilot areas; however, the major part of respondents said that improved rural social infrastructure promotes normal participation of rural people not only in rural community, but also in society as well as enable rural people to manage different rural development processes related to improvement of personal and social wellbeing.

Summarizing it should be mentioned that research confirmed that by taking a positive approach to community activity, the changes of rural social infrastructure are possible. In spite of difficulties, rural communities understand the importance of social infrastructure changes in rural areas. As it is stated in the Lithuanian Progress Strategy "Lithuania 2030" (2012), modern communities shall be open-minded for community-based initiatives to become essential representation of rural community needs in all rural development processes.

Conclusions

1. The role of rural community enhancing rural social infrastructure changes can be understood in several ways. Active rural community is like a representer and defender of its members various needs for social infrastructure services. It was found out that depending on pilot areas rural communities' activity different rural agents (local government, public, private and volunteer sectors, etc.) should support local people seeking changes whether to see social progress in rural environment.
2. Rural social infrastructure serves as a social bridge integrating rural people in various activities, promotes participation and collaboration. Accordingly, the research results proved that the need to enhance rural social infrastructure in pilot areas is based on different social group's needs. As well active role of rural community can strengthen both the process building rural human capacity and initiating better living conditions through social infrastructure improvement.

References

1. Atkočiūnienė V., Aleksandravičius A., Kiaušienė I., Vaznonienė G., Pakeltienė R., Lukė R. (2015) Kaimo socialinės infrastruktūros vystymasis siekiant užtikrinti teritorinę ir socialinę sanglaudą (Improvement of rural social infrastructure for the territorial and social cohesion). Mokslo studija. Akademija: Aleksandro Stulginskio universitetas, 213 p.

2. Cavaye J.M. (2001) Rural Community Development: New Challenges and Enduring Dilemmas. *The Journal of Regional Policy Analysis,* Vol. 31 No 2 pp. 109-124.
3. Chifamba E. (2013) Confronting the challenges and barriers to community participation in rural development initiatives in Duhera district, ward 12 Zimbabwe. *International Journal of Current Research and Academic Review.* 1(2), pp. 01-19.
4. *Compendium of OECD Well-Being Indicators*. OECD (2011) Available at: http://www.oecd.org/std/47917288.pdf, 2 December 2014.
5. Flora C.B., Flora J.L. (1993) Entrepreneurial Social Infrastructure: A Necessary Ingredient. *Annals of the American Academy of Political and Social Science*, Vol. 529, Rural America: Blueprint for Tomorrow, pp. 48-58.
6. Gopalakrishna B.V., Leelavathi D.S. (2011) Infrastructure and Human development in India: An Interstate comparison. *Journal of Global Economy* (ISSN 0975-3931), Volume 7 No 4, pp. 225-244.
7. Kuliešis G., Vidickienė D. (2008) Lietuvos kaimo gyventojų nuomonės tyrimai dėl kaimo infrastruktūros gerinimo. Vadybos mokslas ir studijos – kaimo verslų ir jų infrastruktūros plėtrai. *Management theory and studies for rural business and infrastructure development*. Lietuvos žemės ūkio universitetas. Ekonomikos ir vadybos fakultetas. Akademija, Nr. 12(1), pp. 92-100.
8. Lietuvos pažangos strategija "Lietuva 2030" (Lithuania's progress strategy "Lithuania 2030"). (2012) Valstybės pažangos taryba. Available at: http://www.lrv.lt/bylos/veikla/2030.pdf, 17 February 2015. (in Lithuanian).
9. Durand M. (2013) Measuring Well-being for Development. 2013 OECD Global Forum on Development. Discussion Paper for Session 3.1. Available at: www.oecd.org/site/oecdgfd/, 20 November 2014.
10. National Research Council. (2013) *Subjective Well-Being: Measuring Happiness, Suffering and Other Dimensions of Experience*. Washington, DC: The National Academies Press, 204 p.
11. OECD (2013) OECD Guidelines on Measuring Subjective Well-being, OECD Publishing. Available at: http://dx.doi.org/10.1787/9789264191655-en, 20 November 2014.
12. Paslaugų kaimo gyventojams plėtra (Developing rural services) (2007) Leader programos biblioteka. Akademija: Lietuvos žemės ūkio universitetas, p. 61. (in Lithuanian).
13. Planning for social infrastructure and community services for urban growth areas (2012) Implementation Guide. Available at: http://www.elton.com.au/wordpress/wp-content/uploads/2012/05/Implementation-Guide.pdf, 15 October 2014.
14. Skinner S. (1997) *Building Community Strengths*. London: Community Development Foundation, 150 p.
15. Stiglitz E., Amartya S., Fitoussi J.P. (2009) Report by the Commission on the Measurement of Economic Performance and Social Progress. 292 p.
16. Steuer N., Marks N. (2008) Local Wellbeing: Can We Measure It? Department for Communities and Local Government. Available at: http://s.bsd.net/nefoundation/default/page/file/c6f4c88b25b2696984_o7cm6ts1z.pdf, 8 March 2015.
17. Suharto T., Tan Y., Severine M. (2010) Social infrastructure planning and sustainable community: example from south east Queensland, Australia. In: *Proceedings of the Business and Social Science Research Conference* 2011, 3-4 January 2011, Novotel World Trade Centre, Dubai, pp. 1-12.
18. The bottom-up approach. Chapter 4. Available at: http://ec.europa.eu/agriculture/rur/leader2/dossier_p/en/dossier/chap4.pdf, 27 February 2015.
19. Vaznonienė G. (2011) Subjektyvi gerovė ir socialinė atskirtis: pagyvenusių žmonių atvejis. Daktaro disertacija (Subjective wellbeing and social exclusion: a case of elderly people, Phd Thesis). Kaunas: Kauno technologijos universitetas, 214 p.
20. Veenhoven R. (2009) Well-Being in Nations and Well-Being of Nations. Is There a Conflict Between Individual and Society? *Soc Indic Res*. 91, pp. 5-21.
21. Women active in rural development. Assuring the future of rural Europe (2000) European Commission Directorate-General for Agriculture. Luxembourg: Office for Official Publications of the European Communities. Available at: http://ec.europa.eu/agriculture/publi/women/broch_en.pdf, 10 January 2015.

THE ROLE OF LOCAL GOVERNMENT FINANCE EQUALIZATION ON RURAL DEVELOPMENT IN LATVIA

Inga Vilka
University of Latvia
inga.vilka@lu.lv

Abstract
Currently one of the hottest local governments' issues on the agenda of the government of Latvia is the elaboration of new improved local government finance equalization system, which is an important integral element of the implementation of regional development policy. Local government finance equalization is affecting development capacity of any territory, including rural territories. The purpose of the article is to highlight and discuss in academic society the finance equalization issues that affect the rural municipalities and work out proposals for the new system. The study does not cover all local government finance equalization system's elements, but gives attention to three – importance of the equalization for rural local governments – municipalities (*novads*); revenue sources, that are necessary to include in the equalization system; criteria for calculation of local governments' expenditure needs.
Key words: local governments, finance equalization, rural municipalities, regional development, community capacity, criteria for expenditure needs.

Introduction

Regional policy is a set of agreed and organised measures for ensuring development across the territory of a country. The objects of regional policy is authorities of different tiers – local governments and where it is regional and other sub-national level authorities (Vaidere et al., 2006), and local governments, their autonomy and capacity is one of most significant elements of regional development. In the past main activities of the regional development policy were directed towards reduction of unfavourable disparities of territories and their growth potential. In recent decades significant changes in the territorial perspective have been observed in the international context, focusing more on the competitiveness of territories rather than on ensuring the traditional support to industries or income redistribution. The policy is directed towards the development of competitiveness of each territory, not only towards the subsidization of the poorest regions, proven to be less efficient (Kalniņa-Lukaševica, 2013). Recently, a place-based approach has been put forward as a new solution to promote regional development and it is a topical EU discussion point (Baltiņa, 2014). In modern governance the principle *one fits all* has been substituted with tailor made approach: in the case of regional development policy, it is implementation of place based approach, what takes into account as possible more specific features – resources, capacities, potentials - of the particular territory in programmes, activities and projects, that impact the development of territories.

One of apparent tool of regional development policy, used in many European countries, is a local government finance equalization system. A substantial degree of financial equalisation is a prerequisite for the success of fiscal decentralisation and sound local self-government. At the same time, financial equalisation is a prerequisite for the success of policies geared to economic stability and balanced, sustainable regional development (CE, 2005). Such system primarily is directed towards reduction of disparities of local governments' financial capacity to ensure provision of basic local governments functions and services in the whole territory of country. By purpose this tool could be evaluated as a tool of traditional, classic regional policy, but in tailoring of the equalization system there is a possibility to implement place-based approach by trying to take into account more specific features of the territories, as it influences the community capacity.

As there are significant differences in the financial capacity among different local governments in Latvia, since 1995 local government finance equalization system has been applied. Existing Law "On Local Government Finance Equalization" was passed in 1998. Local government finance equalization system ensures both equalization of revenue and equalization by different necessity (needs) for expenditures for municipalities. In general, the fact that there is such a system and some features of the system have to be evaluated positively, but at the same time there is a number of shortcomings in the system (RAPLM, 2007a). In 2009 the *Saeima* passed amendments in the Law, that could be considered as quick fixes for old equalization system adaptation for new local government system after the administrative territorial reform, but elaboration of more fundamental changes for improvement of the system (new system) was included in the agenda of the government and legislator.

In the current Declaration of the Government in the section Regional Development it is determined that „we will develop a new financial equalization system of local governments that will provide a balanced, regionally balanced access to resorces for all local governments (Cabinet of Ministers, 2014). A similar

promise was in declaration of previous government, too.

The topic is extremely important for the development of all local governments of Latvia and is affected development capacity of any territory, including rural territories. The purpose of the article is to highlight and discuss in academic society the finance equalization issues that affect the rural municipalities and work out proposals for the new system. The study does not cover all local government finance equalization issues, but it gives attention to three – importance of the equalization for rural local governments – municipalities (*novads*); revenue sources included in the equalization system; it uses criteria for calculation of local governments' expenditure needs.

Materials and Methods

In the study, the author uses literature review, legal acts analysis, as well as personal experience from participation in projects and working groups aimed at local governments finance equalization improvement. Besides qualitative approach, the author also uses quantitative method as statistical analysis. Over the history of management, many fashions and fads have appeared. Regular survey project has been implemented since 1993 and it shows that in 2009 benchmarking became the most popular tool (Daft, 2012). Also, in public sector the use of benchmarking is increasing and it has become the integral part of modern public governance. In this study for benchmarking of qualitative character the principles from recommendations of the Council of Europe as well as foreign experience are used for inspecting estimated revenues and expenditure needs criteria in equalization.

Results and Discussion

The importance of the finance equalization for municipalities as rural local governments

The share of the Local Government Finance Equalization Fund (LGFEF) in local government (basic) budget revenues reflects the significance of finance equalization. In previous five years the volume of LGFEF raised from 92.15 million EUR in 2010 to 109.6 million EUR in 2014 and the share of revenues of grants from the LGFEF in total annual local governments basic budget revenues during the period varied within limits between 4.7% and 5.2%. From all 119 local governments (9 republic cities and 89 municipalities) five republic cities and 11-13 municipalities from Riga planning region were the contributors in the LGFEF. For instance, in 2013 five republic cities (*Jelgava, Jūrmala, Rīga, Valmiera, Ventspils*) and 13 municipalities (*Ādažu, Babītes, Carnikavas, Garkalnes, Ikšķiles, Ķekavas, Mārupes, Olaines, Salaspils, Saulkrastu, Sējas, Stopiņu*) paid in the LGFEF. 92 local governments - three republic cities (one third of cities) and 89 municipalities (81% from all municipalities) received the grant from the LGFEF, but ten local governments - one city and nine municipalities - neither paid nor received the grant. Figure 1 reflects the structure of the LGFEF– share of contribution from republic cities, municipalities and state budget. In 2013, 76.9% of the LGFEF was formed from republic cities contributions, 10.8% from municipalities' contributions and 12.2% from the state budget grant.

At the same time budgets of municipalities receive more than 95% of the LGFEF, in 2013 – 97%, but the share that republic cities receive, does not exceed 5% of the LGFEF (see Figure 2), so the finance equalization is very significant for municipalities,

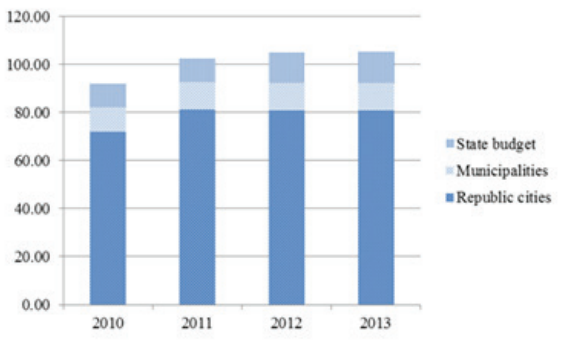

Figure 1. The revenue sources of the Local Government Finance Equalization Fund in Latvia in 2010-2013, million EUR.

Source: Treasury, local governments' annual basic budget reports, author's calculation.

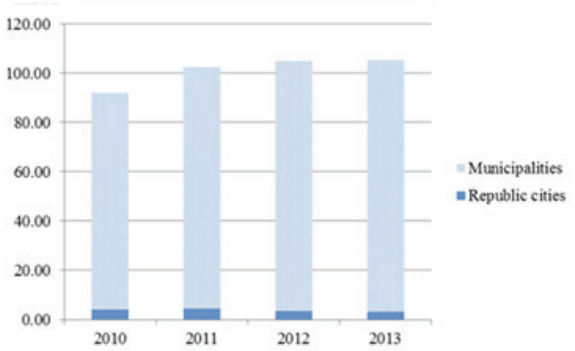

Figure 2. The grants from the Local Government Finance Equalization Fund in Latvia in 2010-2013, million EUR.

Source: Treasury, local governments' annual basic budget reports, author's calculation.

as they represent the rural territories of the country, the finance equalization is important for rural development.

The republic cities are totally urban administrative territories, but the municipalities formally either consist from one or several former rural administrative territories (*pagasts*) or from a combination of former urban administrative territory (town) and rural administrative territories. After the finish of administrative territorial reform in 2009 and disunion of one municipality in 2011 in Latvia, there are 50 municipalities which are formed only from rural territories and 60 municipalities with at least one town, five of those municipalities have several towns, for example *Talsu novads* has four towns in its territory.

According to analysis of local government basic budget data (2013) that contains a comparison of two main tax revenues (personal income tax and real estate tax) with the grant from the LGFEF, in the group of cities the volume of received grants is 0.4% from the volume of the two tax revenues, but the paid contribution in the LGFEF is 11% from the volume of tax revenues. In the group of municipalities, the volume of grants from the LGFEF is 20.3% compared with the tax revenues, but for particular municipalities, which are receivers of the grant, it varies from 2.2% to 113.1%. There were four municipalities in 2013 whose revenues from the LGFEF were higher than tax revenues, the grant from the LGFEF in 25 municipalities (including 4 above mentioned) is higher than half of the tax revenues. Tax revenues used to be one of main local governments finance capacity indicator. The grant from LGFEF like tax revenues has unconditional character of revenues and its volume comparison proves that for significant part of municipalities it is a very important element of the finance capacity of local government that impacts the development capacity of local government and its community.

Estimated revenues for local government finance equalization in Latvia

The Council of Europe recommends that the estimate of the financial capacity of local authorities should preferably include all sources of revenues (CE, 2005). Here the earmarked grants, service charges, as well as capital revenues (as sale of property, for instance), that preferably have to be used for capital investments, are not included. Besides CE suggests where there is more than one tax, equalisation should not take place for each tax: a representative fiscal system should be devised that reflects the total local tax-raising potential (CE, 2005). Since local government finance equalization system has been introduced in Latvia it uses two main tax revenue sources – personal income tax revenues and real estate tax revenues as estimated revenues for equalization calculations.

Total tax revenue share in local government basic budgets in previous years formed 53.3 to 59.7% from basic budget revenues (see Table 1). Besides two above mentioned taxes, local government budgets have revenues from two more taxes – gambling tax and natural resource tax. The personal income tax revenues

Table 1

Tax and fee revenues in local government budgets in Latvia

Year / Revenue position	2010	2011	2012	2013	2014
Total tax revenues, million EUR	1037.55	1087.08	1166.80	1247.78	1307.11
Tax revenue share in local government basic budget, %	53.3	54.0	57.5	58.1	59.7
Personal income tax revenues, million EUR	904.36	924.08	992.04	1067.04	1108.09
Share of personal income tax in total tax revenues in local budgets, %	86.8	84.5	84.5	84.9	84.2
Real estate tax revenues, million EUR	127.58	156.78	167.00	172.71	190.90
Share of real estate tax in total tax revenues in local budgets, %	12.2	14.3	14.2	13.7	14.5
Gambling tax revenues, million EUR	5.22	5.47	6.61	6.81	7.02
Share of gambling tax in total tax revenues in local budgets, %	0.5	0.5	0.6	0.5	0.5
Natural resource tax revenues, million EUR	4.79	6.71	8.71	9.65	10.00
Share of natural resource tax in total tax revenues in local budgets, %	0.5	0.6	0.7	0.8	0.8
Local fees, million EUR	5.32	6.11	8.49	7.73	na
Share of local fees in local government basic budget, %	0.4	0.4	0.6	0.5	na

Source: Treasury, for the years 2010-2013 annual local governments' budget reports, for 2014 month reports (January-December), author's calculations.

form the major part of total local governments' tax revenues - 84.2%, real estate tax - 14.5%, but natural resource tax - 0.8% and gambling tax - 0.5% (in 2014). As the uneven distribution of personal income tax leads to disparities of local governments finance capacity, from that following development capacity, no doubt that it has to be included in equalization. Also, in other European countries it is most used equalized revenue type. But during preparation of proposals for the development of new equalization system as improvement of existing one, a question about including the real estate tax was raised. For instance in Norway, local tax revenues are formed from income tax, property tax, wealth tax and tax on natural resources. Three taxes – income, wealth and natural resources taxes are included in equalization of revenues, but real estate tax as fully local voluntary tax is not included (Skarvang, 2015). In Latvia, real estate tax revenues formed 8.1% from basic budget revenues in 2013, 8.7% - in 2014. Data analysis of 2013 shows that 64% of this tax volume comes from the cities, but 36% - from municipalities. The average real estate tax per capita in the group of municipalities (68 EUR) is 1.9 times lower than in the group of cities (120 EUR). In the group of municipalities the lowest real estate tax revenues per capita in 2013 was 26 EUR (*Viļānu novads*), the highest 194 EUR (*Saulkrastu novads*). Exclusion of this tax from the local governments finance equalization would be unfavourable for the local governments of municipalities, especially for rural ones. In Latvia, the year 2013 was the first year when local governments had rights to set the real estate tax rate within limits stated in the Law. It is a new challenge for tax revenue estimation which is necessary for equalization calculations. To support the local governments to use taxation regarding local needs, it was decided to use the lowest rate for calculations. The local governments practice of the real estate tax rate setting after several years have to be evaluated and if necessary approach to evaluation method of this tax revenue would be reasonable to change. There are countries (for instance, Poland) where the highest possible rate is used for equalization calculations (Zeikate, Vilka, 2007).

To add the natural resource tax in equalization system is not possible as this tax is earmarked – it must be used for environmental protection purposes. The total revenues of gambling tax in 2014 formed 0.3% of basic budget revenues and 0.5% from all tax revenues. This tax mainly forms revenues in cities. The reason why the gambling tax is not included in the equalization system is its small volume, forecasting problems, and besides mentioned, the activities, what is subject of this particular tax, raise the additional problems what local governments have to solve (PKC and Astrop, 2007b). Previous five years gambling tax revenues have increased. It could be reasonable to return to decision about including this tax in equalization system, when its share in budget revenues or at least in total tax revenue volume will exceed at least symbolical 1%. Inclusion of this tax in the system would be favourable for municipalities.

One more local government own revenue source that theoretically could be added in the system is local fees. The total revenues of revenues from local fees in 2013 formed 0.5% of basic budget revenues, compared with previous year the share decreased. Like with gambling tax the volume of local fees is too small to be included in the equalization system. Besides, it is concluded, that local governments insufficiently use fees as local fiscal incentives (RAPLM, 2010), it must be promoted more, but the inclusion of fees in the equalization system will not promote incentives.

Criteria for expenditure needs

The recommendations of the Council of Europe states that the equalisation of specific spending needs should be effected through grants based on appropriate and objective criteria. Spending needs should be estimated primarily on the basis of criteria which are objective and which local authorities do not directly control and they are unlikely to affect local authorities' freedom of choice, within the limits of the budgets available; do not penalise local authorities that endeavour to streamline the management of their services to make them more efficient, to increase the number of users and units produced in order to obtain economies of scale. And the Council of Europe recommends to take on account, as far as possible, of demographic, geographical, social and economic features leading to disparities in costs (Council of Europe, 2005).

It is reasonable to consider the range of criteria and their weights (significance) as the complex index for regional development. In practice countries establishing criteria on national level try to take into account either obligations facing the local government (its structural needs), its ability to meet those obligations in relation to its resources (its own and that of its constituent), or both. Study of PKC and Astrop (2007), Dexia (2008) reflects a wide variety of used indicators. Dexia had grouped them in four groups:

- Demographic criteria: the number of inhabitants, age structure, density, school-aged children, elderly, unemployed, immigrants, municipal counsellors, members of cultural or linguistic minorities, dwellings, etc.;
- Geographic criteria: surface area, topography, remoteness, climate (water shortage problems, for

example), forest and agricultural land coverage, water surfaces, etc.;

- Financial criteria: differences in fiscal wealth, financial needs, the level of government spending on a certain area (health, transportation, social programs), etc.;
- Socio-economic criteria: GDP (for regions), quality of infrastructure, the extent of networks (road, water supply and water treatment networks), level of social services, social housing stock, number of businesses, energy production, per capita added value, etc. (PKC and Astrop, 2007; Dexia, 2008). In the socio-economic category, one can sometimes find criteria relating more specifically to cities and aimed at compensating their higher spending responsibilities as core cities (centrality charges). In Denmark, for example, the fact of whether a municipality is classified as a central or peripheral city is considered when distributing grants. In Austria, a special demographic criteria exists known as a „scaled population multiplier" which gives priority to larger municipalities for which financial needs are presumed to be greater, although not on a proportional basis (Dexia, 2008).

Generally, a grant allocation combines a few of those criteria. It can be very elaborate. In the Netherlands, as many as 50 different criteria are considered for the allocation of the Municipal Fund and the Provincial Fund (Dexia, 2008). In Norway for counties as second tier governments 14 criteria are used (for instance, 6 age groups, area, sea route network, urban factor, and other), but for local governments of the first tier 28 indicators are used - mainly different age groups and other population groups (immigrants, mentally handicapped, unmarried over 67, education level – inhabitants with academic education etc.) and also such criteria as agriculture index, urbanity measure, travelling distance within the local zone, travelling distance to the closest district and other (Skarvang, 2015). For example, criteria of academic education level is connected with the provision of kindergarten services, as research proves the direct correlation between the demand for kindergarten services and the education level of parents – if there is higher education level, it demands for the more and higher service.

Assessing the disparities in determination of the financial necessity of each local government, the Latvian system uses only the division of local governments into two groups – republic cities and municipalities - and demographic criteria (the number of residents, the number of children up to age of 6 (included), the number of young people of the ages 7 to 18, the number of people above working age). This division in groups, where one group is considered as rural territories, for municipalities in general is more favourable than for cities, but at the same time the richest local governments in Latvia (by tax revenue per capita) are among municipalities – so called *sleeping cars* in Riga hinterland. This grouping for equalization calculations makes cities feeling that the system is unfair and leads to the conflicts between the cities and municipalities. The use of few criteria leads more to the *one fits all* approach, while including of more different category criteria conforms to more place-based approach, to more tailor made approach. Also, the Council of Europe recommendations and foreign experience justified the necessity of more criteria that exists now in the Latvian system of equalization.

The study managed by the author done in 2007 (RAPLM, 200b7) and later for new local government finance equalization system besides four already used demographic criteria proposed four new criteria – area, distance to Riga (but for local governments that are closer than 30 km distance, this indicator is calculated in favour of Riga not a particular local government), the number of amalgamated units in municipality, and centre indicator of spillover effect for cities and town municipalities (with a different mark for Riga, national and regional significance centres) (RAPLM, 2007b). In current situation, responsible ministry and other stakeholders of the system are ready to extend the range of criteria only with one more – area. But implementing the place-based approach and use of more tailor made system would be the manifestation of modern thinking in the regional development policy. That is why the author suggests this discussion in academic society.

Latvia's population data source problem

One of main indicators characterizing any local government is the number of its population – permanent residents. This indicator is essential for monitoring, evaluation and development of regional development policy and essential for equalization system as an important part for provision of balanced regional development. The population data is necessary both for estimation and comparison of local government revenues and for estimation of expenditure needs. In the current calculations for local governments finance equalization the data of the Office of Citizenship and Migration Affairs (OCMA) are used. This is the situation since the year 2000, but prior to this, the data of Central Statistical Bureau (CSB) was used. Since the last Census of CSB in Latvia in 2011, there is a significant difference between the data about the number of population by the OCMA and data of CSB (see Table 2) and this difference in the country is increasing more rapidly in the group of cities. In 2014, the number of population of Latvia according to the data of CSB was 8.2% lower than according to the data of OCMA; in the group of cities this difference was larger (-8.9%) than in the group of municipalities

Table 2

The difference between the data of Central Statistical Bureau and the Office of Citizenship and Migration Affairs on the number of population of Latvia

Year	2011	2012	2013	2014
Number of population by data of OCMA	2,236.910	2,217.053	2,201.196	2,180.293
Number of population by data of CSB	2,074.605	2,044.813	2,023.825	2,001.468
Difference (CSB-OCMA against OCMA), %	-7.3	-7.8	-8.1	-8.2
Difference in group of republic cities, %	-6.9	-7.8	-8.4	-8.9
Difference in group of municipalities, %	-7.6	-7.7	-7.7	-7.5

Source: OCMA, CSB, author's calculation.

(-7.5%), but in 2011 situation was opposite – difference was larger in the group of municipalities.

The problem of data difference has already been indicated (VRAA, 2012; Vilka and Brēķis, 2013), but following activities are not sufficient enough. The problem would not be considered so important, if the difference would be symmetrical for all administrative territories, but it is not so. Looking at individual local governments, the difference between different sources vary from -0.2% to -13.4%, in five cities and 57 municipalities the difference is larger than average in the county. One can recognize that in group of municipalities in general smaller difference is in municipalities around the Riga. Those also are the richest municipalities with the highest local government budget tax revenues per capita. In 2014, using OCMA data the tax revenues in local budgets per capita varied from 241 EUR to 1290, using CSB data it indicates data from 264 EUR to 1303 EUR, bet minimal and maximal values or personal income tax revenues in local budget per capita was from 190 EUR to 1137 EUR (difference 6 times) according to OCMA and from 208 EUR to 1148 EUR (difference 5.5 times) using CSB data on population. Using data of CSB difference between the lowest and highest values is not as high as using data of OCMA. As the LGFEF grant/contribution values are directly connected with the number of population, for local governments where the difference between data sources is higher than average difference, the use of OCMA data is more beneficial. But what about the fairness of the system? And why is the regular Census necessary? Although for almost half of local governments more favourable could be the use of CSB data, most of local governments support the use of OCMA data, as this indicator is higher and used to be used for local government representation. Stay on this source avoids the explanation for society about the rapid decrease of indicator on population, which is expected in case of the change of data source.

As the CSB are the official source for data submitted to Eurostat, and they are used also for international comparison, it is suggested to use CSB data on population in local government finance equalization, too. Based on Law on Regional Development in 2014 The Cabinet of Ministers adopted new regulations (No 367 from 01.14.2014.) on regional development monitoring and evaluation order and according them, the new calculations of territory development level index are introduced, where beside other amendments data of CSB on population are included again instead of previous calculations (since 2010) where data of OCMA were used. In 2015, based on the same Law the Cabinet of Ministers adopted new regulations (No 42 from 27.01.2015.) on criteria and order for state grant allocation to local governments for the EU funds co-financed projects implementation in the planning period of 2014-2020. Calculations of those regulations refer to the local government budget capacity indicator that is calculated as standardised values of local government estimated revenues before the equalization. This connection also justifies the necessity of using CSB data in local government finance equalization. If the data of CSB on population will not be used in equalization calculations, then the situation with local government data as base for different analysis including monitoring of development will become more confused.

Conclusions

1. For municipalities as completely or partially rural local governments, grant from local government finance equalization system is very important budget revenue, in many cases by importance it is close to tax revenues.
2. Inclusion of two taxes' – personal income tax and real estate tax - revenues in calculations of estimated revenues is optimal. For rural local governments it is important to leave the real estate tax revenues in the system. In case of significant increase of gambling tax revenues, this tax also has to be included in the system. The tailor-made system development approach supports the evaluation of as possible more sources.
3. Modern approach to regional development, as well as the Council of Europe recommendations and foreign experience on benchmarking, supports inclusion of several new criteria for expenditure

needs' calculations. More specific criteria also lead to higher fairness of the system.

4. To avoid the further and larger confusion in monitoring and evaluation of regional development, it is suggested to use the CSB data on population in the local government finance equalization system's calculations.

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References

1. Baltiņa L. (2014) *Application of a place based approach for regional development planning amelioration in Latvia*. Summary of the doctoral thesis, Riga, University of Latvia, 141 p.
2. Cabinet of Ministers (2014b) *Declaration on the Intended Activities of the Cabinet of Ministers Headed by Laimdota Straujuma*, Riga, November 2014, 19 p. Available at: http://www.mk.gov.lv/sites/default/files/editor/05_deklaracija.pdf, 12 February 2015.
3. Cabinet of Ministers (2014c) Regulations No 367, 1 July 2014, Available at: http://likumi.lv/doc.php?id=61002, 27 February 2015. (in Latvian).
4. Cabinet of Ministers (2015) Regulations No 42, January 27, 2015, Available at: http://likumi.lv/ta/id/271933-noteikumi-par-kriterijiem-un-kartibu-valsts-budzeta-dotacijas-pieskirsanai-pasvaldibam-eiropas-savienibas-strukturfondu-un-kohe..., 27 February 2015. (in Latvian).
5. Čapkova S., Rončakova L. (2013) *Tax sharing as an instrument of interregional fiscal equalization.* In: 21st NISPAcee Annual Conference „Regionalisation and Inter-Regional Cooperation", conference proceedings, CD 9 p.
6. Council of Europe (2005) *Recomendation Rec (2005)1 of the Committee of Ministers to member states on the financial resources of local and regional authorities*. Available at: https://wcd.coe.int/ViewDoc.jsp?id=812131, 29 January 2015.
7. Daft R.L. (2012) *New Era of Management*, Tenth Edition, International Edition, South-Western Cengage Learning, 700 p.
8. Dexia (2008) *Sub-National Governments in the European Union. Organisation, responsibilities and finance*, France, 655 p.
9. Kalniņa-Lukaševica Z. (2013) *Development of regions in Latvia – Model of the Regional Economic Planning and Evaluation.* Summary of the doctoral thesis, Riga, University of Latvia, 101 p.
10. LR Saeima (1997) *Likums „Par nekustamā īpašuma nodokl*i" (Law On Real Estate Tax). approved June 4, 1997. Available at: http://likumi.lv/doc.php?id=43913, 12 February 2015. (in Latvian).
11. LR Saeima (1998) *Likums „Par pašvaldību finanšu izlīdzināšan*u (Law On Local Governments Finance Equalization). approved 5 March 1998, Available at: http://likumi.lv/doc.php?id=47361, 28 January 2015. (in Latvian).
12. LR Saeima (2002) *Reģionālās attīstības likums* (Regional Development Law). approved 21 March 2002, Available at: http://likumi.lv/doc.php?id=61002, 20 February 2015. (in Latvian).
13. PKC, Astrop (2007a) *Pašvaldību finanšu izlīdzināšana. 1.ziņojums. Teorētiskie aspekti un ārvalstu prakses apkopojums. Latvijas pašvaldību finanšu izlīdzināšanas sistēmas izvērtējums* (Local governments finance equalization. Theoretical aspects and foreign expierence. Evaluation of local government finance equalization system in Latvia). Reģionālās attīstības un pašvaldību lietu ministrija, Rīga, 80. lpp. (in Latvian).
14. PKC, Astrop (2007b) *Pašvaldību finanšu izlīdzināšana. 2.ziņojums. Priekšlikumi pašvaldību finanšu sistēmas pilnveidošanai* (Local governments finance equalization. Suggestions for improvement of local government finance equalization system in Latvia). Reģionālās attīstības un pašvaldību lietu ministrija, Rīga, 95. lpp. (in Latvian).
15. RAPLM (2010) Informatīvais ziņojums „Par pašvaldību budžetu finanšu avotu palielināšanu un dažādošanu" (Informative report On increasing and diferentation of local governments budgets revenues sources). Available at: http://tap.mk.gov.lv/mk/tap/?pid=40186852, 6 March 2015. (in Latvian).
16. Reiljan J., Ulper A., Puolokainen T. (2013) Local public services' demand side factors' structure in different types of Estonian municipalities. EGPA Annual Conference proceedings pp. 15.
17. Skarvang H.M. (2015) *Levels of government and local deomocracy in Norway*, Norwegian Ministry of Local governments and modernization
18. Vaidere I., Vanage E., Vanags I., Vilka I. (2006) *Reģionālā politika un pašvaldību attīstība Eiropas Savienībā un Latvijā* (Regional Policy and Development of Local Government in the European Union and Latvia). Latvijas Universitātes Apgāds, Latvijas Statistikas institūts, Rīga, 295. lpp. (in Latvian).

19. Vilka I., Brēķis E. (2013) Comparing local government elections in Latvia and other European countries. *Social Research*, No 3 (32), 2013, pp. 5-16.
20. VRAA (2012) *Reģionu attīstība Latvijā 2011* (Development of Regions in Latvia), Rīga, VRAA, 172 lpp. Available at: http://www.vraa.gov.lv/lv/parskats/parskats2011/, 28 February 2015. (in Latvian).
21. Zeikate S., Vilka I. (2007) Decentralizācija un pašvaldību finanšu izlīdzināšana. Teorētiskie aspekti un ārvalstu prakses apkopojums (Decentralization and local governemnts finance equalization. Theoretical aspects and expierence of foreign countries). In: *Statistikas un pārvaldes problēmas 2007*, Latvijas Statistikas institūts, Rīga, 202.-2015. lpp. (in Latvian).

SUPPORT AND VIABILITY ISSUES: LITHUANIAN FARMERS' VERDICT

Nelė Jurkėnaitė
Lithuanian Institute of Agrarian Economics
nele@laei.lt

Abstract
One of the most challenging issues of EU agriculture is viability of farmers' and family farms. These farms used to play a major role in new member states. However, the last decades are characterized by the significant decrease in the number of farmers' farms. The paper deals with the issues of these farms' viability and the role of support. A literature review on viability concept and indicators justify the selection of socio-economic viability criteria for the survey. The findings are based on the results of Lithuanian farmers' opinion survey. The analysis of the selected socio-economic criteria of viability shows that crop production farms are characterized as the most viable. According to the survey results, the farms with less than 30 ha, and the farms operated by farmers aged 60 and older belong to the most vulnerable group. These farms are non-viable in the long-run. The risk estimation of staying in agricultural business if support is abolished for viable and non-viable farms shows dependence of farm's behaviour and viability status.
Key words: support, viability, farm, agricultural policy.

Introduction

Regulations of Common Agricultural Policy (CAP) have been underlining the relevance of farm viability issues for the last decades. The main efforts were directed towards measures of economic viability. This policy is being criticized for the significant impact of the support (particularly direct payments) on the structural changes of agriculture. The loss of the EU agriculture diversity and new environmental concerns are often mentioned as key long-term effects of excessive attention to economic issues. Some researchers declare that agricultural production has become dependent on support. However, selected measures to secure economic viability were inefficient solving one of the most important problems of the long-run viability in agriculture – generational renewal. Young generation recognizes other economic sectors as a more attractive career choice.

This situation encouraged research on farm viability issues around the world. However, the common definition of farm viability and the determination of complete viability threshold remain an open question. It empowers a deeper analysis of different viability aspects and the role of farmers' support is one of the most challenging topics. The performed studies analyse the impact of direct payment abolition on viability of agriculture (Vrolijk et al., 2010; Agrosynergie, 2011; Coppola et al., 2013), propose to include indicators reflecting the role of support into the set of viability criteria (Dillon et al., 2008; Dillon et al., 2009; Dillon et al., 2010; Scott, 2001) or define different levels of viability including/excluding various types of support (Fritzsch et al., 2010).

Most of the studies are based on official statistics. Farmers' opinion surveys could be a useful tool to get a better understanding of the phenomenon. For example, J. Scott (2005) applied the qualitative research interview method to analyse farmers' attitudes towards farm income support programmes and subsidies, V. Vitunskienė, J. Baltušienė (2011) conducted a survey to deepen the knowledge about the role of direct payments for small farms. This study supplements limited research based on farmers' opinion survey and analyses the relations between the support and farm viability.

The main aim of the study was to identify the most vulnerable areas of Lithuanian agriculture, which could experience change if farmers' support was abolished. The following tasks were set: 1) to analyse the concept of viability, main viability indicators and propose criteria for the evaluation of socio-economic viability; 2) to determine the most vulnerable areas of Lithuanian agriculture applying selected socio-economic viability criteria; 3) to define the interconnections between dependence on farmers' support and viability status of farms identified.

Materials and Methods

The study consists of two sections applying different research methods. The first section provides the results of scientific literature review. The concept of viability is discussed and the selection of appropriate viability criteria is justified.

The second section provides the results of conducted survey on farmers' opinion towards their farm viability issues and the role of the support. The questionnaire was structured to classify farms in accordance with selected socio-economic viability criteria, the main viability factors of agriculture and the role of the support for continuity of farming. All respondents were beneficiaries of farmers' support.

Questionnaires were collected from June to July 2014. The study is based on the opinion of 937 farmers (the sample's confidence level is 95%, confidence interval – 3.2). Respondents were located in all counties of Lithuania (Alytus, Kaunas, Klaipėda, Marijampolė, Panevėžys, Šiauliai, Tauragė, Telšiai, Utena, Vilnius). The target group of the survey

was farmers' farms (further details of the survey methodology can be found in the section 'results and discussion'). Data were proceeded with IBM SPSS 22.0 software. The findings are based on the results of SPSS graphic displays, cross-tabulation and risk estimation reports.

Results and Discussion

The concept of viability and main research directions

There is no commonly agreed definition of viability and this research area challenges scientists' and policy-makers' attention around the world. Definitions of viability could be divided into two groups: 1) universal definitions mapping all dimensions of viability; 2) definitions designed for applied research.

Universal definitions are not bonded to viability thresholds, harmonized with the system theory approach and sustainability issues. For example, C. Park, M. Allaby (2013) describe viability as 'the ability to survive, or to live and develop normally'. H. Bossel (1999; 2001) proposes more system-orientated definition and underlines the impact of 'particular system environment' on system's viability. The researcher argues that all viable systems in the long-run must be sustainable and proposes to use terms 'viable' and 'sustainable' interchangeably, i. e. the author introduces economic, social and environmental dimensions of viability. The orientation theory is offered as a tool assisting in selection of viability criteria (Bossel, 1999). System-based viability criteria frameworks describe general attributes of analysed systems. The method provides a structure for indicator derivation (Van Cauwenbergh et al., 2007) and assists in selection of criteria accompanied by individual viability thresholds. However, the outcome is highly dependent on experts' knowledge and the selection of the right viability criterion is an open question. Different system-based frameworks could be created to monitor the same viability problem.

S. Baumgärtner, M.F. Quaas (2009) apply viability theory analysing issues of economic-ecologic viability. This theory applies mathematical tools to obtain a 'regulation map' assisting in governing viable system evolutions (Aubin et al., 2011). The selection of right tasks and description of environmental constrains of viable farm is a real challenge. To summarize, the research mapping all dimensions of universal definitions is limited and the most challenging issue of this research direction is the complexity of applied evaluation models and incompatibility of goals introduced by the sustainability concept. This research also faces a lack of environmental statistics, which could be used as reliable indicators of viability.

The application of definitions covering narrow aspects of viability and designed for the applied research became widespread. These definitions clearly identify the object of the research and viability threshold. Typical examples of such definitions are represented in research conducted by M. Morehart (2000), L. Connoly (2009), E. J. Dillon et al. (2009; 2010), J. M. Agrilés (2010), N. Jurkėnaitė (2013).

The most challenging direction of the performed research deals with the economic dimension of viability. The definitions are grouped into the short-run and the long-run economic viability. This classification determines the selection of viability indicators and thresholds. The short-run viability is associated with financial results of analysed year, while the definition of the long-run viability often deals with economic costs and attractiveness of farming business, compared to other activities. M. Morehart (2000) states that the revenue from the sale of goods of viable in the short-run farm must cover production costs. Other examples of indicators could be net farm income, expense to income ratio (Scott, 2001; Scott and Colman, 2008) and etc.

Scientists argue that negative indicators of the short-run viability do not explain farmer's decision to stay in business (Morehart, 2000; Agrilés, 2010). It is suggested including the long-run viability indicators into analysis. M. Morehart (2000), L. Connoly (2009), E. J. Dillon et al. (2009), J. M. Agrilés (2010), H. C. J. Vrolijk et al. (2010), E. J. Dillon et al. (2010), Agrosynergie (2011), A. Coppola et al. (2013) propose the indicators based on numerous methods of opportunity costs' assessment (the variation is based on different starting points evaluating remuneration for family labour, land and capital). Viable farms in the long-run operate at a profit.

The literature review shows that the link of performed research with the short-run and the long run economic viability is not compulsory. Researchers often use other financial or economic indicators useful for economic viability analysis. Most of these indicators are introduced from studies on financial stress, insolvency and bankruptcy prediction. The proposed methods evaluate viability applying individual indicators (Jakušonoka et al., 2008; Scott, Colman, 2008; Agrosynergie, 2011) or multi-criteria models for viability assessment (Kopta, 2009; Tamošaitienė et al., 2010). A farm is classified as viable if the threshold of one or group of criteria is satisfied.

The important direction of research is the analysis of non-financial indicators of viability. J. M. Agrilés (2010) argues that farms could be non-viable in the long-run even if economic viability criteria are satisfied. These farms face the generational renewal problem as young generation refuses to stay in agricultural business. Researchers propose different indicators to identify generational renewal problem on time: average age (Scott, Colman, 2008), structure

of farmers by age (Scott and Colman, 2008), ratios of critical age groups (Dillon et al., 2008), ageing index (Trisorio, 2004), demographic viability criteria (Dillon et al., 2008; Dillon et al., 2009; Dillon et al., 2010; Jurkėnaitė, 2013). It should be noted that the criterion of farm demographic viability goes beyond official statistics and shows the potential of family farms.

To summarize, the most popular directions of research on farm viability issues include socio-economic indicators. Clear and understandable criteria of farm viability must be selected to perform an opinion survey. The dimension of economic viability is analysed applying criteria of the short- and the long-run viability of the farm. The viable farm in the short-run generates income (without subsidies) that is sufficient to cover production costs. The evaluation is based on the respondent farms' financial results of 2013. The viable farm in the long-run operates in agricultural business for at least 5 years. It is assumed that a farmer confirms the attractiveness of agricultural business compared to other economic activities.

The indicator of demographic viability was included into the questionnaire. Demographically viable farm has young farmers (including family members) able to operate a farm. The age limit of 40 years was selected to identify a young farmer.

Viability of Lithuanian agriculture: farmers' opinion survey

Three important factors were selected to characterize the most vulnerable aspects of viability in agriculture: type of farming, size of the farm and farmer's age. The percentage of viable farms in the analysed group was derived by calculating the share of farms corresponding viability criterion in selected group of farms.

To describe type of farming the prevailing share of product (50.0% and more) in the structure of farm income was used. Respondent farms were classified into five groups: crop production, livestock, horticulture, mixed (income from crop and livestock production is balanced ± 10.0%), other. The majority of farms were classified as crop production (44.7%), livestock (26.8%) and mixed (17.0%). Horticulture and other farms accounted for 4.5% and 7.0%, respectively.

The comparison of selected indicators of the short- and the long-run economic viability by type of farming shows a significant difference (Fig. 1). The vast majority of farmers declared losses in 2013, and their farms were non-viable in the short-run. However, the share of farms viable in the long-run was much higher. The conducted survey shows that crop production was the most viable type of farming. The short-term viability indicators of other types of farming did not exceed 41.0%.

It should be noted that the long-run economic and demographic viability indicators by different types of farming are almost similar. The share of farms with young farmers is higher than the share of farms willing to stay in agricultural business at least 5 years (with the exception of mixed farms). The gap between the long-run economic viability and demographic viability indicators in livestock farms is higher than in other types of farming. This sector could face the generational renewal problem if this trend continues.

The distribution of respondent farms by size was as follows: 1–4.9 ha (14.4%), 5–19.9 ha (25.3%), 20–29.9 ha (14.3%), 30–49.9 ha (11.7%), 50–99.9 ha (17.1%), 100 ha and more (17.2%). The survey results show that the highest share of non-viable farms belongs to the group of farms below 30 ha (Fig. 2). The farms below 5 ha is the most vulnerable as the low short-run viability indicator is accompanied by the lowest indicators of the long-run viability. The 2010 Agricultural Census of the Republic of Lithuania shows that the farms below 5 ha account for 58.7% of the farms larger than 1 ha. A low indicator of demographic viability could be treated as a threat

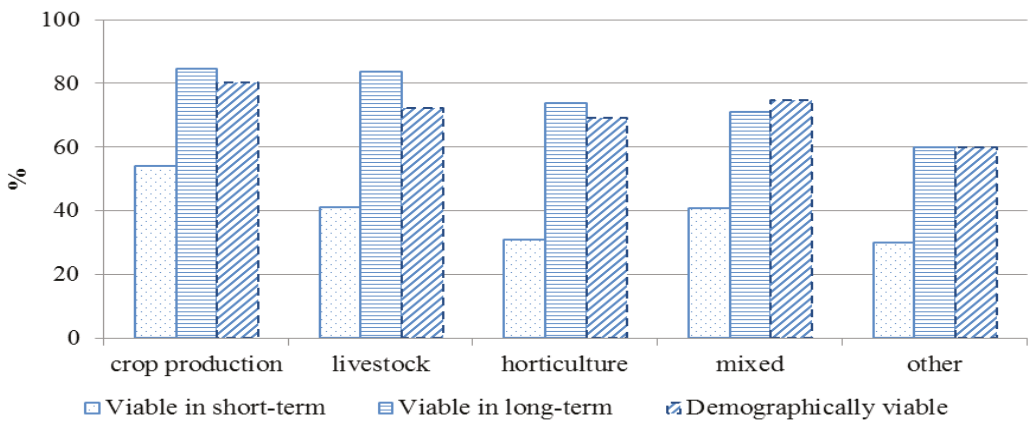

Figure 1. Viable farms by type of farming.

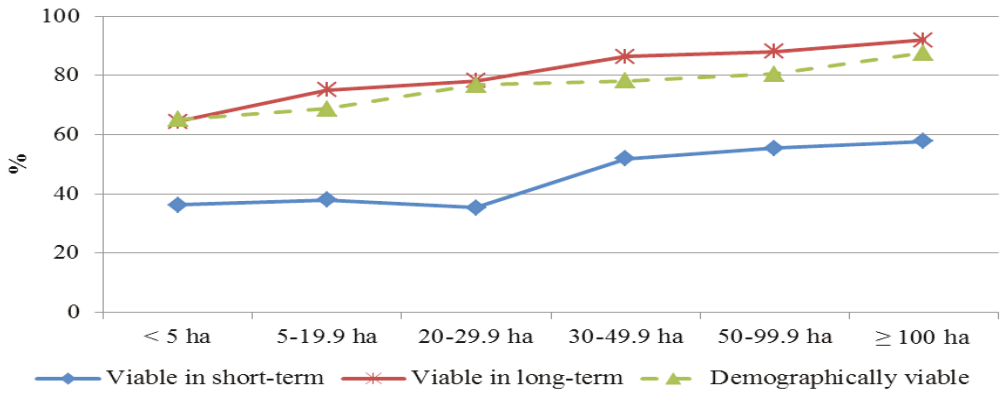

Figure 2. Viable farms by size.

of structural changes in the immediate future. Figure 2 shows that the share of viable farms is growing together with the size of the farm. Farmers operating larger farms have successors and wish to keep family farms in business.

Three farmers' age groups were identified: 1) younger than 40 years old, 2) 40–59 years old, 3) 60 years old and older. The first group, i. e. young farmers, accounted for 35.6%. The share of 60 years old and older farmers was 20.0%. The farmer's age does not determine the short-term viability of a farm. By age, the highest share of non-viable farms was operated by the farmers aged 60 or older. This group of farms faces generational renewal challenge. According to the results of the 2010 Agricultural Census of the Republic of Lithuania, the farmers aged 60 or older exceeded one-third of the Lithuanian farms.

The conducted analysis of selected viability indicators by type of farming, farm size and farmers' age has identified the most vulnerable areas. However, respondents can change their behaviour in case if farmers' support is abolished. SPSS risk estimation function was used to analyse consequences of the farmers' support abolition. To evaluate possible changes in agriculture, the farmers were asked to answer the following question: '*Will you stay in farming business if farmers' support is abolished?*' One-third of farmers could not answer this question and this group was rejected from the risk estimation data set.

The results of SPSS risk estimation (i.e. odds and relative risks and the 95.0% confidence intervals for calculated risks) are introduced in the Table 1. The risk estimation function investigates the relationship between different viability indicators (treated as a 'risk factor') and the occurrence of certain condition (intention of staying in agricultural business without farmers' support). It is important to note that risk estimation was accompanied by Chi-square test of homogeneity. The test confirmed statistical significance of relations for the analysed groups (p-values were less than 0.05).

Odds ratios for all viability indicators show that the behaviour of viable and non-viable farms in case of support abolition differs. The odds ratio shows that the probability to stay in agricultural business without farmers' support for viable farms is 2.5 times higher (CI 95% 1.8 to 3.5) than for non-viable ones in the short-run, for viable ones in the long-run – 3.6 (CI 95% 2.2 to 6.0), for demographically viable – 1.5 (CI 95% 1.0 to 2.2).

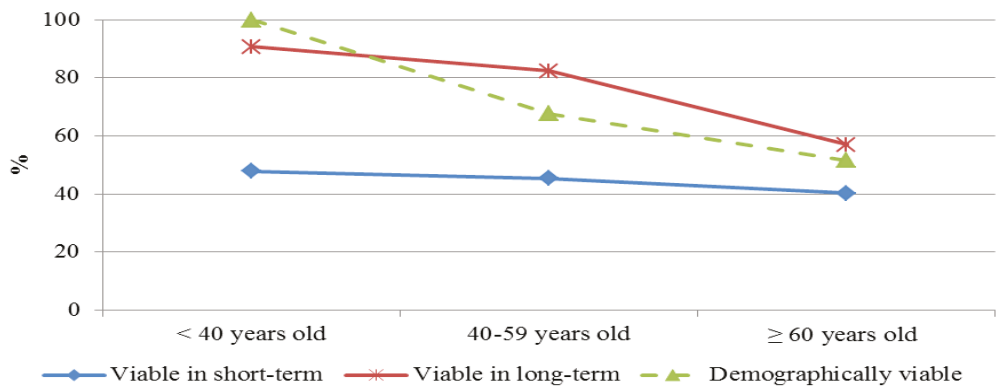

Figure 3. Viable farms by age groups.

Table 1

Risk estimates for farmers' behaviour after support abolition by viability criteria

	Value	95% confidence interval	
		lower	upper
Odds Ratio for the short-term viability (viable / non-viable)	2.510	1.814	3.474
For cohort *Will you stay in farming business if farmers' support is abolished?* = yes	1.760	1.439	2.153
For cohort *Will you stay in farming business if farmers' support is abolished?* = no	0.701	0.615	0.800
Odds Ratio for the long-term viability (viable / non-viable)	3.638	2.201	6.011
For cohort *Will you stay in farming business if farmers' support is abolished?* = yes	2.489	1.667	3.716
For cohort *Will you stay in farming business if farmers' support is abolished?* = no	0.684	0.612	0.765
Odds Ratio for the demographic viability (viable / non-viable)	1.507	1.040	2.185
For cohort *Will you stay in farming business if farmers' support is abolished?* = yes	1.302	1.016	1.670
For cohort *Will you stay in farming business if farmers' support is abolished?* = no	0.864	0.763	0.978

The relative risk between viable and non-viable in the short-run farms for the group of staying in agricultural business without farmer's support is 1.8 (CI 95% 1.4 to 2.2) and 0.7 (CI 95% 0.6 to 0.8) for the group of leaving business without farmer's support. Cross-tabulation of the short-run viability and respondents' intention to stay in business without support confirms that viable farms are more likely to stay in business. The share of viable farms staying in business is higher than the share of viable farms leaving farming in these groups: 1) below 5 ha and larger than 50 ha, 2) operated by young farmers, 3) crop production and horticulture.

The relative risk between viable and non-viable in the long-run farms for the group of staying in farming without support is 2.5 (CI 95% 1.7 to 3.7) and 0.7 (CI 95% 0.6 to 0.8) for the group of leaving agricultural business without farmer's support. Cross-tabulation of the long-run viability and farmers' willingness to stay in business without support confirms that viable farms are more likely to continue farming. The less vulnerable groups of viable farms were as follows: 1) below 5 ha and larger than 100 ha, 1) crop production.

The relative risk between demographically viable and non-viable farms for the group of staying in farming without support is 1.3 (CI 95% 1.0 to 1.7) and 0.9 (CI 95% 0.8 to 1.0) for the group of leaving agricultural business without farmer's support. Cross-tabulation of the demographic viability and farmers' willingness to stay in farming without support shows that viable farms are more likely to stay in business. However, the gap between viable farms staying in farming without support and leaving is lower than for other viability criteria. Viable farms larger than 100 ha were more likely to continue farming than leaving the business.

Conclusions

The analysis of scientific literature shows that the concept of viability is multi-dimensional. Farm's viability could be conceptualized as viability of the system mapping all dimensions of sustainable development. However, the performed studies propose a vast majority of estimation criteria and methods focusing on narrow definitions of viability designed for the applied research.

The survey focuses on the short- and the long-run dimensions of economic viability. The results show that care should be taken with the interpretation of viability based on the short-run indicators. According to the survey results, the share of farms willing to stay in business for at least 5 years was significantly higher than the share of farms viable in the short-run. The indicators of the long-run and the demographic viability demonstrated the same distribution trends by type of farming, size of the farm and farmers' age.

The analysis of all indicators of viability shows that the highest share of non-viable farms belongs to these groups: 1) farms below 5 ha; 2) farms operated by farmers aged 60 or older. These farms represent a significant share of Lithuanian agriculture. The survey shows that horticulture, mixed and other farming also face viability challenge.

The risk estimation shows that farmers' support plays a significant role. Viable farms are more likely to stay in business without support. The groups of farms with the highest concentration of non-viable farms could be named as the most vulnerable. The risk estimation applying different indicators of viability shows that the highest odds ratio was for the indicator of the long-run viability (3.6), while the lowest – for demographical viability (1.5).

References

1. Agrosynergie (2011) *Evaluation of Income Effects of Direct Support*, Brussels: EEIG Agrosynergie, 261 p.
2. Argilés J.M. (2010) Accounting Information and Prediction of Farm Non-Viability. *European Accounting Review*, 10(1), pp. 73-105.
3. Aubin J.-P., Bayen A.M., Saint-Pierre P. (2011) *Viability Theory: New Directions*, 2nd edition, Springer-Verlag Berlin Heidelberg, 830 p.
4. Baumgärtner S., Quaas M.F. (2009) Ecological-Economic Viability as a Criterion of Strong Sustainability under Uncertainty. *Ecological Economics*, 68(7), pp. 2008-2020.
5. Bossel H. (1999) *Indicators for Sustainable Development: Theory, Method, Applications*, Canada: International Institute for Sustainable Development, 124 p.
6. Bossel H. (2001) Assessing Viability and Sustainability: a Systems-based Approach for Deriving Comprehensive Indicator Sets. *Conservation Ecology,* 5(2), pp. 1-12.
7. Connolly L. (2009) Changing Structure and Production Patterns of Irish Agriculture – Trends and Prospects. *The 17th International Farm Management Congress: Congress Proceedings*, Illinois: Illinois State University, vol. 1, pp. 487-502.
8. Coppola A., Scardera A., Tosco D. (2013) Economic Profitability and Long-Term Viability in Italian Agriculture. *PAGRI,* 1/2013, pp. 71-84.
9. Dillon E., Hennessy T., Hynes S., Commins V. (2008) Assessing the Sustainability of Irish Farming. *The 107th EAAE Seminar 'Modelling of Agricultural and Rural Development Policies'*, Sevilla, Spain, pp. 1-15 p.
10. Dillon E.J., Hennessy T., Hynes S. (2009) Towards Measurement of Farm Sustainability – an Irish case study. Paper prepared for presentation at *the International Association of Agricultural Economists Conference*, Beijing, China, pp. 1-21 p.
11. Dillon E.J., Hennessy T., Hynes S. (2010) Assessing the Sustainability of Irish Agriculture. *International Journal of Agricultural Sustainability*, 8(3), pp. 131-147.
12. Fritzsch J., Wegener S., Buchenrieder G., Curtiss J., Gomez y Paloma S. (2010) *Economic Prospect for Semi-Subsistence Farm Households in EU New Member States*, Luxembourg: Publications Office of the European Union, 326 p.
13. Jakušonoka I., Jesemčika A., Ozola E. (2008) Assessment of Economic Viability for Agricultural Holdings Included into the FADN of Latvia. *Economic Science for Rural Development*, 17, pp. 77-86.
14. Jurkėnaitė N. (2013) Lietuvos ūkių demografinis gyvybingumas (Demographic Viability of Lithuanian Farms). *Management Theory and Studies for Rural Business and Infrastructure Development,* 35(4), pp. 544-553. (in Lithuanian).
15. Kopta D. (2009) Possibilities of Financial Health Indicators Used for Prediction of Future Development of Agricultural Enterprises, *Agricultural Economics – Czech*, 55(3), pp. 111-125.
16. Morehart M. (2000) A Fair Income for Farmers? *Agricultural Outlook*, AGO-271, May 2000, pp. 22-26.
17. Park C., Allaby M. (2013) *Dictionary of Environment and Conservation*, 2nd edition, Oxford: Oxford University Press, 504 p.
18. Scott J. (2001) *The Nova Scotia Genuine Progress Index Soils and Agriculture Accounts. Part 1: Farm Viability and Economic Capacity in Nova Scotia*, NS: GPI Atlantic, 71 p.
19. Scott J. (2005) *Farm and Community Viability*, NS: GPI Atlantic, 116 p.
20. Scott J., Colman R. (2008) *The GPI Soils and Agriculture Accounts: Economic Viability of Farms and Farm Communities in Nova Scotia and Prince Edward Island – an Update*, NS: GPI Atlantic, 87 p.
21. Tamošaitienė A., Juškevičienė D. Kriščiukaitienė I., Galnaitytė A. (2010). Ūkininkų ūkių verslo stabilumo vertinimas naudojant finansinės analizės santykinius rodiklius (Farmers Farms Business Stability Assessment Using Financial Analysis of Comparative Indicators). *Management theory and studies for rural business and infrastructure development*, 5(24), pp. 173-185. (in Lithuanian).
22. Van Cauwenbergh N., Biala K., Bielders C., Brouckaert V., Franchois L., Garcia Cidad V., Hermy M., Mathijs E., Muys B., Reijnders J., Sauvenier X., Valckx J., Vanclooster M., Van der Veken B., Wauters E., Peeters A. (2007) SAFE – A hierarchical framework for assessing the sustainability of agricultural systems. Agriculture, Ecosystems and Environment 120, pp. 229-242.
23. Vitunskienė V., Baltušienė J. (2011) Tiesioginių išmokų žemės ūkio veiklai socialiniai padariniai paramos gavėjų subjektyviu vertinimu (Subjective Approach to Social Effects of Direct Aid to the Agricultural Producers). Management theory and studies for rural business and infrastructure development, 5(29), pp. 211-220. (in Lithuanian).
24. Vrolijk H.C.J., de Bont C.J.A.M., Blockland P.W., Soboh R.A.M.E. (2010) Farm Viability in the European Union. Hague: LEI. 67 p.

ANALYSIS OF YOUTH INTEGRATION INTO THE LABOUR MARKET BY THE QUINTUPLE HELIX MODEL IN LATVIA'S REGIONS

Liva Grinevica, **Baiba Rivza**
Latvia University of Agriculture
Liva_g2@inbox.lv

Abstract
In the current context of economic instability, youths are faced with the emergence of a feeling of uncertainty with respect to their own chances of having a good debut on the labour market. The world crisis, the social reality that all societies are faced with, brought again up to the forefront the idea of young individuals' fragility on the labour market (Balan, 2014).
According to Eurostat statistical data, in the European Union young people represent one-fifth of the total population. Today the young people are facing the impacts of economical crisis and globalisation, population ageing and innovation explosion, which affects employability, education and training systems and social development. Successful youth's integration into the labour market is one of the main factors for future development and their inclusion into society. One of the main indicators for youth's inclusion into society is the development of a knowledge-based economy. It is important to aim at the development of a knowledge-based economy in rural regions because the majority of unemployed persons are concentrated in these regions.
The Quintuple Helix Model represents the relationships between universities, firms and governments and, in this case, their influence on youth's integration into the society and labour market in rural regions.
The paper presents a brief analysis of youths' unemployment development and their integration into the labour market in Latvia's regions and an analysis of the factors affecting this phenomenon by using the Quintuple Helix Model.
Key words: youth integration, labour market, Quintuple Helix Model.

Introduction

The downturn on the global financial markets that struck the world economy in the mid 2008 affected the world economy in its whole; nevertheless, it also had a great impact upon the labour force market in the European countries. After several years of economic growth and of relatively high labour force occupation rate, this caused the European Union to register levels of decrease that had not been registered for decades (Balan et al., 2012).

According to the International Labour Organisation, the weakening of the global recovery in 2012 and 2013 has further aggravated the youth jobs crisis and the queues for available jobs have become longer and longer for some unfortunate young job seekers. So long, in fact, that many youths are giving up on the job search and choose to study only. The prolonged job crisis also forces the current generation of youth to be less selective about the type of job they are prepared to accept - a tendency that was already evident before the crisis. Increasing numbers of youth are now turning to available part-time jobs or find themselves stuck in temporary employment. Secure jobs, which were once the norm for previous generations – at least in the advanced economies – have become less easily accessible for today's youth (Global Employment Trends…, 2013).

The typical problem when young people choose to study only is more seen in rural areas, where the unemployment level is higher.

The 94 million Europeans aged between 15 and 29 years face, besides the traditional challenges when beginning adult life, a life in an era of complete globalization and with the need to cope with the responsibility of an aging population. How these young people have been hit so hard by the economic crisis is very worrying (Balan and Vasile, 2012).

According to the Ministry of Environmental Protection and Regional Development of Latvia, the decrease in the number of pre-school age children (compared with the number of 2008) in 2023 is expected at 25-50%. The authors thought that it is clearly pronounced that Latvia will meet with significant demographical problems especially in rural regions, and it is important to make the economic situation effective for human capital resuscitation.

The aim of the research is to analyse youths' integration into the labour market in Latvia's regions and to identify their main viewpoints by using the Quintuple Helix Model.

The following tasks are set to achieve the aim:

1) To evaluate the theoretical findings on youth unemployment and integration into the labour market as well as the Quintuple Helix Model by different authors;
2) To analyse the statistical data on youth unemployment;
3) To analyse the youth integration into the labour market by the Quintuple Helix Model.

Novelty of the research: The youth integration into labour market is analysed not by using the concept of Quintuple Helix Model but by gathering information on the main influencing indicators and drivers.

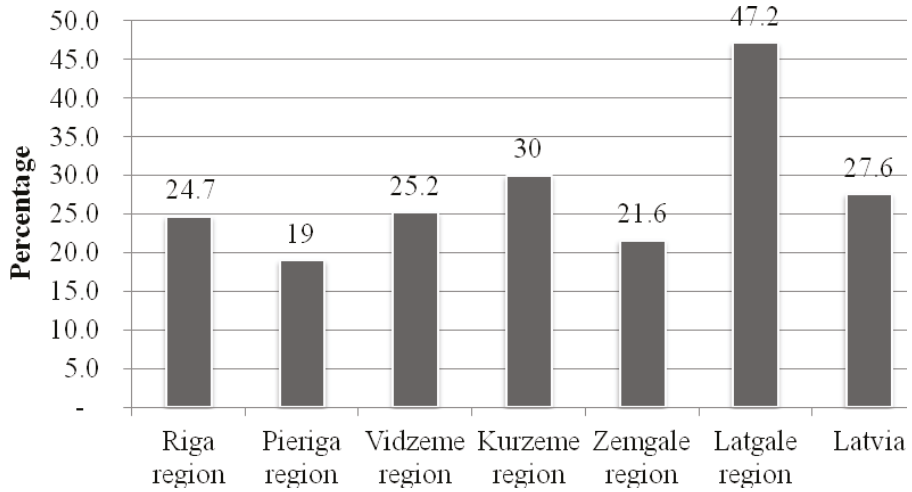

Figure 1. Share of unemployed young people aged 15-24 in total active youth in the 3rd quarter of 2013 by region, %.

Source: Central Statistical Bureau of Latvia, 2013.

Materials and Methods

Research methodology: the monographic and descriptive methods, the methods of synthesis and logical construction, statistical data analysis as well as scientific discussion were applied for fulfilment of the aim and tasks.

Theoretical framework of the research: the research elaboration is based on other scientific researches and findings in the economic field, statistical information provided by Eurostat, the OECD and the ILO.

Results and Discussion

Youth participation in the labour market

The social inclusion of young people issue has always been on the political agenda, but in the last two decades it has received a special attention. Between 2010-2018, European Union (EU) directives regarding youth were gathered in the strategic document "Youth – Investing and Empowering" concerning the policies related to young people in Europe in terms of education, employment, social inclusion, civic participation, entrepreneurship etc. (An EU Strategy..., 2009).

Since economic growth and the number of young people without a job are inversely related, during recession, young people are particularly vulnerable: frequently, they are the first to leave and the last to enter the labour market. To seek for a job, they have to compete with people more experienced professionally in a market that offers very few employment opportunities (Balan and Vasile, 2013).

According to the OECD, the Latvian workforce is well educated. About a third of economically active population has tertiary education, a significant increase from about 20% ten years ago. The secondary education attainment is also high, 80% of the working age cohort has at least upper secondary education. The education system has undergone significant reforms during the transition and students perform relatively well (OECD Economic Surveys..., 2015).

The labour market participation is described by indicators such as employment and unemployment rates. They provide information on those who already have a job or are actively looking for one. However, basic unemployment and employment statistics do not adequately capture the issue for young people, as those who are students are classified as being out of the labour force (Balan and Vasile, 2013).

The statistics provided by various international statistical institutions about youth unemployment and long-term unemployment as well as information about the situation in the labour market, in all cases, do not accurately reflect the real situation because many of students are only studying and do not want to work, some of them are not registered as unemployed persons with the State Employment Agency, some of them are not studying and are trying to find a job. In that case, it is not correct to represent them as a part of the unemployed, especially young people from age 15 to 24, as a part of them are only students and will study for a couple of years. For that reason, the European Union policy makers are using the concept of NEET, which means that young people are not in employment, education or training. This concept is used for separating these persons from those participating in the labour market. These people are at a higher risk of social exclusion than the employed.

In 2014, 16.9 thousand of the unemployed were young people aged 15 to 24. Their share in the total number of economically active youth declined to 19.6%, which was 3.6 percentage points less than

in 2013. Compared with 2013, the number, as well as the share of unemployed young people aged 15 to 24 in the total number of unemployed persons, decreased by 4.6 thousand or 2.2 percentage points, respectively. In 2014, 40.4% of the people aged 15 - 24 were economically active, i.e. employed or seeking a job. The remaining part (59.6%) was economically inactive mostly still studying and not seeking a job (Unemployment Rate decreases..., 2015). The authors think that the unemployment rate minimally decreases, but there is still the youth unemployment problem, especially in the rural regions.

In the 3rd quarter of 2013, in Latvia there were 27.1 thousand unemployed youngsters – 22.4% of the total number of unemployed persons aged 15-74. Labour Force Survey results compiled by the Central Statistical Bureau of Latvia indicate that most (86.9%) of them were aged 20-24 (Unemployment of Young..., 2013).

According to Figure 1 for the 3rd quarter of 2013, the youth aged 15- 24 unemployment rate was 47.2% in Latgale region, which was the highest rate among Latvia's regions; this rate was about 19.6% higher than the average level in that period. The second highest youth unemployment rate was in Kurzeme region, where it was 30%. The lowest unemployment rates were in Pieriga region – 19% and in Zemgale region – 21.6%, but in Riga region – 24.7%. According to this figure, it is clearly seen that the highest youth unemployment is observed in rural regions.

The employment rates of those with tertiary education are high in comparison with top OECD performers. Yet, there is a considerable gap in employment rates of those with secondary and basic education (Figure 2). The gap is smaller for the younger cohorts, which can signal not only difficulties in maintaining appropriate skills, but also that the younger cohorts have better labour market skills (given that the older cohorts acquired education under the centrally planned economy) (OECD Economic Surveys..., 2015).

According to the OECD Economic Survey of February 2015, 13% of youths were not in employment, education and training in 2013.Young men seem to be at a higher risk of so-called scarring (i.e. failing to form a labour market attachment early on in their working life), as they are over-represented among early-school leavers and have lower higher

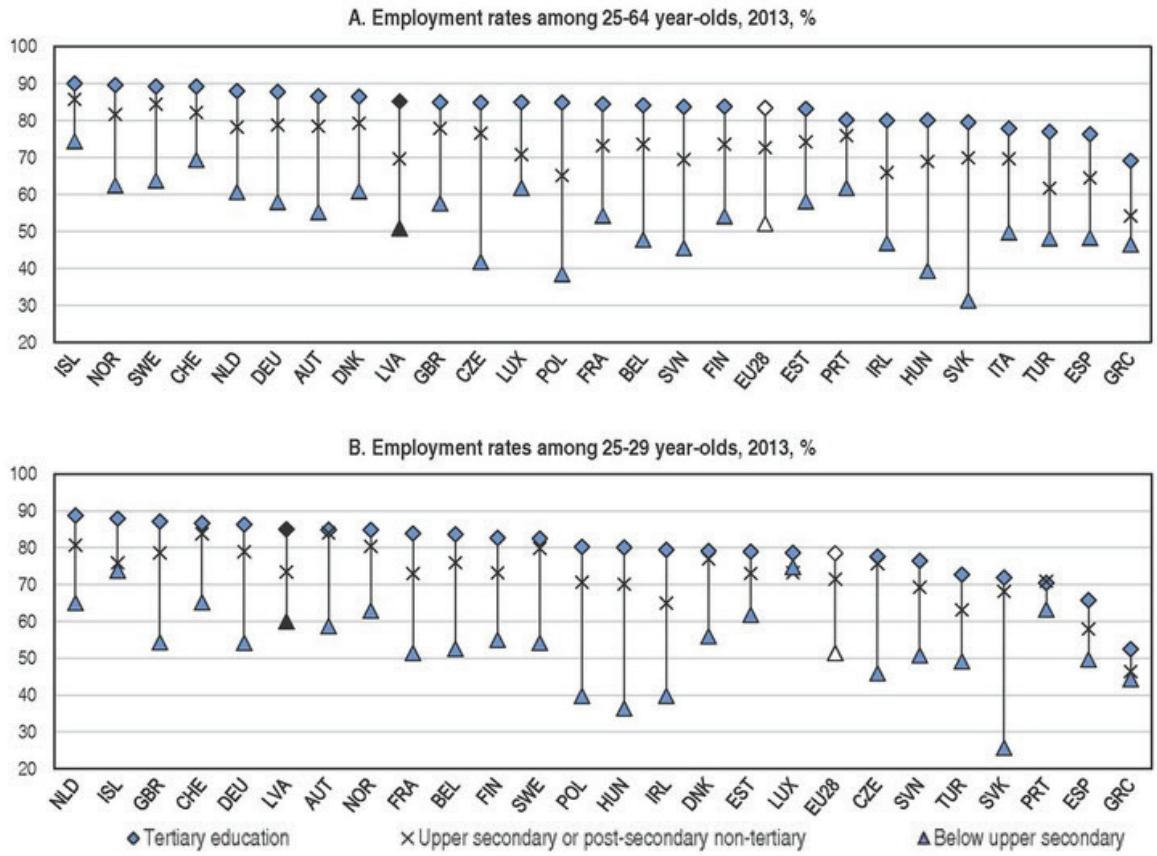

Figure 2. The employment rates of those with lower education attainment lag behind top OECD performers.

Source: OECD Economic Surveys, Latvia, 2015.

education attainment. Most of these young people are from rural regions.

According to Figure 2, the youth employment rates among 25-29 year-olds in Latvia in 2013 are higher than in European Union 28 (EU 28) countries. In this context, the tertiary educated young people are 85% in Latvia and in the EU 28 only 79%; youth with upper secondary or with post secondary non-tertiary education in Latvia -73% and approximately the same in EU 28 - 72%; young people employed with education below upper secondary in Latvia are 58%, while in the EU 28 only 50%.

A lower employment rate than in Latvia and the EU 28 is in Estonia – young people who are with tertiary education- 79%, with the secondary or post secondary non-tertiary education- 73% and with education below upper secondary- 73%.

According to Figure 2, which shows employment rates, it is seen that the employed people from the age 25 to 64 in 2013 in the EU 28 with the tertiary education are more employed than young people from the age 25 to 29, most of them have already finished their studies and are working only, of course, some of them are studying and working. Employed people aged from 25 to 64 years with tertiary education in the EU 28 were 83 %, in Latvia – 85%, in Estonia – 83%. According to that statistical information, the difference between tertiary educated people aged from 25 to 64 and 25 to 29 year olds in Latvia does not exist. The authors determined that in Latvia the problem with employability was with young people with education below upper secondary.

According to the OECD Economic Survey of 2015, the educational attainment and skills have a strong influence on labour market outcomes and effective investment in youth skills determines the capacity of countries to face various shocks and get the most out of globalisation, technological changes and innovations. The education system has undergone significant reforms during the transition and Latvian students perform relatively well by international comparison.

One of the recommendations for Latvia from the OECD is to raise productivity and ensure robust convergence to develop incentives for international cooperation in local research and innovation as well as a regular external evaluation exercise. The authors think that cooperation at international level with research institutions and also with entrepreneurs and state institutions is one of the main incentives that can help to improve our quality of education and position our state internationally. These relationships can help to provide young people with experience from other countries as well as to develop their future possibilities. It is important to improve that kind of practice in universities from rural regions.

As one of the main solutions for youth employability in European Union Planning documents are mentioned self-employment and business support, but according to the OECD Survey of February 2015, Latvia is positioned as one of the states that had higher barriers for entrepreneurship in 2013. In Latvia, the index of barriers for entrepreneurship in 2013 was 2, the OECD average index was 1.7, but in Estonia the index was smaller than the OECD average – 1.5.

In 2030, according to the research under the ESPON 2013 Programme, Latvia is positioned as a "depressive" region with an insufficient population of young people. Consequently, Latvia as a country with a friendly environment for business development will not be competitive in relation to other European countries and the flow of investment will be at risk as well as passed on other regions, which are more competitive and more developed.

The Quintuple Helix Model for youth employment

Knowledge in a *Quintuple Helix Model* is the pivotal force and driver for progress. The *Quintuple Helix* is a model which grasps and specializes on the sum of the social (societal) interactions and the academic exchanges in a state (nation-state) in order to promote and visualize a *cooperation system* of knowledge, know-how, and innovation for more sustainable development. The specialty of the *Quintuple Helix Model* can thus be described in the following way: the Quintuple Helix Model is interdisciplinary and transdisciplinary at the same time: the complexity of the five-helix structure implies that a full analytical understanding of all helices requires the continuous involvement of the whole disciplinary spectrum, ranging from the natural sciences (because of the natural environment) to the social sciences and humanities (because of society, democracy and the economy) (Figure 3) (Carayannis et al., 2012).

Knowledge has become in growing extent a potential product that can be exploited on the market, which means the industrialisation of the production of scientific knowledge (Jacob, 1997).

The development in the information and the telecommunication technology that took place in the 20th century basically changed the economic and social relations in the world of globalization. The industrial capital became the main direction. In the history of nowadays, which is also called as the newest history, the knowledge centres are the economic and political centres, the base of the society is the knowledge society, and the direction of the capital investments is the knowledge capital. The institutions dealing with the production, the distribution and the reproduction of knowledge became the most important institutions of the knowledge-based society. Nowadays this role

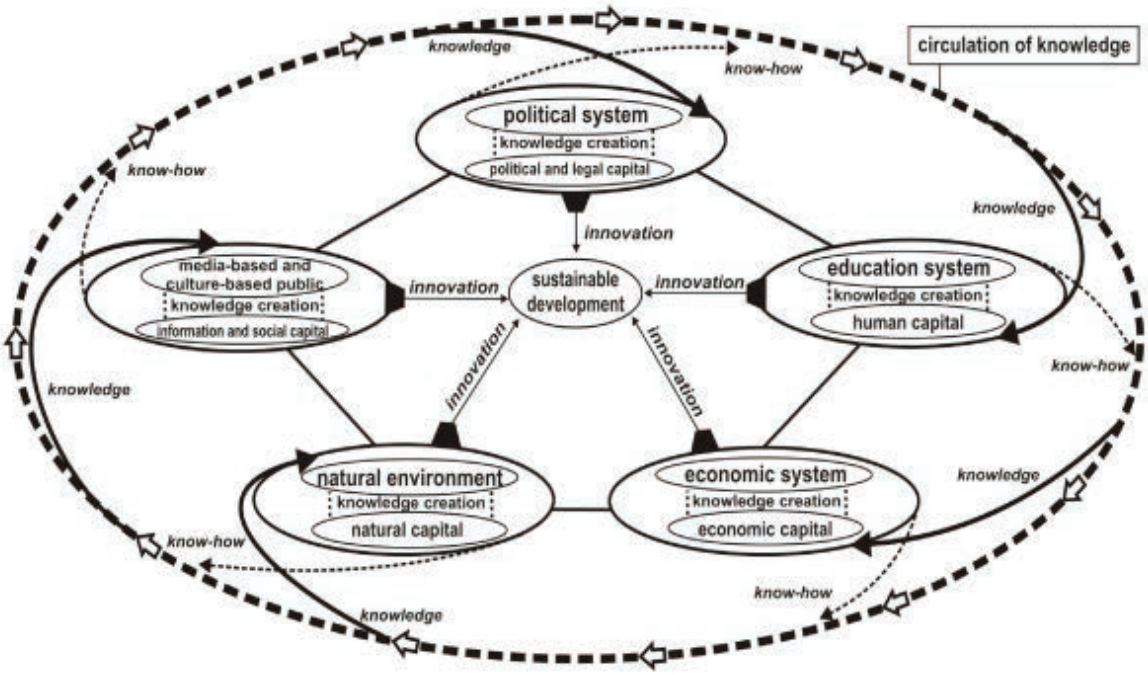

Figure 3. The Quintuple Helix Model and its functions.

Source: Carayannis et al., 2012.

is increasingly occupied by the education institutes, among them the higher education. The role and the function of higher education institutes have been revaluated worldwide nowadays and consequently a new aspect of economic and social roles and functions have appeared (Filep et al., 2013).

The society based on knowledge is the condition of all transfer of knowledge on an individual and an organizational level. We live in a network-oriented society, where the development primarily depends on ability to cooperate. Earlier the condition of development were the more and more specialized research and education, therefore we should penetrate deeper and deeper into the certain fields of science (Filep et al., 2013).

Investment in human capital is a key factor in facilitating transitions from school to work and putting youth on promising career tracks. Indeed, an access to productive and rewarding jobs improves as the level of educational attainment increases (The Challenge of..., 2012).

It is clearly seen that in a network-oriented society, it is easier for young people to adapt to the labour market in the case when there is need for people with knowledge of internet technologies or where work with a computer and basic knowledge with various computer programs are required. In this case employability problems are for older people without that knowledge. Also, a very significant obstacle is that employers do not want to pay young people a wage, which is the average wage in that profession; a large proportion of employers are paying the minimum wage only. And it is a serious problem and one of the reasons why young people are leaving Latvia's rural regions in search of an adequate wage in other country and, in most cases, working a low-skilled job being inadequate for their obtained professional qualification.

The authors think that the main principles the Quintuple Helix Model are directly related to successful youth integration into the labour market. The youth employability and inclusion into the labour market are affected by the young person's level of education, living conditions in the family, quality of life in childhood, social affiliation to the public, life vision and plans for the future, the possibility of finding a well-paid job, the opportunity to build his/her life and many other indicators. To clearly understand the interaction between the youth and the systems for successful integration into the labour market, the authors determined the main system rates (Table 1).

With reference to the literature analysed in the paper and the views of foreign economic literature, the authors in advance, the authors understand that there is an opinion that there is not a strong enough linkage between industry, the government, enterprises, research institutions and universities. If there is no strong connection between all these public and private sectors, the future development for young people will be endangered, especially for those from rural regions, because of today's economic situation and the effect of globalisation. That kind of problem is specific not

Table 1

Interaction between the types of systems of knowledge creation for youth's integration into the labour market

Type of systems of knowledge creation	Interaction between system rates
Human capital	• Secondary schools, high schools, professional schools, Universities • Research institutes • Investments in scientific field • Education level • Education quality • Knowledge of teachers, professors • Future development, tendencies
Economic capital	• Gross domestic product (GDP) • Export, import volume • Taxes • Banking system • Employment • Standard of living, social risk • Inflation • Payment, average level of wages • Entrepreneurship development, self-employability
Natural capital	• Resources (wood, coal, minerals, ore, gravel etc.) • Geographical location
Information and social capital	• Innovation • Information technologies • Knowledge based technologies • Cultural environment • Cultural characteristics • Social inclusion, exclusion • Social integration • Society
Political and legal capital	• Legislation • Political field • Regional economy • Economic situation of the European Union • Globalisation • Integration into society • Relations with the European Union • Relationships between the government and entrepreneurs, society

Source: authors' construction.

only in Latvia, but also in other European countries.

The authors accent that the knowledge based economy and the successful interaction between human capital and the development of technologies are one of the key factors for the state's economic growth at the world level.

The authors think that there are significant differences in the youth labour market across the European Union Member States. These differences vary from one state to another, and youth employability is directly associated with a state's economic growth, technological development, level of business development and human capital.

Conclusions

The youth unemployment and integration problem is one of the central focus for the European Union to deal with, because in some European region's countries there is a very high youth unemployment, especially long-term unemployment, rate in rural areas, according to data of ESPON (2012) for Greece, Spain, Italy etc.

According to the information mentioned in the paper, the scientists think that at the moment, one of the unsatisfactory elements in the European system has been that the linkages between universities and industry, the research and business worlds are not strong enough. There is a need for closer interaction between these elements.

The key obstacles for economic growth nowadays, when a knowledge-based economy plays an important role for development and competitiveness, are unsuccessful interaction between the public and private sectors, as the interaction between these two

groups are one of the preconditions for the national economy's successful development.

According to the research results, the highest unemployment rate of the youth aged 15-24 in Latvia was in Latgale region (47.2%), the second highest rate was in Kurzeme region (30%), while the lowest rate was in Pieriga region (19%) and Zemgale region (21.6%). It is surprising that in Riga region youth unemployment was higher than in Pieriga region and Zemgale region because most enterprises registered in Latvia concentrate in Riga.

As it is known, future development is unimaginable without the young generation's successful integration into the labour market. The young people are the most important national capital for the state's future development. It is important to build for young people a successful transition from their school to their job in order not to subject the new generation to poverty and social risks, and to help them to successfully integrate into the labour market. The young people are the cornerstone of future technological development and these people are those who will use their knowledge for developing the national economy of rural regions.

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References

1. An EU Strategy for Youth: Investing and Empowering – A renewed open method of coordination to address youth challenges and opportunities (2009) Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, pp. 1-15.
2. Balan M. (2014) Analysis of Unemployment among Young Individuals from Romania by Econometric Methods. International Auditing & Risk Management, No. 3 (35), pp. 90-97.
3. Balan M., Uzlau C.M., Ene C.M. (2012) Evolutions of Unemployment among the Young over the Economic and Financial Downturn. Annales Universitatis Series Oeconomica, 14 (1), pp. 193-203.
4. Balan M., Vasile V. (2013) Features, Dimensions and Costs of Romanian "NEET" Youth in the European Context, Proceedings of the IER Seminar in Empirical Economics, pp. 141-158.
5. Carayannis E.G., Barth T.D., Campbell D.F.J. (2012) The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. Journal of Innovation and Entrepreneurship. Available at: http://www.innovation-entrepreneurship.com/content/1/1/2, 15 February 2015.
6. Filep B., Kovacs Z., Kara A., Tomboly T. (2013) „City- University- Company" Coordinated Stategic Development: Industry zone in Gyor focused on the Vehicle industry. Active Citizenship by Knowledge Management & Innovation. pp. 797-808.
7. Global Employment Trends for Youth 2012 (2012) International Labour Organisation, Geneva: ILO, Available at: http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_180976.pdf, 13 February 2015.
8. Jacob M. (1997) Life in the Triple Helix: The contract researcher, the university and the knowledge society. Science Studies 10(2). pp. 35-49.
9. OECD (2015) OECD Economic Surveys: Latvia 2015, OECD Publishing, Paris, pp. 1-115.
10. Raugze I. (2011) Regional Development Challenges in Latvia towards 2020, Ministry of Environmental Protection and Regional Development, Presentation materials, Available at: http://www.varam.gov.lv, 3 March 2015.
11. Territorial Dynamics in Europe. Trends in Population Development (2008) Territorial Observation No. 1., The ESPON 2013 Programme, European Union, European Regional Development Fund, Belgium, pp. 1-15.
12. The Challenge of Promoting Youth Employment in the G20 Countries (2012) OECD Better Policies for Better Lives, Available at: http://www.oecd.org/els/emp/50304960.pdf, 27 February 2015.
13. Unemployment of Young People still a Major Issue in Latvia (2013) Central Statistical Bureau of Latvia, Available at: http://www.csb.gov.lv/en/notikumi/unemployment-young-people-still-major-issue-latvia-39293.html, 27 February 2015.
14. Unemployment Rate Decreases in 2014 (2015) Central Statistical Bureau of Latvia, Available at: http://www.csb.gov.lv/en/notikumi/unemployment-rate-decreases-2014-42339.html, 3 March 2015.

PRACTICAL ASPECTS OF BUSINESS MODEL APPLICATION IN VETERINARY ACTIVITIES

Lina Ašmenskaitė[1], Adelė Astromskienė[2]
[1]Lithuanian University of Health Sciences
[2]Aleksandras Stulginskis University, Lithuania
lina.asmenskaite@lsmuni.lt; adele.astromskiene@asu.lt

Abstract
In the article, following the theoretical aspect, there is analyzed the business model canvas and there is presented the business model classification involving the discussion related to the particularity of veterinary activities. The research aim is after having summarized theoretical aspects of business models, to disclose business model application peculiarities in veterinary activities. In order to disclose the business model application peculiarities in veterinary activities and to supplement the research by other authors, there was disclosed the peculiarity of veterinary service and there was completed the most relevant business model analysis allocated to the development of veterinary activities. Having systematized the business models introduced in different sources it was noticed that there had not been found any business models which were named as ones being unambiguously relevant to veterinary activities. There have been accurately analyzed application possibilities of the *business model canvas* for the analysis and development in veterinary service activities.
Key words: business model canvas, veterinary activities, veterinary service.

Introduction

In the scientific literature there are provided a lot of different interpretations of business model canvas. Timmers (1998) defines a business model as architecture of product, service and information flows that involves business participants and their roles, the identification of income sources and the determination of potential benefits for business participants. Linder and Cantrell (2000) define a business model as organizational logic, following which, there is created new or higher value. The scientists, Magretta (2002), Zott and Amit (2010), Beattie and Smith (2013), define a business model as a story that explains the operation principle of a company. Teece (2010) indicates that a business model discloses the fact related the transformation of the company income and its possibilities into some economical value. Osterwalder and Pigneur (2005; 2010) describe a business model as a conceptual means that includes elements, their correlative relations and that enables the definition of business logic in the certain company. Casadesus-Masanell and Ricart (2010) describe a business model as company logic, data and other details which maintain the value proposal for a customer, income framework and company costs. Chesbrough and Rosenbloom (2002) claim that a business model is business logic which creates value form new service or products. A business model discloses the fact how value is created to a customer and how the following proposal secures financial benefit or network value for a company or the interested parties (Bouwman et al., 2008; Haaker et al., 2006).

The versatility of entrepreneurial activities and business model definitions and classifications is closely interrelated. In the Table 1 there is presented the business model classification by several authors:

However, general business models and their descriptions are not always relevant for particular entrepreneurial activities. One of the particular/specific entrepreneurial activities is veterinary activity. Veterinary activity has an exclusive quality among other entrepreneurial activities, providing services – different level and role participants in the service design process. Veterinary service is provided to animals and the customer is the service purchaser. Besides, the following service requires a high customer's participation level when a customer (service purchaser and animal owner) and service

Table 1

Business Model Classification

Author	Business Model Types
Linder and Cantrell, 2000	Intermediate, broker, direct sales to s customer and other business models
Rappa, 2001	Broker, producer trader, partner and service focused business models: advertising agencies, information communication intermediate and internet service supplier
Alt et al., 2001	Business models, focused on different markets and company roles Business models, focused on income generation Business models, focused on sectors and industries
Michelini, 2012	Isolated and interactive business models

supplier (a person engaged in the veterinary practice) share the information, knowledge and efforts, necessary for the design of qualitative service.

The business model application in veterinary activities has not been widely analyzed yet. In order to remain competitive in a constantly changing entrepreneurial environment, veterinary service suppliers have to be able to cognize business models and be able to adapt them constantly not only in a changing business environment, but be able to conform with constantly changing veterinary service purchasers' needs.

The research aim is after having summarized theoretical aspects of business models, to disclose business model application peculiarities in veterinary activities.

Materials and Methods

The article has been prepared applying the methods of scientific literature analysis, general and logic analysis, generalization and comparison. The business activities run by economical subjects, those provide veterinary service in Lithuania, were selected as a research object. The analysis of scientific literature involved scientific article search and the analysis of their contents in the following educational data bases: „EBSCO Publishing", „Emerald Management eJournals Collection"„Sciencedirect", and Google Scholar. Articles are selected according to the key word „business model".

Results and Discussion

Veterinary activities are a kind of service provided by the veterinary service supplier to the animal keeper for the fee or voluntarily: a consultation concerning animal welfare and health issues, diagnostics, treatment and prophylaxis against animal diseases, temporary animal accommodation and care in terms of treatment in the veterinary service supplier's premises, animal marking, the identification of animal death causes, etc. Following the classifier of economic activities, the structure of veterinary activities consists of: inpatient treatment of livestock and animals, outpatient treatment of livestock and animals, veterinary diagnostic activities and veterinary lab activities (Statistics Lithuania, 2008).

Recently, there are predominant complex and intensive changes in the veterinary sector, that impact business environment of veterinary service. Some of them are related to the security of animal welfare and others are related to the increase of domestic (small) animal/companions number and the decrease of farm animals (Lowe, 2009). Agreeably with the data of the European Pet Food Industry Federation, in the year 2007, 350 thousand dogs and 270 thousand cats were kept in the households of Lithuania, respectively in the year 2012 – 740 thousand dogs and 670 thousand cats, i.e. the number of dogs and cats increased more than twice. Following the research, completed in Germany, 87% of dog keepers regularly purchase veterinary service and check-up their companions not less than once a year, and 27% of dog keepers visit veterinary surgeons three times and more a year. Meanwhile, only 9% of cat keepers check-up their animals three times a year, and 30% - have no regular visits to veterinary surgeons. The following fact sets new requirements for veterinary service suppliers: to attract more domestic (small) animal raisers and to provide them with more and better quality service.

Agreeably with the regulations of the Lithuanian Veterinary Law, legal entities and natural persons, who have been concurred the veterinary surgeon's qualification and veterinary practice license, can deliver veterinary service in Lithuania. The veterinary service supplier can be both – a private veterinary surgeon and a company, where there are employed private veterinary surgeons and that provides with veterinary service. According to the data of Statistics Lithuania, in the year 2015, 159 economical subjects run veterinary service supply and in comparison with 359 companies, providing veterinary service in the year 2009, their number decreased more than twice.

During the execution of veterinary activities in Lithuania, there are applied obligatory standards for service and safety to private veterinary service suppliers in Lithuania – licenses, which confirm employees competencies and permits, which confirm the service supplier's competence and the relevance of buildings/premises. Following the data of Lithuanian State Food and Veterinary Service, in the year 2015, the licensed veterinary practice was executed by 1970 natural persons, and 995 natural persons had licenses for veterinary pharmaceutical practice; one license is issued for production of drugs; 159 licenses are possessed by the executors of veterinary pharmacy activities and 49 licenses are possessed by economical subjects involved in veterinary medicine trade in bulk.

During the analysis in the change of veterinary companies according to the number of the employed, it can be noticed that in the year 2015 as well as in the previous years the largest group of companies are and used to be very small companies, i.e. the companies that employ up to 4 people and they make 76.7% of all operating companies (see Table 2). In the year 2015, the company structure according to the groups of the employed has not changed at all in comparison with the year 2014.

At the beginning of the year 2015, there have been employed 700 people in veterinary service companies. During the period of six years, their number has decreased almost three times in comparison with the

Table 2

The distribution of the active veterinary company number in accordance with the number of the employed

Year	Classification of companies agreeably with the number of the employed			
	0-4 employees	5-9 employees	10-19 employees	20-24 employees
2012	125	24	9	5
2013	110	21	6	5
2014	106	27	7	5
2015	122	21	12	4

Source: the Lithuanian Statistics..., 2015

year 2009. The situation when the number of domestic (small) animals in Lithuania is significantly increasing annually and the number of the specialists providing service to them and sales of veterinary service are decreasing rapidly, forces to find out the causes for the following disproportion. One of the reasons can be the veterinary service suppliers' age. During the analysis of demographic indicators related to the veterinary surgeons, running veterinary practice, it was identified that 69.4% of the physicians, running private veterinary practice are at the age of 51-60 and only 2.8 of physicians are younger than 40. Under the data of the Lithuanian Veterinary Association, average age of the private veterinary surgeon, who works with farm animals, is 54. Being aware of the fact that 20 and more years ago, veterinary studies were focuses on the farm animals' healthcare, domestic (small) animals' service is a new activity for the veterinary surgeons at the senior age, and that activity requires supplementary knowledge, means and experience. I.e. that the previous veterinary activity model does not suit anymore. There arises an objective for scientists to find and adapt business models relevant to the changing character of veterinary activities.

In order to identify business model application peculiarities in veterinary activities there was completed the comparative analysis of some scientific research, related to the interpretation of business model structure. Analyzing scientific literature it was noticed that in definition case of the business model canvas, the scientists' research can be divided into several categories:

- Research focused on a business model canvas (Casadesus-Masanell and Ricart, 2010; Linder and Cantrell, 2000; Magretta, 2002; Osterwalder and Pigneur, 2005; Timmers, 1998);
- Research focused on the business model structure elements (Afuah and Tucci, 2002; Osterwalder and Pigneur, 2005; Petrovic et al., 2001; Rayport and Jaworski, 2001; Weill and Vitale, 2001);
- Research in the representation methods for a business model (Casadesus-Masanell and Ricart, 2010; Osterwalder and Pigneur, 2005; Tapscott et al., 2000; Weill and Vitale, 2001);
- Research in business model development methods (Morris et al., 2005; Osterwalder, 2004; Pateli and Giaglis, 2004);
- Business model innovations (Linder and Cantrell, 2000; Petrovic et al., 2001; Sosna et al., 2010).

The versatility of theoretical business models enables the selection of the most relevant ones for the development of veterinary activities. Having assessed the peculiarities of veterinary activities as specific service business with the participants in several levels of the service design process, the most relevant models are the ones those enable the definition and exclusion of the model relevance criteria:

- Service value for animal keepers agreeably with their relationship with an animal;
- Veterinary service consumers in the target market according to the kinds of the kept animals;
- Veterinary service suppliers' internal possibilities – available competencies and licenses for veterinary activities;
- Competitive strategies – veterinary service suppliers' interpersonal relationship in the certain locations;
- Economical activity logic – the identification of service profitability limits and price level;
- Personal factors – interest in separate animals' biology and ethology, possibilities of communication, the level of entrepreneurship, etc.

The enumerated criteria most relevantly comply with business model structure elements excluded by M. Morris, M. Schindehutte, & J. Allen (2005): value proposal (describes how a company creates a new value for the interested persons), target market (describes a value that a company offers to consumer segments), internal possibilities (the company possibilities/ internal potentials and competences), competitive strategies (security of competitive advantage), economical activity logic (involves all economical aspects in a company) and personal factors (time and ambitions). Following these criteria there was carried out the comparison of business model relevance for veterinary activities (Table 3):

The analysis of business models has disclosed that there have not been noticed any business models

Table 3

Selection of Business Model Relevance for Veterinary Activities

Authors	Business Model Structure Elements					
	Value Proposal	Target Market (consumers)	Internal Possibilities	Competitive Strategy	Economical Activity Logic	Personal Factors
Mahadevan, 2000	+		+		+	
Alt and Zimmermann, 2001	+	+	+	+	+	+
Petrovic et al., 2001	+	+	+		+	
Chesbrough and Rosenbloom, 2002	+	+	+	+	+	
Hedman and Kalling, 2001	+	+	+	+		
Morris et al., 2005	+	+	+		+	+
Osterwalder, Pigneur, 2005	+	+	+	+	+	
Johnson et al., 2008	+	+	+		+	
Al-Debei and Avison, 2010	+	+	+		+	
Demil and Lecocq, 2010	+	+	+		+	
Kijl and Boersma, 2010	+	+	+	+	+	
Onetti et al., 2010	+	+	+	+	+	
Kindström, 2010	+	+	+		+	
McGrath, R. G. 2010	+		+		+	
Zott and Amit, 2010	+	+	+			
Teece, 2010	+	+	+			
Zott et al., 2011					+	

those were named as unambiguously relevant ones for veterinary activities. There are most frequently discussed processes and the creation of the value proposal in business models focused on the service supply; however, there is not analyzed customer feedback (Uvarina, 2013) and this is an inseparable part of veterinary service in veterinary activities: animal's keeper is like an intermediate between the veterinary service supplier and its receiver (consumer). The veterinary service supplier receives information concerning the service relevance not from the service receiver but from its purchaser – animal's owner or raiser.

Following the research authors' attitude, *business model canvas* by Osterwalder and Pigneur (2009) was selected for the description of entrepreneurial aspects in veterinary activities as the most relevant one. Under the analyzed business models, the following model structure and its elements enable the expression of entrepreneurial logic in veterinary activities and business particularity in a company that supplies veterinary service best. *Business model canvas* structure consists of the following elements: consumer segment, value proposal, distribution channels, consumer relationship, key activities, key resources, key partnerships, the structure of costs and income flows. Besides, in the following business model there can be excluded two most significant dimensions those impact income flows of the subjects (natural persons or companies) those provide with veterinary service:

- *Human resources, their activities and the created value in the system of service.* Veterinary service and its supply process depends not only on people's (the physicians, who run veterinary practice and the employed in veterinary companies) professional competencies a lot, but on their entrepreneurship, helpfulness, attentiveness to a customer and animal, and an ability to communicate. The following personal veterinary service suppliers' characteristics/qualities are the key element of successful entrepreneurial activities.
- *Contact maintenance (feedback).* One of the most significant elements of *Business model canvas* is the focus on a customer. The creation of tight business relations among specialized veterinary service suppliers and the creation of veterinary tool distributors in veterinary activities, secure successful activities for all veterinary surgeons, running veterinary practice. In the following case, the focus on the customer involves the employees' in a company that provides with veterinary service and separate physicians', who provide with veterinary service directly, efforts in communication with animal keepers in order to identify the need of the help necessary for an

animal; supply processes of the very veterinary service and supplementary services under the aid of which there is formed the feeling of reliability, closeness, and emotional strength. If an animal owner during the supply of veterinary service for an animal, experiences more positive than negative emotions, such an animal owner will turn into a permanent veterinary service supplier's customer and he/she will use the service repeatedly and will recommend it to potential customers – other animal keepers. In summary it can be stated that *Business model canvas* can be applied for the analysis of veterinary service business, the structure elements of which involve all veterinary activity processes and enable the analysis of separate structural parts of veterinary service supply process and discloses creation peculiarities of exclusive attention and veterinary service value to customers and consumers, excluding the animal owners' and the service animals' role and place in the development process of veterinary service supply.

Conclusions

1. The literature analysis in a business model discloses that there is no existent the only and steady definition of a business model. In order to disclose the business model application peculiarities in veterinary activities and supplement other scientists' research, there is necessary a deeper and more systematized review of business model canvas and structure elements in order to be able to provide with purer structure elements of a business model.
2. Veterinary activities possess an exceptional quality – the participants of different levels and roles in the creation process of service. Veterinary service is provided to animals and the customer is a service purchaser. Business model structures in veterinary activities have to be prepared in such a way that they presented the particularity of veterinary activities, the value created by Human Resources and the maintenance of relationship with consumers. It is noticed that veterinary activities have to be focused on changes – the application of new business models aid at the reordering of business processes, foster dynamic development of veterinary service suppliers and new business possibilities.
3. The completed business model relevance analysis for veterinary activities discloses the fact that there have not been noticed any business models those were named as ones being unambiguously relevant for the analysis and development of veterinary activities. One of the most relevant models is *Business model canvas* that enables the disclosure of peculiarities related to the creation process of exclusive attention and different level and role of veterinary service value and service for the process participants, excluding the role and place of animal owners and the service animals in the development process of veterinary service supply.
4. The further research in veterinary entrepreneurship could be developed in the following directions: in the direction business model practical analysis, in the direction business model classification and application in order to exclude the certain factors of success, those impact the development of the following specific activity positively.

References

1. Afuah Allan, Tucci C.L. (2002) *Internet business models and strategies: text and cases* (2nd ed.), McGraw-Hill Higher Education, 480 p.
2. Al-Debei M.M., Avison D. (2010) Developing a unified framework of the business model concept. *European Journal of Information System,* 19(3), pp. 359-376.
3. Alt R., Zimmermann H.D. (2001) Preface: Introduction to Special Section – Business Models. *Electronic Markets,* 11(1), pp. 3-9.
4. Beattie V., Smith S. (2013) Value creation and business models: refocusing the intellectual capital debate. *The British Accounting Review,* 45(3), pp. 243-254.
5. Bouwman H., Haaker T., De Vos H. (2008) *Mobile service innovation and business models*, Springer, New York, 325 p.
6. Casadesus-Masanell R., Ricart J.E. (2010) From strategy to business models and onto tactics. *Long Range Planning*, 43(2–3), pp. 195-215.
7. Chesbrough H. (2010) Business model innovation: opportunities and barriers. *Long Range Planning*, 43(2-3), pp. 354-363.
8. Chesbrough H., Rosenbloom R.S. (2002) The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, 11(3), pp. 529-555.
9. Demil B., Lecocq X. (2010) Business Model Evolution: In Search of Dynamic Consistency. *Long Range Planning,* 43(2-3), pp. 227-246.

10. Haaker T., Faber E., Bouwman H. (2006) Balancing customer and network value in business models for mobile services. *International Journal of Mobile Communications*, 4(6), pp. 645-661.
11. Hedman J., Kalling T. (2001) *The Business Model: A Means to Understand the Business Context of Information and Communication Technology. Working Paper No. 9*, Lund: Institute of Economic Research in the School of Economics and Management at Lund University, pp. 148-162.
12. Johnson M.W., Christensen C.M., Kagermann H. (2008) Reinventing your business model. *Harvard Business Review,* 86(12), pp. 57-68.
13. Kijl B., Boersma D. (2010) Developing a business model engineering & experimentation tool – the quest for scalable 'lollapalooza confluence patterns. Paper 567, In: *Proceedings of the Sixteenth Americas Conference on Information Systems (AMCIS 2010)*, Lima, Peru, pp. 1-13.
14. Kindström D. (2010) Towards a service-based business model – Key aspects for future competitive advantage. *European Management Journal,* 28(6), pp. 479-490.
15. Linder J., Cantrell S. (2000). Changing business models: surveying the landscape. Accenture Institute for Strategic Change, UK: Cambridge, pp. 1-15.
16. Lowe P. (2009) *Unlocking Potential – A Report on Veterinary Expertise in Food Animal Production,* Department for Environment and Food Rural Affairs (DEFRA), London, 90 p.
17. Magretta J. (2002) Why business models matter. *Harvard Business Review*, 80(5), pp. 86-92.
18. Mahadevan B. (2000) Business models for internet-based E-commerce. *California Management Review*, 42(4), pp. 55-70.
19. McGrath R.G. (2010) Business Models: A Discovery Driven Approach. *Long Range Planning,* 43(2-3), pp. 247-261.
20. Michelini L. (2012) *Social Innovation and New Business Models,* Springer, London, UK, 90 p.
21. Morris M., Schindehutte M., Allen J. (2005) The entrepreneur's business model: toward a unified perspective. *Journal of Business Research*, 58(6), pp. 726-735.
22. Onetti A., Zucchella A., Jones M., McDougall-Covin P. (2010) Internationalization, innovation and entrepreneurship: business models for new technology-based firms. *Journal of Management and Governance,* 15(3), pp. 1-32.
23. Osterwalder A. (2004) *The business model ontology – a proposition in a design science approach. Business*. PhD Thesis, Universite de Lausanne: Ecole des Hautes Etudes Commerciales HEC, 173 p.
24. Osterwalder A., Pigneur Y. (2005) Clarifying business models: origins, present, and future of the concept. *Communications of the Association for Information Systems*, 16(1), pp. 1-25.
25. Osterwalder A., Pigneur Y. (2010) *Business model generation*, Hoboken, Wiley, New Jersey, 278 p.
26. Pateli A.G., Giaglis G.M. (2004) A research framework for analysing eBusiness models. *European Journal of Information Systems*, 13(4), pp. 302-314.
27. Petrovic O., Kittl C., Ryan D.T. (2001) Developing business models for ebusiness. In: *International Conference on Electronic Commerce (ICEC) 2001*, Vienna, Austria, pp. 1-6.
28. Rayport J., Jaworski B. (2001) *E-commerce*, McGraw-Hill/Irwin, New York, 456 p.
29. Sosna M., Trevinyo-Rodrı´guez R.N., Velamuri S.R. (2010) Business model innovation through trial-and-error: learning the Naturhouse case. *Long Range Planning*, 43(2-3), pp. 383-407.
30. Tapscott D., Ticoll D., Lowry A. (2000) *Digital capital: harnessing the power of business webs,* Harvard Business School Press, Cambridge, MA, 320 p.
31. Teece D.J. (2010) Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), pp. 172-194.
32. Timmers P. (1998) Business models for electronic markets. *Electronic Markets*, 8(2), pp. 3-8.
33. Uvarina J.A. (2013) Business Model Working Diagram for a Service Oriented Company. *World Applied Sciences Journal*, 26(10), pp. 1261-1266.
34. Weill P., Vitale M. (2001) *Place to space: migrating to e-Business models*, Harvard Business School Press, Boston, 372 p.
35. Zott C., Amit R., Massa L. (2011). The business model: recent developments and future research. *Journal of Management*, 37(4), pp. 1019-1042.
36. Zott C., Amit, R. (2010) Business model design: an activity system perspective. *Long Range Planning*, 43(2-3), pp. 216-226.

DETERMINATION OF THE IMPORTANCE AND PERFORMANCE OF FACTORS AFFECTING RURAL TOURISM HOMESTEAD CHOICE IN LITHUANIA

Viktorija Grigaliūnaitė, **Lina Pilelienė**
Vytautas Magnus University, Lithuania
viktorija.grigaliunaite@fc.vdu.lt; l.pileliene@evf.vdu.lt

Abstract
The aim of the research was to determine the balance between the importance and performance of factors affecting the choice of rural tourism homestead in Lithuania. The questionnaire research was provided in Lithuania in 2014. Tourists' evaluations regarding five exogenous latent variables: 'accommodation and catering', 'activities in destination', 'natural features', 'destination aesthetics', and 'environmental preservation', and four endogenous latent variables: 'destination marketing', 'perceived value', 'satisfaction', and 'loyalty' were measured. The total effects for the specific endogenous constructs in the structural model (importance) and the average values of the latent variable scores, rescaled to a range of zero and 100 (performance) were measured to compose the importance-performance grid. The research results indicate that the most important factors for tourists while choosing a rural tourism homestead in Lithuania are 'destination marketing', 'environmental preservation', 'perceived value' and 'satisfaction'. Moreover, the highest share of the total investments allocated to satisfy tourists and enhance the level of loyalty should be accrued to the improvement of 'destination marketing' and 'environmental preservation'.
Key words: importance-performance analysis, Lithuania, rural tourism, tourist satisfaction, tourist loyalty.

Introduction

The WTO has rated Rural Tourism as one of the fastest growing segments in the tourism industry, with an annual growth of 5 per cent worldwide and representing 6 per cent of the world GDP (Rădac et al., 2012). Moreover, according to Radnić et al. (2011), it may be rightfully called 'the future of the world tourism', thus, in the EU Member States it is an important segment of the tourist market offer. Rural tourism can be considered as a potential source of social, economic, cultural and environmental benefits for rural areas (Cvetanovska-Gugoska et al., 2013). According to Rădac et al. (2012), rural tourism encompasses all tourist activities and recreational experiences that occur in non-urban, populated areas, thus, it creates growth potentials for rural areas: it can provide income for local businesses, help to protect the traditional values and the community assets and help to sustain local services (Cvetanovska-Gugoska et al., 2013), revitalise rural areas, enable valorisation of economic resources (Radnić et al., 2011).

Considering all its benefits for a small country like Lithuania, rural tourism development becomes an area of key interest. However, managing tourist destinations is a challenging and complex process (Griffin and Edwards, 2012). Kaže et al. (2011) accentuate that rural tourism management requires a proper positioning of tourism propositions to meet consumer needs and expectations. Martilla and James (1977) introduced the importance-performance analysis, which offers a number of advantages for evaluating consumer acceptance of a marketing program, facilitates management interpretation of the data and increases their usefulness in making strategic marketing decisions. Accordingly, the **scientific problem** analyzed in the article is formulated by a question: what factors for customers while choosing a rural tourism homestead in Lithuania are important and how these factors are managed.

The **aim** of the research is to determine the balance between the importance and performance of factors affecting the choice of rural tourism homestead in Lithuania. To meet the aim of the research, following tasks were set: 1) to perform the questionnaire research and to determine the method of importance-performance analysis suitable to reach the aim of the research; 2) to analyse the importance and performance levels of factors affecting the choice of rural tourism homestead in Lithuania; 3) to provide recommendations resulting in the balance between the importance and performance of factors affecting the choice of rural tourism homestead in Lithuania.

Materials and Methods

Charaf and Rahmouni (2014) propose using the importance-performance analysis (IPA) as a marketing tool for the study of customer satisfaction with regard to the attributes of any service or product. According to Griffin and Edwards (2012), this method, originally developed in a marketing context, has been applied for a range of tourism products, services, and destinations. The IPA can be used to identify improvement opportunities as well as to guide strategic planning efforts for the hospitality industry: it indicates the priority areas of focus in order to improve the overall performance (Cvelbar, Dwyer, 2013). The elaborators of IPA analysis Martilla and James (1977) emphasize that an attractive feature of importance-performance analysis is that the results may be graphically displayed on an easily-interpreted, two-dimensional grid. Since its origination, the IPA is graphically presented on a grid divided into four quadrants (Gwo-Hshiung, Hung-Fan, 2011). According to Sooreh et al. (2011), a typical importance-performance grid is organized

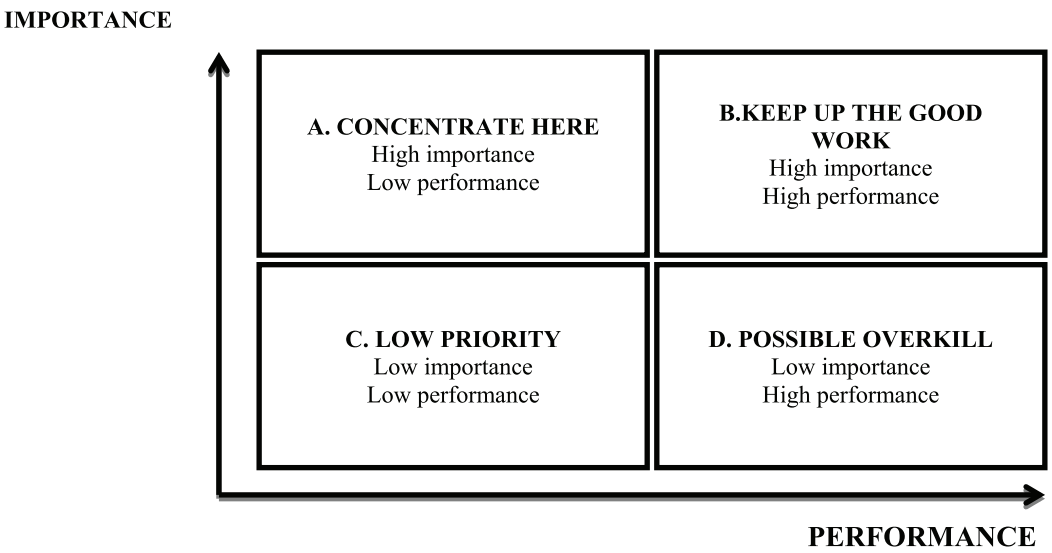


Figure 1. The importance-performance grid.

Source: adapted by Cvelbar and Dwyer (2013) from Martilla and James (1977).

as follows: the horizontal axis reflects performance, but the vertical one – importance. Finally, the graph produces four zones enabling the classification of service attributes according to their importance and performance (Charaf, Rahmouni, 2014), which helps in identifying the areas for improvement and actions for minimising the gap between the two dimensions (Cvelbar, Dwyer, 2013). The traditional IPA grid is presented in Figure 1.

According to Martilla and James (1977), it is critical to determine what attributes to measure. As the IPA analysis is mainly elaborated for customer satisfaction measurement, we decided to use the previously elaborated model of Rural Tourist Satisfaction Index (see Grigaliūnaitė, Pilelienė, 2014) as the background. The model contained five exogenous latent variables: 'accommodation and catering', 'activities in destination', 'natural features', 'destination aesthetics', and 'environmental preservation', and four endogenous latent variables: 'destination marketing', 'perceived value', 'satisfaction', and 'loyalty' (see Fig. 2).

The Rural Tourist Satisfaction Index model had 22 manifest variables, which were provided in a questionnaire for respondent evaluations (*available from the authors upon request*). According to Martilla and James (1977), frequently a five- or seven-point scale yields a good spread of ratings, and the middle position constitutes a useful division for the grid. However, Coelho and Esteves (2006) emphasize

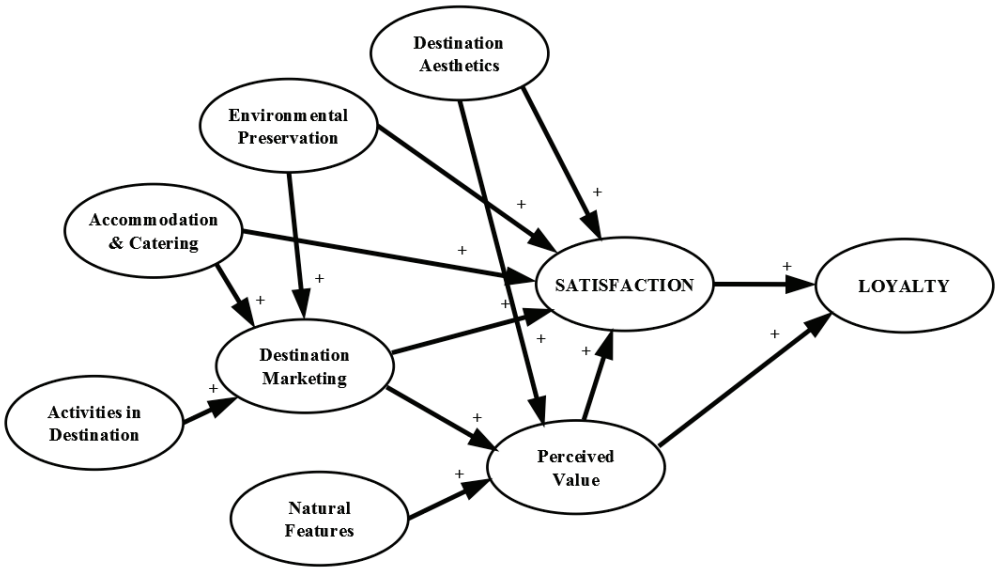


Figure 2. The Model of Rural Tourist Satisfaction Index.

that the accuracy of the satisfaction researches' results is higher when the 10-point scale is used for the research; thus, the 10-point evaluation scale was applied in the questionnaire. The total sample size was 200; the survey was conducted in 2014. SPSS Statistics v.20, SmartPLS V.3 (Ringle et al., 2014) and Matlab R2012b software packages were applied for the statistical analysis of research results.

Charaf and Rahmouni (2014) suggest measuring the performance and importance of the attributes by the average score of the criteria of all respondents. By grouping all of the importance measures in one section and all of the performance measures in a later section, the respondent moves in a natural progression from general to more specific questions with a distinct separation between his ratings for each attribute (Martilla and James, 1977). However, if the information of importance is lacking, several methods such as variance, regression, and sensitivity analysis can be applied to derive the importance for each item from the survey results (Shieh and Wu, 2011). Lacking the direct responses referring to the attributes' importance, Ban (2012) proposes indirectly to determine this dimension by checking the correlation between the perceived performance and the global satisfaction. Hair et al. (2012) for IPA suggest calculating the total effect for the specific endogenous construct in the structural model (importance) and the average values of the latent variable scores, rescaled to a range of zero and 100 (performance). We choose the latter method for the analysis.

Results and Discussion

It is well established in practice, that the performance of the variable constituting satisfaction model is considered as high / very high if the score value is above 75 (EPSI Rating, 2008). Regarding the total effect, which represents the sum of the direct effect and all indirect effects of a particular latent variable on another (Henseler et al., 2009), the threshold value is 0.3 to consider it high. Following this approach, for each of the endogenous variables Importance-Performance matrix is composed. Latter matrix for the variable 'destination marketing' is presented in Figure 3 (a). As it can be seen, 'environmental preservation' has high level of performance and high level of importance, thus maintaining the existing level of performance of latter variable is essential in order to keep 'destination marketing' well managed. On the other hand, variables 'accommodation and catering' and 'activities in destination' have low level of performance. Considering the fact that these variables have low level of importance as well, there is no necessity for high investments to improve the performance of latter variables in order to enhance 'destination marketing'.

The Importance-Performance matrix for the variable 'perceived value' is presented in Figure 3 (b) below. In this case, 'destination marketing' is the one variable, which has high level of performance as well as importance, while 'environmental preservation' has high level of performance, but low level of importance. Bearing in mind, that 'environmental preservation' is the most important variable for keeping high level of 'destination marketing', which is the most important variable for 'perceived value', it can be stated that 'environmental preservation' indirectly influences tourists' perception of value; thus, the importance of latter variable must be realised.

The assumption is made that 'natural features' is a constant because of the requirement of high investments in order to change the performance of it. The analysis substantiates that investments into latter variable even would not pay off due to low level of importance of latter variable's perceived value for tourists. Moreover, the analysis of the research results reveals that variables 'destination aesthetics', 'accommodation and catering', and 'activities in destination' (latter variable is marked with X because it has no statistically significant influence on 'perceived value') have low level of importance and performance. Consequently, 'destination aesthetics'

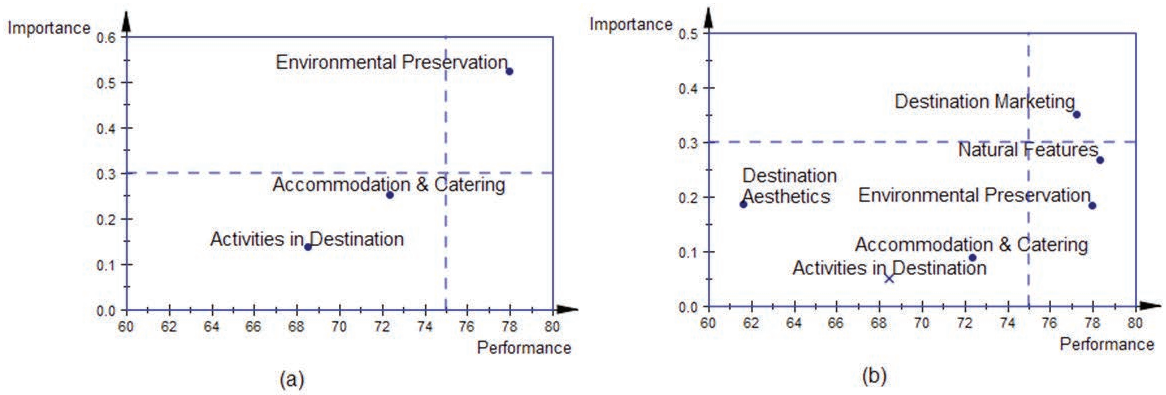


Figure 3. Importance-Performance matrix for the variable:
(a) 'destination marketing'; (b) 'perceived value'.

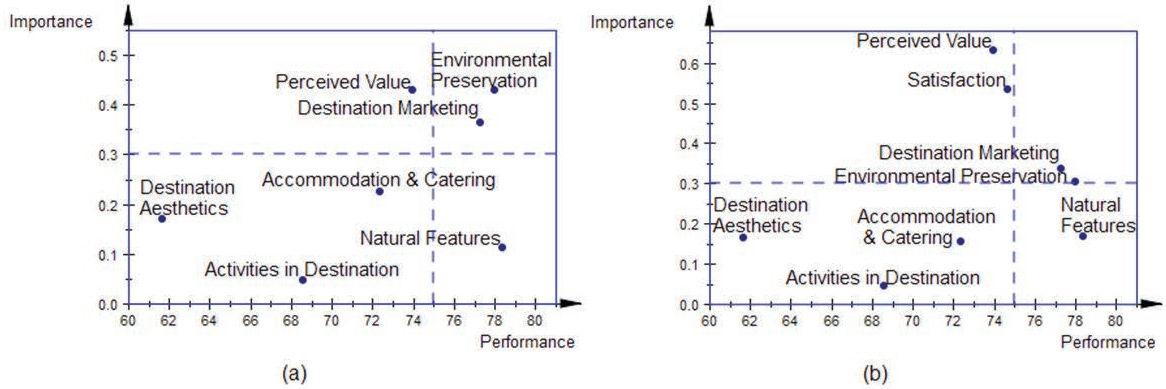


Figure 4. Importance-Performance matrix for the variable: (a) 'satisfaction'; (b) 'loyalty'.

and 'accommodation and catering' becomes low priority variables, worth only small percentage of the investments.

Variables 'destination aesthetics', 'accommodation and catering', and 'activities in destination' have low importance for the variables 'satisfaction' (see Fig. 4 (a)) and 'loyalty' (see fig. 4 (b)), thus, it is fully substantiated that latter variables are worth only a small percentage of the investments. The variable 'natural features' is not worth high investments that it would require in order to be enhanced, because it has low importance for all of the endogenous variables in the analyzed model (including 'satisfaction' and 'loyalty') and high performance.

Variables 'environmental preservation' and 'destination marketing' have high importance for tourist satisfaction and loyalty and these variables achieve high performance levels; thus, the management of latter variables is appropriate. On the other hand, 'perceived value' has a high importance for the variables 'satisfaction' and 'loyalty', but the level of performance is low, implying that even though management of 'environmental preservation' and 'destination marketing' is appropriate, it is not sufficient in order to enhance the performance level of 'perceived value'. Furthermore, the variable 'satisfaction' has high importance for the variable 'loyalty', but the level of performance is low as well. Considering that 'satisfaction' is influenced by 'perceived value', the obvious implication can be made that a high level of performance of variables 'environmental preservation' and 'destination marketing' is not satisfactory to ensure tourist loyalty.

Based on the analysis of the research results, general guidelines for Lithuanian rural tourism homesteads are composed and provided in Figure 5 below. One variable that falls within the zone D ('possible overkill') is 'natural features', which is assumed to be a constant and the analysis shows that trying to higher the level of performance of latter variable is very risky. Three variables that fall within the zone C ('low priority') are 'destination aesthetics', 'activities in destination', and 'accommodation and catering'. In this case, it does not mean that investments are

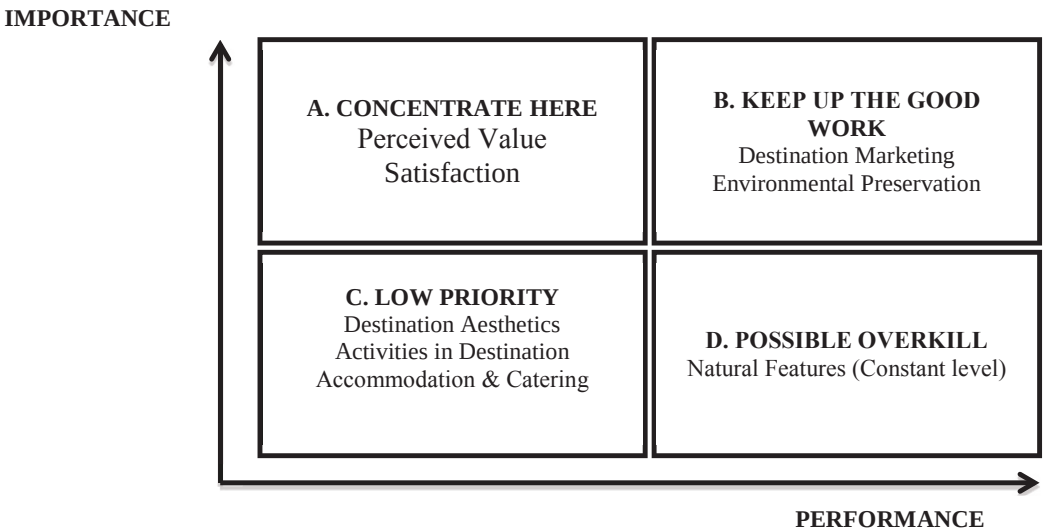


Figure 5. General guidelines for Lithuanian rural tourism homesteads.

not required, but they should constitute only a small percentage of total investments allocated to satisfy tourists and enhance the level of loyalty.

The two variables that fall within the zone B ('keep up the good work') are 'destination marketing' and 'environmental preservation', implying that the management of latter variables is appropriate. Despite this, the analysis of the research results reveals that the two variables, that fall within the zone A ('concentrate here') are 'perceived value' and 'satisfaction'; and latter variables are influenced by 'destination marketing' and 'environmental preservation'. Consequently, the performance level of the variable 'perceived value' should be enhanced in order to improve 'satisfaction'; the enhanced levels of performance of latter variables can result in higher tourist loyalty. Hence, even though the 'destination marketing' and 'environmental preservation' are managed appropriately, this is not sufficient. The highest share of the total investments allocated to satisfy tourists and enhance the level of loyalty should be accrued to the improvement of 'destination marketing' and 'environmental reservation', and that would lead to the balance between the importance and performance of factors affecting the choice of rural tourism homestead in Lithuania

Conclusions

Research results revealed that the most important factors for tourists while choosing a rural tourism homestead in Lithuania are 'destination marketing', 'environmental preservation', 'perceived value' and 'satisfaction'. Two of latter factors ('destination marketing' and 'environmental preservation') are managed appropriately, though this is not sufficient in order to enhance tourist satisfaction and loyalty. The research results imply that the highest share of the total investments allocated to satisfy tourists and enhance the level of loyalty should be accrued to the improvement of 'destination marketing' and 'environmental preservation'. On the other hand, the investments in order to enhance variables 'destination aesthetics', 'activities in destination', and 'accommodation and catering' should constitute only a small percentage of total investments allocated to satisfy tourists and enhance the level of loyalty. Finally, none of the investments should be allocated to enhance 'natural features' due to the non-guaranteed return on investments. These recommendations of how the factors affecting tourists' choice of Lithuanian rural tourism homestead have to be managed may result in the balance between the importance and performance of factors affecting the choice of rural tourism homestead in Lithuania.

References

1. Ban O. (2012) The Construction of Importance-Performance Grid in Tourist Services Research without the Direct Determination of the Attributes Importance. *Annals Of The University Of Oradea, Economic Science Series*, 21(1), pp. 474-480.
2. Charaf K., Rahmouni A.F. (2014) Using Importance Performance Analysis to Evaluate the Satisfaction of Activity-Based Costing Adopters. *Accounting & Management Information Systems / Contabilitate Si Informatica De Gestiune*, 13(4), pp. 665-685.
3. Coelho P.S., Esteves S.P. (2006) The Choice between a Five-point and a Ten-point Scale in the Framework of Customer Satisfaction Measurement. *International Journal of Market Research*, 49(3), pp. 313-339.
4. Cvelbar L.K., Dwyer L. (2013) An Importance-performance Analysis of Sustainability Factors for Long-term Strategy Planning in Slovenian Hotels. *Journal Of Sustainable Tourism*, 21(3), pp. 487-504. doi:10.1080/09669582.2012.713965
5. Cvetanovska-Gugoska B., Goceva V., Angelova B. (2013) Regional Development through the Use of the Potentials for Rural Tourism. *Economic Development / Ekonomiski Razvoj*, 3, pp. 9-22.
6. Griffin T., Edwards D. (2012) Importance-performance Analysis as a Diagnostic Tool for Urban Destination Managers. *Anatolia: An International Journal Of Tourism & Hospitality Research*, 23(1), pp. 32-48. doi: 10.1080/13032917.2011.653630
7. EPSI Rating (2008) Customer Satisfaction 2007, Pan European Benchmark. Available at: http://www.ncsi.or.kr/data/download/epsi_report_2007.pdf, 2 February 2015.
8. Grigaliūnaitė V., Pilelienė L. (2014) Rural Tourist Satisfaction Index: a Case of Lithuania. *Research for rural development: annual 20th international scientific conference proceedings*, 2, pp. 271-277.
9. Gwo-Hshiung T., Hung-Fan,C. (2011) Applying Importance-Performance Analysis as a Service Quality Measure in Food Service Industry. *Journal Of Technology Management & Innovation*, 6(3), pp. 106-114.
10. Hair J.F., Ringle C.M., Sarstedt M. (2013) Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance. *Long Range Planning*, 46(1-2), pp. 1-12. doi:10.1016/j.lrp.2013.01.001

11. Henseler J., Ringle C.M., Sinkovics R.R. (2009) The Use of Partial Least Squares Path Modeling in International Marketing. *Advances in International Marketing*, 20, pp. 277-319. doi: 10.1108/S1474-7979(2009)0000020014
12. Kaže V., Škapars R., Ščeulovs D. (2011) Development of Rural Tourism in Latvia Capitalizing on Regionally Relevant Human Values. *Management Theory & Studies For Rural Business & Infrastructure Development*, 26(2), pp. 97-104.
13. Martilla J.A., James J.C. (1977) Importance-Performance Analysis. *Journal Of Marketing*, 41(1), pp. 77-79.
14. Rădac A.B., Csösz I., Iulianamerce I., Matiaş C.G., Dobra C.I. (2012) The Benefits of Rural Tourism. *Agricultural Management / Lucrari Stiintifice Seria I, Management Agricol*, 14(4), pp. 369-372.
15. Radnić R.A., Gračan D., Zadel Z. (2011) Analysis of Rural Tourism in the European Union and Croatia. *Proceedings Of The International Scientific Conference, Juraj Dobrila University Of Pula, Department Of Economics & Tourism 'Dr. MijoMirkovic'*, pp. 1593-1621.
16. Ringle C.M., Wende S., Becker J.-M. (2014) *Smartpls 3*. Hamburg: SmartPLS. Retrieved from http://www.smartpls.com., 14 January 2015.
17. Shieh J., Wu H. (2011) Applying Information-based Methods in Importance-Performance Analysis when the Information of Importance is Unavailable. *Quality & Quantity*, 45(3), pp. 545-557. doi:10.1007/s11135-010-9312-1
18. Sooreh L.K., Salamzadeh A., Safarzadeh H., Salamzadeh Y. (2011) Defining and Measuring Entrepreneurial Universities: A Study in Iranian Context Using Importance-Performance Analysis and TOPSIS Technique. *Global Business & Management Research*, 3(2), pp. 182-199.

CONDITIONS, PRESUPPOSING CREATION OF CONSUMPTION VALUE OF LOGISTICS SERVICES IN AGRARIAN SECTOR

Audrius Gargasas, **Indra Mūgienė**
Aleksandras Stulginskis University
audrius.gargasas@asu.lt

Abstract
With increasing competition between companies providing logistics services, a need for new services occurs, entire service packages are formed in order to retain customers. Logistics companies frequently have similar machinery and equipment, employees with similar professional qualifications; they also work in essentially identical economic environment. Investments to technical base are not enough in order to attract new users of logistics services or to retain existing users. In order to be profitable, companies providing logistics services try not only to satisfy the needs of users, but also to provide value for the services that would totally meet implied expectations of the users. When using the same service, different users may assess it completely differently. Therefore, one of the most important aspects in business activity of the companies providing logistics services is the creation of consumption value without the need for significant financial investments ensuring high-end performance. The objective of the research is to determine conditions presupposing the creation of consumption value of logistics services in agrarian sector upon analyzing theoretical assumptions of the creation of consumption value. The research was conducted in the Republic of Lithuania by interviewing executives of the companies providing different logistics services and operating in different regions. Main logistics service groups specific to agrarian sector are defined in the article, and conditions presupposing the creation of consumption value of logistics services are determined.
Key words: consumption value, logistics services, agrarian sector.

Introduction

Logistics companies operate under conditions of fierce competition. New companies providing similar services are being established, range of services is being expanded, and new addition services are being offered as well as service packages are being formed. Logistics companies frequently have similar machinery and equipment, employees with similar professional qualifications; they also work in essentially identical economic environment. Investments to technical base are not enough in order to attract new users of logistics services or retain existing users. Users expect to receive services that would satisfy their needs to maximum, which is not always possible to be measured using only technical parameters. Fisk P. (2007) aptly defines a modern user: "Today's users are more diverse and individualistic, they distinguish themselves and are more demanding. They are more intelligent and scrupulous and have higher expectations."

In order to be profitable, companies providing logistics services try not only to satisfy the needs of users, but also to provide value for the services that would totally satisfy implied expectations of the users. A notion that the value of goods or services consists of exchangeable value and consumption value prevails in scientific literature. Exchangeable value defines monetary aspect, while the consumption value is considered to be dependent from the subjective assessment of the buyer. When using the same service, different users may assess it completely differently. Some users shall be totally satisfied with it, however, others shall deem it to be of a lower quality, or on the contrary, their expectations shall be satisfied over and above. Therefore, it is quite difficult to determine the value of the service unambiguously. "In some cases, it can be difficult to assess the service even after using it." (Barksdale and Day, 2003) Thus, sometimes it is hard for the user to decide whether the service provided the benefit expected, or maybe he expected to get a better service in other company for the same price. Therefore, one of the most important aspects in business activity of the companies providing logistics services is the creation of consumption value without the need for significant financial investments ensuring high-end performance.

Research object was creation of consumption value.

Objective of the research was to determine conditions presupposing the creation of consumption value of logistics services in the agrarian sector upon analyzing theoretical assumptions of the creation of consumption value.

Goals of the research are the following:

- to reveal theoretical assumptions of the creation of consumption value;
- to define main groups of logistics services specific to agrarian sector;
- to determine conditions presupposing the creation of consumption value of logistics services in agrarian sector.

Research methodology. In order to reveal theoretical aspects of creation of consumption value, general research methods were applied – comparative analysis of scientific literature, generalization and interpretation methods. A semi-structured interview method was applied when analyzing the possibilities for creation of consumption value in companies

providing logistics services in agrarian sector. The research was conducted by interviewing authorized employees of the companies providing different logistics services and operating in different regions of Lithuania.

Materials and Methods

Concept of consumption value was formed by developing the notion of the value for the user, as well as by analyzing possibilities for increasing the value the user of the service receives. According to Paulraj, A. and Chen, I. J. (2007), an effective management and development of the organization are directly related to the management of logistics processes. Distribution of goods and determination of stock level, storage and transportation, order handling and satisfaction of the needs of the customer are an integral part of the sale of products and logistics servicing of the customers. With an increasing competition, logistics companies are motivated to improve customer service policy in order to satisfy the needs of the customers and develop long-term profitable relationships in this way (Grant, 2005). In order to remain in the market, companies providing logistics services use more than economic leverage. Increasing needs of the customers and increasing levels of the quality of logistics services force logistics companies to look for additional elements of services provided that would provide additional value of the service to the customer without significant financial investments.

The aspect of increasing the value for the user becomes more relevant to the companies providing logistics services. Customer satisfaction is one of the principal elements of objectives and success of the company (Naik et al., 2010). According to Piskoti I. and Nagy S. (2009), maintaining the relationships with customers and creation of maximum value in different ways is the orientation of each company, and this increases the success of the business. It is important to understand the benefit the customer expects to receive when planning to acquire the service. It is the value for the customer that is a prerequisite for all other values (Khalifa, 2004).

In the opinion of Christopher, M. and others (2003), the creation of value for the user is a set of certain activities orientated to physical process "for the production and sale of the product" in the context of one-time interaction with the user. Veloutsou C., Saren M., and Tzokas N. (2002) analyze the processes of creation of value for the user that are orientated to the creation of higher value for the user instead of orientation to the product by distinguishing fundamental stages of this process: establishing the value, its creation, communication and assessment. A statement by Khalifa A. S. (2004) that the benefit received by the user can be expressed by tangible or intangible properties of goods and (or) services being offered may be presented as a summary. This author believes that the perception of the value for the user can be referred to as constantly developing and dynamic concept.

When analyzing the possibilities for increasing final value received by the user based on intangible properties of services, a concept of consumption value formed in scientific literature is considered to be dependent from subjective assessment of the buyer, and this assessment depends on the extent to which this need for the user is significant and the degree of necessity for the satisfaction of this need. It is a subjective perception of the buyer that provides a unique value to the value of goods or services that is defined as consumption value by combining functional, conditional, epistemic, emotional, and social values (Sheth et al., 1991).

Potential user of logistics services selects service provider on the basis of subjective assessment of desired service. Barksdale H.C. and Day E. (2003) distinguish four dimensions significant for the selection of service provider:

- Perceived experience, expertise, and competence of service provider.
- Service provider's understanding of customers needs and interests.
- Service provider's interaction, relationship, and communication skills.
- Likelihood of service provider's adaptability to contractual and administrative requirements.

Based on these dimensions, a statement that relationships and competences are most important aspects in the creation of consumption value can be made. The notion is confirmed by the scientist Moller, K. (2006) who argues that certain competences and skills are necessary for the creation of value. Similar ideas are expressed by a scientist analyzing professionalism of services. These authors state that only professional services are adapted to individual needs of the user (Wemmerlov, 1992; Peterson and Sharma, 1999, and others). According to Laing A.W. and Lian P.C.S. (2007), a high degree of interaction between service provider and the customer is specific to professional services created by employees of high competences. These services are of advisory nature and are focused to problem solving and involve tasks given by customers (Cohel, 2006). Creation of consumption value in the context of relationships (interaction) is analyzed in works by scientists Lapierre, J. (1997) and Gronroos, Ch. (2006).

Configuration of value is described as organization of use of activity and resources, which is necessary in order to create value for users, also in order for the business model to function (Osterwalder, 2009). Consumption value in logistics is a new concept as

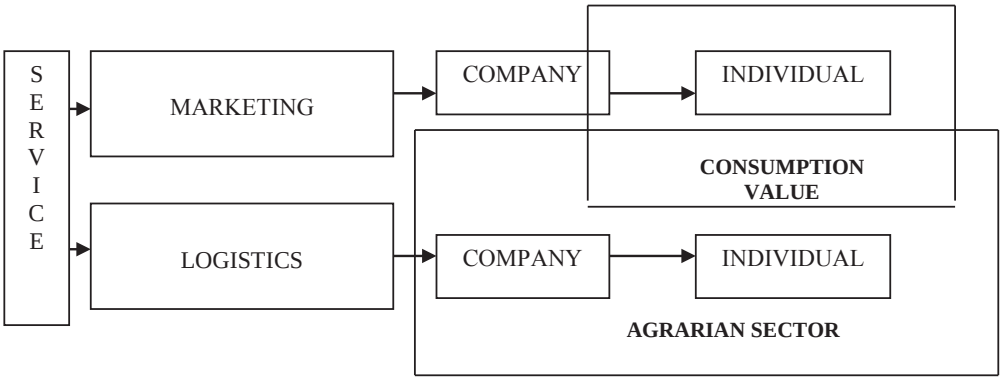


Figure 1. The concept of a user from the perspective of logistics and marketing.

it is commonly believed that logistics services are limited by the chain "production company – wholesale company – retail company". Naturally, the analysis of creation of consumption value is omitted in the chain "company – company". This is the area for future research.

However, the agrarian sector is unique in a way that the majority of users of logistics services are not only companies or organizations, but also natural persons participating in the production of agricultural products and using technical maintenance, transportation, storage, production buying up, and other services. Therefore, one of the most significant aspects of logistics services provided for agrarian sector is the fact that for the most part a farmer or a producer of agricultural products operating under certificate of individual activity instead of a company is the user of the service (Figure 1).

Thus, it can be said that the concept of the user in agrarian sector is almost identical from the perspective of both logistics and marketing. It presupposes the assumption for the analysis of the creation and possibility of increasing consumption value.

Results and Discussion

The objective of the research conducted was to determine conditions motivating to create a higher consumption value of services in logistics companies servicing agrarian sector.

The research was conducted throughout the territory of the Republic of Lithuania, in all geographical regions. Received data shows that logistics services, like buying up fish, storage and transportation of it more often are provided in western regions. Such services, like buying up of mushrooms and berries, freight forwarding most often are provided in the southern regions of Lithuania. Buying up of grain, storage, cleaning and processing of it, supply of chemicals, buying up of root vegetables services are demand in the middle of Lithuania. Other logistic services in agrarian sector are provided equally across Lithuania.

In order to obtain objective data, companies providing different logistics services and operating in different regions of Lithuania were randomly selected and executives or employees responsible of these companies were interviewed. Geographical distribution of the companies selected for the research is presented in Figure 2.

A semi-structured interview method was applied when conducting the survey with the most important question groups being introduced in advance by supplementing or adjusting them during the interview. Three main question groups were formed defining the following: the nature of services provided by the company; peculiarities of the region the company operates in; concentration of companies providing similar services in research region. The nature of logistics services in different companies is presented in Table 1.

According to the survey conducted, following main groups of logistics services generally provided in agrarian sector were identified: supply, buying up, storage, transportation and selling.

Combinations of logistics services prevailing in agrarian sector were formed in accordance with research data:

- supply, buying up, storage, selling;
- supply, buying up, transportation, selling;
- supply, storage, selling;
- transportation, provision;
- transportation, buying up;
- transportation, storage.

According to theoretical assumptions of the creation of consumption value, it can be said that companies providing services of buying up and storage of raw milk, mushrooms and berries have lower opportunity for the creation of consumption value. In these cases, the vector of service provision is directed towards the direction "recipient – company". The aspect of creation of consumption value is important to companies providing logistics services with a farmer or producer of agricultural products being the end-user.

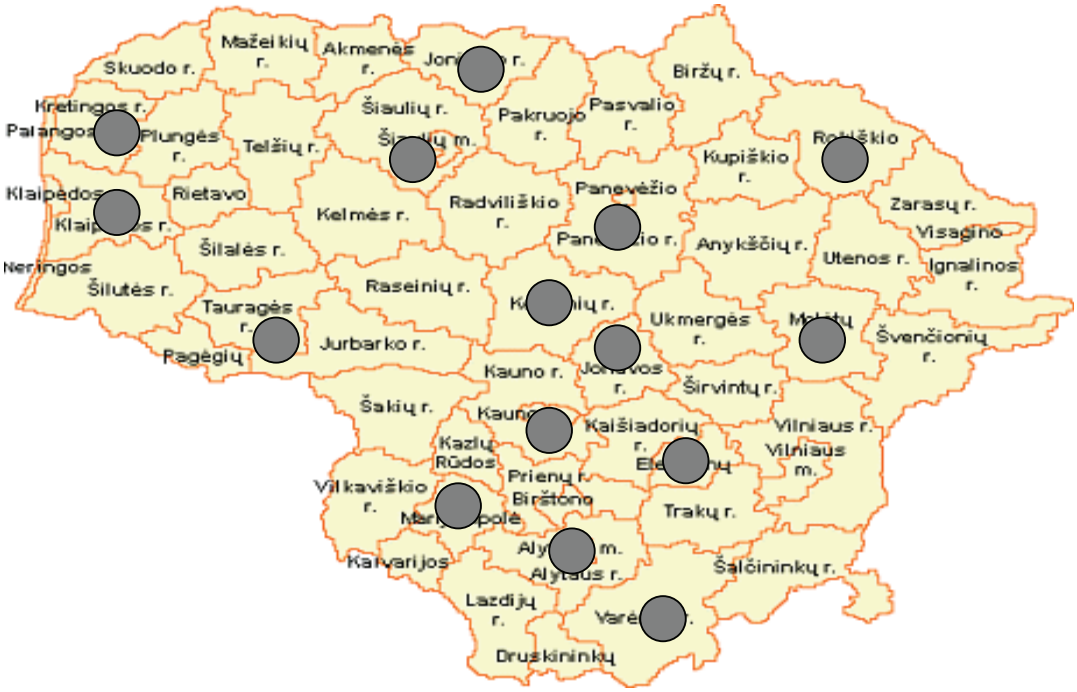


Figure 2. Geographical distribution of companies being researched.

When analyzing conditions presupposing the creation of consumption value in agrarian sector, companies providing logistics services are divided into three groups:

- according to the nature of product;
- according to geographical region;
- according to combination of logistics services.

Production of different agricultural products prevails in different regions. This leads to the demand of different logistics services.

Logistics service group according to the nature of the product includes companies engaged in buying up mushrooms, berries, raw milk, fish, and grain, also providing technical maintenance and transportation services.

When dividing according to geographical region, logistics companies engaged in buying up mushrooms, berries, fish, and grain (Southern, Western, Northern, and central Lithuania) and companies providing general storage and transportation services can be defined.

When taking into consideration the combination of logistics services provided, a zone in central Lithuania reveals itself, where a concentration of logistics companies engaged in buying up grain and providing storage, drying, cleaning services, also supplying necessary materials for packing, chemical and energetic materials is observed. Higher land productivity score as compared to other regions is the main condition for the establishment of the companies providing logistics services of this nature resulting in active involvement of organizations growing crops and individual farmers. The number of companies buying up grain and providing storage and selling services in southern districts of Lithuania with a lower land productivity score is significantly lower; here, buying up of mushrooms and berries, also transportation, servicing wood preparation companies, and freight forwarding services are provided more often. If there is no stronger demand for predominant logistics service group, the number of companies providing homogenous services is not great. They work under conditions of low competition and are not interested in increasing the level of consumption value of services provided.

Thus, research results demonstrate that land productivity score and competitive conditions of companies providing similar services in the region are the main conditions motivating the creation of consumption value of logistics services in agrarian sector (Figure 3).

Competition is the main condition presupposing the creation of consumption value. The greater the concentration of companies providing similar logistics services, the more relevant the issue of customer loyalty and service quality. Specifics of the region the company providing logistics services operate in is an equally important factor. Land productivity score is the most important condition in agrarian sector determining the nature of desired logistics services.

It is worth to consider the application of classical attributes of components of consumption value to the agrarian sector when analyzing possibilities for increasing consumption value of logistics services.

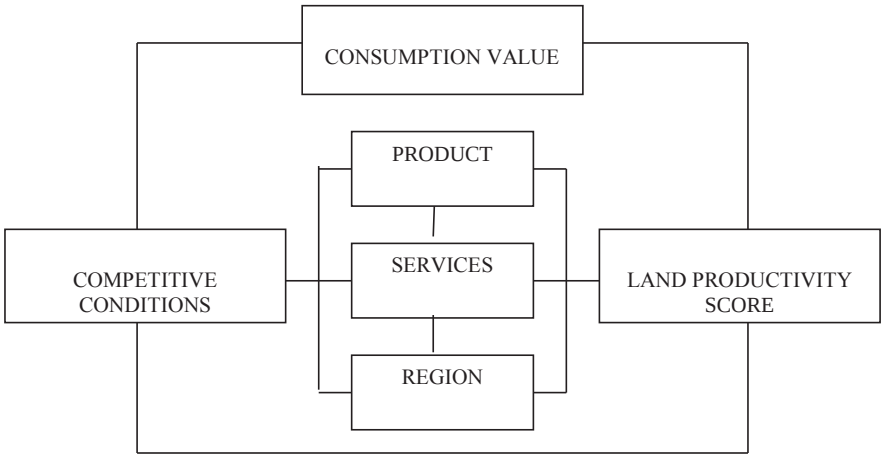


Figure 3. Conditions motivating the creation of consumption value of logistics services.

Possible groups of attributes of components of consumption value of logistics services specific to agrarian sector are presented in Table 2.

According to the research conducted, it can be said that attributes of components of consumption value of different logistics services provided in agrarian sector may overlap. This is related to the multiplicity of attributes of value being created. For example, time attribute in agrarian sector carries different value in the context of the duration of transportation and production realization period during season. It is likely that emotional and social component of consumption value for the users of logistics services in agrarian sector shall have minimum value, while functional, conditional, and epistemic components shall be of greater significance. Functional component of value is related to technical measures. If consumption value is increased using this component, significant investments for the improvement of equipment and control measures are necessary. Epistemic component in this context reflects the quality of information management, while conditional component reflects settlement form and possibility for provision of additional services. In order to create a greater consumption value with minimum investment, it is appropriate to aim for the improvement of attributes of components of conditional and epistemic value by using classical management measures: information about price changes, possibility of additional services provided operatively; implementation of more diverse and flexible settlement forms; coordination of delivery schedules.

Conclusions

A concept of consumption value formed in scientific literature is considered to be dependent from subjective assessment of the buyer, and this assessment depends on the extent to which this need for the user is significant and the degree of necessity for the satisfaction of this need. It is a subjective perception of the buyer that provides a unique value to the value of goods or services that is defined as consumption value. Agrarian sector is unique in a way that the majority of users of logistics services are not only companies or organizations, but also natural persons participating in the production of agricultural products and using

Table 2

Components of consumption value

Classic components of consumption value	Components of consumption value specific to agrarian sector
FUNCTIONAL VALUE: rationality, physical properties, price	FUNCTIONAL: time, settlement, safety, reliability, technical specifications
CONDITIONAL VALUE: situation, context, circumstances	CONDITIONAL: time, quality, settlement, control, technical specifications
EPISTEMIC VALUE: curiosity, innovations, knowledge	EPISTEMIC: price, settlement, information, control, technical specifications
EMOTIONAL VALUE: religions, feelings, childhood memories	EMOTIONAL: settlement, technical specifications
SOCIAL VALUE: traditions. Demographic, socioeconomic, ethnical stereotypes	SOCIAL: settlement, technical specifications

technical maintenance, transportation, storage, production buying up, and other services. Therefore, one of the most significant aspects of logistic services provided for agrarian sector is the fact that for the most part a farmer or a producer of agricultural products operating under a certificate of individual activity instead of a company is the user of service. It can be said that the concept of the user in agrarian sector is almost identical from the perspective of both logistics and marketing. It presupposes the assumption for the analysis of the creation and possibility for increasing consumption value.

Supply, buying up, storage, transportation, and selling are main logistics service groups generally provided in agrarian sector. Combinations of logistics services prevailing in agrarian sector usually include provision, transportation, and buying up. The aspect of creation of consumption value is important to companies providing logistics services with a farmer or producer of agricultural products being the end-user.

Companies providing logistics services may be divided into three groups: according to the nature of product, according to geographical region and according to combination of logistics services. Production of different agricultural products prevails in different regions. This leads to the demand of different logistics services. Competition is the main condition presupposing the creation of consumption value. The greater the concentration of companies providing similar logistics services, the more relevant the issue of customer loyalty and service quality. Land productivity score is the most important condition in agrarian sector determining the nature of the most desired logistics services.

References

1. Barksdale H.C., Day E. (2003) Selecting a professional service provider from the short list. *Journal of Business & Industrial Marketing,* Vol. 18, No. 6/7, pp. 564-579.
2. Christopher M., Payne A., Ballantyne D. (2003) Relationship Marketing: creating stakeholder value. *Oxford: Butterworth-Heinemann. Marketing Theory*, No. 3 (1), pp. 159-166.
3. Cohel T.G. (2006) Barriers to Marketing within Professional Service Firms: A thesis submitted for degree of Doctor of Philosophy. *Brunel Business School, Brunel University*, p. 356.
4. Fisk P. (2007) Rinkodaros genijus. *Vilnius: Verslo žinios* (Marketing genius. Vilnius : Business News). p. 488. ISBN 978-9955-460-40-4. (in Lithuanian).
5. Grant D. (2005) The transaction – relationship dichotomy in logistics and supply chain management. *An international Journal*, No. 6, pp. 38-48.
6. Gronroos Ch. (2006) Adopting service logic for marketing. *Marketing theory articles*, Vol. 6, No. 3, pp. 317-333.
7. Khalifa A.S. (2004) Customer value: a review of recent literature and an integrative configuration. *Management decision*, No. 42, (5), pp. 645-666.
8. Laing A.W., Lian P.C.S. (2007) Relationships in the purchasing of business to business professional services: The role of personal relationships. *Industrial Marketing Management,* No. 36, pp. 709-718.
9. Lapierre J. (1997) What does value mean in business-to-business professional services? *International Journal of Service Industry Management*, Vol. 8, No. 5, pp. 377-397.
10. Moller K. (2006) Role of competences in creating customer value: A value-creation logic approach. *Industrial Marketing Management*, 35, pp. 913-924.
11. Naik K., Bhargavi S., Prabhakar V. (2010) Service quality and its effect on customer satisfaction in retailing. *European Journal of social sciences*, No. 16 (2), pp. 239-251.
12. Osterwalder A., Pigneur Y. (2009) Business model generation. Available at: http://www.businessmodelgeneration.com/downloads/businessmodelgeneration_preview.pdf, 11 May 2014.
13. Paulraj A., Chen I.J. (2007) Strategic Buyer-Supplier Relationships, Information Technology and External Logistics. *Integration The Journal of Supply Chain Management*, No. 43 (2), pp. 2-14.
14. Petterson G.P., Sharma N. (1999) The impact of communication effectiveness and service quality on relationship commitment in consumer, professional services. *The Journal of Services Marketing,* No. 13, (2), pp. 151-170.
15. Piskoti I., Nagy S. (2009) A new customer satisfaction management model (methodology and practice). *Economics and managements,* No. 14, pp. 483-490.
16. Sheth J.N., Newman B.I., Gross B.L. (1991) Why We Buy What We Buy: A Theory Of Consumption Values. *Journal Of Business Research,* 22, pp. 159-170.
17. Veloutsou C., Saren M., Tzokas N. (2002) "Relationship marketing: What if … ?", *European Journal of Marketing*, No. 36 (4), pp. 433-449.
18. Wemmerlov U. (1992) A Taxonomy for Service Processes and its Implications for System Design. *International Journal of Service Industry Management*, No. 3, pp. 62-75.

COST PRICE CALCULATION METHODOLOGY FOR BEEF FARMS

Linda Siliņa[1], Raivis Andersons[2]
[1]Latvia University of Agriculture
[2]Latvia University of Agriculture
raivis_andersons@inbox.lv

Abstract
Quality of information about cost structure of farm is of high importance when making management and production process improvement decisions. Aggregating and analyzing production process cost information by correct and unified methodology provides possibility of evaluating the structure of expenditures. Moreover, it is possible to identify most important cost positions and get perspective on production process. By collecting and processing data using unified methodology it is possible to conduct comparing evaluation between different farms. This is done to identify the most and less efficient farms, their work methods and cost structure. When developing unified methodology, it is essential to take into account that different farms might use different production systems and structure. When creating revenue and expense calculations, it is essential to receive accurate data. Good quality data is fundamental for receiving good quality and usable results. Precise data accounting is another important factor that ensures good quality of cost calculation. Precise accounting decreases number of cost allocation coefficients used for allocation of cost positions and thus decreasing effect of assumptions on unit production cost calculation. Fixed cost allocation by its nature to divide all costs by farm specializations is the most challenging when calculating unit production cost. In order for calculations to be of good quality, precise data on use of assets, specifics and intensity of farming is necessary. By identifying these indicators it is possible to create maximally precise calculation of unit production cost of beef.
Key words: unit production cost, data quality.

Introduction

It is important to conduct evaluation of production process and cost analysis for farm of any specialization that is involved in production. This would provide a possibility for improving production process, decreasing production costs and improve or maintain quality of the product produced. Thus, it is necessary for farms to have efficient decision-making system, which is swift and precise, in order for farms to be competitive (Tanure et al., 2013). Taking into account soon-to-be cancelled milk quota in the EU, there is a possibility that milk production output will increase, which will increase demand for fodder. Prices will increase for roughage and concentrated forage (Kempen et al., 2011). In order for beef farms to preserve or improve their competitiveness, they must improve efficiency and ability to produce product of good quality. In the times of growing competition in global agricultural market, it is essential to pay attention to increasing production efficiency and competitiveness of the farm for the farm not to rely on the EU and governmental subsidies as a substantial part of its income (Potter, 2007). For a farm to become more efficient, it has to identify its weak spots that are in need of improvement. One of the tools for identifying and analysis of the weak spots is unit production cost calculation. Unit production cost calculation provides detailed information on production cost positions and significant insights for decision-making regarding further production. In order to be able to conduct such a calculation, a methodology is necessary as well as knowledge for interpretation of the results.

The aim of this article is to create a farm activity evaluation methodology of calculating unit production cost, which can be used by beef producing farms.

Tasks of the research:

1. Identify information necessary for unit production cost calculations and methods of acquiring information;
2. Create cost classification and grouping system of costs for beef producing farms;
3. Investigate use of unit production cost at beef producing farms in evaluating farm performance.

Materials and Methods

Monographic and graphic methods, analysis and synthesis, induction and deduction are used in this article. Research results of different authors on farm efficiency evaluations, cost calculation methods and cost classification are used as a source of information.

Results and Discussion

Accounting and cost allocation

In times of increasing competition between producers of agricultural products, necessity to improve efficiency is increasing as well. It can be improved by analyzing cost structure and production results (Bezat-Jarzębowska and Rembisz, 2013). When calculating costs of production process, a farmer has to know, which data should be taken into consideration, what kind of accounting should be conducted in order for the calculation to be useful for decision making when dealing with managerial issues on the farm. It is very important to calculate unit production cost by using reliable data (Jurgens et al., 2013).

Expenses, amounts sold and sales prices should be accounted for (Paracchini, 2015). When calculating, only amount of beef sold is taken into account rather than amount of beef produced (Jurgens et al., 2013). For calculating unit production costs, data quality is very important and it has very strong effect on end result. The more precise is the input data, the more precise is the result. In collecting good quality and valid information it is necessary to collect interim results. For instance, a farm that is involved in production of beef has to follow the unit production cost of fodder because it has direct effect on unit production cost of beef (Tanure et al., 2013). That would also facilitate allocation of costs between specializations.

When calculating unit production cost of beef, one has to take into account these positions:

- Direct costs contain purchase of production resources that are connected to beef cattle. These are fertilizer, seeds, crop protection products, fodder, fuel, electricity, veterinary services, medicines, energy, insurance, contract workers etc. Production activity costs should be taken into account as well. For instance, services bought from outside the farm, consumption on a farm, herd renewal or expansion costs (buying cattle).
- Indirect costs are costs that are attributed to the whole farm and allocated to each enterprise by proportion defined (European Commission, 2012; Schader et al., 2013; Paracchini, 2015).

If beef producing farm has other cattle enterprises, it would be helpful to divide contract labor costs, veterinary costs, and fodder cost separately for each enterprise (Åby et al., 2012a). It should be done in order to avoid using allocation coefficients for calculating variable costs allocated to beef production and other cattle breeding enterprises. If separate accounting for each enterprise is not possible and large portion of farm's income is generated by crops, it is more helpful to create interim cost calculations by calculating production costs of each crop. Production costs of crop include purchase of seeds, crop protection products, fertilizer etc. (Manjunatha et al., 2013; Meul et al., 2014). When calculating indirect costs, farm's cost analysis has to include costs of maintenance of agricultural machines, service costs. When calculating workloads of machinery and intensity of use, it is possible to calculate adequacy of the machinery to the needs of the farm (Lansink et al., 2004). By calculating costs of using machinery and analyzing its use, it is possible to calculate fuel use and labor costs that are connected with operating the machinery.

There is also a possibility of creating more accurate calculation that analyzes different production cycles on the farm. These cycles are starting from calculation unit cost of production of calves at different stages of their lives, for example, calves under 6 months old, calves between six months and a year of age etc. It is also possible to calculate for how long a suckler cow should be held in a herd for it to break even (Åby et al., 2012b). By aggregating information it is possible to construct a calculation model where data can be entered (Table 1).

Calculations should include governmental and the EU support. By adding the EU and governmental support, it is possible to analyze what portion of total revenues comes from production and what portion comes from subsidies and support payments (Helming and Peerlings, 2014). These payments are important factor that reduces production costs and is significant source of funds (Schader et al., 2013). Size of payments is significant factor to ensure efficiency of production – it can be impeding as well as supporting (Bojneca and Latruffe, 2013).

When evaluating farm's activity, impact on environment should be evaluated as well. This includes taking samples for soil nutrient balance analysis, analysis of fertilizer used; yield (Pacini et al., 2003). This kind of analysis shows if farm's production model is sustainable or is it short-term, where unit production cost is decreased on the account of exploiting environmental resources.

Methods for data collection

Data for calculating unit production cost can be obtained from accounting data. Farms, especially the multidisciplinary ones, should have precise accounting in order to be able to identify stages of production process that create the whole operational system (Schouten et al., 2014). L. Mouysset has investigated that it is preferable for farms to have several enterprises. This is so because prices of agricultural products are unstable and are influenced by many external factors. Multidisciplinary farming ensures risk diversification and improves profitability of the farm (Mouysset et al., 2011). Multidisciplinary farming decreases risk of becoming insolvent, however, having more than one field of specialization creates significant problems for calculating unit production costs. This is so because two or more enterprises utilize the same production resources, for example, land, labor, machinery etc. In everyday life it is almost impossible to identify which enterprise has benefitted from particular resource and thus increased attributable costs.

Therefore, cost accounting should be conducted based on the product the cost is attributed to. It would allow identifying costs that are attributed to production of beef and the rest of the enterprises of the farm (Frank, 1996). The more complex is the farming system, the harder it is to conduct accurate tracing of production stages, which has an effect on reliability of calculations of production results and use of the results in further planning (Kempen

Table 1

Methodology scheme of calculation

Income	**Comments**
Income from sales of beef cattle production (beef, rearing material, manure, other income)	Units produced, sales price and amounts sold should be taken into account for calculation of costs to units produced, which results in unit production cost.
Expenses	**Comments**
Purchased fodder	Expense position that is attributed to all grazing livestock units. It is possible to allocate position by using livestock unit under assumption that all grazing livestock units are given constant amount of fodder per livestock unit.
Forage costs: • Seed • Fertilizers • Pesticides • Other specific costs related to fodder crops	Complicated variable expense position, especially, if the farm is involved in producing crops for sale. In such cases precise accounting of costs is necessary for allocating variable costs to crop production.
Other cattle breeding related costs (veterinary costs, purchase of rearing material etc.)	Expense position that can be attributed not only to grazing livestock but to other livestock units as well. That is why precise accounting of expenses is necessary. In practice it is observed that most of these costs are attributed to cattle, usually dairy cattle.
• Building and machinery upkeep expenses • Energy expenses • Labour costs • Other expenses • Taxes and dues	Expenses that are attributed to the farm as a whole. Building upkeep related to beef cattle breeding is separated from this position.
Wages, rent, interest paid	Expenses that are attributed to the farm as a whole. Beef cattle related expenses are separated from this position.
Depreciation	Expenses that are attributed to the farm as a whole. Beef cattle related expenses (depreciation of buildings, specialized machinery, etc.) are separated from this position.
Unit production cost: expenses of producing beef in (euro) divided with beef produced (kilograms)	Total beef sold divided by total costs attributed to beef production.

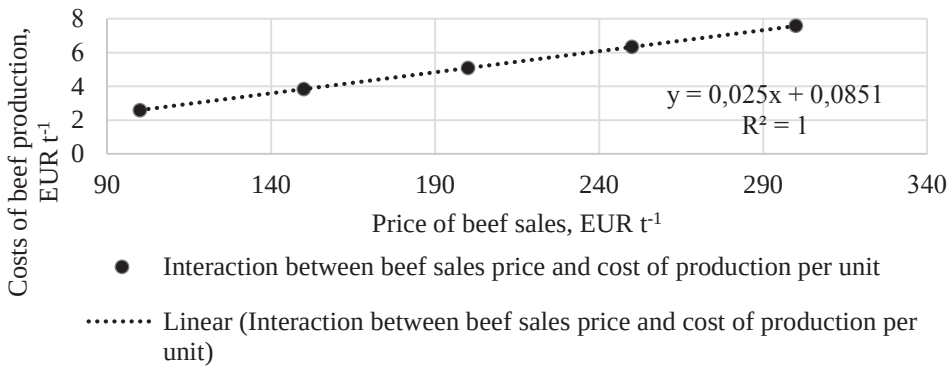
Source: Created by author using data of Jurgens et al., 2013.

et al., 2011; Schouten et al., 2014). In the analyzed articles significant role in reliability of data is played by two factors- accuracy of cost accounting and cost accounting directly related to particular enterprises. Essentially, the most significant risk in accounting is not sufficient level of detail. This data collection method has an advantage of access to the origin of the data, which allows collection of data necessary for unit production cost calculation.

If observing the issue on more global scale, to be able to compare unit production costs between farms in a state, region or Europe, a unified data accounting system should be used. Within the country Farm Accountancy Data Network (FADN) data can be used for unit production cost calculation (Latruffe et al., 2012; Jurgens et al., 2013). FADN data is gathered with a purpose of using them for analysis. Therefore, risk of data being insufficient for analysis decreases. The major problem of FADN data is their reliability. Accounting data for calculating unit production cost can be used if unit production cost analysis is necessary for one or several farms. However, if data is necessary to more farms for inspection of a particular tendency or comparison, it is preferable to use FADN data.

Cost grouping and structuring

For more accurate unit production cost calculation, it is necessary to divide costs by their nature. For instance, all crop related costs should be grouped by particular crop, which is crop's unit production cost (Martin et al., 2014; Picasso et al., 2014). Moreover, to identify the most suitable production technology to particular conditions, farms can use interim results. For instance, cost of building a shed and its effect on cost of kilogram of beef should be taken into account (Tanure et al., 2013). Technology used on the farm has a significant effect on efficiency of the farm. For example, how fast the farm can produce fodder, how well it can be preserved and feed it to cattle (Latruffe et al., 2012). By separating costs attributed to a particular production phase, procedure or production of interim production it is possible to use coefficients to allocate costs to beef production. Costs can be grouped by purpose whether they are related to whole farm operations or to cattle only. By



Source: Calculated by author based on theoretical data

Figure 1. Sales price effect on functionality of coefficient of indirect costs, theoretical calculations (European Commission, 2012).

using this approach European Commission (European Commission, 2012) has included coefficients into cost calculation method. Coefficients are used to separate costs related to milk production from total costs. The same method can be used to separate costs attributed to beef production. Variables in the coefficients have to be altered to calculate unit cost of production of beef kilogram. Coefficients are calculated based on a real situation in the farm. Thus, coefficients are dynamic and there are no two identical coefficients if production conditions are different. In the section of variable costs that contain costs of growing crops by European Commission methodology, costs of growing crops are not separated. This creates an inaccuracy because crops that are not consumed within the farm or are not added to stock, are sold. Therefore, for more accurate results it is preferable to use coefficients based on hectares by dividing area of fodder crops by total area used by the farm. This results in proportion of area of total area that is used for growing fodder crops. By using this indicator costs of growing crops that should be allocated to cattle breeding can be found. Afterwards fodder preparation costs can be used to calculate how much of farm's used land is given to beef production. This parameter is created by adding suckler cows to rearing bull to calves (in livestock units) and dividing it by total livestock units on the farm (European Commission, 2012).

European Commission has included calculation of indirect cost coefficient in the Dairy Report 2012. It is calculated by dividing total income from milk by total income from farm.

Calculation of this coefficient is simple, however, it does not provide accurate information because sales price has significant effect on coefficient (Figure 1). By creating a theoretical calculations under certain assumptions or changing only sales price of beef, it is possible to have different unit prices as a result. Production cost dynamic per unit depends on sales price. For example, using the equation 'y=0.025x', it can be concluded that the increase in beef sales price for one euro per ton increases unit production cost for 2.5 euro cents per kilogram. R^2 shows that coefficient calculation methodology does not include a mechanism that limits the impact on the selling price on production cost. This leads to a situation when lower sales price leads to lower costs per one kilogram produced.

Currently the best alternative to using indirect cost coefficient is to use farmers' or experts' evaluation of allocation of costs in multidisciplinary farm.

Data processing and analysis, result analysis

Data from farms can be analyzed in different dimensions. For instance, costs of fodder effect on growth rate of cattle or on total beef output. By processing unit production cost data, it is possible to analyze efficiency of farm's production. Production efficiency is determined by such factors as return on investment in assets, for instance cost per unit, profit from one hectare etc. (Gadanakis et al., 2015). Significant impact on farm's profitability is its ability to reaching maximum yield from one hectare, e.g., ability to utilize land and capacity of the crop to produce the highest quality fodder at the lowest cost (Martin et al., 2014). Sustainable use of agricultural land is key to prosperity of a farm (Kuhlman et al., 2010). Essentially, beef production is turning grass into a product with value added.

In the process of data processing different indicators of efficiency of utilization of resources can be used.

- Cost of fodder and actually produced amount of fodder (tonnes) is an important indicator of efficiency (Rearte and Pordomingo, 2014).
- Efficiency is affected by the farm's ability to utilize appropriate agricultural machinery and harvest adequate amount of yield depending on invested resources (Gadanakis et al., 2015).

- Farm's efficiency is determined by its ability to utilize its resources. For example, manure can replace fertilizer, thus decrease cost of production (Ondersteijn et al., 2003).
- The number of people employed on farms with the same number of cattle indicates the level of efficiency or availability of machinery for improving efficiency of production (Figiel and Kufel, 2013).

It has to be noted that in the conditions of limited resources a farmer has to maximize output of land, which makes possible herd expansion and make production more intensive (Bezat-Jarzębowska and Renebisz, 2013). One of the ways of effective utilization of land is to use it as intensively as possible, for example, by seeding grass that produces at least 40 tonnes of grassland yield from a hectare. Great attention should be paid to the quality of grass because grass is an important factor of production of fodder, consequently affecting the quality of beef and production efficiency (Sullivan et al., 2010).

One can conclude that it is essential to create accurate dosage of fodder according to physiological condition of an animal, intensity of growth to age and other factors. Feeding inappropriate dosage of fodder leads to not only wasting resources but possible damages of cattle health by causing digestive disorders. For a farm to utilize resources effectively it is important to pay attention not only to quantity of fodder but quality as well. For example, fodder and purchased forage can be compared based on protein content in dry matter per kilogram and cost per kilogram of protein in grown and purchased fodder (Van Middelaar et al., 2013). This would provide objective perspective on the value of grown fodder crops and how much the farm can save up by improving the quality of grasslands and not buying feed additives.

In order for a farm to maintain high quality of fodder production, soil analysis, soil nutrient balance analysis have to be conducted regularly and soil fertilizing plan that is based on results of analyses has to be fulfilled (Halberg et al., 2005; Schönhart et al., 2011).

When evaluating consumer demands and expectations towards beef quality, one has to calculate if cost reduction would not negatively affect the demand for beef production (Lobato et al., 2014). It is possible to create very intensive and fast production technology; however, one has to evaluate the effect of fodder on beef quality.

Evaluation of beef production technology, data for decision-making

When deciding upon which beef production technology to use, one has to consider cost calculation methodology, which eventually can affect end result (Åby et al., 2012a). While for analysis of current production technology or alternative technology it is essential to have accurate data, in cost structuring it is recommended to divide indirect costs based on experts' evaluation.

When seeking for the most appropriate farming model, it is useful to calculate the period for how long it is profitable to keep a cow or a bull in a herd. Necessary data for analysis is growth rate, amount of fodder fed to cattle, costs of fodder, labor costs (Oishi et al., 2013). Farms that are aware of their unit production costs can plan and analyze production activities. In case of necessity they can adjust and change cost positions that are related to beef production. This kind of analysis of cost positions provides an opportunity of swift and focused changes in production intensity and structure because economic structure and functional principles of production process is known prior to the change (Samson, 2013).

Efficiency of a farm is affected by its production technology – crop yield is lower at biological farms than at conventional farms, which affects efficiency of utilizing of particular production factors (Nemecek et al., 2011). When analyzing production, one has to take into account cattle life cycle, growth rate for more accurate planning of feeding and create culling scheme (Oishi et al., 2013). Not all breeds of beef cattle have the same growth rate potential. Productivity of the cattle has s significant impact on unit production cost of one kilogram of beef. By developing genetics of a herd farm can improve growth rate dynamics (Murphy, 2014). Before establishing beef production or working on improving production efficiency, one has to be able to detect which of the beef cattle breeds is the most suitable for given production conditions.

When choosing beef production technology, several factors have to be taken into account. These are value of production, added value of production, total income of the farm, income structure, and diversification of the farm (Paracchini, 2015). Low unit production cost does not imply having profit. Profit is difference between revenues and cost of production. Thus, when optimizing production cost, it should be done so that beef quality, visual appearance and taste would not be affected (Morales et al., 2013). Therefore, production technology planning, intensive or extensive, should account for potential revenues from one kilogram of beef (Lobato et al., 2014). Essentially, when choosing production technology not only cost of producing one kilogram of beef should be considered, but price at which the produced beef can be sold should be considered as well (Åby et al., 2012a). The most significant difference between production technologies is intensity of feeding – costs of fodder in intensive breeding technology will

be higher than in extensive breeding technology. Therefore, it is important to calculate variable costs per one kilogram of growth rate (Åby et al., 2012a). When reaching unified quality level on the farm at which quality of beef of all cattle is equal, a farmer has to evaluate if beef pre-processing and storage can be introduced into production cycle to postpone sales to the moment when consumers are ready to purchase beef for particular price (Kristensen et al., 2014). When conducting cost analysis of a farm, it is easier for manager to make managerial decisions, develop the farm and improve production process, which leads to increased production efficiency and higher quality of beef produced.

Conclusions

1. Data quality is of high importance for ensuring validity of unit production cost calculations. Unit production cost calculation is directly dependent on quality and accuracy of input data. Poor data quality can lead to misconceptions about true costs of production. Inaccurate information of production costs is not valid for decisions which affect farm development.
2. In order to get an accurate beef kilogram cost calculation, qualitative and accurate information of beef production costs that should be separated from other farm operating costs is required. If costs of beef producing are not separated from other farm costs, it is possible to apply weightings to separate costs which are related to production of beef and other economic activity.
3. Operating costs have to be classified according to their nature, why certain costs are made. This will ensure more cost accuracy and reliability. Classifying costs, it is possible to get an accurate picture of the cost structure of farms beef specialization.
4. By cost calculation with the exact distribution of costs relating to one kilogram of beef production, farms allow a farm manager to make more qualitative decisions concerning farm development and raise efficiency.

References

1. Åby B.A., Aass L., Sehested E., Vangen O. (2012a) A bio-economic model for calculating economic values of traits for intensive and extensive beef cattle breeds. *Livestock Science*, 143, pp. 259-269.
2. Åby B.A., Aass L., Sehested E., Vangen O. (2012b) Effects of changes in external production conditions on economic values of traits in Continental and British beef cattle breeds. *Livestock Science*, 150, pp. 80-93.
3. Bezat-Jarzębowska A., Rembisz W. (2013) Agri-Food Sector. *Social and Behavioral Sciences*, 81, pp. 359-365.
4. Bojneca Š., Latruffe L. (2013) Farm size, agricultural subsidies and farm performance in Slovenia. *Land Use Policy*, 32, pp. 207-217.
5. European Commission (2013) European Commission Efficiency-Focused Economic Modeling of Competitiveness in the EU dairy farms report 2012. Available at: http://ec.europa.eu/agriculture/rica/pdf/Dairy_report _2012.pdf, 9 March 2015.
6. Figiel S., Kufel J. (2013) Macroeconomic Performance and International Competitiveness of the Agro-Food Sectors in the EU Countries: Implications for the Future CAP. *Social and Behavioral Sciences*, 81, pp. 405-410.
7. Frank G.G. (1996) Calculating Your Milk Production Costs and Using the Results to Manage Your Expenses. Available at: http://cdp.wisc.edu/pdf/fresults.pdf, 9 March 2015.
8. Gadanakis Y., Bennett R., Park J., Areal F.J. (2015) Evaluating the Sustainable Intensification of arable farms. *Journal of Environmental Management*, 150, pp. 288-298.
9. Halberg N., Verschuur G., Goodlass G. (2005) Farm level environmental indicators; are they useful? An overview of green accounting systems for European farms. *Agriculture, Ecosystems and Environment*, 105, pp. 195-212.
10. Helming J., Peerlings J. (2014) Economic and environmental effects of a flat rate for Dutch agriculture. *NJAS - Wageningen Journal of Life Sciences*, 68, pp. 53-60.
11. Jurgens K., Poppinga O., Wohlgemuth M. (2013) What is the cost of producing milk? Available at: http://www.europeanmilkboard.org/fileadmin/Dokumente/Press_Release/EMB-allgemein/2013/ study_milk_production_costs_EN.pdf, 9 March 2015.
12. Kempen M., Witzke P., Domínguez I.P., Jansson T., Sckokai P. (2011) Economic and environmental impacts of milk quota reform in Europe. *Journal of Policy Modeling*, 33, pp. 29-52.
13. Kristensen L., Støier S., Würtz J., Hinrichsen L. (2014) Trends in meat science and technology: The future looks bright, but the journey will be long. *Meat Science*, 98, pp. 322-329.
14. Kuhlman T., Reinhard S., Gaaff A. (2010) Estimating the costs and benefits of soil conservation in Europe. *Land Use Policy*, 27, pp. 22-32.

15. Lansink A.O., Reinhard S. (2004) Investigating technical efficiency and potential technological change in Dutch pig farming. *Agricultural Systems*, 79, pp. 353-367.
16. Latruffe L., Fogarasi J., Desjeux Y. (2012) Efficiency, productivity and technology comparison for farms in Central and Western Europe: The case of field crop and dairy farming in Hungary and France. *Economic Systems*, 36, pp. 264-278.
17. Lobato J.F.P., Freitas A.K., Devincenzi T., Cardoso L.L., Tarouco J.U., Vieira R.M., Dillenburg D.R., Castro I. (2014) Brazilian beef produced on pastures: Sustainable and healthy. *Meat Science*, 98, pp. 336-345.
18. Manjunatha A.V., Anik A. R., Speelman S., Nuppenau E.A. (2013) Impact of land fragmentation, farm size, land ownership and crop diversity on profit and efficiency of irrigated farms in India. *Land Use Policy*, 31, pp. 397-405.
19. Martin P., Ronfort C., Laroutis D., Souchère V., Sebillotte C. (2014) Cost of best management practices to combat agricultural runoff and comparison with the local populations' willingness to pay: Case of the Austreberthe watershed (Normandy, France). *Land Use Policy,* 38, pp. 454-466.
20. Meul M., Van Middelaar C.E., de Boer I. J.M., Van Passel S., Fremaut D., Haesaert G. (2014) Potential of life cycle assessment to support environmental decision making at commercial dairy farms. *Agricultural Systems*, 131, pp. 105-115.
21. Morales R., Aguiar A.P.S., Subiabre I., Realini C.E. (2013) Beef acceptability and consumer expectations associated with production systems and marbling. *Food Quality and Preference*, 29, pp. 166-173.
22. Mouysset L., Doyen L., Jiguet F., Allaire G., Leger F. (2011) Bio economic modeling for a sustainable management of biodiversity in agricultural lands. *Ecological Economics*, 70, pp. 617-626.
23. Murphy G., Hynes S., Murphy E., O'Donoghue C. (2014) An investigation into the type of farmer who chose to participate in Rural Environment Protection Scheme (REPS) and the role of institutional change in influencing scheme effectiveness. *Land Use Policy*, 39, pp. 199-210.
24. Nemecek T., Dubois D., Huguenin-Elie O., Gaillard G. (2011) Life cycle assessment of Swiss farming systems: I. Integrated and organic farming. *Agricultural Systems*, 104, pp. 217-232.
25. Oishi K., Kato Y., Ogino A., Hirooka H. (2013) Economic and environmental impacts of changes in culling parity of cows and diet composition in Japanese beef cow–calf production systems. *Agricultural Systems*, 115, pp. 95-103.
26. Ondersteijn C.J.M., Beldman A.C.G., Daatselaar C.H.G., Giesen G.W.J., Huirne R.B.M. (2003) Farm structure or farm management: effective ways to reduce nutrient surpluses on dairy farms and their financial impacts. *Livestock Production Science*, 84, pp. 171-181.
27. Pacini C., Wossink A., Giesen G., Vazzana C., Huirne R. (2003) Evaluation of sustainability of organic, integrated and conventional farming systems: a farm and field-scale analysis. *Agriculture, Ecosystems and Environment*, 95, pp. 273-288.
28. Paracchini M. L., Bulgheroni C., Borreani G., Tabacco E., Banterle A., Bertoni D., Rossi G., Parolo G., Origgi R., De Paola C. (2015) A diagnostic system to assess sustainability at a farm level: The SOSTARE model. *Agricultural Systems*, 133, pp. 35-53.
29. Picasso V.D., Modernel P.D., Becoña G., Salvo L., Gutiérrez L., Astigarraga L. (2014) Sustainability of meat production beyond carbon footprint: a synthesis of case studies from grazing systems in Uruguay. *Meat Science*, 98, pp. 346-354.
30. Potter C., Tilzey M. (2007) Agricultural multifunctionality, environmental sustainability and the WTO: Resistance or accommodation to the neoliberal project for agriculture? *Geoforum*, 38, pp. 1290-1303.
31. Rearte D.H., Pordomingo A.J. (2014) The relevance of methane emissions from beef production and the challenges of the Argentinean beef production platform. *Meat Science*, 98, pp. 355-360.
32. Samson G.S., Gardebroek C., Jongeneel R.A. (2013) Analysing Dutch dairy farmer behaviour towards the provision of public goods: The added value of an economic simulation experiment. *Land Use Policy*, 34, pp. 321-331
33. Schader C., Lampkin N., Christie M., Nemecek T., Gaillard G., Stolze M. (2013) Evaluation of cost-effectiveness of organic farming support as an agri-environmental measure at Swiss agricultural sector level. *Land Use Policy*, 31, pp. 196-208.
34. Schönhart M., Schauppenlehner T., Schmid E., Muhar A. (2011) Integration of bio-physical and economic models to analyze management intensity and landscape structure effects at farm and landscape level. *Agricultural Systems*, 104, pp. 122-134.

35. Schouten M., Verwaart T., Heijman W. (2014) Comparing two sensitivity analysis approaches for two scenarios with a spatially explicit rural agent-based model. *Environmental Modelling and Software,* 54, pp. 196-210.
36. Sullivan C.A., Skeffington M.S., Gormally M.J., Finn J.A. (2010) The ecological status of grasslands on lowland farmlands in western Ireland and implications for grassland classification and nature value assessment. *Biological Conservation*, 143, pp. 1529-1539.
37. Tanure S., Nabinger C., Becker J.L. (2013) Bioeconomic model of decision support system for farm management. Part I: Systemic conceptual modeling. *Agricultural Systems*, 115, pp. 104-116.
38. Van Middelaar C.E., Berentsen P.B.M., Dijkstra J., De Boer I.J.M. (2013) Evaluation of a feeding strategy to reduce greenhouse gas emissions from dairy farming: The level of analysis matters. *Agricultural Systems*, pp. 121, 9-22.

THE CHARACTERISTICS OF MODERN FARM

Vilma Atkociuniene, **Romualdas Zemeckis**
Aleksandras Stulginskis University, Lithuania
vilma.atkociuniene@asu.lt; romualdas.zemeckis@asu.lt

Abstract
The purpose of this paper is to identify the main characteristics of the modern farm in Lithuania and to analyse correlation between features, which should have a modern farm, to understand the age of agricultural system and agricultural concept. The research based on the answers of two groups of experts (180 experts: 98 experts-professionals and 82 experts-farmers). The present paper is examining the characteristics and role of agriculture modernization in the economic and social development of Lithuania. The main characteristics of the modern farm are: new machinery and equipment, technologies, modern production buildings, farms apply a range of innovations, farmers are seeking knowledge are interested in innovation, take part in exhibitions, events, they are energetic, creative and implementing good management practices. Big farms in Lithuania had the opportunity to devote more funds to co-finance structural support, and were able to get more support and modernize faster than small or medium-sized farms. The big farms are more modernised than small ones, but the impact of farm modernization on the rural development sustainability is bigger and more positive from the smaller farms than bigger ones.
Key words: modern farm, agriculture, rural development.

Introduction

Modernization has been a worldwide phenomenon approximately since 18th century. Agricultural modernization is an important aspect of modernization and also an important interdisciplinary component of world modernization. During the twentieth century and especially in the second half of it the world has witnessed very impressive increases in agricultural output. This trend is continuing and achievement is mainly ascribed to the improved agricultural practices leading to higher productivity of land and labour. Lately the contribution of extensive cultivation has not been significant. Bringing more land area under agriculture is becoming more and more difficult in most countries. Since prosperous agriculture is considered to be the most crucial base for economic development particularly in the less developed countries, the only viable option for them is to continue to enhance the productivity of land and labour in agriculture. Increased productivity in agriculture has been achieved in several parts of the world mainly by modernizing agriculture.

The topicality and purpose of the research is based on the facts and prospects of world agricultural production and agricultural factors (China Modernization Report …, 2012) in the 21st century: 1) The agricultural resources per capita will continue to decline. 2) Agricultural labour force will continue to decline in both quantity and ratio, agricultural land intensification will continue to rise, agricultural capital input will continue to increase but change in structure, and the intensity of pesticide and chemical fertilizer use will decline. 3) The ratio of agricultural added value will continue to decline, and the total amount of agricultural added value will drop in some countries. 4) The farmers will become even better qualified, with those in developed countries mostly receiving higher education. Farmer income will continue to increase, and come from diversified sources. 5) The ratio of world rural population and that of rural agricultural population will continue to decline, and rural infrastructures will continue to develop and improve. 6) The total world agricultural demand will continue to grow, and the problems of agricultural subsidy, agricultural trade and ecological environment will continue to exist.7) The agricultural science and technology respectively correspond to the age of agricultural economy, the age of industrial economy and the age of knowledge economy. 8) The evolution of agricultural system and agricultural concept can be roughly divided into three major stages: those in the age of agricultural economy, those in the age of industrial economy and those in the age of knowledge economy (China Modernization Report…, 2012).

Scientific problem: modernization consists largely of using improved seeds, modern farm machinery such as tractors, harvesters, threshers, etc., chemical fertilizers and pesticides in an optimal combination with water. The agriculture farms modernization is not linked with innovations and sustainability. The theoretical fundamentals formed up to this day are unusable for creation of innovative agriculture farms management opportunities. For this reason the analysis of main characteristics of the modern farm should be defined and justified.

The object of research is the characteristics of the farm and agricultural enterprise. **The purpose** of this paper is to identify the main characteristics of the modern farm in Lithuania and to analyse correlation between features, which should have a modern farm, to understand the age of agricultural system and agricultural concept. The present paper is examining the characteristics and role of agriculture modernization in the economic and social development of Lithuania with the help of findings from the case study 'Resilient farming systems and market differentiation:

Challenges and opportunities in farmers' markets'. This case study is a part of RETHINK 'Rethinking the links between farm modernization, rural development and resilience in the world of increasing demands and finite resources' project. This research project funded through RURAGRI is an ERA-NET supported by the European Commission under the 7th Framework Programme and national funding agencies in 14 countries.

Materials and Methods

In order to identify the main characteristics of the modern farm in Lithuania and to analyse correlation between features, which should have a modern farm, there were two groups of experts (180 experts: 98 experts-professionals and 82 experts-farmers) selected. Their opinions have allowed the comparison of assumptions regarding the main characteristics of the modern farm in Lithuania. The survey of academics, advisors, and heads of Agriculture departments (on municipal level), Lithuanian Ministry of Agriculture, farmer's organizations, agricultural companies and farmers nationwide was carried out in June-August 2014. Experts-professionals represented all of the major Lithuanian institutions involved in the agricultural sector in science, education and consulting, rural development administration. An interactive questionnaire available on the web was used for the data collection. The research is based on the positive research paradigm, content and descriptive analysis, empirical study methods, logical and systematical reasoning, graphic presentation, abstracts and other methods.

Results and Discussion

Agricultural modernization - theoretical aspects. The modern *agricultural revolution* that triumphed in the developed countries from the late 1950s onwards was based on the development of new means of production and trade which, in turn, resulted from revolutions in industry, biotechnology, transport and communications. Agricultural modernization occurred gradually as a result of progress in industrialization, breeding technology and transport and communications, and in step with the enlargement of farms (The state of food and agriculture, 2000).

Agricultural modernization is mostly analyzed on sector or rural development policy level. 'It comprises the transition from traditional agriculture (self-sufficient agriculture) to preliminary modern agriculture (marketized agriculture), the transition from preliminary modern agriculture to advanced modern agriculture (knowledge agriculture), the continuous increase of agricultural efficiency and farmer income, the continuous improvement of farmer wellbeing, the assurance of agricultural product supply-demand balance and national food security, and the change of national agricultural status and international agricultural system' (China Modernization Report…, 2012). In this study it is assumed that farm modernization forms the modern agricultural sector. Rural development policy directs the activities of rural development actors, creates the need for certain purposes.

The specificity of current EU rural development policies reflects the specific nature of rural development practices. At grass root level these rural development practices represent a multifaceted rupture of the prevailing trend towards agricultural modernization. The main contrasts between these two trajectories were summarized by Van der Ploeg J., Jingzhong Y., Schneider S. (2010) in Table 1.

In the rural development policy implementation, there is a participation of many actors and it reflects, even if only partially, their interests, concerns and visions. Rural development policies have to deal with new emerging practices that are seeking to reshape considerable parts of the countryside. Innovative development of the organizations allows to solve many problems of competitiveness and ensures comprehensive improvement of the various chains of organization modernization (Smalskys and Skietrys, 2008; Zakarevicius, 2012). The research results in 865 Dutch farms show that innovative activities are positively related to labour resources (which is highly correlated to farm size), market position (indicating

Table 1

Strategic contrasts between the practices of agricultural modernization and rural development

Agricultural modernization	Rural development
Specialization	Multifunctionality
High dependency on agro-industrial inputs and credit	Low external input agriculture
Ongoing scale increase and reduction of rural labour force	Maintenance or even increase of population economically active in agriculture
Spatial concentration in favoured areas	Widely practised (and especially in 'less favoured areas')
Ongoing extension, in time and space of food circuits	Shortening and localizing of food circuits
Centrality of capital	Centrality of labour

(Van der Ploeg et al., 2010)

whether a farm produces for a market that permits product differentiation), and a farmer's access to information (where an indicator of the extent of his network is used as a proxy) (Diederen et al., 2003).

Innovative activities are negatively related to solvency. This may indicate that farms with a high solvency rate are risk averse and not eager to innovate. The scientists found that adoption behaviour shows some persistence in time: being an innovator (or a late adopter) in the past increases the probability of being an innovator (a late adopter) in the current period. The characteristics of the business environment matter. Especially, a high degree of market regulation seems to have a negative impact on adoption behaviour (Diederen et al., 2003).

P. Zakarevicius (2012) scientific research was focused on the change of an organization concept, the description of a modern organization paradigm, as well as on the formulation of modern organization features. The following characteristics of a modern organization have been distinguished: developing organization, learning organization, socially responsible organization, entrepreneurial organization, organization satisfying customers' needs, organization ensuring social security, structurally mobile organization.

The scientists Banterle A., Cavaliere A., Carraresi L., Stranieri S. (2011) made research of innovativeness in food small business. The exceptional attention was given to the innovativeness relationship with marketing. With regard to the relation between innovativeness and the firm size, the regression revealed a significant and negative link, underlining that the SMEs can innovate more highly than large companies in the food sector, better adjusting their business to the market evolution and consumer preferences. Good skills in marketing activities lead to a high propensity in adopting the innovative conduct, such as the product improvement and the search for new markets.

Their analysis reveals that not all the steps of the marketing management process affect the firm innovativeness. Market research and marketing strategy are the two steps that showed a significant and positive correlation with the firm innovativeness, whereas the variables connected with planning and implementation, and control and evaluation were not significant, the only exception being the variable concerning benchmarking with the firm's competitors (Banterle et al., 2011).

The research results by Vidickiene D., Melnikiene R., Gedminaite-Raudone Z. (2013) revealed that motivation and barriers for applying innovation differs at the farms implementing cost leadership or differentiation strategy. The main reason for different type of innovations is rapid growth of consumers who decide to opt for healthy and environmentally friendly ways produced food. Increased awareness of consumers for higher quality of local food and increase its consumption, particularly of products from small-scale farms, and also linking these local products to food sovereignty and environmental awareness. Customer needs and interests create new opportunities for farmers from the standard products switch to high quality and exclusive products for the final consumer. In addition to the new production technology is becoming increasingly topical organizational innovation for new marketing, logistics, accounting, working methods for organizing farm activities. Policy makers of the innovation policy should differentiate policy measures based on the competitive strategies used in the farm.

The scientists J. Ramanauskas and J. Kirstukas (2009) offer projects recognized by the EU support to measure not only financial indicators, but also by their innovativeness. Scientists have identified the criteria to determine the evaluation of the level of innovativeness of the investment project. According to J. Ramanauskas and J. Kirstukas (2009), the level of project innovativeness has to be assessed by the following basic criteria: innovation influence on product, influence innovation on production processes, innovation influence on the entity's organizational restructuring, innovation based on results of scientific research, staff training, researchers and highly skilled staff recruitment.

From the perspective of agricultural evolution and agricultural transition, agricultural modernization can advance and succeed in every country. But countries vary from each other in the speed of agricultural advance, the level of agriculture, and the timing of success (China Modernization Report…, 2012).

The features of a modern farm in Lithuania. Assessing the situation in Lithuanian agriculture after the restoration of independence in 1990, it was possible to state that the policy makers faced with a situation, similar to what was after the Second World War when economies of many countries were destroyed. They had to start building the private agrarian sector using the extensive growth strategy, i.e. increasing the supply of production supplies; increase the volume of production. Rural policy has been oriented to implement the strategy of extensive growth and achieve production scale effect. Implementation of extensive growth strategy, organizational structure consists of producer households having fixed assets. The main and the only way of improving the organizational structure was an increase in assets for productive activities. There was rapidly improved supply with agricultural machinery and facilities on the means of extensive growth strategy implementation (Vidickiene and Melnikiene, 2014)

Table 2

Payments to **Lithuanian farms (on average by farms) 2004–2012, in thousands EUR**

Farm size, ha of AL	2004	2006	2008	2010	2012
private farms					
< 10.1	909	980	1301	1335	1156
10.1–20.0	2015	2347	2588	2727	2282
20.1–30.0	2822	3932	4860	5122	4718
30.1–40.0	3828	5780	6506	7066	6242
40.1–50.0	4808	7601	7674	8231	7951
50.1–100.0	7604	11289	11472	12953	12628
100.1–150.0	11453	21101	21221	24501	21397
>150	25794	47714	47326	49407	47689
agricultural companies					
> 150.0	25794	47604	47326	49407	47689
< 501	30218	49328	38229	47091	34898
500–1000	66376	88771	106240	116570	111794
> 1000	168769	256751	284291	332515	279979

Source: Lithuanian FADN data

Big farms in Lithuania had the opportunity to allocate more funds to co-finance structural support and were able to get more support and modernize faster than small or medium-sized farms. They could use all the direct payments paid by the EU and the additional national payments for this purpose. Although one of the objectives of the CAP is to support farmers' income, small farms sponsorship was insufficient for their needs. On the contrary, large farm households received resources for extensive development. Received payments of farms larger than 150 hectares was 47.7 thousand EUR, while smaller than 10 hectares farms on the average received less than 1.15 thousand EUR, or 42 times less in 2012 (Table 2).

FADN data show that during the period of 2004-2012, farms smaller than 10 ha, on the average received 2.6 thousand EUR of investment support, 10-20 hectares farms - 6.1 thousand EUR, 20-30 hectares farms – 9.9 thousand EUR, 30-40 hectares farms – 24.1. thousand EUR, 40 - 50 hectares farms - 45.7 thousand EUR, 50-100 hectares farms – 51.1 thousand EUR, 100-150 hectares farms - 67.7 thousand EUR. The largest farms owning more than 150 hectares of land, on the average received investment support during 2004-2012 amounted to 139.1 thousand EUR, which is 54 times higher than the support received by the smallest farms group, managing up to 10 hectares (Vidickiene and Melnikiene, 2014).

While the big farm support, implementing rural policies to promote the production growth, Lithuania has not identified as a priority; support mechanism has enabled increased use of extensive growth strategy-related measures. The performed analysis suggests that farm size was associated with investment size: the larger the farm, the bigger support has received.

Which characteristics do a modern farm and agricultural enterprise in Lithuania have? According to the opinion of experts, it was difficult to identify the characteristics of a modern farm, as the first problem is to recognize what a 'modern farm' is. Experts, describing the characteristics of modern farms in Lithuania, paid more attention to one of the principles of social responsibility - taking care of the environment (meeting good agricultural and environmental condition), just a few experts pointed out that modern farms collaborate with scientists working in the field of agriculture, small-farm energy costs, and safe work (Table 3).

Experts observe a direct correlation between farm size and modernity (once large means modern) and the narrow specialization and farm modernity. Experts as features of modern farm in Lithuania have named good farm activity management ('modern management' and 'well-organized farm activity / production', 'order', 'soil testing, animal control, the presence of plans', 'continuous improvement of production'). The characteristics of modern farm production markets in Lithuania ('from the field to the final product', 'selling their products to processors', 'produced crude production', 'agriculture is characterized by unstable production purchase price') show the prevalence of various forms of sales launched to apply a short food supply chain. Identified negative aspects of modern farm in Lithuania: 'farmers' oppressing their staff', 'what is modern is perceived differently; 'wealthy but dishevelled'.

Results of the study in 2007-2013 reflect the established innovation practice, less fuel-efficient and less polluting nature of agricultural machinery has been supported as an innovation (Ramanauskas and Kirstukas, 2009).

Table 3

Characteristics of modern farm and agricultural enterprise, referred by experts-professionals and experts-farmers, 2014

Characteristics of modern farm and agricultural enterprises in Lithuania	The number of iterations of arguments support the allegation		Features, which should have a modern farm and agricultural enterprise	The number of iterations of arguments support the allegation
	opinion of experts-professionals	opinion of experts-farmers		opinion of experts-professionals
New machinery and equipment, technology, modern industrial buildings	20	12	New machinery and equipment, technology, modern industrial buildings	10
Introducing different innovations	19	12	Introducing different innovations	13
Socially responsible farm environmentally friendly / high production culture	5	16	Socially responsible farm, sustainable farming and production; follow environmental standards; organic farming methods	13
High economic competitiveness and profitability	5	12	High economic competitiveness and profitability	10
Good management of farm activities	7	11	Good management of farm activities, permanent progress	11
Farmer seeks for knowledge, is interested in innovation, attends exhibitions, events, is impetuous and creative	8	4	Educated, constantly learning farmer, skilled professionals; seek for knowledge; interested in innovation, attends exhibitions and events	9
Oriented to different markets and niches	4	9	Short food supply chains are used, processing and marketing	7
Produce of high-quality and added value products	2	9	Produce of high-quality and added value and new products	3
Good farm base material, purposeful farm investments	5	4	Proper use of investment on the farm	2
Farmer is an independent, quick to make decisions	2	3	Farmer is autonomous, operative, impetuous	3
Farm is of narrow and deep specialization	4	-	Specialized and co-operative farm	4
The farm, which maintains jobs and creates new ones	-	7	-	-
Big farm and high production volumes	5	-	More of modern small farms	2
Grown new varieties of plants and animals	2	-	Ongoing animal and plant breeding	2
The farm has a 3-5 year development vision	2	-	The farm has a 3-5 year vision, smoothly develops	3
Allegations in total	90	99	Allegations in total	90

Source: own calculation based on our survey.

Which characteristics should have a modern farm and agricultural enterprise? Experts describing the definition of the components of a modern farm, more focused on two principles of social responsibility - taking care of the environment (‘good agricultural and environmental condition maintenance’, ‘development of sustainable farming’, ‘sustainable production methods’, ‘application of environmental standards’, ‘organic’) and self-perception as a socially responsible member of the rural community.

A modern farm is specialized and cooperative, based not only on new technology, but also on the employees’ knowledge. The basis of the modern farm - the family farm (‘more modern small farms’). Modern agricultural farm products should be ‘disposed of without intermediaries’, ‘from the field to the final product’, ‘advertise the farm’ ‘processing of its production and delivery to the end – consumer’, ‘flexible and focused on domestic and foreign consumers’, ‘should organize their own processing and marketing’; ‘agricultural enterprises, farmers

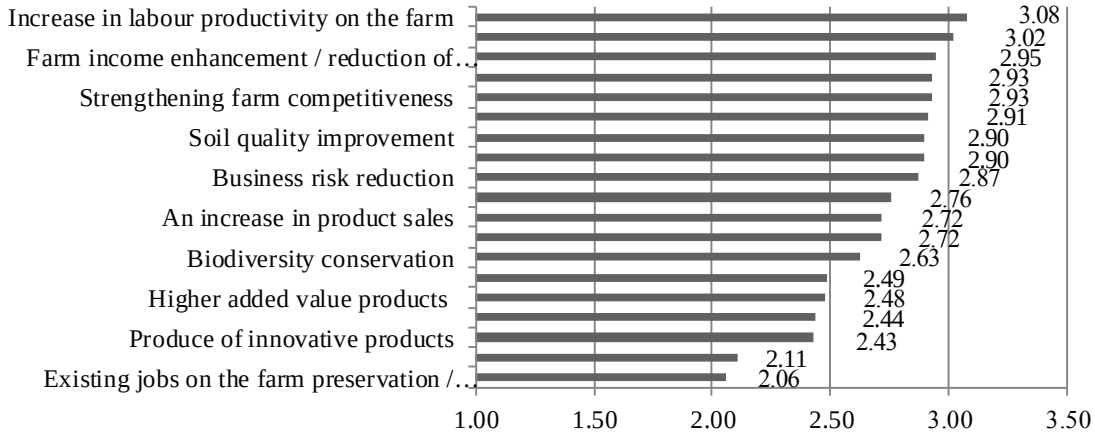


Figure 1. Lithuanian farms and agricultural enterprises modernizing action created benefits, farmers – expert application scorings, 2014.

should form partnerships to realize the production'; 'comprehensive approach to market conditions'). One of the modern farm characteristics often marked by experts is farm operational flexibility ('flexible and focused on domestic and foreign user', 'based on their staff knowledge', 'and valued experiments').

Good management practice should be implemented in a modern farm, i.e.: 'well-structured and balanced production line', 'the rational use of resources', 'a good database', 'everything is computerized', 'high production culture', 'order', 'increased investment to labour resources', 'application of effective disease prevention and control', 'to improve soil quality indicators, to participate in the breeding of plants and animal'.

During survey the experts evaluated how factors of farm and agricultural enterprise modernization contributed to the creation of various benefits. They rank factors from 1 to 4 points: 1 - did not quite contribute, 2 - weakly contributed, 3 – contributed, 4 - contributed significantly (Figure 1).

Lithuanian farms and agricultural enterprises modernization were more oriented to the farm but not to the external effects and rural area sustainability. The main benefits created by farms modernizing action were as follows: an increase in the labour productivity, product quality improvement and farm incomes. Lithuanian agricultural sector 2010 - 2012 is displayed as an example of successful mastering of the EU investment support. Farms have successfully used the Lithuanian Rural Development Programme 2007-2013 measure 'Modernization of agricultural holdings' - purchased modern agricultural techniques (Mokslinės rekomendacijos…, 2013). However, the agricultural modernity for 2007 - 2013 programming period farmers were perceived one-sided. Such a perception is destroying rural living as a 'body' foundation for rural areas equally important for the survival of the three corner stones - production, environmental protection and social welfare.

Conclusions

The current generation of Lithuanian rural development policy does not much differ from the previous ones, which were mainly limited to developing countries and basically seen as a support mechanism for agricultural modernization. The agricultural system and agricultural concept in Lithuanian case are still in the age of industrial economy and just same characteristics show features of the age of knowledge economy.

Most often Lithuanian experts indicated the following features of modern Lithuanian farms and agricultural enterprise: new machinery and equipment, technologies, modern production buildings, farms apply a range of innovations, farmers are seeking knowledge, are interested in innovation, take part in exhibitions, events, are energetic, creative and implementing good management practices. The characteristics of modern farm production markets in Lithuania show the prevalence of various forms of sales launched to apply a short food supply chain. Identified negative aspects of modern farm in Lithuania: 'farmers' oppressing their staff', 'what is modern is perceived differently; 'wealthy but dishevelled'.

Big farms in Lithuania had the opportunity to devote more funds to co-finance structural support, and were able to get more support and modernize faster than smaller or medium-sized farms. The big farms are more modernised than small ones, but the impact of farm modernization on the rural development sustainability is bigger and more positive from the small farms than big farms.

The agricultural modernization increased food supply to humanity and raised the income level of

farmers, but the public goods and positive external effects to the rural areas development were not raised satisfactorily. The modern farm not always is innovative and sustainable farm. The main attention has to be paid to the social innovations, creation of new labour places and food safety and security.

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References

1. Banterle A., Cavaliere A., Carraresi L., Stranieri S. (2011) *Innovativeness in food small business: What is its relationship with marketing?* Agriculture Economics. – Czech, *57*, 2011 (10): pp. 474-483.
2. China Modernization Report: A study of agricultural modernization (2012). Modernization Science Newsletter (2012). Vol.2, No. 4 December 2012. Available at: http://www.modernization.com.cn/ms201204.pdf, 10 February 2015.
3. Mokslinės rekomendacijos dėl žemės, maisto ūkio, žuvininkystės ir kaimo plėtros taikomųjų mokslinių tyrimų bei inovacijų plėtros (Scientific recommendation for land, food agriculture, fisheries and rural development of applied research and innovation development). 2014-2020 m. Galutinė ataskaita (2013) Tyrimo vadovas *Egidijus Šarauskis*, Akademija, Kauno r. 2013, 48 p. (in Lithuanian).
4. Diederen P., van Meijl H., Wolters A. (2003) *Modernisation in Agriculture: What Makes a Farmer Adopt an Innovation?* Agricultural Economics Research Institute, Zaragoza, October 23-25, pp. 13.
5. Ramanauskas J., Kirstukas J. (2009) *Inovacijų plėtra modernizuojant ūkininkų ūkius* (Development of innovations within the modernization framework of the farms). Management Theory and Studies for Rural Business and Infrastructure Development. 2009. No. 18 (3), pp. 50-58. (in Lithuanian).
6. Smalskys V., Skietrys E. (2008) *Viešojo valdymo modernizavimo aspektai ir įgyvendinimo problemos* (Aspects of Public Management Modernization and the Problems of its Implementation). Viešoji politika ir administravimas, 2008. Nr. 24, pp. 60-66, (in Lithuanian).
7. The state of food and agriculture (2000) *The socio-economic impact of agricultural modernization*. pp. 329. Available at: http://www.fao.org/docrep/x4400e/x4400e10, 10 February 2015.
8. Van der Ploeg J., Jingzhong Y., Schneider S. (2010) *Rural development reconsidered: building on comparative perspectives from China, Brazil and the European Union* // Rivista di eco-nomia agrarian. Nr. 65 (2), pp. 164-190.
9. Vidickienė D., Melnikienė R. (2014) *Kaimo politikos evoliucija* (Rural Policy Evolution), Vilnius, 272 p. (in Lithuanian).
10. Vidickiene D., Melnikiene R., Gedminaite-Raudone Z. (2013) *Inovacių diegimo Lietuvos ūkininkų ūkiuose motyvai ir barjerai* (Motives and Barriers of Using Innovations by Lithuanian Farmers). Management Theory and Studies for Rural Business and Infrastructure Development. Vol. 35. No. 1, pp. 140-149. (in Lithuanian).
11. Zakarevičius P. (2012) *Modernios organizacijos bruožai* (The Features of a Modern Organization). Management of Organizations: Systematic Research, Issue: 64 / 2012, pp. 135-144. (in Lithuanian).

SOME PROBLEMS OF LOCAL DEVELOPMENT: THE EXAMPLE OF FORMER STATE AGRICULTURAL FARMS IN POLAND

Marcin Feltynowski[1], Adam Senetra[2], Jadwiga Biegańska[3], Elżbieta Grzelak-Kostulska[3], Mirek Dymitrow[4], Stefania Środa-Murawska[3]
[1]University of Lodz, Poland
[2]University of Warmia and Mazury in Olsztyn, Poland
[3]Nicolaus Copernicus University in Toruń, Poland
[4]Economics and Law University of Gothenburg, Sweden
marcinf@uni.lodz.pl; adam.senetra@uwm.edu.pl; jadwigab@umk.pl; grzelak@umk.pl; mirek.dymitrow@geography.gu.se; steffi@umk.pl

Abstract
The paper aims at examining the levels of social cohesion and socio-economic dysfunctionality in former State Agricultural Farms (post-PGR) areas and at assessing the possibilities for initiating bottom-up actions, and for participating in the creation of mechanisms for local development. Data used in the study was obtained in multi-methods approach, i.e. mainly during a questionnaire survey, in-depth interviews and observation concerning the financial situation and the social environment (social problems and cohesion), that is, the elements predicted to be the key factors obstructing effective corrective actions within local development. We have demonstrated that post-PGR areas should be treated as especially problematic not only because of their economic dysfunctionality, but mainly because of the complex social problems they experience (lack of local ties, hostility, aggression between neighbors). Such a difficult environment requires substantial interference which should take into account the problems specific to the population. The threat resulting from the heterogeneity of such communities should be a significant factor shaping the perception of local development problems.
Key words: local development; rural areas; State Agricultural Farm; Poland.

Introduction

Local development has been discussed in Western Europe since 1970s (Stöhr, 1990), but it is only after 1989 that it became an object of research in the countries of the former Eastern Bloc. In Western European countries, bottom-up initiatives – initially accepted and later actively supported by authorities (Stöhr, 1990) – arose mainly in response to the needs of local communities. Citizens protesting against mass consumption, fighting for improving their livelihoods, and suffering from economic crises began to stress the need to use local resources in a rational way and to protect the natural environment (Sekuła, 2005). At that time, in Eastern European countries there was no possibility to undertake bottom-up actions. As Jałowiecki (1988) states, 'in a centrally planned and managed society, there is, by definition, no place for spontaneous collective actions, let alone social movements, since every social activity is organized and controlled by special organizations created for that purpose' and 'an excessive rationing of social behaviors naturally limits initiatives and creates passive attitudes' (Jałowiecki, 1988). The collapse of the Eastern Bloc and the ensuing restructuring of economy activated, among others, mechanisms of local development. In the case of Poland, a very important factor supporting the development of bottom-up initiatives were those post-1989 actions undertaken to establish closer links with the European Union countries, including an administrative reform (The law from 24 July 1998 on the implementation of a national tripartite territorial division), which in 1999 introduced a three-tier division of the country (into voivodships – NUTS 2, poviats – NUTS 4 and gminas – NUTS 5).

At present, however, 25 years after the changes, in Poland, like in other countries of the European Union, local development has become a basic direction of socio-economic policy, whose specific character is shaped by positive determinants supporting development (referred to as 'factors'), and negative determinants which obstruct or limit the possibilities for local development (so-called 'barriers') (Sekuła, 2005). The latter, which can be divided with respect to their origin into external and internal barriers, are particularly strong in the areas of the so-called post-PGR estates, both 'central' and 'peripheral' (Psyk-Piotrowska, 2011). One of the most important internal barriers in the development of post-PGR estates is the consequence of regime transformation.

The estates discussed in this article were created in place of former State Agricultural Farms (*Państwowe Gospodastwo Rolne*, PGR), once called 'the centers of agrarian culture and progress' (Psyk-Piotrowska, 2011) according to the decree of the Polish National Liberation Committee from the 6 September 1944 on the implementation of the agricultural reform (Dekret Polskiego…). In accordance with the decree in the emerging socio-economic system in Poland, PGRs became the most common form of organizing large farms (1112 units from several dozen to several thousand km^2 –

Ziętara, 2005 cited in Kraciński, 2011). As a form of economic organization of agriculture, State Agricultural Farms had existed since the mid-1950s to the early 1990s. Their formation was accompanied by changes in the settlement structure: an integral part of PGRs where housing estates were created in order to satisfy the needs of the employees. Some of them, particularly in central and southern Poland, were heterogenic structures (like Chotel, introduced later). These estates were distinguished by: 1) specific morphology: in contrast to traditional planning, they consisted of two- or five-storey blocks of flats or rows of low-roofed buildings; 2) social aspects: a characteristic feature was a high turnover of workers coming from various backgrounds, often impoverished, and with different customs, which resulted in failed place attachment (Sakson, 2003). In comparison to the long-settled families of private farmers, the PGR families were characterized by a general sense of transience, which did not contribute to social integration (Borowski, 2013).

The PGRs were particularly strongly affected by the post-1989 political and economic changes in Poland. Most of them went bankrupt, the property was devastated, the land was left untended, and the workers faced unemployment, experienced social exclusion and other socially pathological phenomena. Some researchers (Rosner, 2002) even see these areas as an extreme example of problems associated with the economic activation of the countryside. This difficult situation was caused predominantly by the maladjustment of monofunctional farms to new economic conditions leading up to their demise, and by the spatial isolation of the inhabitants who found themselves in an exceptionally demanding position with regard to access to the job markets (Rosner, 2007).

From the perspective of local development, it should be stressed that all decisions concerning State Agricultural Farms – their establishment, functioning, aim and eventual divestment – were top-down decisions. The opinions of local communities were never taken into account at the decision-making stage, thus strengthening the inhabitants' conviction that they had no influence on local affairs (Monografia powiatu Gołdapskiego [Poviat Gołdap Monograph], 2008).

As indicated above, the areas once associated with the PGRs are highly problematic ones (most difficult of all rural areas), and, as such, require a special attention from the researchers. The search for effective problem solutions must be based on thorough knowledge of such areas. Accordingly, the aim of this study is to examine the levels of social cohesion and socio-economic dysfunctionality in post-PGR areas and to assess the possibilities for initiating bottom-up actions, and for participating in the creation of mechanisms for local development. The analysis assumes it is the social situation determined by historical and economic factors that have shaped the living conditions of the population that is responsible for the lack of development in these areas. In order to verify that claim, the following assumptions have been posited: 1) the economic situation determining living conditions of the examined PGR is very bad, making its inhabitants marginalize higher needs and focus on satisfying basic needs; not only does this situation fail to improve, it also unravels a whole spectrum of social problems; 2) the low level of education and low socio-economic status of members of the studied PGR influence the formation of passive attitudes and the ensuing reluctance to change; 3) despite the passage of time, the population of post-PGR estates remains heterogeneous and is marked by low social cohesion, very weak bonds between neighbors, absence of communital actions, and no sense of belonging to the local community in terms of shared objectives. Exploring these assumptions may help gain deeper knowledge on the issue at hand and undertake more effective actions set to deal with problems in local development.

Materials and Methods

Chotel, the PGR (closed 1993) here chosen for investigation, follows the transformation pattern described above. Like other similar settlement units, our referential estate suffered a rapid rise in the number of the unemployed as a result of economic changes. The lack of sufficient human capital, low qualifications and relatively low mobility (also called the syndrome of learnt helplessness, see Tarkowska, 2001; Karwacki, 2002) have led to a dire situation. Moreover, the lack of opportunities to get a good job and the decreasing real income worsen the living conditions, while poverty and social exclusion are passed over to the next generations of Chotel's inhabitants.

In regard to social change and the search for the causes of the encountered development problems, it is important to stress the problem of continued heterogeneity (although in new economic conditions), both in the examined area and in other PGRs. Processes of assimilation have a very limited scope: there still exists an implicit division into the inhabitants of the village proper (Kazanki – to which Chotel formally belongs) and the Chotel itself, while the growing social polarization seems to reinforce the division. This problem is particularly visible at Chotel; in relation to Kazanki, Chotel occupies a peripheral location, which loosens and infects social bonds. Izbica Kujawska, the nearest town and the seat of the local government (gmina), is located 3 km from Chotel.

In 2014, the population of the estate amounted to about 120 (23% at pre-productive age; 64% at productive age; and 1% at post-productive age). Currently, the estate is domiciled primarily by former PGR employees and their families, but also, to a lesser degree, by some new residents assigned there by the municipal office. Of the 77 working-age people nearly half are unemployed, living off various benefits and occasional work. The housing area today (3.4 ha) comprises an isolated land island located amidst agricultural fields some 1.3 km north of the village proper. South of the housing block area (equipped with a supermarket) is a large and now defunct PGR complex (4.3 ha).

The study is based on data obtained from a questionnaire survey concerning the financial situation and the social environment (social problems and cohesion), that is, the elements predicted to be the key factors obstructing effective corrective actions. Since it was impossible to estimate the exact size of the population (some of the inhabitants live unregistered), the study is based on a non-random sample (increasingly seen as an important alternative to random sampling). The non-random sampling was based on the principle of accessibility. The questionnaire consisted of closed format questions, including closed-ended, bipolar, rating scale, Likert-scale, semantic differential and 'buying propensity' questions, and, to a much lesser degree, dichotomous questions. Open questions also played an important role although their number was intentionally limited. Due to such design, only selected aspects were studied; for example, the free association method, used to evaluate and characterize the image of an area (Reilly, 1990; Crouch, Ritchie, 2003; Daszkiewicz, 2012), was employed to describe the estate and its social environment.

The questionnaire was filled out by 31 respondent over 15 years of age. 52% of the respondents were women and 48% were men. About 1/3 of the respondents were under 20; 2/3 were not older than 45; the oldest respondent was 60. The decision to set the upper age limit at 60 reflected the conviction that the most important role in shaping local development was played by inhabitants who had not reached retirement age. The biggest groups were unmarried people (about 40%) and spouses (36%). A predominance of partnerships was noticed among younger respondents (under 25), and of divorcees among the older respondents (over 40). On average, every third person over 15 years old was surveyed, which makes it possible to map the situation and to draw valid conclusions.

The data has been deemed reliable and fully reflecting the state of knowledge about the examined areas, which was verified at the last stage of the study through in-depth interviews. This extremely difficult stage was conducted after the questionnaire survey, i.e., when the respondents became accustomed to the study procedures and when the areas that needed further investigation were identified on the basis of gathered information. Some of the questions asked during the interview resulted directly from the analysis and could be examined only by the use of qualitative methods. Open interviews were found to be the optimal solution. The study was conducted with the help of a gatekeeper (who introduced the authors to the examined community because of its closed nature). Ten interviews were conducted. The respondents were divided with regard to gender, age, and professional activity. The interviews confirmed the results of the questionnaire and allowed for a better understanding of the emerging contexts whose knowledge was necessary to draw adequate conclusions.

The information gathered from the respondents was supplemented by and confronted with the knowledge of public officials dealing with the examined area in the municipal office in Izbica Kujawska. During the interviews, detailed information about local infrastructure, the technical state of the buildings, the social problems identified in the whole population, and other issues were gathered. The information provided a valuable supplement to the empirical material obtained from the questionnaire survey and the interviews.

Results and Discussion

Diagnosing crucial socio-economic features of the examined community provides the starting point for understanding and improving the implementation of local development. Accordingly, this was the procedure adopted in this study by making three basic research assumptions.

First of all, it was assumed that the economic situation of the inhabitants of the post-PGR estate was very bad and showed no signs of improvement, which has led to a range of social problems. The results of the study show that the major and omnipresent problem is poverty. As one of the inhabitants noted, *'Sometimes there is not enough money for bread and butter, and the kids are growing up hungry.'* As much as 51.6% of the inhabitants stated that poverty was a problem in the estate (Table 1B). According to their declarations, in 10% of the households there is not enough money to satisfy basic needs, in almost 40% only the immediate needs are met, and in more than 30% of the households expenses must be closely monitored (Table 1A). Nearly every fourth respondent seeks help from family and relatives, every fifth borrows money and takes loans, and every tenth sells property or pawns assets. Due to insufficient benefits, food and current fees (electricity, water) dominate in

Table 1

Answers to questions concerning financial situation and social problems

Questions	% of answers
A. How would you describe your economic situation?	
Not enough money even for basic needs	9.7
Enough money for basic needs only	38.7
Restrictions are necessary but some savings are possible	32.3
No restrictions necessary, enough money for most needs	6.5
No restrictions necessary, enough money even for extra needs	12.9
B. Which of the following occur at Rolnicza/Chotel? (multiple answers possible)?	
Alcoholism	54.8
Poverty	51.6
Domestic violence	48.4
Theft	45.3
Fraud	41.9
Prostitution	16.1
Drug abuse	9.7

Source: Own elaboration on the basis of questionnaire survey.

the expense scheme of the respondents. Much less frequently the inhabitants can afford to buy clothes or better home furnishings. Newspapers, entertainment or holidays are beyond their reach. Except for expenses on basic goods, every sixth respondent of Chotel is behind in loan payments, and every fourth in gas and electricity fees.

Poverty, however, is not the only social problem (Table 1B). The inhabitants enumerate the following problems: family brawls, thefts and frauds, betrayals, 'loose conduct', use of stimulants, alcohol and drugs. Alcohol abuse was listed by 54.8% of the respondents, and this significant share confirms the results of other studies, which identified alcoholism as a major problem among the inhabitants of post-PGR estates (Wilkin, 1997; Sakson, 2003; Bereza and Kasprzak, 2004). Drugs were stated as a problem by 9.7% of the respondents. Other social problems included family brawls in connection with violence in alcoholic families, which were noticed by 48.4% of the respondents. The picture is completed by behaviors so extreme that they can be linked with law violation. For example, 16.1% of the respondents reported instances of so-called 'loose conduct', including prostitution, in the estate. Moreover, 41.9% enumerated frauds (in a broad sense of the term) and 45.3% listed thefts. Taking into account the observations of the respondents, such frequencies testify to the highly dysfunctional character of the estate under examination.

Social bonds are one of the basic premises of local development and their absence undoubtedly does not help solving such extreme saturation of social problems. As assumed in the study, the population of post-PGR estates is characterized by intense heterogeneity; low social cohesion, very weak bonds between neighbors, absence of communal actions and of the sense of belonging to a local community aiming at achieving common goals. The answers to the key question 'Do you think that the inhabitants of Chotel are close to each other?' included: *'The inhabitants of the estate surely do not feel close to each other. There are groups of people who spend time together – guys aimlessly wandering at night. People are false and hypocritical. Gossip rules everywhere'* and *'Close? They would drown one another in a spoonful of water or backstab each other.'* According to 56.7% of the respondents, there are no bonds between the inhabitants of the estate. In the study, almost every fourth respondent declares that s/he does not like his/her neighbors. Thus, the results point to mutual hostility between the inhabitants. The absence of social cohesion is accompanied by the problem of their difference and isolation from other neighboring estates or villages. This, in turn, determines their exclusion from a bigger local community of the inhabitants of Chotel.

Dysfunctionality and isolation are certainly not conducive to the implementation of local development solutions; in fact, they can make the latter impossible. The major factor contributing to dysfunctionality and isolation is the low social and spatial mobility of the people. As has been assumed in the study, the low level of education and low socio-economic status of the inhabitants of the post-PGR estate lead to the formation of a passive attitude and the ensuing resistance to change. Thus, it is symptomatic that out of the several dozen respondents none had had higher education and only every fourth had had primary schooling (Table 2A). Basic vocational agricultural training prevailed. The choice of school was determined by the closeness of agricultural education (the School Complex in Izbica Kujawska) rather than by the belief that this kind of education reflected the

Table 2

Answers to questions concerning social and spatial mobility

Questions	% of answers		
	A	B	C
A. Education			
Higher	0	0	0
Secondary	12.5	23.1	0
Basic vocational	37.5	76.9	66.7
Basic	50.0	0	33.3
B. Are you planning to continue education?			
Yes	77.8	35.7	16.7
Hard to say	22.2	21.4	0
No	0	42.9	83.3
C. What are you willing to do to improve your financial situation? (multiple answers possible)			
Write an application	33.3	7.1	14.3
Seek professional advice	33.3	7.1	14.3
Continue studying/join a course	55.6	35.7	14.3
Give up stimulants	22.2	7.1	14.3

Explanation: A – respondents at pre-productive age (under 18); B – respondents at productive mobile productive age (18-44); C – respondents at productive immobile age (45-60)
Source: Own elaboration on the basis of questionnaire survey.

demands of the job market. Significantly, the lack of education was frequently not caused by economic reasons, but was a matter of choice. As one of the inhabitants of Chotel explained, *'The most important thing is to have a job. And today you can't get a job, with or without education.'* It should be noted, however, that in the case of the inhabitants of Chotel the most advantageous, although far from satisfactory, structure of education was noted among people at mobile productive age, and the least advantageous (no one with secondary or higher education) among the respondents at the immobile productive age.

Lack of education does not have a good influence on the spatial mobility of the inhabitants of Chotel. The respondents listed the availability of cheap flats or being allotted a council flat as some of the major reasons for settling down in Chotel. The level of education determines chances for finding a place for oneself in the fast-changing job market. In every second household, there is at least one person unemployed. What is more, in every fifth household the unemployed person has been without a job for more than two years. Looking for an additional job seems to be a perfect solution for the inhabitants of Chotel, but only every third respondent declared s/he had done that. It is, therefore, intriguing that, for example, in the group of mobile productive age – theoretically the most influential group with regard to local development – only 7.1% of the respondents were willing to write an application or seek professional advice, and 35.7% would join an additional course. More than a half of the respondents at the pre-productive age selected an additional course or training, but in the same question almost 1/4 of the respondents pointed to giving up stimulants as the chance for improving their financial situation, which can be surprising in people so young (Table 2C). Since the level of education influences both the chances on the labor market and the possibilities of introducing changes in the socio-economic dimension at the local level, it should undergo a radical transformation in the community under examination. Meanwhile, 3/4 respondents at the pre-productive age, merely 1/3 at mobile productive age and 1/6 at immobile productive age plan their further education (Table 2B).

The interviews complementing the questionnaire provided a chance to establish what the respondents saw as the barrier preventing the solution of their problems. Some of them pointed out that the dependence on welfare was a phenomenon related to the past: *'It began in socialism and people have learnt that they should take when they are given something. They haven't learnt the 'no work, no gain' principle.'* In effect, people do not see their helplessness and its consequences as a problem, and they are hardly capable of noticing and using the potential of their community, which determines its development at the local level.

Conclusions

The results of the study have made it possible to verify the initial assumptions. The diagnosis of the respondents' economic situation made on the basis of the answers to a questionnaire survey and during interviews confirmed the assumption that the

economic situation of the inhabitants of the estate is disastrous. We have also ascertained that the continuing problems shape needs and behaviors; for example, the needs related to recreation, tourism, and participation in culture are almost totally reduced. As confirmed by objective facts, there appear behaviors that are pathological (drinking, domestic violence) or simply criminal (thefts, brawls, prostitution).

Such a cursory description of living conditions is often treated as exhaustive from the cognitive point of view, and therefore providing a satisfactory basis for defining various strategies. However, from the perspective of this study this seems to be an oversimplification. It has been established that the examined population forms a very specific category burdened by 'persisting heterogeneity'. As already mentioned, this feature determined by the genesis of such estates has not disappeared and has a major influence on the development of the local community. The study has proved that the inhabitants, despite the passage of time, continue to experience very weak bonds between neighbors. Their frequent dislike of members of the local community establishes relations which make the success of any communal action impossible and which incapacitate any bottom-up initiatives. Such attitudes are strongly reinforced by the sense of economic instability, low level of education, and low socio-economic status of the respondents as well as by the sense of social injustice, which, according to the respondents, they undeservedly suffered after the closure of the PGR. As a result, there appear attitudes testifying to their resistance to change. Changes demand engagement and activity, and these are not among the declared needs (in a sense, this is also the post-communist legacy, deeply rooted in people's mentality).

It should be emphasized that areas like the one examined in the study should be treated as especially problematic not only because of their economic dysfunctionality, but mainly because of the complex social problems they experience (lack of local ties, hostility, aggression between neighbors). Such a difficult environment requires substantial interference, which should take into account the problems specific to the population. The threat resulting from the heterogeneity of such communities should be a significant factor shaping the perception of local development problems. The efficiency of all actions at the level of local politics depends predominantly on solving the problems of low social cohesion (see Stenseke, 2009). This seems to be the most important aspect since it introduces disintegration to all other categories: it determines passivity, blocks initiatives and entrepreneurship, and it may make corrective actions inefficient. The exceptional burden on the community confirmed in the study seems to be the key element of the diagnosis. The latter should be used to devise a wise local policy. A wise policy alone will not, however, automatically solve all economic problems of the population since the living conditions of the inhabitants of post-PGR areas cannot be improved without strengthening social bonds.

References

1. Bereza A., Kasprzak T. (2004) Wewnętrzny Sybir czyli ballada o pegeerach (Interior Siberia Aka the Ballad about State Agricultural Farms). *Niebieska Linia*, 5(34), pp. 6-9. (in Polish).
2. Borowski A. (2013) Cooperative and national agricultural farm as total institutions. *International Letters of Social and Humanistic Sciences, 11,* pp. 100-105.
3. Daszkiewicz M. (2012) Badanie wizerunku terytorialnego z wykorzystaniem metod opartych na swobodzie skojarzeń (Research on the territorial image using methods based on free association). In Mazurek-Łopacińska K. (ed.) *Nauki o Zarządzaniu*, WUE, Wrocław, pp. 74-83. (in Polish).
4. Dekret Polskiego Komitetu Wyzwolenia Narodowego z dnia 6 września 1944 r. o przeprowadzeniu reform rolnej (Dziennik Ustaw 1944 nr 4 pozycja 17) (The decree of the Polish National Liberation Committee from the 6 September 1944 on the implementation of the agricultural reform). *Journal of Laws*, 1944. No. 4, pos. 17, pp. 18-21. (in Polish).
5. Jałowiecki B. (1988) Lokalne ruchy społeczne w perspektywie procesów globalnych (Local social movements in the perspective of globalization). In: Dutkiewicz P., Gorzelak G. (eds.) *Problemy rozwoju lokalnego,* IGiPZ PAN, Warszawa, pp. 9-31. (in Polish).
6. Karwacki A. (2002) The Culture of Poverty in the Post-State Farm Community. *Eastern European Countryside*, 8, pp. 79-93.
7. Kraciński P. (2011) *Rozdysponowanie Własności* Rolnej *Skarbu Państwa* w latach *1992–2009 (*The disposition of agricultural property of the National Treasury 1992-2009). *Ekonomika Organizacja Gospodarki Żywnościowej*, 87, pp. 41-53. (in Polish).
8. Psyk-Piotrowska E. (2011) Aktywizacja i rozwój lokalny jako program i metoda działania na rzecz zmian (Activation and local development as a program and a method of changes). *Acta Universitatis Lodziensis, Folia Sociologica,* 37, pp. 149-169. (in Polish).

9. Reilly M.D. (1990) Free elicitation of descriptive adjectives for tourism image assessment. *Journal of Travel Research*, 28, 4, pp. 21-26.
10. Ritchie J.R.B., Crouch G.I. (2003) *The competitive destination*, CABI Publishing, Cambridge, 304 p.
11. Rosner A. (ed) (2002) *Wiejskie obszary kumulacji barier rozwojowych* (Rural areas as cumulative developmental barriers). IRWiR PAN, Warszawa, 214 p. (in Polish).
12. Rosner A. (ed) (2007) *Zróżnicowanie poziomu rozwoju społeczno-gospodarczego obszarów wiejskich a zróżnicowanie dynamiki przemian* (Differences in the socio-economic development of rural areas and the dynamics of change). IRWiR PAN, Warszawa, 279 p. (in Polish).
13. Sakson A. (2003) Kształtowanie się nowej społeczności powiatu słupskiego po 1945 roku na tle przemian społecznych na Ziemiach Zachodnich i Północnych (The creation of new communities in the Słupsk district after 1945 to the background of societal transformations in Western and Northern Territories). In: Czarnik A. (ed) *Obrazy Ziemi Słupskiej. Społeczeństwo-administracja-kultura*, Materiały z VII Konferencji Kaszubsko-Pomorskiej, Słupsk, pp. 132-139. (in Polish).
14. Sekuła A. (2005) Bariery rozwoju lokalnego (Barriers of local development). In: Filipiak B., Szewczuk A., Zychowicz Z. (eds.) *Samorząd terytorialny w zintegrowanej Europie, Zeszyty Naukowe*, 401, Uniwersytet Szczeciński, Szczecin, pp. 587-600. (in Polish).
15. Stenseke M. (2009) Local participation in cultural landscape maintenance: lessons from Sweden. *Land Use Policy*, *26*(2), pp. 214-223.
16. Stöhr W. (1990) On the theory and practice of local development in Europe. In: Stöhr W. (ed) *Global challenge and local response. Initiatives for economic regeneration in contemporary Europe*, The United Nations University, Mansell, London and New York, pp. 35-54.
17. Tarkowska E. (2001) An underclass without ethnicity: the poverty of Polish women and agricultural laborers. In Emigh R., Fodor E., Szelényi I. (eds.) *Poverty, ethnicity & Gender in Eastern Europe During The Market Transition*, Praeger, Westport, pp. 83-122.
18. *Ustawa z dnia 24 lipca 1998 r. o wprowadzeniu zasadniczego trójstopniowego podziału terytorialnego państwa* (Dziennik Ustaw z 1998 r. Nr 96, pozycja 603) (The law from 24 July 1998 on the implementation of a national tripartite territorial division). *Journal of Laws*, 1998. No. 96, pos. 603, 75 p. (in Polish).
19. Wilkin J. (1997) Przekształcenia sektora państwowych gospodarstw rolnych w Polsce w opinii władz lokalnych i mieszkańców „osiedli pegeerowskich" (Transformation of the former State Agricultural Farms in Poland according to local authorithies and the local residents of post-SAF estates). In: Korab K. (ed) *Ludzie i ziemia po upadku pegeerów*, Wydawnictwo SGGW, Warszawa, pp. 44-75. (in Polish).

INNOVATIVE ACTIVITIES OF SMES[1] OF THE CROSS-BORDER REGIONS (LATVIA-LITHUANIA-BELARUS)

Olga Lavriņenko, **Oksana Ruža**, **Alina Ohotina**
Daugavpils University, Latvia
Olga.lavrinenko@du.lv; Oksana.ruza@du.lv; Alina.ohotina@du.lv

Abstract
Innovative activity of small and medium-sized enterprises is one of the factors for effective business. The aim of the article is to determine the innovative activities of small and medium-sized businesses in the frontier regions of Latvia (Latgale region), Lithuania (Vilnius region, Alytus region, Utena region, Panevezys region, Kaunas region), Belarus (Vitebsk region, Grodno region, Minsk region, Mogilev region). The novelty of the research has a cognitive character: the authors have determined the level of innovation potential for small and medium-seized enterprises in the regions, which is characterized by a complex of various resources, the amount of the production of innovative product and innovative technology, service in the regions, the branch structure of innovations in the regions, dominance of certain models of innovative entrepreneurship on the basis of innovative process organization in the companies located in the frontier regions has been established. The following methods are used for the research: logical analysis and synthesis, monographic and analytical method for studying economic theoretical and empirical sources of the international level, quantitative and statistical methods of data processing – frequency analysis, sampling; for the collection of the initial primary data the instrument of questionnaire was used.
Key words: Innovative entrepreneurship, innovation potential, cross-border regions.

Introduction

Innovative entrepreneurship is a process of creation and commercial use of technical and technological innovations. One of the tasks for the entrepreneurs is to reform the production process by the implementation of inventions, but in a broader sense – by the use of new technological combinations for the production of either new or the same product, but using a new method, thanks to the discovery of new raw material source or new market for finished products – up to the reorganization of the previous one or the establishment of a new branch of industry (Шумпетер, 1982).

The aim of the article is to determine the innovation potential of small and medium-seized enterprises, which is characterized by a complex of various resources, as well as to define the models of innovative entrepreneurship and the branch structure of innovations in the frontier regions.

In order to achieve the aim, it was necessary to solve the following tasks: to choose a corresponding research methodology, to describe the methods of collection and processing of empirical data, as well as research limitations.

Materials and Methods

According to a narrow interpretation, innovations mean: a radical updating (invention), technological product, innovative process. According to Porter (Porter, 1990), innovations can be defined in a broader sense, i.e., they include advancements in technologies, methods or ways of operation, which may result in the changes in the products, technologies, new marketing approaches, etc. A broader interpretation of innovations may include also those changes, which are new for a certain company despite the fact that other companies have already implemented such changes. The authors give preference to a broader approach to innovations as it allows to focus on the study of the frontier regions in periphery (Storhmmar, 2003). Small and medium-sized enterprises give a strong impulse for the increase of employment and economic growth in the regions due to their innovative activity (Keizer, 2002). Innovative activity is one of the most important means with the help of which small and medium-sized enterprises foster economic growth – innovations are even more crucial for small and medium-sized companies than for large companies (Fritz, 1989).

Innovations serve as a specific entrepreneurship instrument, which is aimed at the search for novelties. "Entrepreneurs are distinguished by the innovative way of thinking. Innovativeness is a special entrepreneurship instrument" (Друкер, 1992). Innovative potential of an enterprise is necessary in order to carry out innovative activity, which is characterised as a complex of various resources.

Innovation – it is a new or significantly improved product or service at the market (BIS.., 2014).

Product innovation – it is an innovation involving the creation and subsequent introduction of new or improved products (goods), or already implemented in the production practice of other enterprises and distributed through the technological exchange (non-patent licenses, consultations) and ensuring the growth of profits, broadening of market share, maintenance of clients and increasing prestige. Incremental innovations are modifications of already

1 Small and medium-sized enterprises

existing platforms and products. Radical innovations are products, which are new both to the market and to the company (Jovanović et al., 2008).

Technology innovation – it is an innovation involving elaboration and implementation of either new, or considerably improved production processes which provide for the application of new production equipment, new methods for the organization of the production process or a set of these methods aimed to raise the productivity of labour and the economy of resources which, in turn, allows to increase the profits of a commercial organisation, improve the labour safety, and ensure the effective use of intra-company information systems.

In the glossary of the Central Statistical Bureau of Latvia, there is a following definition of innovation: «An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. The minimum requirement for an innovation is that the product, process, marketing method or organizational method must be new (or significantly improved) to the enterprise» (Economically.., 2015).

Depending on the opportunities and strategic goals, the enterprise may purchase innovations from the other party or develop them itself. In the first case, it is recommended to establish a strategic partnership with specialized scientific research or designing organization. In the latter case, it is preferable to organize own specialized innovative subdivisions.

Thus, on the basis of the ways of organizing the innovative process in the company, three models of innovative entrepreneurship can be distinguished:

1) innovative entrepreneurship on the basis of the internal organization, when an innovation is created and adopted within the company by its specialized subdivisions on the basis of planning and monitoring of their interaction within the innovative project;
2) innovative entrepreneurship on the basis of the external organization by the way of contracts, when an order to create and adopt innovations is placed among the outside organizations;
3) innovative entrepreneurship on the basis of the external organization, when the company founds subsidiary venture capital companies which attract additional external financing.

The basic data for the analysis of the cooperation among small and medium-sized companies in the researched frontier regions are collected with the help of the survey of 620 entrepreneurs of small and medium-sized businesses in the frontier regions of Latvia (Latgale region), Lithuania (Vilnius region, Alytus region, Utena region, Panevezys region, Kaunas region), Belarus (Vitebsk region, Grodno region, Minsk region, Mogilev region) within the period from April to July, 2014[2]. The survey was made in the basic languages of communication in the regions: in Latvian and Russian for Latvia, in Lithuanian – for Lithuania, and in Russian for Belorussia. The design of sample according to the type of selection – combined, according to the method – unrepeated, according to the way of sampling – stratified by the main directions of the research. The survey was carried out anonymously with the help of a questionnaire available in paper format, as well as on-line on the internet.

During the working process with the database in SPSS programme, the data of the questionnaire were subjected to weighting according to the main directions of stratification; as the result, the deviations of the parameters of sample from the parameters of general population made up less than 6%. One of the limitations of the empirical study is different methodological approaches for the determination of the scale of business in the EU and Belarus; therefore, the EU criteria (Department.., 2015) were used for weighting sample of the enterprises in the regions of Lithuania and Latvia, but in the regions of Belarus – criteria established by the legislation of the Republic of Belarus (Законодательство.., 2015), as weighting is based on the statistical data, but the subsequent analysis of the obtained data from the questionnaire is based on the EU methodology. The method of frequency analysis was used for data processing.

Results and Discussion

Results

It was found that all the regions have most of the difficulties with financial potential of small and medium-sized enterprises. In *Vilnius region* difficulties with financial resources were found (11.3% of the enterprises "have a shortage" or "have an absolute shortage" due to the ineffective exploitation in 1.2% of the enterprises), 9.2% of the enterprises have a shortage in temporary resources due to the ineffective exploitation in 1.2% of the enterprises, 1.2% of the enterprises have a shortage in human resources, although they are exploited effectively. Other resources are also exploited effectively.

In *Alytus region* difficulties with financial resources were found (29.3% of the enterprises "have a shortage" or "have an absolute shortage" at the effective exploitation in all the enterprises), 11.7%

2 The survey done within the framework of the project „The Establishment of the United Entrepreneurship Support and Networking System for the Sustainable Latvia, Lithuania and Belarus Cross Border Cooperation" (B2B) funded by the cross-border cooperation programme Latvia-Lithuania-Belarus „European Neighbourhood and Partnership Instrument 2007-2013"

of the enterprises have a shortage of technological resources due to the ineffective exploitation in 2.6% of the enterprises, 2.7% of the enterprises have a shortage in human resources, 2.6% of the enterprises have a shortage in temporary resources. The effectiveness of exploitation of human, energy, finance, information, and temporary resources are rather high.

In *Utena region* 12.3% of the enterprises have difficulties with financial resources, 5.3% of the enterprises have a shortage in human resources, 3.9% of the enterprises have a shortage in temporary resources, 2.9% of the enterprises have a shortage in energy and technological resources. 2.9% of the enterprises exploit information resources ineffectively. The effectiveness of exploitation of human, energy, finance, technological, and temporary resources are rather high.

In *Panevezys region* most of the difficulties concern financial resources: 32.2% of the enterprises "have a shortage" or "have an absolute shortage", 9.1% of the enterprises have a shortage in temporary resources, 6.5% - technological, 3.7% - information, 1.9% - human resources. However, the effectiveness of exploitation of all the resources is rather high (except information resources – 5.8% of the enterprises exploit them ineffectively).

In *Kaunas region* there are no serious problems neither with resources nor with their effective exploitation. Very slight difficulties are observed concerning financial resources: 7.2% of the enterprises "have a shortage" or "have an absolute shortage", 6.7% of the enterprises have a shortage in temporary resources, 5.1% - energy and information resources, 4.2% - technological resources. The effectiveness of exploitation of all the resources is very high.

Thus, the enterprises in *Latgale*, as well as in *Belorussian regions* have serious difficulties both with the resource potential, and with the effective exploitation of resources. In the *regions of Lithuania* there is the most advantageous situation with the effective exploitation of resources, as well as with the resource potential.

Depending on the opportunities and strategic goals, enterprises are either developing innovations on their own by establishing own specialized innovative subdivisions, or purchasing innovations from the other party by establishing strategic partnership with specialized scientific research or designing organization.

The authors have found that innovative entrepreneurship *on the basis of internal organisation*, when innovations are created and (or) adopted within the company by its specialized subdivision on the basis of planning and monitoring of their interaction within the innovative project is characteristic in the following regions: the answers "partially agree", "agree", and "totally agree" to the corresponding questions were received from 67.8% of the enterprises in Latgale region, 69.4% of the enterprises in Kaunas region, 43.6% of the enterprises in Utena region, 62.4% of the enterprises in Vilnius region, 33.6% of the enterprises in Alytus region, 39.9% of the enterprises in Panevezys region, 46.6% of the enterprises in Vitebsk region, 24.6% of the enterprises in Grodno region, 23.9% of the enterprises in Minsk region, 58.7% of the enterprises in Minsk, and 67.9% *of the enterprises in Mogilev region.* An important precondition for success here is the level of scientific treatment, its perception at the market, knowledge about the potential customers and clients, availability of team members with innovative management skills.

Innovative entrepreneurship *on the basis of the external organization by the way of contracts*, when an order to create and (or) adopt innovations is placed among the outside organizations is characteristic in the following regions: the answers "partially agree", "agree", and "totally agree" to the corresponding questions were received from 38% of the enterprises in Latgale region, 51.1% *of the enterprises in Kaunas region*, 28.6% of the enterprises in Utena region, 36.3% of the enterprises in Vilnius region, 12.3% of the enterprises in Alytus region, 16.3% of the enterprises in Panevezys region, 22% of the enterprises in Vitebsk region, 15.2% of the enterprises in Grodno region, 38.3% of the enterprises in Minsk, and 67.3% *of the enterprises in Mogilev region.*

Venture enterprises[3] are functioning mainly on the stages of the development of a new product or technology. They assess market perspectives of innovations at the development stage, but, as a rule, they are not dealing with the production or organization of the production of products, but deliver a final product to large companies. The foundation of venture companies implies availability of the following components: innovation ideas, public demand and venture capital for financing (own or external capital). Innovative entrepreneurship *on the basis of external organization with the help of ventures* is characteristic in the following regions: the answers "partially agree", "agree", and "totally agree" to the corresponding questions were received from 25% of the enterprises in Latgale region, 31.9% *of the enterprises in Kaunas region,* 10.5% of the enterprises in Utena region, 10.2% of the enterprises in Vilnius region, 6.1% of the enterprises in Alytus region, 2.1% of the enterprises in Panevezys region, 14.8% of the enterprises in Vitebsk region, 11.7% of the enterprises in Minsk region, 14.7% of the enterprises in Minsk, and 50.5% *of the enterprises in Mogilev region.*

3 Companies with „a high risk level"

Table 1

Number of enterprises by regions having 5 to 75% of innovative product or service (percent)[4]

Region	Latgale Region	Vilnius Region	Alytus Region	Utena Region	Panevezys Region	Kaunas Region	Vitebsk Region	Grodno Region	Minsk region	Minsk	Mogilev Region
A	6.3	8	0	0	44.4	7.8	0	5.8	7.9	1.7	2.3
B	0	0	0	0	0	0	2	0	0	0	0
C	9.4	2	0	0	0	9.8	25.5	9.6	31.7	6.8	9.1
D	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	1.6	0	0
F	7.8	6	0	0	11.1	7.8	2	9.6	15.9	3.4	9.1
G	26.6	20	33.3	0	44.4	27.5	21.6	40.4	17.5	52.8	45.5
H	1.6	2	0	0	0	9.8	3.9	3.8	4.8	2.8	4.5
I	1.6	3	0	0	0	2	2	1.9	0	1.1	4.5
J	10.7	2	0	0	0	9.8	2	1.9	0	2.3	11.4
K	1.6	0	0	0	0	0	0	0	0	1.7	0
L	10.9	40	66.7	100	0	15.7	0	5.8	0	0	0
M	7.8	6	0	0	0	0	2	0	0	0	0
N	0	0	0	0	0	3.9	2	1.9	0	1.7	0
O	0	0	0	0	0	0	7.8	7.7	0	6.3	0
P	6.3	4	0	0	0	3.9	11.8	0	0	5.7	2.3
Q	1.6	3	0	0	0	2	3.9	0	3.2	1.7	2.3
R	0	0	0	0	0	0	0	0	0	0	0
S	7.8	4	0	0	0	0	13.7	11.5	17.5	11.9	9.1

Source: authors calculations in SPSS according to the survey data in 2014 within the project „The Establishment of the United Entrepreneurship Support and Networking System for the Sustainable Latvia, Lithuania and Belarus Cross Border Cooperation" (B2B) funded by the cross-border cooperation programme Latvia-Lithuania-Belarus „European Neighbourhood and Partnership Instrument 2007-2013".

It was found that the share of innovative product in the revenue of the enterprise in Vilnius region makes up 31.6%, in Mogilev region – 26.8%, Kaunas region – 26.4%, Utena region – 25.4%. Slightly lower indicators are in Panevezys region – 20.7%, Latgale region – 18.9%, Alytus region – 16.8%, Minsk – 15.2%. The smallest share of innovative product in the revenue of the enterprise have the enterprises in Vitebsk region – 10.2%, Grodno region – 8.1% and Minsk region – 7.4%.

Concerning the branch structure of innovations, the authors have found that the largest development of innovations is characteristic for wholesale and retail trade and car and motorcycle repair (G): from 5 to 75% of innovative product or service have the companies in Minsk – 52.8%, in Mogilev region – 45.5%, in Panevezys region – 44.4%, in Grodno region – 40.4%, in Alytus region – 33.3%, in Kaunas region – 27.5%, in Latgale region – 26.6%, in Vitebsk region – 21.6%, in Minsk region – 17% of the companies. Further, according to the level of innovation development, comes the branch of real estate operations (L): from 5 to 75% of innovative product or service have all the companies in Utena region, in Alytus region – 66.7% of the companies, 40% of the companies in Vilnius region, in Kaunas region – 15.7%, 10.9% of the companies in Latgale region, 5.8% of the companies in Grodno region. Next comes the branch of manufacturing industry (C): from 5 to 75% of innovative product or service have 31.7% of the companies in Minsk region, 25.5% of the companies in Vitebsk region, 9.6% of the companies in Grodno region, 9.8% of the companies in Kaunas region, 9.4% of the companies in Latgale region, 9.1% in Mogilev region, 6.8% of the companies in Minsk. Innovations in agriculture, forestry, fisheries are more developed in Panevezys region – 44.4% of the companies have from 5 to 75% of innovative product, next comes Minsk region – 7.9% of the companies have from 5 to 75% of innovative product, then Kaunas region –

4 (A) Agriculture, forestry, fisheries, (B) Mining industry and opencast pit management, (C) Manufacturing industry, (D) Electric energy, gas supply, heat supply and air conditioning, (E) Water supply; management and treatment of sewage and waste, (F) Construction, (G) Wholesale and retail trade; car and motorcycle repair, (H) Transport and storage, (I) Accommodation and catering industry (hotels, etc.), (J) Information and communication services, (K) Financial and insurance activities, (L) Real estate operations, (M) Professional, scientific and technical services, (N) Activity of administrative and maintenance services, (O) State administration and security; obligatory health insurance, (P) Education, (Q) Health and social care, (R) Art, entertainment and recreation, (S) Other services.

7.8%, Latgale region – 6.3%, Grodno region – 5.8%. Innovations exist also in construction (F): the leader is Minsk region – 15.9% of the companies have from 5 to 75% of innovative product, in Panevezys region 11.1% of the companies have from 5 to 75% of innovative product, in Grodno region 9.6% of the companies have from 5 to 75% of innovative product, in Mogilec region 9.1% of the companies have from 5 to 75% of innovative product, 7.8% of the companies in Kaunas and Latgale region have from 5 to 75% of innovative product. In Vitebsk region the sphere of education (P) has also an innovative character: 11.8% of the companies have from 5 to 75% of innovative product or service. In the sphere of information and communication services (J) 11.45% of the companies in Mogilev region have from 5 to 75% of innovative product, in Latgale region 10.7% of the companies have from 5 to 75% of innovative product, in Kaunas region 9.8% of the companies have from 5 to 75% of innovative product (see Figure 1).

Discussion

The notions of „innovations" and „innovative activity" are rather vague, not very clear: "An innovation is a new or significantly improved product or service on the market". How does a significantly improved product or service differ from slightly improved product or service? Is there any difference between the notions "a new product" and "an innovative product"? Thus, the criteria for the assessment of innovations and innovative activity are also vague and unclear; they require deeper clarification and detailed elaboration. Because of the unclearness of the above mentioned definitions, there arises a question about the objectivity of the assessment of innovations and innovative potential of small and medium-sized enterprises in the scientific researches. In Latvia, according to the data from 2008 to 2010, on average 31.7% of the companies are innovative, among the small-sized enterprises – 28.4% of the companies, among the medium-sized enterprises – 36.9% of the companies, among the large-scale enterprises – 66.1% of the companies (Number.., 2015), in the UK in 2013 on average 44% of the companies are innovative (Fritz, 1989). Therefore, the assessment of the number of innovative companies in the frontier regions by the authors of the research (with the indicated limitations) is rather adequate, introducing specification of the number of innovative companies in the small frontier regions. Predominance of the innovative entrepreneurship on the basis of the internal organization, considering the problems with the resources, in all the frontier regions (irrespective the location in various states), probably, is not the most effective. It would be more logical to develop entrepreneurship on the basis of the external organization by the way of contracts, which would allow in part to merge the resources and to avoid shortages. Venture business in the frontier area is poorly developed (with the exception in several regions) – it is clear, there are few resources, very high degree of risk irrespective the support from business incubators and other instruments.

The data obtained by the authors conform to the researches done by other researchers, in which the second variant is more characteristic for the countries of the former Soviet Union and Russia, while in the countries with the developed innovative economy more predominant is the variant of the attraction of venture resources.

Conclusions

1. For the objectivity of the researches, the definitions of the main notions in the research field such as „innovations" and „innovative activity" require deeper clarification and detailed elaboration.
2. The existence of serious difficulties both with resource potential and with its effective exploitation is established for the enterprises in Latgale and Belarus, the enterprises in the regions of Lithuania are in the most advantageous situation with the effective exploitation of the resources as well as resource potential. The problem of small and medium-sized enterprises, which have rather serious intellectual potential, as a rule lies in the fact that in order to create sophisticated patterns, they need expensive material and technical base.
3. The authors have discovered that the innovative entrepreneurship on the basis of the internal organization predominates among small and medium-sized enterprises almost in all the regions. However, there are some exceptions – the models of innovative entrepreneurship on the basis of the external organization by the way of contracts and innovative entrepreneurship on the basis of the external organization with the help of ventures are more developed in the enterprises of Mogilev and Kaunas region.
4. The research on the branch structure of innovations has revealed that business prefers to be engaged in those fields that guarantee profits, for example, trade, real estate than to invest financial resources in the high-risk innovation projects.

References

1. Fritz W. (1989) Determinants of product innovation activities. *European Journal of Marketing*, 23(10), pp. 32-43.

2. Keizer J., Dijkstra L., Halman J. (2002) Explaining Innovative Effort of SMEs. An exploratory survey among SME in the mechanical and electrical engineering sector in the Netherlands'. *Technovation,* 22, pp. 1-13.
3. Porter M. (1990) *The Competitive Advantage of nations*. London: Macmillan, pp. 12-20.
4. Storhammar E., Virkkala S. (2003) The emergence of innovation strategy and local milieu: theoretical starting points for empirical study. *43th Congress of The European Regional Science Association*. Jyvaskyla, Finland, pp. 27-30.
5. Sweeney G. (1983) *New Entrepreneurship and the Smaller Firm*. Campus, Frankfurt, New York, pp. 54-61.
6. BIS PERFORMANCE INDICATORS. Proportion of firms who are innovation active OCTOBER 2014. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/367675/Proportion_of_firms_who_are_innovation_active_Oct_2014.pdf, 9 January 2015.
7. Economically active statistical units by statistical region, city and district 2004-2008. Available at: http://data.csb.gov.lv/pxweb/en/uzreg/uzreg__ikgad__01_skaits/?tablelist=true&rxid=6d80318d-abbe-49fb-ae7b-81c644d38214, 9 January 2015.
8. Department of Trade and Industry Website: Small and Medium Enterprise (SME) Statistics - Definitions. Available at: www.dti.gov.uk/SME4/smehome.htm, 9 January 2015.
9. Законодательство Беларуси. Правовая библиотека: Закон Республики Беларусь от 16.10.1996. N685-XIII «О государственной поддержке малого предпринимательства в республике Беларусь» (Legislation of the Republic of Belarus - Act No. 685/XIII of 16 October 1996 on State support to small enterprise). Available at: http://old.bankzakonov.com/rep2010/vse15/str21n.htm, 9 January 2015.
10. Number of innovation cooperations as a percentage of innovative enterprises by type of partner, 2008–2010.
11. Number and share of innovative enterprises by type of innovation. Available at: http://data.csb.gov.lv/pxweb/en/zin/zin__inovac/IN0040.px/table/tableViewLayout1/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8, 9 January 2015.
12. Allocation of science and research funding 2011/12 to 2014/15. Available at: https://www.gov.uk/government/publications/allocation-of-science-and-research-funding-2011-12-to- 2014-15, 9 January 2015.
13. Друкер П.Ф. (1992) Рынок: как выйти в лидеры (How To Become Leaders, Practice and Principles). Практика и принципы: пер. с англ. / П.Ф. Друкер. –М.: Бук Чембер Интернешнл, 351 с. (in Russian).
14. Шумпетер Й. (1982) *Теория экономического развития* (Theory of Economic Development). М.: Прогресс. (in Russian).
15. Jovanović A., Zakić N., Stamatović M. (2008) External and Internal Factor Affecting the Product and Business Process Innovation. Economics and Organization Vol. 5, No 1, 2008, pp. 17-29.

TECHNICAL AND SCALE EFFICIENCY OF PGI BEAN FARMS IN GREECE

Giannis Karagiannis[1], **Katerina Melfou**[2]
[1]University of Macedonia, Greece
[2]Technological Education Institute of Western Macedonia, Greece
karagian@uom.gr; kmelfou@teikoz.gr

Abstract
In the EU during the last decade, interest has risen for both consumers and producers in Food Quality Schemes for agricultural products and foodstuffs. For producers, the appeal lies in the benefits associated with the collective reputation of quality that characterizes labels linked to geographical origin. This paper obtained estimates of technical and scale inefficiencies of PGI bean farms in Greece by applying the DEA methodology. The main part of the divergence from the efficient frontier is more due to inadequate use of inputs and less because farms are not operating at the optimal size. The vast majority of the farms in the sample achieved technical efficiency scores in the range of 70–100% and scale efficiency scores in the range of 80–100%. Average technical efficiency is lower than average scale efficiency which means that a larger segment of overall inefficiency is due to producing below the frontier than to operating at an inefficient scale.
Key words: Scale and technical efficiency, Data envelopment analysis, PGI beans, Food Quality Schemes.

Introduction

Participation in the EU Food Quality Schemes for agricultural products and foodstuffs is a way for farmers to maintain competitiveness and profitability via all the advantages collective reputation of quality products can offer. Three widely adopted EU schemes are the following: PDO (protected designation of origin), PGI (protected geographical indication) and TSG (traditional specialty guaranteed). Protected Geographical Indication – PGI is a label for agricultural products and foodstuffs whose production is closely associated with a particular geographical area and at least one of the stages of production, processing or preparation takes place in the defined area. In addition, the product's quality, reputation or other characteristic is essentially attributable to its geographical origin (Regulation (EU) No 1151/2012).

The PGI common bean of Prespes is a protein crop cultivated in the province of Florina, in Western Macedonia, on almost half of the available farmland in an area adjacent to the Prespes lakes. The farmland allocated to bean production in Greece, is 9,062 ha (FAO, 2013) or 0.36% of total arable land which is the highest in the EU-27 for this product. The cultivated area with beans under the Prespes PGI brand accounts for more than a third of that farmland. In addition, it is a very significant source of income and employment in the particular area. Europe has experienced a major reduction in protein crop cultivation from 4.7% of the arable crop area in 1961, to 1.8% in 2011 which was the result of falling demand for such crops for direct human consumption, coupled with increasing demand for livestock products. However, during the last decade developments in the markets changed European farmers who are now interested in protein crops that are increasing in value faster than wheat with which they compete for land. The forthcoming CAP support in the cultivation of protein crops is expected to be a significant influence to the sustainable development of European agricultural and food systems (IP/B/AGRI/IC/2012-067 PE 495.856 EN).

The proliferation of Food Quality Schemes for agricultural products and foodstuffs in the EU has occurred because of the benefits associated with collective reputation, in the form of substantial rents obtained by firms renowned for producing high quality products within such schemes. Tirole (1996), suggested that the better the reputation enjoyed by a group of firms producing under a Food Quality Scheme, the more incentive there is for a particular firm to maintain a level of quality, whereas new-comers at least partially inherit the reputation established by the collective quality brand. However, Winfree and McCluskey (2005) showed that collective reputation can be treated as a dynamic common property resource problem and, in that case, as the number of firms in the group increases, the incentive to supply the same level of quality decreases, when there is no firm traceability. That being so, these firms still profit from high prices because of the added value associated with the quality collective label.

The question that arises in either case, that is whether firms have the incentive to maintain quality or not, is to what extent they are more technically and scale efficient compared to those outside the quality schemes. Sellers-Rubio and Mas-Ruiz, (2014) examined the capacity of PDO labels in the Spanish wine sector to lead to greater firm efficiency while controlling for the role of different characteristics of members such as the average wage paid and the age of firms. They tested the hypothesis that a PDO label has a positive impact on firms' economic efficiency because it is a collective reputation indicator and stimulates efficient investment in quality, using the

non-parametric efficiency estimation method Data Envelopment Analysis. Results obtained suggest a low average level of technical efficiency for the whole sample (0.47) but significantly higher average technical efficiency of PDO wineries compared to non PDO wineries. Average scale efficiency is large (0.92) pointing to inefficient use of inputs rather than firms not operating at the optimal size. No statistically significant difference in scale efficiency was found between PDO and non PDO wineries. High scores of scale efficiency (0.97) were also achieved by a large panel of Spanish DO wineries - DO standing for a Spanish label of quality for wines since 1932 - over the period 2008-2010. Average technical efficiency (0.72) is rather stable during this period, but great divergence is detected in the sample with some highly efficient and some highly inefficient firms the latter being the largest in size (Vidal1 et al., 2013). Generally, research results regarding the experience goods of wine and cheese in Spain reveal that PDO brands exert a positive influence on technical efficiency and demonstrate the importance of PDOs in sectors in which firms do not rely on the reputation of individual brands (Sellers-Rubio and Más-Ruiz, 2015).

In the beef sector, Iraizoz et al., (2011) compared two types of beef farms, one under a PGI label and one without any certification, as regards profitability and economic efficiency. Although they find a positive association between PGI production and profitability, PGI beef farms appear less efficient with lower pure technical efficiency scores. The reverse holds for scale efficiency with PGI farms operating closer to optimal size.

Dimara et al., (2005) compares the effects of two alternative quality schemes on farm efficiency, using a sample of Greek black currant producers who either farm conventionally under a PDO label or employ organic methods, and are located either inside or outside the PDO zone. It appears that the location of the farm - inside or outside the designated quality zone - significantly affects technical and scale efficiency of conventional producers. Average technical efficiency for those located inside the zone is lower (0.67) and average scale efficiency is higher (0.77) than the corresponding average estimates for farmers located outside the quality zone (0.79 and 0.703, respectively). On the contrary, no statistically significant difference was found between the two groups of organic farmers. Overall, findings indicate that the contradictory effects of these quality schemes on farm efficiency require policies for organic farming to apply outside the PDO zones.

The objective of this paper is to estimate the technical and scale efficiency of Greek PGI bean farmers by applying the DEA methodology. The rest of the paper is organized as follows: the empirical model for the estimation of output-oriented technical and scale efficiency is presented in the next section. The empirical results are discussed in the third section followed by concluding remarks in the last section.

Materials and Methods

Suppose that we have input-output data for a sample of K farms using the same technology to produce a given output by means of N inputs. Let's further assume that farmers have a control over the different inputs but not over the output they produce due to weather uncertainty. For this reason we follow an output oriented approach to assess their performance, and we are going to estimate by means of the following linear programming problem how much they could have increased their output using the same level of inputs and employing the same technology if they had eliminated technical inefficiency. In terms of activity analysis, the radial Farrell-type output-oriented technical efficiency measure is given by solving for each farm in the sample the following linear programming problem (Equation 1):

$$F_O^k(x^k, y^k) = \max_{\phi,\lambda}\{\phi: \sum_{k=1}^{K} \lambda_k x_n \leq x_n^k \ \forall n, \sum_{k=1}^{K} \lambda_k y^k \geq \phi y^k, \lambda_k \geq 0 \ \forall k\} \quad (1)$$

Where *x* and *y* refers respectively to input and output quantities, λ_k are the intensity variables, x_n are (*1xK*) row vectors of the sample input matrix *X* with elements the quantities of a particular input that are used by the *K* firms in the sample, and *n=1,...,N* is the number of inputs. The restrictions on the intensity variables are related to the structure of returns to scale. The above formulation implicitly assumes constant returns to scale for the whole range of input values and results in what is called the benchmarking technology (Farrell, 1957; Fare et al., 1994).

An alternative specification that restricts the sum of the intensity variables to be equal to one corresponds to a variable returns to scale technology which is referred to as the frontier technology. In this case, output-oriented technical efficiency is estimated by solving for each farm in the sample the following linear programming problem (Equation 2):

$$E_O^k(x^k, y^k) = \max_{\phi,\lambda}\{\phi: \sum_{k=1}^{K} \lambda_k x_n \leq x_n^k \ \forall n, \sum_{k=1}^{K} \lambda_k y^k \geq \phi y^k, \sum_{k=1}^{K} \lambda_k = 1, \lambda_k \geq 0 \ \forall k\} \quad (2)$$

As the convexity constraint related to variable returns to scale is more restricted than the non-negatively of each intensity variable required in the constant returns to scale technology, we have $E_O^k(x^k, y^k) < F_O^k(x^k, y^k)$.

Table1

Descriptive statistics of inputs and outputs values, PGI Beans Farms

	Output (euros)	Land (str)	Labor (annual working hours)	Fertilizer cost (euros)	Pesticides cost (euros)	Irrigation cost (euros)	Capital (euros)
Average	64467	64	2539	2550	2294	1716	53135
Minimum	5632	6	450	262	223,5	162	1000
Maximum	361375	295	7025	9870	9420	8000	153000
Median	37385	40	2050	1807	1599	1100	52000
Standard deviation	60822	53	1589	1951	1794	1425	37841

In addition, one can estimate scale elasticity (Equation 3) using the benchmarking and the frontier based technical efficiency scores, namely:

$$S_O^k(x^k, y^k) = \frac{F_O^k(x^k, y^k)}{E_O^k(x^k, y^k)} \quad (3)$$

Output-oriented scale efficiency measures the distance to optimal scale after moving a farm to the frontier technology in the vertical direction. It gives the potential output that a farm can produce operating at optimal scale assuming that its technical inefficiency (if any) has been removed. The optimal scale, on the other hand, is determined by the point in the input-output space which corresponds to local constant returns to scale prevails. That point determines by default the maximum average productivity. Elaborating slightly the above relation, we can see that benchmarking performance, i.e., the extent of technical efficiency with respect to constant returns to scale technology, is decomposed into a best practice performance component, i.e., the extent of technical efficiency with respect to variable returns to scale frontier, and a scale component related to the extent of deviation from the optimal scale size. This decomposition provides a useful information regarding the sources and importance of productive efficiency and helps in designing more appropriate policy measures to reduce or even eliminate resource waste.

Results and Discussion

Summary statistics of the variables used for the purposes of the present study are given in Table 1. Output is measured in terms of total gross revenue, measured in euros. Six inputs are included in the production model, namely land measured in stremmas (1 stremma = 0.1 ha), labor (including family and hired workers) measured in annual working hours, fertilizer, pesticides, irrigation cost, measured in euros, and capital stock (including machinery and building,) also measured in euros. Capital stock is expressed in end-of-the-year terms.

Frequency distributions of technical and scale efficiency scores are reported in Table 2. The average

Table 2

Frequency distributions of technical and scale efficiencies of PGI Bean Farms

	Technical efficiency (CRS)	Technical efficiency (VRS)	Scale efficiency
Efficiency Score	Number of farms in range		
30-40	1	1	0
40-50	0	0	0
50-60	1	0	0
60-70	18	5	1
70-80	33	30	5
80-90	33	41	9
90-100	12	13	82
No of eff. units	6	14	7
Average	0.794	0.837	0.949
Median	0.795	0.839	0.975
Minimum	0.395	0.398	0.614
Maximum	1	1	1
Standard deviation	0.112	0.104	0.07

technical efficiency under constant returns to scale (CRS) and variable returns to scale (VRS) are 0.794 and 0.837, respectively. This result implies that, on average, the bean farms in the sample could have achieved the same level of output using 16% less inputs. The average scale efficiency of the sample is 0.949, which means that the largest part of the deviation from the efficient frontier is due to inadequate use of inputs and, to a lesser extent, because farms are not operating at the optimal size. The technical efficiency scores vary between 0.395 for the least efficient farm and 1, for 6 farms which are technically efficient, under constant returns to scale (CRS) and for 14 farms which are technically efficient under variable returns to scale (VRS). There are 7 farms with optimal scale efficiency. The vast majority of the farms in the sample achieved technical efficiency scores in the range of 70–100% and scale efficiency scores in the range of 80–100%. In addition, only one farm in the sample faced severe technical inefficiency problems while nearly 6% were fully efficient farms in the use of existing technology.

Average technical efficiency is lower (0.837) than average scale efficiency (0.949). Thus, a greater portion of overall inefficiency is due to producing below the frontier than to operating at an inefficient scale. As a result, bean farms in the sample could have on average increased their output by 5% if they had adopted the optimal scale and they could have further increased their output by 16% if they had used existing technology more efficiently.

Conclusions

The rising trend in consumer preferences towards agricultural products and foodstuffs of certified quality linked to a geographical origin, along with farmers' interest in the benefits associated with collective reputation, has prompted an interest in the investigation of Food Quality Schemes. Aside from the general interest in the production of such goods for the reasons mentioned above, there is a clear intention from the EU to give greater support to protein crops such as beans and Prespes PGI bean farmers, located in a marginal, less advantaged region, may be expected to expand their activities.

In this paper, estimates of technical and scale inefficiencies of PGI bean farmers in Prespes are obtained using a non-parametric approach. The degree of technical efficiency was found to be lower than the degree of scale efficiency and consequently a greater part of overall inefficiency can be attributed to farms producing below the production frontier than to operating at an inefficient scale. The empirical results suggest that there are no significant scale inefficiencies for the bean farms in the sample given that average scale efficiency is around 95%. Further research is required to look into the specific factors that mainly influence the degree of technical and scale efficiency.

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References

1. Dimara E., Pantzios C.J., Skuras D., Tsekouras K. (2005) The impacts of regulated notions of quality on farm efficiency: A DEA application. *European Journal of Operational Research,* 161, pp. 416-431.
2. Directorate General for Internal Policies Policy Department (2013) Agriculture and Rural Development. The Environmental Role of Protein Crops in the New Common Agricultural Policy-Study. IP/B/AGRI/IC/2012-067 PE 495.856 EN, pp. 21-33.
3. European Commission, (9/2/2015) Regulation (EU) No 1151/2012 of the European Parliament and of the Council. Available at: http://eur-lex.europa.eu/legal- content/en/TXT/?uri=CELEX:32012R1151, 20 Febryary 2015.
4. Fare R., Grosskopf S., Lovell K. (1994) *Production Frontiers*. Cambridge University Press, pp. 95-128.
5. Farrell M.J. (1957) The measurement of productive efficiency. *Journal of the Royal Statistical Society* Series A CXX Part 3, pp. 253-290.
6. Iraizoz B., Bardají I., Rapún M. (2011) Do 'Protected Geographical Indications' (PGI)-certified farms perform better? The case of beef farms in Spain. *Outlook on Agriculture*, 40(2), pp. 125-130(6).
7. Sellers-Rubio R., Más-Ruiz F.J. (2015) Economic efficiency of members of protected designations of origin: sharing reputation indicators in the experience goods of wine and cheese. *Review of Managerial Science*, 9(1), pp. 175-196.
8. Sellers-Rubio R., Mas-Ruiz F. (2014) The Economic Efficiency of Wineries of Protected Designations of Origin: Empirical Evidence from Spain. XXII Enometrics Conference 2014 Lyon France, pp. 1-11.

9. Tirole J. (1996) A Theory of collective reputations (with applications to the persistence of corruption and to firm quality). *Review of Economic Studies*, 63, pp. 1-22.
10. Vidal1 F., Pastor J.T., Borras F., Pastor D. (2013) Efficiency analysis of the designations of origin in the Spanish wine sector. *Spanish Journal of Agricultural Research,* 11(2), pp. 294-304.
11. Winfree J.A., McCluskey J.J. (2005) Collective reputation and quality. *American Journal of Agricultural Economics,* 87(1), pp. 206-213.

CONSUMER ATTITUDE TO FAST FOOD: THE CASE STUDY OF LITHUANIA

Vilma Tamuliene
Aleksandras Stulginskis University, Lithuania
vilma.tamuliene@gmail.com

Abstract
The fastening pace of life is changing Lithuanians' nutrition habits and the following change turns to be the most favorable for the development of fast food industry. The attitude has a very strong meaning for consumer behavior. The attitude determines the obtainment and loyalty of consumer product and service. It is significant for marketing specialists to identify the components, which form positive attitude towards service or products The availability of food is increasing; however, there emerges a lot of fast food, the consumption of which the aggressive advertising is promoting a lot. As in all fields, as well as in the industry of fast food, there are people, who support the following business and there are some against it. The following attitude might be determined by different components, which shape one's attitude. The research problem: what are the attitude components and how do they evidence in the selection of fast food in Lithuania? The article aim is as following: after having investigated the consumer attitude components to identify their impact on Lithuanian consumer attitude towards fast food. The research object: the impact of Lithuanian consumer attitude on the selection of fast food. For the research completion, the methods of questionnaire survey were applied. The gained research outcome has disclosed that the selection of fast food in Lithuania is determined under hedonistic consumption although, there is present the expression of the cognitive information process between the components of cognition and behavior.
Key words: consumer behavior, consumer attitude, fast food, Lithuania.

Introduction

Social and economic causes, such as price, comfort, fast pace of life and constantly increasing employment – all that is a modern human‘s daily life when there is not left any time to eat, fast prepared fast food turns to be a modern person‘s daily life. The origin of fast food has radically changed human‘s lifestyle, attitude towards nutrition and its peculiarities. According to Oxford University Press, (2006) fast food – is fast prepared processed food served in bars or restaurants as a fast snack or it is intended for takeaway. The availability of food is increasing and a lot of fast food restaurants and cafes emerge, the consumption of which is promoted by advertising. There is flood of fast food restaurants and cafes in Lithuania, Latvia and Estonia, and their turnover is increasing. According to Ieva Salmela, the development director of Hesburger, in Lithuania ‚Hesburger‘ reached the turnover of 25 million Litas in the year 2011, and that is about 38% or 9.5 million Litas more than in the year 2010. Hesburger‘s turnover in Lithuania increased by 24%, i.e. 31 million Litas in the year 2012 in comparison with the year 2011. It is the greatest increase in all Baltic States in comparison with the growth of the company turnover in Latvia (8%) and Estonia (7.3%) in the same period. General sales incomes in all Baltic States reached 141 million Litas in the year 2012: in Lithuania - 31 million in Latvia – 52 million and in Estonia – 56 million Litas. In the year 2013, Hesburger‘s turnover reached 36 million Litas in Lithuania in comparison with the year 2012, the restaurant chain turnover increased by 13.2% last year and that is the greatest increase among three Baltic countries (in Latvia – 11.35%, but in Estonia – 9.9%). (Business week, 2012). The turnover of the fast food restaurant chain - McDonald‘s is increasing. Since the year 2012, the sales in operating McDonald‘s restaurants in Lithuania has increased by 9% in comparison with the same period in the year 2011. McDonald‘s restaurant sales increased in other Baltic countries too: by 11% in Latvia and even by 20% in Estonia (Business week, 2012). That reveals that fast food demand is increasing in Lithuania and other Baltic countries. According to T. T. Ming et al. (2011), a major part of consumers have a negative attitude towards the consumption of fast food and there forms a paradoxical situation as the consumption food is not decreasing and oppositely it is increasing. Thus, it is significant to research the components forming consumer attitude towards fast food as they turn to be significant for consumer behavior and the selection of the accepted information, trademarks and fast food products. The research problem is the attitude components and how they evidence in the selection of fast food in Lithuania. The research object is the impact of Lithuanian consumer attitude on the selection of fast food. The aim of the following article is after having researched consumer attitude components, to identify their impact on Lithuanian consumer attitude towards fast food.

Materials and Methods

Lithuanian consumer attitude towards fast food was researched after having adapted a three-component model according to the attitude by M. Solomon et al. (2006). There has been chosen the quantitative, questionnaire-survey method for the research of the empirical research problem. The scope of the research

sample is 386, while surveying the population of Alytus, Kaunas, Klaipėda, Marijampolė, Panevėžys, Šiauliai, Tauragė, Telšiai, Utena and Vilnius. 30% of men and 70% of women participated in the survey. 52% of the surveyed are married people. The major part of the surveyed (75.6%) is at the age of 35 and even 74% have average income a month that exceeds 1.5 thousand Litas, and 73% of the surveyed have an advanced vocational education and training or higher education. Respondents are from all over Lithuania, i.e. survey outcomes reveal population opinion from different Lithuanian regions. The questionnaires were distributed to respondents in an electronic way (uploading them on websites and sending via emails).

For the completion of the research there were set three hypotheses: H1: attitude towards fast food is based on the cognitive information process; H2: attitude towards fast food is based on behavioral learning process; H3: attitude towards fast food is based on hedonistic consumption. For the validation of hypotheses there were applied the methods of correlation and regression. In order to identify correlations among variables, there was completed the computing of variables and the question statement were combined into blocks "affective", "cognitive", "behavioral" and "attitude".

A correlation strength scale for the estimation among variables in order to assess correlation coefficients was applied. According to V. Kasiulevičiaus et al., 2008, there is existent very weak (0.00–0.19), weak (0.20–0.39), average (0.40–0.69), strong (0.70–0.89) and very strong correlation (0.90–1.00). The correlation coefficient varies from 0 to 1, and its strength is not equal. In order to validate/accept or reject the set hypotheses, there was completed a regression analysis. The regression analysis can be completed, because after having completed a correlation analysis it was determined that among variables there is existent direct positive and significant correlation. Carrying out a linear regression analysis, three main indicators were taken into consideration: the coefficient of determination (R^2), the influence coefficient of (non-standardized β) and model relevance (p). The coefficient of determination R^2 gains values from the interval [0.1]. The higher the coefficient value is, the more the model is relevant for data. It is irrelevant when $R^2 < 0.20$. If ANOVA p-value is less than 0.05, the model is relevant. The non-standardized β – coefficient estimates (Čekanavičius et al., 2004). There was applied Cronbach's alpha coefficient for the estimation of the data reliability. The data were analyzed and managed applying a statistic software package for social sciences (SPSS Statistic 17.0 version).

Results and Discussion

Attitude conception and the components for its formation

Attitude formation can be one of the most significant marketing objects as it is highly significant for consumer behavior, accepted information and the selection of trademarks and products. The formulated attitude determines the assessment of fast food and the quality sets assigned to them in consumers' mind. The attitude is determined under the fact if an individual is keen or not on the certain issues and how he/she behaves in terms of it (Oxford University Pres, 2006). According to G. Antoanides et al., (1998), the mentioned conception – an individual trend to assess the existent objects or phenomena in a favorable or unfavorable manner. The attitude forms the human's respective conception concerning any object, etc. Besides, it is unique agreeably with the fact that it saves the resources of thinking and energy and especially due to the following reason, attitudes change with difficulties (Bakanauskas et al., 2010). The components of the attitude have quite significant impact on its formation: beliefs/emotions, behavior and cognition, further *cognitive* – it is a way of the object cognition, comprehension and understanding (Urbanskienė et al., 2000). As C. L. Bovee et al. (1992) claims, the following component is the easiest to be penetrated. It consists of the certain consumers' beliefs and knowledge. The following beliefs can be false and correct, positive or negative. *Emotional component (further affective)* – these are positive and negative consumer's feelings and emotions in terms of the certain object, i.e. how strong something what a person likes or dislikes, is. However, it is necessary to highlight that the individuals', with the same beliefs or opinions, response might differ (Bovee et al., 1992). Consumers' emotional response to an object means 'affective' attitude. For example, a person states: "I like fast food" or, Fast food is terrible'. Such an example reveals emotional assessment (affective) of the trial result (Urbanskienė et al., 2000). *Behavioral component (further behavioral)* consists of different actions that a consumer involves while following his/her beliefs or opinions and feelings (Bovee et al., 1992). As R. Urbanskienė et al. (2000) state, the following component outlines an intention to act in terms of an object. A lot of decisions related to purchase and non-purchase of a respective product or recommendation of the service to friends and coworkers reflects "*behavioral"* in the formation of attitudes. According to C. L. Bovee et al., (1992), only a positive attitude is not the final factor that determines the purchase of a good. After all, a consumer might simply have a need or some factors might limit its purchase, for example, financial possibilities or a good might be absent in the

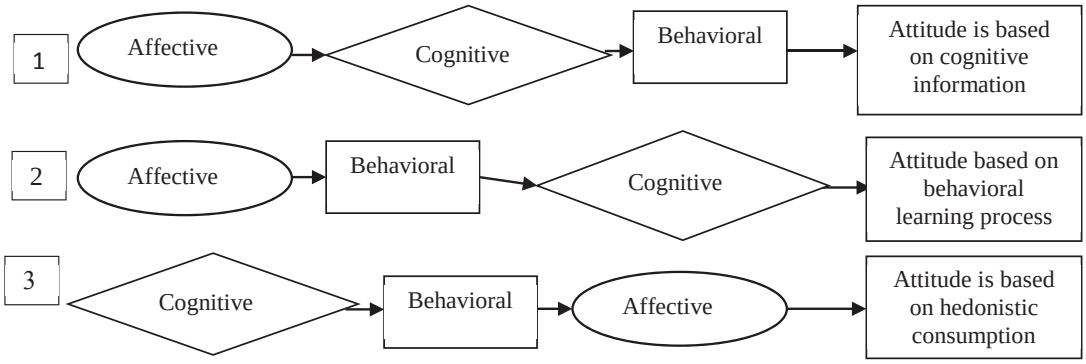

Figure 1. Three-component model of attitude.

Source: M. Solomon, G. Bamossy, S. Askegaard and M. K. Hogg (2006).

points-of-sales that are available to a consumer, etc. All three attitude components are significant and relative significance of each of it might differ depending on the consumer's level of motivation with the attitude object (Solomon et al., 2006). The scientists, who investigate attitude, created a lot of conceptions of formation. M. Solomon et al., 2006, investigated a three-component conception of attitude. The designed three-component theory of effect hierarchy interprets relative effect of three components on the formation of consumer attitude. The authors claim that 'behavioral' is one of the structural parts of attitude; however, it is not related with the very completion of the action, as it is action presumption of the attitude expression. During the analysis of a classical three-component structure of attitude, it is sought to find out which component impacts the formed attitude most or in other words, the following of which component enables the most precise expectation of the attitude trend. In order to achieve the following aim, there was formed the conception of hierarchical structures, see Fig.1. Each hierarchy represents a static way or in other words the succession of components in the formation attitude.

1) Standard learning hierarchy - an attitude is based on cognitive information process. In the following hierarchy, beliefs concerning respective attributes of a good are formed. A consumer grounds the following beliefs under cognition (assessment). Finally, according to the previously completed assessment, a consumer behaves in one or another way, e.g. purchases a product. In the standard learning hierarchy there is drawn a presumption that a consumer gets involved into the acceptance of a purchase decision. A person is motivated to receive as much information as possible to consider alternatives accurately and make a reasonable decision. In the following hierarchy, persons give a great part of time to the search of information and its processing, and the assessment of different alternatives in order to be able to make a reasonable decision, thus the following process quite often determines trademark loyalty. 2) Hierarchy of passive participation in the process - attitude based on behavioral learning process. Differently from the first hierarchy model, in the second hierarchy, very poor attention is paid to the formation of beliefs and the selection of information related to the object and its characteristics. A consumer does not pay a lot of difference to the selection of one or another good for a purchase. Nevertheless, although there are collected minimal data concerning the object, a consumer decides to act positively in terms of it – to purchase a good. However, the attitude is formed only after the purchase process, when a person can try and assess the good and finally make a positive or negative feeling about it. That can be called learning from behavior, when a person's choice is strengthened with positive or negative experience after the completion of an action. There is drawn a presumption that a person does not show a great willing in collection of knowledge about an object, considering that being an absolutely unnecessary activity and waste of time. The selection of purchase is mostly impacted by stimulus – reaction links. Consumers are likely to be affected by different advertising in the points-of-sales, expressive packages, slogans, encouraging to purchase, etc. A consumer can assess a product only when it is purchased or used. A consumer does not need to collect information for every decision-making in the following sequence. 3) Empirical hierarchy – the attitude is based on hedonistic consumption. The key attention is committed to 'affective' in the following hierarchy. Other two components of the attitude are moved to the second plan although the final attitude is created after having formed all three components. The objects, characteristic to the following hierarchy, distinguish by exclusive untouchable or intangible characteristics: a product representation or the package design, advertising or trademark brand. A consumer purchases a good under hedonistic belief that the selected good will provide some pleasure and

Table 1

***Cronbach's alfa* coefficients for blocks of questions**

Blocks of questions	Number of questions completing the block	Cronbach's alpha, α
Assessment of emotional statements concerning fast food	15	0.837
Assessment of cognitive statements concerning fast food	15	0.942
Assessment of behavioral statements concerning fast food	10	0.801
Assessment of attitude statements concerning fast food	8	0.727

joy.

Empirical research outcomes

According to a three –component model of attitude there was a completed empirical research in Lithuanian consumer attitude towards fast food. Reliability/credibility indicators of questionnaire questions are presented in Table 1.

All coefficients exceed 0.7, and as a result there might be drawn a conclusion that the questions are consequent and reliable. The highest reliability manifests in the assessment of the following category questions: cognitive (0.942), affective (0.837) and behavioral (0.801).

Correlation analysis

In order to identify connection among variables, computing of variables was carried out and question statements were divided into blocks 'attitude', 'affective', 'cognitive', and 'behavioral'. The estimated coefficients are provided in Table 2.

As it can be seen from Table 2, variables intercorrelate as in all cases p = 0.000 and it is less than the determined significance level (α = 0.01) and the following means that there is present a statistically significant relationship among variables. Due to the fact that all coefficients are positive, the correlational relationship among variables is positive, too. Correlational coefficients among variables vary from 0.331 to 0.882. The strongest correlational relationship is between 'attitude' and 'cognitive' (r = 0.882) variables. Agreeably with correlational coefficients it can be seen that strong relationship is between 'behavioral' and 'cognitive' (r = 0.839), between 'behavioral' and 'affective' (r = 0.801) variables. The relationship of average strength was determined between 'attitude' and 'cognitive' (r = 0.461) and between 'cognitive' and 'affective' (r = 0.451) variables. Weak correlational relationship is between 'attitude' and 'behavioral' (r = 0.331) variables. In summary, it can be stated that it was statistically determined that there is existent positive and statistically significant relationship among the components which form consumer attitude: affective, cognitive, behavioral and attitude.

Regression analysis

As it can be seen from the data presented in Table 2, the signs of all coefficients are positive as the correlational coefficients are; thus, the regression analysis is relevant. Besides, the coefficient of determination is quite high in all cases (R^2>0.20); thus, this means that he model describes data quite well, and simple linear regression model cannot be rejected as irrelevant one. The generalized data of the regression analysis are presented in Table 3.

In Table 3, it can be seen that in all cases p value of ANOVA criterion is less than 0.05 (p=0.000), thus it can be stated that there is present dependence among variables. The coefficient estimates are presented in the column of Unstandardized Coefficients β. Thus, simple linear regression analysis is relevant for data, and the gained coefficients are statistically significant. Agreeably with the data presented in Table 3, it can be seen that there exists a simple linear regression between

Table 2

Correlations coefficient between variables

	Affective	Cognitive	Behavioral	Attitude
Affective Correlation Coef. Sig. (2-tailed)	1.000	.451** .000	.801** .000	.882** .000
Cognitive Correlation Coef. Sig. (2-tailed)	.451** .000	1.000	.839** .000	.461** .000
Behavioral Correlation Coef. Sig. (2-tailed)	.801** .000	.839** .000	1.000	.331** .000
Attitude Correlation Coef. Sig. (2-tailed)	.882** .000	.461** .000	.331** .000	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3

Main influence on variable

Independent variable	R^2	β	p	Dependent variable
Affective	0.218	0.317	0.027	Cognitive
Affective	0.284	0.304	0.021	Behavioral
Cognitive	0.760	0.817	0.000	Behavioral
Behavioral	0.210	0.217	0.034	Attitude
Behavioral	0.294	0.392	0.014	Cognitive
Cognitive	0.276	0.319	0.012	Attitude
Behavioral	0.603	0.858	0.000	Affective
Affective	0.616	0.843	0.000	Attitude

'affective' and 'cognitive' ($p<0.05$), thus, when there is increasing 'affective', there is respectively increasing cognitive' component. The following regression is statistically significant as the least coefficient of determination is $R^2=0.210>0.20$. 'Affective' impacts 'cognitive' that is equal to 0.317. The following shows a weak, but statistically significant relationship. Although being weak, however, 'affective' has statistically significant impact on 'behavioral' (β=304), and 'behavioral' impacts 'attitude' weakly (β=217), 'behavioral' impacts 'cognitive' component weakly (β=392), 'cognitive' does not have a strong impact, but very significant statistically one on 'attitude' component (β=319). 'Cognitive' has a strong impact on 'behavioral' component as it was determined that when there is increasing 'cognitive', 'behavioral' component is increasing too, as there is present simple linear regression among them ($p<0.05$) that is statistically significant ($R^2=0.760>0.20$), o β =0.817. As it can be seen from the data in Table 3, there is present linear ($p < 0.05$), statistically significant ($R^2=0.603>0.20$) relationship among 'behavioral' and 'affective' component, and 'behavioral' impact on 'affective' is equal 0.858. The analysis has disclosed that when 'affective' is getting better, 'attitude' is getting better too, as there is present linear ($p<0.05$) statistically significant ($R^2=0.616>0.20$) relationship. 'Affective' impact on 'attitude' is equal 0.843. The data committed to the validation of the set hypotheses in the methodological part of research are illustrated in 'a three-component model of attitude', see Fig. 2.

Standard hierarchy forms Lithuanian consumer attitude towards fast food. When consumer attitude towards fast food is based on the cognitive information process, respectively the gained data ($R^2=0.218>0.20$; β=0.317), when 'affective' has a very weak impact on 'cognitive'; ($R^2=0.760>0.20$; β=0.817), when 'cognitive' has a very strong impact on 'behavioral'; ($R^2=0.210>0.20$; β=0.217), when 'behavioral' has a very weak impact on 'attitude'. That discloses the fact that Lithuanian consumer attitude towards fact food is weakly grounded by cognitive information process, although 'cognitive' has strong impact on 'behavioral'. Agreeably with the gained data of empirical research it was determined that *the hierarchy of passive participation in the process* determines Lithuanian consumer attitude towards fast food. Lithuanian consumer attitude towards fast food is grounded under behavioral learning process, when the gained 'affective' has weak impact on 'behavioral' ($R^2=0.284>0.20$; β=0.304), 'behavioral' has weak impact on 'cognitive' component ($R^2=0.294>0.20$; β=0.392), 'cognitive' has weak impact on consumer attitude towards fast food ($R^2=0.276>0.20$; β=0.319). Following the research, it was determined that empirical hierarchy forms the Lithuanian consumer attitude trend towards fast food when 'cognitive' impacts 'behavioral' component ($R^2=0.760>0.20$; β=0.817), 'behavioral'

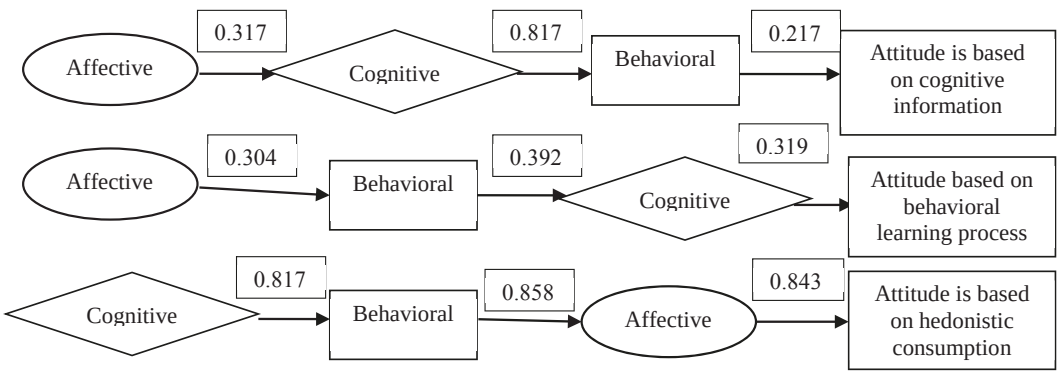

Figure 2. Empirical data in a three-component model of attitude.

impacts 'affective' (R^2=0.603>0.20; β=0.858), and 'affective' impacts 'attitude' (R^2=0.616>0,20; β=0.843). Nevertheless, *empirical hierarchy* reflects Lithuanian consumer attitude towards fast food best, where *attitude towards fast food is based on hedonistic consumption*. 'Affective' component has some impact on Lithuanian consumer attitude towards fast food. Two other components of attitude are moved to 'the second plan' although the final attitude is created after having formed all three components. Fast food is distinguished by exclusive untouchable or intangible characteristics: product representation or the package design, advertising or trademark brand. A Lithuanian consumer purchases fast food under hedonistic belief that the selected fast food will provide some pleasure and joy. As the research shows, Lithuanian consumers' *standard attitude hierarchy,* when the attitude towards fast food is based on cognitive information process towards fast food, is expressed weakly although 'cognitive' component has strong impact on consumer behavior. That discloses the fact that nevertheless, Lithuanian population pays attention to information search related to fast food and assessment of food alternatives in order to make a reasonable decision. Meanwhile, Lithuanian population's *hierarchy of passive participation in the process,* where consumer attitude towards fast food is based on behavioral learning process, is expressed weakly. Consequently, there is drawn a presumption that Lithuanian consumer attitude towards fast food is weakly formed only after the process of purchase, when a person can try and assess the fast food product, while forming a positive or negative feeling about it. The stimulus – reaction links impact the consumer's purchase selection weakly. Lithuanian consumers are not affective for fast food advertising in the points-of-sales, expressive packages and slogans, those are encouraging to buy, etc. Lithuanian consumers pay greater attention to beliefs while selecting information about an object or its characteristics.

Generalizing the statistical claim of hypotheses, it can be stated that all three hypotheses, set in the methodological part, have been validated. The following means that all links determined under the adapted three component model according to M. Salomon et al. (2006) are statistically significant, and there is a present direct impact of variables. Three hierarchies form the trend of Lithuanian consumer attitude towards fast food: standard, when Lithuanian consumer attitude towards fast food is based on cognitive information process; passive participation hierarchy, when Lithuanian consumer attitude towards fast food is based on behavioral learning process most weakly and empirical hierarchy, when Lithuanian consumer attitude towards fast food is based on hedonistic consumption most.

Conclusions

A fastening pace of life and changing nutrition determine consumer attitude towards fast food, those are impacted by rapid economical development, globalization and employment. The fastening pace of life changes consumers' nutritional habits, and the following change is the most favorable to the development of fast food industry, the turnover of which is increasing not only in Lithuania, but in other Baltic States too. A need for already ready i.e. fast food is increasing.

Consumer attitude towards fast food is formed by 'affective', 'cognitive' and 'behavioral' components, the succession outlining of which determines the trend and hierarchy of attitude. The trend of attitude can be based on three hierarchies: standard, when the attitude is based on cognitive information process; passive participation hierarchy, when the attitude towards fast food is based on behavioral learning process and empirical hierarchy, when the attitude towards fast food is based on hedonistic consumption.

Empirical hierarchy forms Lithuanian consumer attitude towards fast food best, when the *attitude towards fast food is based on hedonistic consumption,* where 'cognitive' strongly impacts 'behavioral' component (R^2=0.760>0.20; β=0.817), 'behavioral' strongly impacts 'affective' (R^2=0.603>0.20; β=0.858), 'affective' strongly impact 'attitude' (R^2 = 0.616 > 0.20; β=0.843). *Standard hierarchy* forms Lithuanian consumer attitude towards fast food weakly, where the consumer attitude towards fast food is weakly based on cognitive information process, respectively, the gained data (R^2=0.218>0.20; β=0.317), where 'affective' has a very weak impact on 'cognitive'; (R^2=0.760>0.20; β=0.817), where 'cognitive' has a very strong impact on 'behavioral'; (R^2=0.210>0.20; β=0.217), where 'behavioral' has a very weak impact on 'attitude'. *The hierarchy of passive participation in the process* determines the trend of Lithuanian consumer attitude towards fast food most weakly. Lithuanian consumer attitude towards fast food is most weakly impacted by behavioral learning process, where the gained 'affective' has a weak impact on 'behavioral' (R^2=0.284>0.20; β=0.304), and 'behavioral' has a weak impact on 'cognitive' component (R^2=0.294>0.20; β=0.392), 'cognitive' has a weak impact on 'consumer attitude towards fast food (R^2=0.276>0.20; β=0.319).

Following the empirical research, it was determined that the selection of fast food in Lithuania, determines Lithuanians' attitude towards fast food, based on hedonistic consumption, although there is present the expression of cognitive information process, particularly between 'cognitive' and 'behavioral' components.

References

1. Antoanides G., Raij W.F (1998) Consumer Behavior: A European Perspective. New York. 619 p.
2. Bakanauskas A., Račkauskaitė I. (2010) Vartotojų lūkesčių formavimo modelis (Consumer expectations formation model). *Organizacijų vadyba: sisteminiai tyrimai*, 54, pp. 7-20.
3. Business week (2012) McDonald's sales. Available at: http://www.verslobanga.lt/lt/spaudai.full/5062e5756bcec, 26 July 2014.
4. Bovee C.L., Thill J.V. (1992) *Business communication today.* Edición; 3 ed, New York, US: McGraw-Hill. 659 p.
5. Čekanavičius V., Murauskas G. (2004) Statistika ir jos taikymai. (Statistics and its applications). Vilnius: TEV. pp. 46-48.
6. Business week (2012) Hesburger apyvarta Lietuvoje (Hesburger turnover in Lithuania). Available at: http://www.verslobanga.lt/lt/spaudai.full/5062e5756bcec, 26 July 2014. (in Lithuanian).
7. Kasiulevičius V., Denapienė G. (2008) Statistikos taikymas mokslinių tyrimų analizėje (Application of statistical analysis for research). Available at: http://www.gerontologija.lt/files/edit_files/File/pdf/2008/nr_3/2008_176_180.pdf, p. 176 - 180. 26 July 2014. (in Lithuanian).
8. Ming T.T., Bin Ismail H., Rasiah D. (2011) Hierarchical chain of consumer-based brand equity: review from the fast food industry. *International Business & Economics Research Journal*, Vol. 10, No. 9 pp. 67-80.
9. Oxford University Press (2006) A Dictionary of Business and Management. Available at: http://www.oxfordreference.com, 26 November 2014.
10. Solomon M., Bamossy G., Askegaard S., Hogg M.K. (2006) *Consumer Behaviuor: A European Perspective.* Third Edition. Prentice Hall, 731 p.
11. Urbanskienė R., Clottey B., Jakštys J. (2000) *Vartotojų elgsena. (Consumer behaviour)***.** Kaunas: Technologija, pp. 219-239.

THE EU FINANCIAL INSTRUMENTS SUPPORT AND RETURN ON INVESTMENTS OF FISH PROCESSING IN LATVIA

Inese Biukšāne
Riga Technical University, Latvia
Latvian State Institute of Agrarian Economics
inese.biuksane@inbox.lv

Abstract
The purpose of the research is to assess the support provided for the sector of Latvia's fish processing in the framework of the EU funding instruments, its use and return of investments, providing recommendations for the development and perfection of further policy of the sector. The author evaluated the return of investments, considering the analysis of the made investments and financial indicators of fish processing companies, using several significant indicators (the number of employees, value of fixed assets, net turnover, net added value, value of production and productivity). As a result of analysis, the author discovered that investments' availability and their use have a significant influence on the development of Latvia's fish processing sector. In further planning of the sector's development it is advisable to take into account changes in the amounts of caught fish, availability of raw materials, as well as social, economic and political changes in markets. The formed combinations of indicators may be used in scientific researches evaluating the return of investments; they may facilitate researches on its calculation and importance, as well as may assist the institutions involved in the fisheries' policy formation to work more successful and improve the common policy in the branch.
Key words: Cohesion policy, European Union financial instruments, fish processing sector, return on investment.

Introduction

In the planning periods 2004 – 2006 and 2007 – 2013, Latvia's fish processing sector received a support in amount of EUR 130.12 million from several financial instruments of the European Union (hereinafter – the EU): European Fisheries Fund (hereinafter – EFF), European Agricultural Fund for Rural Development (hereinafter – EAFRD), Cohesion Fund (hereinafter – CF), European Regional Development Fund (hereinafter – ERDF), European Social Fund (hereinafter – ESF), Climate Change Financial Instrument (hereinafter – CCFI), European Agricultural Guidance and Guarantee Fund (hereinafter – EAGGF), Financial Instrument for Fisheries Guidance (hereinafter – FIFG), including Latvian Guarantee Agency (hereinafter – LGA), state and private co-funding (Central Statistical Bureau, 2014; *Food and Veterinary Service*, 2014; Ministry of Agriculture, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014). Kinds of economic activity and specialization of fish processing sector's participants, as well as their needs and opportunities, defined the use of different EU financial instruments.

Latvia's fish processing sector has been receiving the support for its development for 10 years, which is a sufficient period of time to evaluate the use of the provided support and return of investments, offering recommendations for further development of the sector.

Research object was Latvia's fish processing sector.

Research subject was the use of support and return of investments.

Research aim was to evaluate the support provided to the Latvia's fish processing sector by the EU financial instruments, its use and return of investments, aimed at elaboration of further support measures for the development of the sector.

Research tasks are as follow:

1) to define the participants of Latvia's fish processing sector, which are/are not the recipients of support in the framework of the EU financial instruments in the planning periods of 2004-2006 and 2007-2013;
2) to evaluate the support channelled to the Latvia's fish processing sector in the framework of the EU financial instruments and its use;
3) to assess the return of investments;
4) to provide suggestions and recommendations for further development of Latvia's fish processing sector.

Research hypothesis – investments' availability and their use have a significant influence on the development of Latvia's fish processing sector.

In the article the author reflects on the main results of the research, yet a more detailed analysis is provided in the research called 'Ražošanas tehnoloģiju pieejamība zivsaimniecības nozares attīstībai Latvijā' (Availability of Production Technologies for Fisheries Development in Latvia) funded by the Latvijas Republikas Zemkopības ministrija (Ministry of Agriculture of the Republic of Latvia).

Materials and Methods

Carrying out the research, the author used the descriptive method, methods of document and statistic analysis.

The author used data of the Ministry of Agriculture, Food and Veterinary Service and Central Statistical Bureau of Latvia to define the participants of fish processing sector.

The analysis comprises the support (public funding and private co-funding, including compensations), provided in the framework of the EU financial instruments in the 2004 – 2006 and 2007 – 2013 planning period (from May, 2004 until April, 2014).

The return of investments in the Latvia's fish processing sector was calculated according to several indicators describing the development and growth of national economy; several well-known researchers have researched and analysed the indicators in their works.

One of the founders of the economic theory, Adam Smith, in his work 'The Wealth of Nations' (1776) pointed out that the basis of any society' welfare lies in human's work (Smith, 1776). In another work called 'The Theory of Moral Sentiments' he proposed that the social welfare of an individual can be defined as a merit or lack of individual's personal work (Smith, 1759). These two pronouncements justify the condition that the social and economic growth of states, regions and branches can be ensured, if the economic welfare of state's inhabitants is increasing in a longer period.

The economists Charles W. Cobb and Paul H. Douglas in their work 'A Theory of Production' (1928) suggested that those are the production factors, including human capital, which ensure the growth of national economy if the economic and political environment is stable. The amount of production goes up as the supply of production factors (work, capital) increases, as well as when the labour productivity grows, using technological process and innovations (Cobb and Douglas, 1928).

Walt Whitman Rostow in his work 'The Stages of Economic Growth: A Non-Communist Manifesto' (1960) continued to develop the ideas of the classical theory supporters and scholars A.Smith, T.R.Malthus, D.Ricardo and J.S.Mill, who as preconditions for development of a state's and its sectors considered to be the application of new technologies within the production process, international trade and labour productivity, which in its turn depended on the specialization and distribution of the labour. The economists believed that the greater are the savings and investments, the faster is the economic growth (Atkinson et al., 1998).

Similar views on the economic growth may be found in the work 'A Contribution to the Theory of Economic Growth' written by a Nobel laureate – an economist Robert M. Solow. He developed the neoclassical model of a national economy, which allowed analysing the interaction of savings, capital and national economy growth and their influence on the employment and increase in the economical welfare of inhabitants (Solow, 1956).

According to the pronouncements of the researchers, it is evident that there are several important indicators for evaluation of development and growth of national economy, including return of investments, such as, a number of employees, value of fixed assets, net turnover, net added value and productivity (Krieviņa, 2009; Mozart et al., 2015; etc.).

Several methods and their combinations were applied to the assessment of the influence of investments. One of the first researches in this field was carried out by a group of researchers with A. Nipers as a leader in 2010, emphasizing the following range of applicable methods:

- quantitative analysis ("Naïve' type methods, quasi experimental methods, non-experimental design methods);
- qualitative analysis (situation analysis and case studies).

Both the European Commission and the authors of the research from the mentioned methods as prior for evaluation of influence indicators recommend the quasi experimental assessment method and non-experimental design methods (European Evaluation Network for Rural Development, 2010). However, taking into account data limitation, the mentioned methods are applicable not in all cases. In the framework of the research to evaluate the influence of investments, the author applied quantitative analysis, using "Naïve' and quasi experimental methods.

The calculations include a review of return of investments only in the fish processing companies, with available financial indicators and which have/have not received the investments by the EU financial instruments (overall 70 fish processing companies: 45 fish processing companies, which have received investments, and 25 fish processing companies, which have not received investments). The return of investments was calculated from 2005 – 2012. The analysis of the return of investments does not include the amount of compensations (EUR 7.13 million) for the carried out measures to balance the intensity of fish fleet and measures of aquatic environment in aquaculture.

The author mostly applied the methods of analysis and synthesis in elaboration of conclusions and suggestions.

Results and Discussion

The support, provided by the EU financial instruments

In 2004 – 2006 and 2007 – 2013 planning periods, the fish processing sector (57% of the total number of fish processing sector's participants) received the

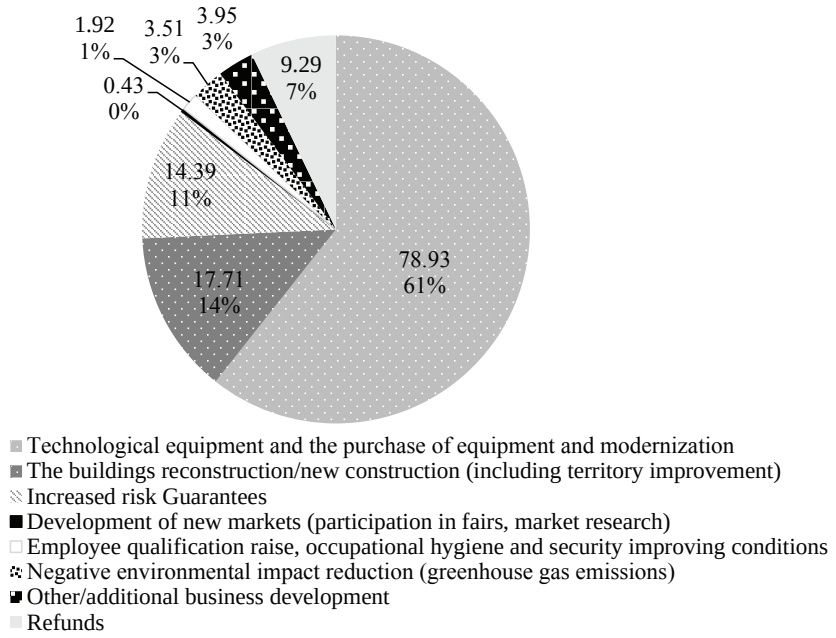

Figure 1. The funding of EU financial instruments, made available to the fish processing companies in Latvia 2004 - 2006 and 2007 - 2013 planning periods, EUR million, % (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, 2014; Ministry of Agriculture, 2014).

support in amount of EUR 130.12 million from the several EU financial instruments: ERDF, ESF, CF, EAGGF, EAFRD, CCPF, FIFG and EFF, including state, LGA and private co-funding. From the total provided support 58% was the public funding, but the other 42% - private co-funding.

Various EU financial instruments were used due to the types of economic activity of the fish processing companies – separate fish processing companies work not only in the field of fish and aquaculture, but also in other fields of economic activity.

The largest support (EUR 78.93 million or 61%) was provided to the purchase of various technological facilities and equipment (Figure 1).

For modernisation and development of production much smaller support (EUR 17.71 million or 14%) was channelled to reconstruction and erection of various buildings (workshop-production units, auxiliary buildings, storing chambers, freezers, laboratories, etc.) including improvement of territories. In addition, LGA provided guarantees of a credit for funding current assets and erection of new production buildings/warehouses, as well as export guarantees to cover for losses in case of foreign debtors' insolvency or lasting default (EUR 14.39 million or 11%).

The support was channelled also for reduction of negative impact on the environment (EUR 3.51 million or 3%), raise of employees' qualifications, improvement of occupational hygiene and labour safety conditions (EUR 1.92 million or 1%), and acquisition of new markets (EUR 0.43 million or 0.3%).

Fish processing companies working not only in the field of fish processing, but also fishing and aquaculture, received compensations for balancing the intensity of fishing (EUR 8.90 million) and compensations for measures of aquatic environment in aquaculture (EUR 0.38 million). Also, organisations of producers received compensations of administrative expenses (EUR 0.02 million). In general, the participants of the fish processing sector received compensations in amount of EUR 9.29 million or 7%.

The development of other/additional business (fishing, tourism, power industry) received the support in amount of EUR 3.95 million or 3%.

Viewing the analysis, it is evident that 89% (EUR 115.40 mil.) of the support was directed to the modernisation and development of production, as well as acquisition of new markets, whereas 4% (EUR 5.46 million) – to social and environmental activities. Remaining support in amount of 7% (EUR 9.29 million) was received as compensations.

Return of investments

The data analysis shows that in 2004 – 2012 45 fish processing companies received investments in amount of EUR 73.17 million, where the largest proportion of investments (46%) was directed to the fish processing companies, specialized in mixed fish production (Figure 2).

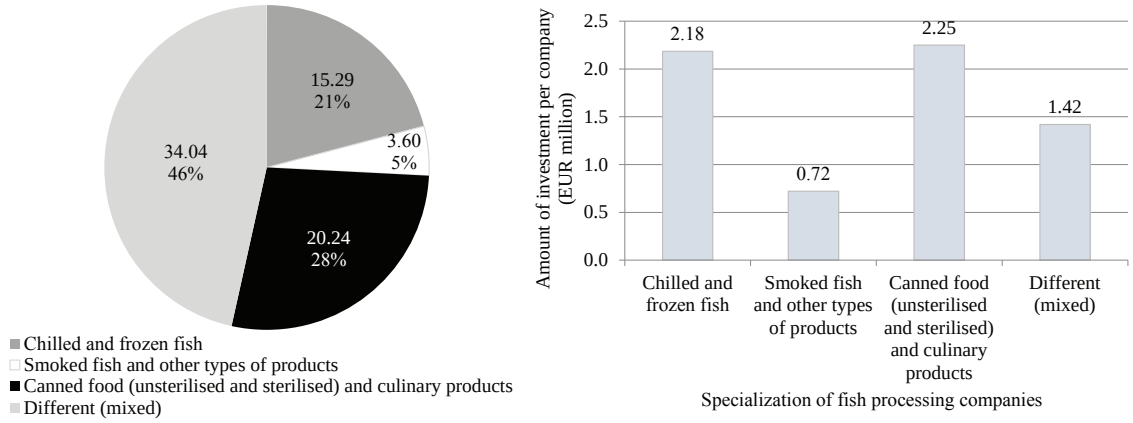

Figure 2. The means invested in 45 fish processing companies in Latvia the framework of the EU financial instruments from 2004 – 2012, EUR million, % (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, 2014; Ministry of Agriculture, 2014).

However, the biggest amount of investments per one company is for fish processing companies, mostly specialized in production of canned fish (sterilized and unsterilized) and culinary products (EUR 2.25 million, accordingly).

The total number of employees in fish processing companies, which have received investments, in the period from 2005 – 2012 decreased by 17%, whereas in the companies which have not received investments the total number of employees decreased by 26%, which is 9 percent points more than in the companies, which have received the investments (Figure 3).

The number of employees has decreased in the fish processing companies, specialized in production of canned fish (sterilized and unsterilized) and culinary products, as well as production of smoked fish and other kinds of good (including repackaging) (accordingly by -26%, -10% and -2%). The number of employees increased by 121% only in the fish processing companies which are specialized in production of chilled and frozen fish production.

Similar situation is with the changes of fixed assets' value: the value of fixed assets of the companies, which have received investments, within this period increased by 53%, in its turn the value of fixed assets of the companies, which have not received investments, increased only by 33% (Figure 3).

Latvia joined the EU, and various EU financing instruments became available, what facilitated a rapid increase in the value of fixed assets in 2005 – 2007; moreover, this positive impact on fish processing companies continued in terms of a regular renewal of their fixed assets in 2007 – 2012.

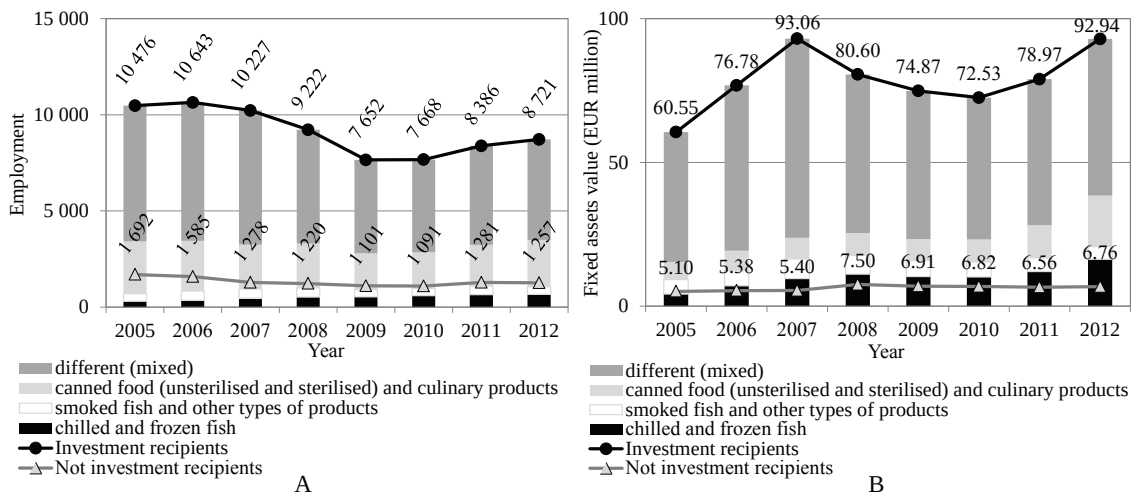

Figure 3. Changes in employment (A) and value of fixed assets (B) in fish processing companies in Latvia from 2005 – 2012, volume, EUR million (author's calculations based on Central Statistical Bureau, 2014; Food and Veterinary Service, 2014; State Revenue Service, 2014; Ministry of Agriculture, 2014).

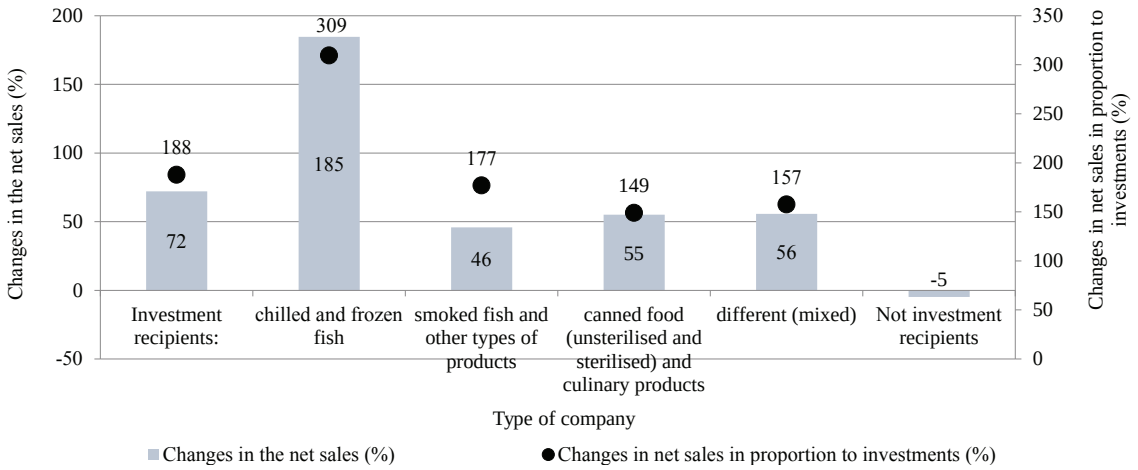

Figure 4. The influence of investments on the net turnover of fish processing companies in Latvia from 2005 – 2012, % (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, 2014; State Revenue Service, 2014; Ministry of Agriculture, 2014).

The largest companies, which renewed the value of their fixed assets, were the fish processing companies, specialized in chilled and frozen fish production (289%).

Also, the companies specialized in production of canned fish (sterilized and unsterilized) and culinary products, as well as production of mixed production, invested into the renewal of their fixed assets (190% and 21%, accordingly)

Despite the fact that the companies specialized in production of smoked fish and other kinds of goods (including repackaging), also invested into renewal of value of their fixed assets, the investments were not sufficient to renew the fixed assets of the companies completely (the value of fixed assets decreased by -13%).

As a result of the investments, human resources employed up till now and the renewed fixed assets have provided the formation of net turnover in the fish processing companies.

The net turnover of fish processing companies, which have received the investments and directed them to the development of business, during 2005 – 2012 increased by 72%, whereas the net turnover of the fish processing companies, which have not received the investments, decreased by -5% (Figure 4).

For a more precise evaluation of investments' impact, the author uses a complex indicator – changes of net turnover compared to the made investments in the framework of the projects supported by the EU financial instruments. The fish processing companies specialized in production of chilled and frozen fish have had the greatest influence of investments on the raise of net turnover (185%). A positive increase of net turnover as a result of investments has been experienced by the fish processing companies specializing in production of smoked fish and other kinds of goods (including repackaging), mixed fish production (177% and 157%, accordingly), whereas the changes of net turnover of the fish processing companies, specializing in production of canned fish (sterilized and unsterilized) and culinary products, in comparison to the invested means was 149%.

There are three indicators that were chosen to describe the benefit of the support from the investments, namely, net added value, value of production and productivity (Table 1).

The analysis of data indicates a significant influence of investments on changes in net value added, value of production and productivity: the indicators of fish processing companies, which received the investments from 2005 – 2012, increased by 102%, 72% and 107%, respectively. In turn, fish processing companies, which have not received the investments, net value added, value of production and productivity in the mentioned period were much smaller: 25%, -7% and 28%, accordingly.

The acquired data show that the investments were efficiently used in all the fish processing companies, which received them: both the companies, specializing in production of chilled and frozen fish production, and smoked fish and other kinds of goods (including repackaging), as well as companies, specializing in production of canned fish (sterilized and unsterilized) and culinary products, and companies specializing in production of mixed fish production.

53% of the total amount produced in 2013 was such canned fish as sprats, sardines and sardinellas (Central Statistical Bureau, 2014), and 50 % of the total amount of prepared and canned fish export was the export to Russia (Ministry of Agriculture, 2014).

Table 1

A comparison of results obtained by the means invested in various fish processing companies in Latvia from 2005 - 2012, EUR, % (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, State Revenue Service, 2014; Ministry of Agriculture, 2014)

Type of company	2005	2012	Changes from 2005-2012 (%)
Net value added (EUR million)			
Investment recipients:	12.11	24.43	102
chilled and frozen fish	0.86	2.17	153
smoked fish and other types of products	-0.34	0.78	327
canned food (unsterilised and sterilised) and culinary products	3.14	5.38	71
different (mixed)	8.45	16.10	91
Not investment recipients	3.45	4.31	25
Production value (EUR million)			
Investment recipients:	197.29	339.25	72
chilled and frozen fish	25.92	74.02	186
smoked fish and other types of products	14.14	20.64	46
canned food (unsterilised and sterilised) and culinary products	57.10	87.78	54
different (mixed)	100.14	156.79	57
Not investment recipients	32.88	30.42	-7
Productivity (EUR thousand per employee)			
Investment recipients:	18.18	37.60	107
chilled and frozen fish	84.86	109.17	29
smoked fish and other types of products	35.33	52.43	48
canned food (unsterilised and sterilised) and culinary products	20.11	34.80	73
different (mixed)	13.63	28.66	110
Not investment recipients	18.18	23.28	28

Taking into account that one of the main raw materials of fish processing sector is sprat, where the amount of its catch in the territorial waters of Latvia in 2005 – 2012 reduced by -52% (Ministry of Agriculture, 2014; Food Safety, Animal Health and Scientific Institute of Environment BIOR, 2013), and that the export of canned fish to Russian markets due to political, social and economical situation is risky for business activity and development, investments into the development of fish processing sector should be channelled to production of innovative goods (to increase the added value) and acquisition of new markets irrespective of company's specialization. Investments aimed at high risk markets should not be supported.

In the light of reduction of total catch, not only in the Latvia's territorial waters (from 2005 – 2012 by -38%) (Ministry of Agriculture, 2014; Food Safety, Animal Health and Scientific Institute of Environment BIOR, 2013), but also all around the world, and the increase of demand for aquaculture fish, in future it is advisable to channel the investments to the fish processing companies, where aquaculture fish are used as a raw material.

Conclusions

By April 16, 2014. the author had identified 129 participants of fish processing sector (companies, societies and non-governmental organizations, 57% of which in the 2004 – 2006 and 2007 – 2013 planning periods received support in amount of EUR 130.12 million in the framework of the EU financial instruments. 89% of the total support was channelled to development and modernisation of production, as well as acquisition of new markets and only 4% - for implementation of social and environmental activities. The remaining support in amount of 7% was the compensation for the carried out measures to balance the intensity of fish fleet and measures of aquatic environment in aquaculture.

Availability and use of investments significantly influence the development of fish processing sector: financial indicators of the fish processing companies, which have received the investments, are much better than the indicators of fish processing companies, which have not received the investments.

Considering the investments and their return in the fish processing sector, as well as changes of catch and availability of raw materials (especially sprat), as well as focus of the canned fish export on Russian market,

in future it is advisable to channel the investments to production of innovative goods and to implementation of marketing measures and acquisition of new markets, as well as to the fish processing companies, where aquaculture fish are used as a raw material.

References

1. Atkinson B., Livesey F., Milward B. (1998) *Applied Economics*, T.J. International Ltd, London, 446 p.
2. Central Statistical Bureau (2014) *Fish production and canned fish according to NACE 2.rev. code 10.20. from 2004 – 2013* (restricted access data).
3. Central Statistical Bureau (2014) *Latvian fish processing companies by NACE 2.rev. code 10.20.* (restricted access data).
4. Cobb W.C., Douglas H.P. (1928) A Theory of Production. Available at: http://digamo.free.fr/cobbdoug28.pdf, 28 March 2015.
5. European Evaluation Network for Rural Development (2010) *Approaches for assessing the impacts of the Rural Development Programmes in the context of multiple intervening factors. Working paper.* Brussels, 150 p.
6. *Food and Veterinary Service* (2014) *Registered fishery product processing companies in Latvian*. Available at: http://www.pvd.gov.lv/lat/uznemumi/, 16 April 2014.
7. Food Safety, Animal Health and Scientific Institute of Environment BIOR (2013) *Latvian Fisheries integrated control and information system "LICIS": Latvian catch from 2005 – 2012* (restricted access data).
8. Krieviņa A. (2009) Impact of capital investments on value added in dairy sector. Available at: http://www.scopus.com/record/display.url?eid=2-s2.0-84893359823&origin=resultslist&sort=plf-f&src=s&st1=Krievi%C5%86a+A&st2=&sid=1BB5D6F6F75126640660280DC8A438F1.WlW7NKKC52nnQNxjqAQrlA%3a10&sot=b&sdt=b&sl=23&s=AUTHOR-NAME%28Krievi%C5%86a+A%29&relpos=1&relpos=1&citeCnt=0&searchTerm=AUTHOR-NAME%28Krievi%C5%86a+A%29#references, 28 July 2015.
9. Latvian Environmental Investment Fund (2014) *The projects supported by the CCFI in the fish processing companies in Latvia by 01.04.2014.* (restricted access data) (in Latvian).
10. Ministry of Agriculture (2014) *Registered fishery product processing companies in Latvia on 01.08.2013.* (restricted access data).
11. Ministry of Agriculture (Zemkopības ministrija) (2014) *Latvijas zivsaimniecības gadagrāmata 2014* (Latvian Fisheries Yearbook 2014th), Latvijas Lauku konsultāciju un izglītības centrs, Rīga, Latvija, 191 lpp. (in Latvian).
12. Ministry of Finance (2014) *The projects supported by ERDF, ESF, EAGGF, FIFG and LGA in the fish processing companies in Latvia by 22.05.2014.* (restricted access data).
13. Mozart B.C.M., Seokjin K., Rongbing H. (2015) Return-on-investment (ROI) criteria for network design. Available at: http://ac.els-cdn.com/S0377221715002027/1-s2.0-S0377221715002027-main.pdf?_tid=f9fc336c-3a1b-11e5-95fd-00000aacb361&acdnat=1438632933_20987234867c0f8d36ceacb6d955a81a, 27 July 2015.
14. Nipers A. (2010) *Metodoloģija LAP 2007-2013 pasākumu ietekmes novērtēšanai* (Methodology for evaluation of the influence of the Rural Development Programs' 2007 – 2013 activities). RSEBAA, Rīga, Latvija, 82. lpp. (in Latvian).
15. Rural Support Service (2014) *The projects supported by EAFRD and EFF in the fish processing companies in Latvia by 02.06.2014.* (restricted access data).
16. Smith A. (1759) *The Theory of Moral Sentiments.* Available at: http://oll.libertyfund.org/titles/smith-the-theory-of-moral-sentiments-and-on-the-origins-of-languages-stewart-ed, 28 March 2015.
17. Smith A. (1776) The Wealth of Nations. Available at: http://www.bartleby.com/10/106.html, 4 January 2015.
18. Solow M.R. (1956) A Contribution to the Theory of Economic Growth. Available at: http://piketty.pse.ens.fr/files/Solow1956.pdf, 29 March 2015.
19. State Revenue Service (2014) *Financial figures from 2005 – 2013* (restricted access data) (in Latvian).

PRODUCTION CAPACITY OF FISH PROCESSING IN LATVIA

Inese Biukšāne
Riga Technical University, Latvia
Latvian State Institute of Agrarian Economics
inese.biuksane@inbox.lv

Abstract
The purpose of the research is to evaluate the technologies, available to the Latvia's sector of fish processing and their utilized capacity, as well as to identify the factors influencing production process, providing recommendations for development and improvement of further policy of the sector. The author evaluated availability and utilized capacity of production technologies in the Latvia's sector of fish processing, considering the analysis of financial indicators of the made investments, production capacity load and fish processing companies. In view of economic theory, the factors, influencing the production process of Latvia's sector of fish processing, were defined. As a result of analysis, the author established that the development of production of Latvia's fish processing sector is to a great extent influenced by the availability of human resources, raw materials and investments, as well as undertaking. For further development and policy planning of the sector it would be advisable to take into account these factors, influencing the production process of Latvia's sector of fish processing and their changes. The formed combinations of indicators may be used in scientific researches on establishment of production technologies availability and their utilized capacity, and identification of factors, influencing the production process; they may facilitate researches for its calculation and importance, as well as may assist the institutions involved in the fisheries' policy formation to work more successfully and improve the common policy in the field.
Key words: capacity utilization, Cohesion policy, fish processing sector, production process, technological equipment.

Introduction

The production process of Latvia's fish processing sector employs various production technologies: facilities (fish preliminary processing and freezing facilities, autoclaves, etc.) and their equipment, as well as various kinds of buildings (production workshops and auxiliary buildings, storage rooms, smokehouses, laboratories, etc.). Within last 10 years their purchase to a great extent has been facilitated by the investments in amount of EUR 96.63 million made in the framework of the EU finance instruments (especially by the Financial Instrument for Fisheries Guidance and European Fisheries Fund) (Central Statistical Bureau, 2014; Food and Veterinary Service, 2014; Ministry of Agriculture, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Investment Fund, 2014).

To work out further support activities for the development of Latvia's fish processing sector and fisheries policy planning, the production technologies available for the sector and their utilized capacity must be evaluated, as well as the factors, influencing the production process, need to be defined.

Research object was Latvia's fish processing sector.

Research subject was availability of production technologies and their utilized capacity, factors, influencing the production process.

Research aim - availability of production technologies and their utilized capacity, as well as factors, influencing the production process in Latvia's fish processing sector, must be evaluated, aimed at elaboration of support activities for further development of the sector.

Research tasks are as follow:

1) to define Latvia's fish processing companies, which are/are not the recipients of investments in the framework of the EU financial instruments in the planning periods of 2004-2006 and 2007-2013;
2) to evaluate the availability of production technologies and their utilized capacity in Latvia's fish processing sector;
3) to define the factors, influencing the production process in Latvia's fish processing sector;
4) to provide conclusions and suggestions for further development of Latvia's fish processing sector.

Research hypothesis: production technologies of Latvia's fish processing sector are not being utilized in their full capacity, thus not reaching the maximum production capacity due to several social and economic factors.

In the article the author reflects on the main results of the research, yet a more detailed analysis of which is provided in the research 'Availability of Production Technologies for Fisheries Development in Latvia' ("Ražošanas tehnoloģiju pieejamība zivsaimniecības nozares attīstībai Latvijā") funded by Ministry of Agriculture of the Republic of Latvia.

Materials and Methods

Carrying out the research the author used the descriptive, document and statistical (qualitative and quantitative) methods of analysis.

The author used data of Ministry of Agriculture, Food and Veterinary Service and Central Statistical Bureau of Latvia to define the participants of fish processing sector.

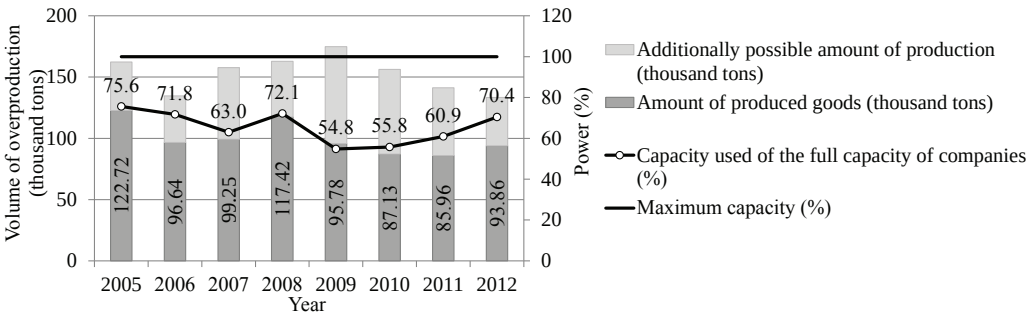

Figure 1. Production volumes and production capacity of fish processing sector in Latvia from 2005 – 2012, thousand tons, % (author's calculations based on Central Statistical Bureau).

To obtain the current information on utilized capacity of technological facilities, kinds of necessary investments and their availability, the author elaborated a questionnaire. The survey was conducted from May 12 to June 16, 2014. The target audience of the survey were 111 Latvia's fish processing companies. 36% of the respondents completed the questionnaire.

In elaboration of conclusions and suggestions mostly the methods of analysis and synthesis were applied.

Results and Discussion

Availability and utilized capacity of production technologies

Analysing the data on the utilized capacity of technologies used in the production process of Latvia's fish processing sector, it is evident that since 2005 the production capacity has been changeable and has not been fully used (Figure 1).

Capacity utilization in 2010 in the Latvia's fish processing sector on average was 56%, whereas in Estonia, Russia, Lithuania and Poland - 61%; 75%; 80% and 80%, respectively (Latvijas Lauksaimniecības universitāte, 2013).

The data analysis shows that the volume of production in the Latvia's fish processing sector from 2005 – 2012 decreased by 7%, thus not utilizing the production technologies in full (average production capacity is 65.5%). If the demand for the ready production of fish processing companies was so big to utilize all production technologies, the maximum volume of produced goods in 2012 on average would be 133.37 thousand tons that would be by 30% more than it was actually produced (93.86 thousand tons).

The actual production capacity of Latvia's fish processing companies in 2012 was on average 256.44 tons a day, not reaching the maximum production capacity – on average 392.41 tons a day (Figure 2).

To ensure the actual production capacity of 2012, on average 197.33 tons of raw materials a day were necessary. However, to reach the maximum production capacity on average 280.40 tons of raw materials a day would be necessary. Viewing the data analysis we can see that at the maximum production powers it would be possible to process all the raw materials available in Latvia: own produced (caught and grown) and imported fish, as well as imported fresh, refrigerated and frozen fish (on average 284.24 tons a day). The available amount of raw materials is not being fully used, as a result of non-stabile and small production volumes and average purchase prices of separate fish kinds.

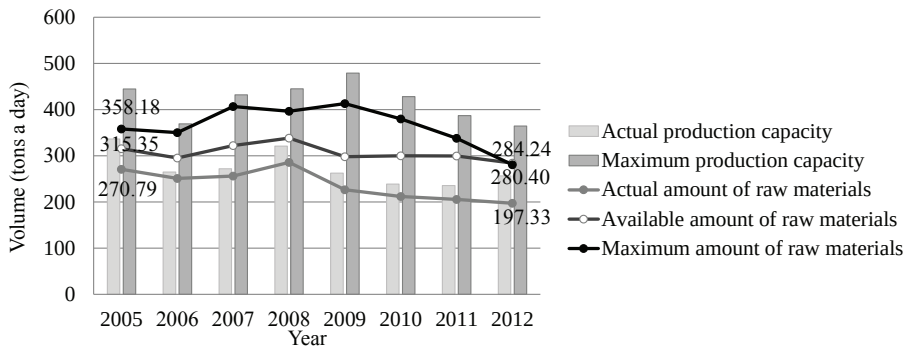

Figure 2. Production capacity of fish processing sector in Latvia from 2005 – 2012, tons a day (author's calculations based on Central Statistical Bureau, 2014; Food Safety and Animal Health and Environment Scientific Institute 'BIOR', 2013; Ministry of Agriculture, 2014).

Table 1

Production capacity of fish processing companies in Latvia (according to the type of their specialization) in 2014, tons a day, % (author's calculations based on Central Statistical Bureau, 2014; Latvian State Institute of Agrarian Economics, 2014; Food and Veterinary Service, 2014; Ministry of Agriculture, 2014)

Kind of specialization	Actual production capacity (tons a day)	Maximum production capacity (tons a day)	Used capacity (%)
Chilled and frozen fish	229.0	362.9	63.1
Smoked fish	37.7	46.5	81.1
Canned fish (sterilized and unsterilized) and culinary products	52.0	77.5	67.1
Various (mixed)	49.8	78.6	63.3

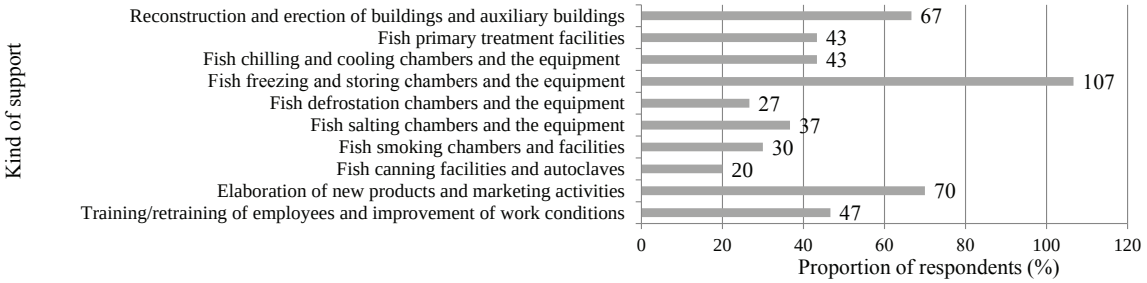

Figure 3. The kinds of support necessary for fish processing companies in Latvia, % (author's calculations based on Central Statistical Bureau, 2014; Latvian State Institute of Agrarian Economics, 2014; Food and Veterinary Service, 2014; Ministry of Agriculture, 2014).

Also, from the results of surveys it is evident that maximum production capacity is not being used, where 36% of respondents noted this fact.

The obtained data show that all kinds of fish production companies do not use the maximum production capacity – both the fish processing companies specialized in the refrigerated and frozen fish production, and the ones that specialize in production of smoked fish, canned fish (non-sterilized and sterilized) and culinary products, as well as production of various (mixed) fish products (Table 1).

Although the maximum production capacity is not reached, 86% of the respondents have indicated a need in a various support for the development and modernization of companies; however, the rest 14% have indicated that their companies are well enough developed and currently no additional support is necessary.

Part of respondents (67%) have indicated that the development of their companies needs construction and reconstruction of buildings and auxiliary buildings, taking into account that the company wants to expand and involve additional human resources (Figure 3).

In addition, the respondents indicated the need in such production technologies as fish primary treatment, chilling and refrigerating, freezing and storing, defrostation, salting, smoking and canning chambers and facilities. 23% of the respondents have indicated that they rent separate technological chambers, facilities and equipment from other companies and institutions, since their own purchased technologies are insufficient.

Furthermore, the respondents have replied that support is also necessary for the development of new products and implementation of marketing activities (70%), which would be very significant in future, considering the fact that in 2013 canned fish – sprat, sardines and sardinellas (the main raw material is sprat – a quota-dependent fish) – constituted 53% of the whole produced amount (Central Statistical Bureau, 2014) and export to Russia constituted 50% of the total prepared and canned fish export amount (Ministry of Agriculture, 2014). Taking into account that the whole production is mostly focused on canned sprat production and export to Russia, which is a great risk for fish processing sector, it is advisable to channel a further support to acquisition of new market and offer innovative products.

The greatest part (80%) of the respondents have mentioned that implementing corresponding support activities a company would increase the volume of present output; however, 60% of the respondents consider that volume of output for elaboration of new products would increase. Only 7% of respondents indicated that as a result of carried out measures, the amounts of the production would remain the same, proving that mostly the support is necessary to renew

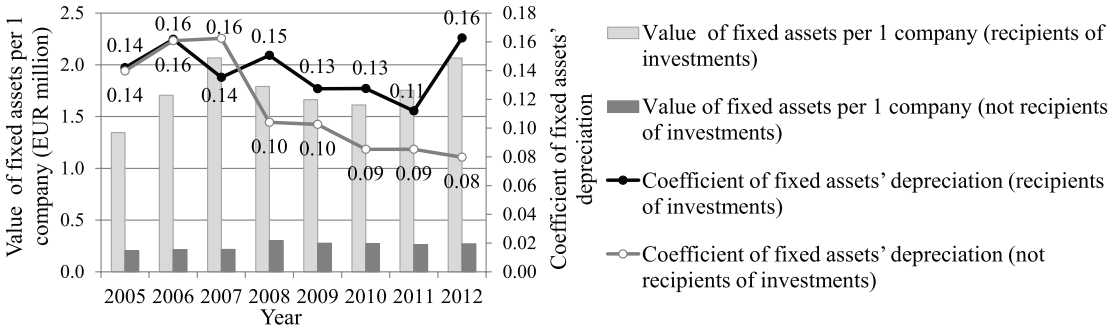

Figure 4. The value of fixed assets and the depreciation coefficient of fixed assets of fish processing companies in Latvia from 2005 – 2012, EUR million, coefficient (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, 2014; State Revenue Service, 2014; Ministry of Agriculture, 2014).

the value of fixed assets of the companies, but not to increase the competitiveness.

To find out, how intensively fish processing companies renew the value of their fixed assets, the author viewed the changes of fixed assets value.

Analysing the value of fish processing companies' fixed assets from 2005 – 2013, we can see that in the value of fixed assets of the fish processing companies, which received investments, it increased by 53%, whereas of the fish processing companies, which did not receive investments, - by 33% (Figure 4).

The depreciation coefficient of fixed assets, characterising the level of technical provisioning in a company, shows that the coefficient of fish processing companies, which received investments, is higher than the one of fish processing companies, which did not receive investments.

The depreciation coefficient of fixed assets of fish processing companies, which received investments, is higher, since they use the technological facilities in the production process more intensively. In its turn, the depreciation coefficient of fixed assets of fish processing companies, which did not receive investments, is lower, as a result of less intensive use of technological facilities.

The fish processing companies, which received investments, renewed the value of their fixed assets more intensively (except during the economic crisis), but slower than the companies, which did not receive investments (Figure 5).

It happened so because the means invested in renewal of the fixed assets of these companies were more voluminous and time consuming than for fish processing companies, which did not receive the investments.

To find out the financial benefit of fish processing companies, the efficiency of fixed assets is analysed (Table 2).

The calculations about the year 2012 show that for fish processing companies, which received investments, one unit of fixed assets' value (EUR) reached the turnover in amount of EUR 3.81 (return of fixed assets) and profit EUR 15.44 (profitability of fixed assets), whereas for the fish processing

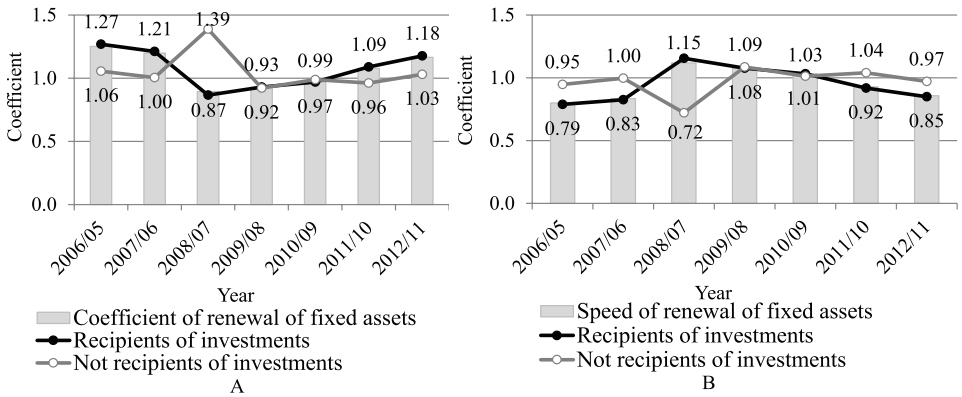

Figure 5. The coefficient of fixed assets' renewal (A) and speed of fixed assets' renewal (B) for fish processing companies in Latvia from 2005 – 2012, coefficient (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service, 2014; State Revenue Service, 2014; Ministry of Agriculture, 2014).

Table 2

The calculation of fixed assets' value of fish processing companies in Latvia from 2005 – 2012, EUR million, coefficient, % (author's calculations based on Central Statistical Bureau, 2014; Ministry of Finance, 2014; Rural Support Service, 2014; Latvian Environmental Investment Fund, 2014; Food and Veterinary Service of Latvia, 2014; State Revenue Service, 2014; Ministry of Agriculture, 2014)

Indicator	2005	2006	2012	Changes from 2005-2012 (%)
Value of fixed assets (EUR million)	65.65	82.16	99.70	52
Recipients of investments	60.55	76.78	92.94	53
Not recipients of investments	5.10	5.38	6.76	33
Net turnover (EUR million)	221.24	250.13	357.16	61
Recipients of investments	190.48	219.80	327.89	72
Not recipients of investments	30.76	30.33	29.27	-5
Profit (EUR million)	6.47	4.77	14.86	130
Recipients of investments	5.86	4.65	13.27	127
Not recipients of investments	0.61	0.12	1.58	159
Return of fixed assets	x	3.38	3.86	14
Recipients of investments	x	3.20	3.81	19
Not recipients of investments	x	5.79	4.40	-24
Profitability of fixed assets	x	6.45	16.04	149
Recipients of investments	x	6.77	15.44	128
Not recipients of investments	x	2.25	23.73	957

companies, which did not receive investments, one unit of fixed assets' value (EUR) reached the turnover in amount of EUR 4.40 and profit EUR 23.73.

Viewing the data analysis, it is evident that fish processing companies, which have received the investments, could not use the available fixed assets completely, unlike the fish processing companies, which have not receive investments – with lower capacity of fixed assets they were able to ensure a bigger return of fixed assets.

Factors influencing the production process

In the theory of economics any production process comprises interaction of several production factors, namely: work, land, capital and undertaking (the founders of the theory are; Smith, 1776; Mill, 1776; Ricardo, 1817; Marx, 1967; Aswathy et al., 2013; Bakhrankova et al., 2015).

All the mentioned production factors influence the production development of Latvia's fish processing companies (including availability and utilized capacity of technological equipment). The factors are:

- availability of labour (especially at giving age) and ensuring a corresponding wage;
- the availability of raw materials (especially sprat) and average price of fish (especially aquaculture);
- the availability of investments for formation of a capital;
- undertaking.
- Also various external factors, such as demand, legislation, social, economic and political situation in the local and foreign markets, etc., influence the development of production process.

Analysing the factors influencing production process, we can see that employees of fish pro-cessing companies receive low gross wages in comparison with average gross wage in the fisheries sector, both in Latvia and the EU-27 (Figure 6).

The size of wages may be an impediment to the development of fish processing companies' production, since it is competitive neither in the local nor in foreign market. The production of fish processing companies is focused on the production of canned fish, where basically manual labour is used and employees do not need any special skills and knowledge. The involved labour may also choose work of equal conditions in some other sphere or abroad, earning much more competitive wage. In its turn, bringing the labour ready to work for low wage in from other countries may cause additional risk for the state.

Production capacity in fish processing companies is not fully utilized, which is determined not only by the technological process (maintenance works), but also availability of raw materials (seasonality) and the prices of their purchase.

The available amount of raw materials in the local market is not fully used – part of fish is also exported. Even if fish were not exported and would be processed, the production capacities of fish processing companies would not be completely utilized and the amount of produced goods would not increase significantly (Figure 7).

The investments in the amount of EUR 96.63 million received in the framework of the EU financial instruments from 2004 – 2006 and 2007 –

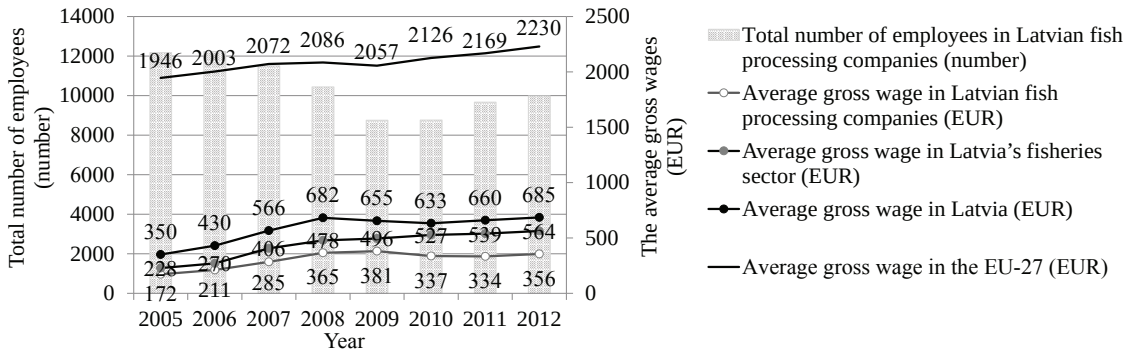

Figure 6. The number of employees and average gross wage in fish processing companies in comparison with the average gross wage in Latvia and the EU-27 from 2005 – 2012, volume, EUR (author's calculations based on Central Statistical Bureau 2014; Eurostat, 2014; State Revenue Service, 2014.

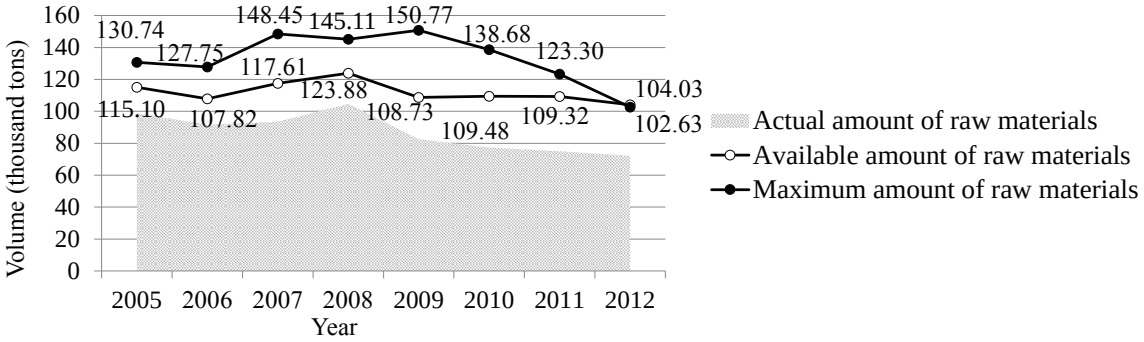

Figure 7. Actual, available and maximum amount of raw materials of fish processing companies in Latvia from 2005 – 2012, thousand tons (author's calculations based on Central Statistical Bureau, 2014; Food Safety and Animal Health and Environment Scientific Institute 'BIOR', 2013; Ministry of Agriculture, 2014.

2013 planning period were allocated to production technologies (buildings, equipment and facilities) and modernization. Despite the fact that 86% of respondents in their surveys replied that support is needed for purchase of these capital goods, the investments made up till now have been sufficient. The indicators of production capacity and efficiency of fixed assets' utilization prove that there was enough of investments.

Besides, undertaking is a significant factor influencing the production process; its rational and efficient application, combining the 3 above mentioned production factors, may considerably influence the development of the sector. Considering the decrease in the amount of catch not only in the Latvian territorial waters, but also all around the world, in future it is advisable to form a close cooperation with Latvian aquaculture companies, aimed at the development of the fish processing sector. A basis of cooperation requires some information to be clarified, such as kinds of fish preferable for processing, the amounts of the fish and their prices. In addition, entrepreneurs should find out if Latvian sector of aquaculture with the production technologies and knowledge it currently has, would be able to provide the local fish processing sector with necessary raw materials. In this case, it would be advisable for promotion of undertaking to channel the support of the EU financial instruments to production of new, innovative products, where as raw materials the aquaculture fish are used, to implementation of marketing measures and acquisition of new markets.

Conclusions

Production technologies of Latvia's fish processing sector are not being utilized in their full capacity, thus not reaching the maximum production capacities. Several factors influence the capacity of technological facilities: demand, availability of raw materials and their prices, availability of human resources and their costs, as well as undertaking.

Despite the fact that in the framework of the EU financial instruments in 2004 – 2006 and 2007 – 2013 planning periods Latvian fish processing sector received investments in amount of EUR 96.63 million for purchasing production technologies and modernization, and the participants of the survey indicated a need in additional support for production development, the investments made up till now have been sufficient.

Taking into account the availability and utilized capacity of Latvia's fish processing sector, as well

as factors, influencing the production process, it is advisable to channel the support for the development of the sector to production of innovative goods, where the aquaculture fish are used as raw materials, to implementation of marketing measures and acquisition of new markets.

References

1. Aswathy N., Narayanakumar R., Salim S.S., et al. (2013) Total factor productivity growth in marine fisheries of Kerala. Available at: http://apps.webofknowledge.com/full_record.do?product=UA&search_mode=GeneralSearch&qid=41&SID=V1685VR4V6qQ7lU9HXq&page=1&doc=1, 27 July 2015.
2. Bakhrankova K., Midthun T.K., Uggen T.K. (2014) Stochastic optimization of operational production planning for fisheries. Available at: http://ac.els-cdn.com/S0165783614001118/1-s2.0-S0165783614001118-main.pdf?_tid=39a5b6fe-3a31-11e5-b298-00000aacb35d&acdnat=1438642060_ca8c5101ab8662ed400d30d992d2debd, 27 July, 2015.
3. Central Statistical Bureau (2014) *Fish production and canned fish according to NACE 2.rev. code 10.20. from 2004 – 2013* (restricted access data).
4. Central Statistical Bureau (2014) *Latvian fish and fish products import and export from 2005 – 2013* (restricted access data).
5. Central Statistical Bureau (2014) *Latvian fish processing companies by NACE 2.rev. code 10.20.* (restricted access data).
6. Central Statistical Bureau (2014) *Production capacity of fish processing in Latvia from 2005 – 2013* (restricted access data).
7. Central Statistical Bureau (2014) *The average gross wage in Latvia and EU-27 from 2005 – 2013* (restricted access data).
8. Eurostat (2014) The average gross wage in the EU-27 from 2005 – 2013. Available at: http://ec.europa.eu/eurostat/data/database, 1 January 2015.
9. *Food and Veterinary Service* (2014) *Registered fishery product processing companies in Latvian*. Available at: http://www.pvd.gov.lv/lat/uznemumi/, 16 April 2014.
10. Food Safety, Animal Health and Scientific Institute of Environment BIOR (2013) *Latvian Fisheries integrated control and information system "LICIS": Latvian catch from 2005 – 2012* (restricted access data).
11. Latvian Environmental Investment Fund (2014) *The projects supported by the CCFI in the fish processing companies in Latvia by 01.04.2014.* (restricted access data).
12. Latvian State Institute of Agrarian Economics (2014) *Latvian fish processing sector participant survey results* (restricted access data).
13. Latvijas Lauksaimniecības universitāte (2013) Latvijas zivju pārstrādes nozares konkurētspējas rādītāju salīdzinošā analīze (A comparative analysis of competitiveness indicators of Latvia's fish processing branch). Available at: https://www.zm.gov.lv/public/ck/files/ZM/TP%20petijumi/Pet_ZIVIS_partikas_konkuretsp_2013_8_6.pdf, 3 January 2015. (in Latvian).
14. Marx K. (1867) Capital: A Critique of Political Economy. Available at: https://www.marxists.org/archive/marx/works/1867-c1/index.htm, 4 January 2015.
15. Mill J.S. (1848) Principles of Political Economy. Available at: http://www.efm.bris.ac.uk/het/mill/book1/index.htm, 4 January 2015.
16. Ministry of Agriculture (2014) *Registered fishery product processing companies in Latvian on 01.08.2013.* (restricted access data).
17. Ministry of Agriculture (Zemkopības ministrija) (2014) *Latvijas zivsaimniecības gadagrāmata 2014* (Latvian Fisheries Yearbook 2014th). Latvijas Lauku konsultāciju un izglītības centrs, Rīga, Latvija, 191 lpp. (in Latvian).
18. Ministry of Finance (2014) *The projects supported by ERDF, ESF, EAGGF, FIFG and LGA in the fish processing companies in Latvia by 22.05.2014.* (restricted access data).
19. Ricardo D. (1817) On the Principles of Political Economy and Taxation. Available at: http://www.econlib.org/library/Ricardo/ricPCover.html, 4 January 2015.
20. Rural Support Service (2014) *The projects supported by EAFRD and EFF in the fish processing companies in Latvia by 02.06.2014.* (restricted access data).
21. Smith A. (1776) The Wealth of Nations. Available at: http://www.bartleby.com/10/106.html, 4 January 2015.
22. State Revenue Service (2014) *Financial figures from 2005 – 2013* (restricted access data).

THEORETICAL ASPECTS OF LOCAL FOOD DISTRIBUTION

Inita Krivašonoka[1,2], Linda Siliņa[1]
[1]Latvia University of Agriculture
[2]Latvian Rural Advisory and Training Centre
inita.krivasonoka@gmail.com

Abstract
Purchasing local products has become a popular trend both in Latvia and in the world; yet, no single definition is available regarding what may be regarded as local products. The term local product is interpreted based on the distance between the producer and the consumer, administrative and political theories, social factors and personal opinions.
Food systems refer to a full cycle from production to sales, whereas local food systems, which are regarded as an alternative to the global food system, are characterised by a short distance between the producer and the consumer, which increases mutual trust between the parties engaged. Besides, it has been found that local food systems are considered sustainable and local communities benefit from them economically, environmentally and socially.
Local products are sold through traditional channels – food products are marketed through wholesale and retail networks – and through those popularising local products – short supply chains and direct sale channels –when products are purchased directly from the producer. The present research gives a summary and a short description of such sale channels.
An essential role in increasing the sales of local products is also played by the public sector, as local products are purchased through municipal public food procurements. Even though the EU legislation stipulates that municipal public procurements may not require bidders to supply only local products because it contradicts the principles of free trade in the EU, yet, food products produced in the local region are preferred if sustainability criteria are integrated in procurement requirements.
Key words: local food, food systems, food distribution, public procurement.

Introduction

Food as well as the food industry plays a vitally essential role in meeting the needs of consumers. The food industry comprises only 2% of the EU gross domestic product (GDP) and employs 13.5% of the workforce in the EU manufacturing sector. Europe's largest revenues are gained from food manufacturing. In Europe, about 310 000 enterprises are engaged in the food industry, of which 99% are small and medium enterprises (SMEs), and its contribution to the EU economy totals EUR 600 billion (Manzini and Accorsi, 2012). The food industry as one of the largest economic sectors in Latvia is of great importance to economic growth as well.

Campaigns that popularise the consumption of local products become increasingly popular, especially owing to Russia's food embargo. The trends in the society indicate that residents consider purchasing food products produced in Latvia because they care about the health of themselves and their family as well as are interested in supporting Latvia's rural areas and local food producers.

The trend to buy local food has increased in recent years. Previous research studies by foreign authors also indicate that the demand for local products increases and the demand shows that expressing belonging to a local area is one of the latest trends in the global food market (Knight, 2011).

However, according to surveys, most residents of Latvia still often buy food in supermarkets (70%). Only 16% of them go shopping mostly to small stores, 7% to a market place, 2% produce food themselves, while 1% buy directly from farmers (SKDS, 2010).

Given the fact that the share of local food available in supermarket chains is relatively low in Latvia, one can conclude that consumer shopping habits regarding local food are little researched and this domain's potential is not fully realised in the entire food distribution system.

So far, in Latvia no studies have been conducted to gather information on local food systems and local food distribution channels. The research aim is to describe the theoretical aspects of local food distribution. Research tasks are to describe the nature and role of local food systems as well as to classify and characterise the local food distribution channels and to analyse their theoretical framework.

Materials and Methods

The following research methods were employed to carry out the present research: analysis and synthesis, induction and deduction, the monographic method and the graphic method.

The paper employed theoretical findings of scientists, the legal frameworks of Latvia and the EU that set the standards on purchasing food and data on population shopping habits regarding local food in Latvia.

Results and Discussion

Local products

Many research studies on local food refer to the term local; yet, there is no single definition of it. Usually the term local food refers to the food produced in the vicinity of its consumers, however, there is no single opinion regarding the terms used to refer to the distance between producers and consumers; it varies by region and depends on enterprises, consumers and the specifics of local food markets. Foreign researchers have defined this distance within a range from one to 100 miles (Blake et al., 2010; Pearson et al., 2011; Adams and Adams, 2011; Khan and Prior, 2010) or the distance is expressed in terms of hours of travel (Khan and Prior, 2010; Zepeda and Leviten-Reid, 2004).

However, in accordance with the US Farm Act of 2008, the total distance within which products may be transported and regarded as 'locally or regionally produced agricultural products' is less than 400 km from the place of origin or within the state where the products are produced (Martinez et al., 2010). This distance is comparatively great and does not contribute to trust between the producer and the consumer, which is essential for local food systems; yet, the size and specifics of the producer country have to be taken into consideration.

Second, the term local relates to certain political boundaries, for instance, a community, a region or a country (Khan and Prior, 2010; Selfa and Qazi, 2005). Besides, the definitions of local food are created based on special criteria or brands relating to a region, for example, Pharma ham (Wilkins et al., 2000).

The third definition associates "local" with particular advantages, for instance, convenience, health, status and sustainability (Blake et al., 2010; Selfa and Qazi, 2005). Fourth, "local" is conceptually opposed to industrial or cooperative agriculture as an alternative social movement (Adams and Salois 2010; SELFA and Qazi 2005; Zepeda and Deal, 2009). And, finally, "local" may be defined as social relationships mostly between consumers and producers (Smithers et al. 2008).

Yet, since there is no general definition on what local food means, consumers themselves may define what the term local means to them (GRACE, 2015), and consumers usually accept one or several the above-mentioned concepts.

The reasons why consumers choose local products as well as their attitudes to local food are diverse. Some consumers criticise the increasing food imports in the national food market and view local food as an alternative friendly to the environment and climate, while other consumers view local food from the hedonistic perspective as fresher, safer and healthier than imported food (Feldmann and Hamm, 2014).

From the authors' point of view, in Latvia, too, there is no clear definition of local product; yet, it is related to the administrative and territorial division and also perceived as social relationships between consumers and producers. In different cases the understanding of it differs: 'local' may be defined as produced in Latvia as a country or as produced in a particular region/municipality. When choosing among products produced in Latvia, consumers define 'local' as the products produced in their municipality, but in the global market 'local' is understood as the food produced in Latvia.

Local food systems

Food systems encompass all food production aspects (the way food is grown, harvested, processed, packed or otherwise prepared for consumption) and food distribution (where and how food is sold to consumers and how food is transported).

In the food system in the industrialised world, large private companies prevail, and the production of food is concentrated spatially and structurally, which results in high-level production; yet, there are a lot of negative environmental and exogenous social factors (Cleveland, 2014). There is increasing interest in alternative food systems as a solution that would reduce these problems and increase the environmental and social sustainability of food systems.

Food systems may be classified into two major groups: the global industrial food system and sustainable/local (or regional) food systems. The global industrial food system features much greater geographic reach than a local or regional food system. The term local food system (or regional food system) is used to describe the geographically localised ways of the production and distribution of food (GRACE, 2015).

The localisation of food systems is extensively popularised both as "good" and as "progressive" (Hinrichs, 2003) by a discourse on closer relationships between food producers and consumers as well as by a commitment to the social, economic and environmental dimensions of sustainable food production, distribution and consumption (Jarosz, 2008).

It is asserted that localised food production can meet many of the diverse community needs more efficiently than a globalised food system because it can give priority to community and environmental integrity before corporate profit-making (Feagan, 2007). By doing so, the ability of communities and individuals to access food of adequate quality improves (Kirwan and Maye, 2013).

A local food system is often regarded as an alternative to the globalised food system. As a response to the globalisation pattern, since the 1970's

many local food initiatives have emerged in the world. Given the fact that the initiatives developed in social, economic and environmental contexts, these food systems, to a great extent, reflect their traditional cultures. (Lehtinen, 2012). Local food systems assume a more sustainable option – a means of getting biodiversity from farm to plate, of saving energy and reducing food miles, of providing social care and improving civic responsibility, and of retaining economic value in a local economy (Ilbery and Maye, 2005).

The Oklahoma Food Policy Council has defined a local food system as a "system with adequate opportunities and infrastructures for food producers to sell their goods to local residents and institutions" (Sharma, 2014).

Individuals have been engaged in the local food movement for various reasons: some due to concerns about the environmental impacts of conventional agriculture, some in reaction to the succession of food scares from the late 1980s, and some who see local food as challenging increasing consolidation and globalization within the agri-food sector (Kirwan and Maye, 2013).

Local food production systems are one of the means of fostering local potentials and of increasing the economic activity of less popular and often depressive territories. The interaction of local producers and consumers ensures that producers supply food to the local market. Working in a local market, producers, to a great extent, have individual contacts with consumers, based on mutual trust. Yet, in the local market, the local public can set certain standards for food producers, and compliance with these standards is a matter of honour for them. However, a commitment of consumers or the local public to invest is also a matter of trust, local patriotism and a wish to invest in the local economy. It is important to be aware that working in a local market takes place within the formal economy; therefore, engaging in these processes through taxes, producers and consumers invest in maintaining and developing the entire country's society, including the local society (Latvijas Lauku foruma…, 2012).

The value of local food systems lies in the short distance between growers/producers and consumers. Besides, local food systems often do not need such stages as packing, transportation, selling to intermediaries and even harvesting.

Local food systems support the local economy. For instance, farmers' markets positively affect local businesses, while at the same time generating considerable revenues for local framers, thus making many small local farms viable. Unlike large industrial farms, small family farms spend more of their money on local products (for instance, seeds, agricultural goods, etc.); besides, food grown, processed and supplied locally (for example, to local restaurants) creates jobs, thus stimulating the local economy (GRACE, 2015).

Sale channels for local products

Food supply chains, which involve production, processing and sales, become increasingly complicated and dynamic. Distances between food production and consumption sites have become greater, and global competition has increased (Agustina et al., 2014). Food supply chains are an important component of the global economy (Ghosh, 2010). Products are produced and consumed in every part of the world, and these processes are associated with the use of natural resources, employment and CO_2 emissions. Food supply chains distribute fast-transportable products in large quantities, which are available to consumers (Ala-Harja and Helo, 2015).

Figure 1 shows the main ways how local food reaches consumers – either directly from producers or through retail sales and institutional schemes, for example, municipal procurements – or through wholesale warehouses as intermediaries.

Most often, processing enterprises distribute their products to stores by supplying the products to logistics centres of retailer chains, to stores – small, regional ones or the ones owned by the processing enterprises, or to wholesalers. Small and medium enterprises need to cooperate with wholesalers, as their quantities produced are insufficient to access Latvia's large retail chains. However, wholesalers can offer them the assortments of several enterprises (use the method of "mixing"), thus facilitating their entry into supermarket chains (LLU, 2013). But further in the research this problem is not examined, given the fact that such a way of selling products is not in line with the nature and values of the local food system.

Purchasing food directly from producers becomes increasingly popular. The most widespread way is agricultural and home producer fairs that, in cooperation with local authorities, are regularly held in municipalities.

Since 2012, 15 direct sale interest groups have been established in Latvia, and during this period campaigns and training have been held to popularise this movement. Presently, more than 500 families and more than 70 farmers engaged in organic farming, as well as home producers, participate in the direct sale interest groups in Latvia (Kas ir tiešās …, 2015) (What Are Direct …, 2015).

Community-supported agriculture is popular in the world (Allen et al., 2003). Such a local food distribution system involves various ways of sales, but their key distinctive feature is personal contacts between producers and consumers, mutual trust and

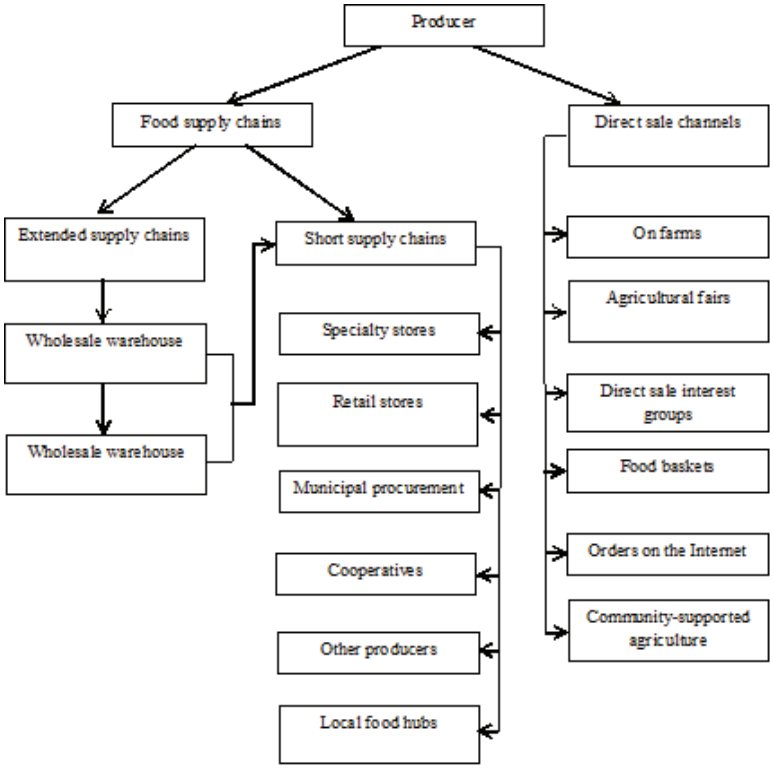

Figure 1. Local food sale channels (Source: authors' construction).

the consumers' wish to learn everything about the food they use in their diet.

However, direct marketing, for instance, in the USA comprises only 0.4% of the total quantity of sales of agricultural products (Cleveland, 2014). It may be explained by the fact that the localisation of food sales lacks an economic, organisational and physical structure of adequate scale in order to supply food from local producers to local consumers. To tackle this problem, food distribution hubs are recommended being established.

Local food hubs are a means of combining and selling food by collecting the food from a number of small farms and of supplying the food to grocery stores, schools, hospitals and restaurants (Cleveland, 2014).

An important way of selling local products, which is different from the other ways of supplying local food, is municipal public food procurements.

The role of the public sector in stimulating sustainable development has been in the spotlight of many researchers (Walker and Brammer, 2009; Rimmington et al., 2006). Sustainable procurement is one that is in accordance with the principles of sustainable development, for instance, it contributes to a strong, healthy and fair society, given the environmental limitations, as well as to good governance (Walker and Brammer, 2009). At EU level, public procurement involves a characteristic tension between a social ideal and environmental sustainability on the one hand, and competitiveness and free trade criteria on the other hand (Morgan and Sonnino, 2007).

Public procurement is important as one of the market instruments to be used to achieve the targets of the EU strategy Europe 2020 (Europe 2020, 2010). In particular, through public procurement, the strategy Europe 2020 encourages to:

- improve framework conditions for business to innovate and make full use of demand side policies,
- support transition to an economy that saves resources and produces low carbon dioxide emissions, for instance, by encouraging wider use of green public procurement,
- improve the entrepreneurship environment, especially for innovative small and medium enterprises (Zaļā grāmata, 2011) (Green Book, 2011).

According to research studies, price is the decisive factor in public catering. Financial pressure is the most important obstacle in implementing sustainable public procurement (Walker and Brammer, 2009). Local food producers are forced to compete with national or even multinational food companies. Local food, on the whole, is more expensive, as small production quantities and high supply cost are specific to it. For these reasons, local food producers have to be encouraged through various extra conditions, so that they remain competitive in procurement, for

instance, through setting economic benefit criteria for evaluating the offers of bidders.

The Treaty establishing the European Community in 1957 introduced the principle of a "single market" and a single Europe for the first time. The Treaty actually sought to ensure a European-scale commitment to free flows of goods among countries and a commitment to economic growth in all the Member States, based on trade among countries. In accordance with this principle regarding the single market, the Treaty, in fact, bans anti-competition in procurement, which would be beneficial to national or local suppliers (Jackson, 2010).

Europe 2020 stresses that public procurement policies have to guarantee as efficient use of public funds as possible as well as procurement markets have to be accessible at EU scale.

EU public procurement rules prohibit specifying 'local' in public catering contracts (Morgan, 2007), even though government institutions may refer to other rules related to sustainability in public food procurement.

In Latvia, public procurement is regulated by the Public Procurement Law of 2006. The purpose of public procurement is to guarantee the transparency of procurement procedures, free competition among suppliers as well as the efficient use of national and local government funding, maximally reducing the commissioning party's risks (Publisko iepirkumu…, 2006) (Public Procurement..., 2006).

The Public Procurement Law stipulates that in order to compare and evaluate bids, the commissioning party selects one of the following criteria:

1) bids at the lowest price;
2) the most economically beneficial bid, taking into consideration the terms of delivery of supplies or the contractual deadline; exploitational costs and other costs, their efficiency; quality of goods, services or construction works; esthetical and functional characteristics; compliance with the environmental standards; technical advantages, availability of spare parts, security of supplies; price and other contract-related factors.

Previous experience in Latvia shows that for the purpose of efficient use of funding, mostly the lowest price criterion is employed in evaluating bids in municipal public food procurement.

However, preference may be given to the food produced in Latvia if successfully employing the criteria of the most economically beneficial bid. Such criteria can involve, for instance, price, quality, terms of delivery, life cycle cost or environmental values. The Law allows taking into account environmental issues, which enables the purchaser, i.e. the municipality to require short supply chain products.

The Operational Strategy 2014-2016 of the Ministry of Agriculture of the Republic of Latvia aims to support agricultural industries producing higher value-added products being demanded in the domestic and foreign markets as one of the priorities in this period (including local food producer quality schemes and organic farming). In this context, one of the most important medium-term tasks is the promotion of production and consumption of local food through implementing measures aimed at increasing the market share of food products produced in Latvia in public procurement and consumption, continuing implementing informative and promotional food programmes and improving food quality schemes (Zemkopības ministrija (Ministry of Agriculture), 2014).

In 2012 in Latvia, the market size of public food procurement was equal to LVL 13.6 mln (EUR 19.35 mln), which comprised about 2% of the food and beverage market in Latvia (Lerhe, 2013).

In recent years, the principle of 'green procurement' has become increasingly important. It involves the systematic integration of environmental (and social) criteria into all procurement-related activities for goods and services. It is one of the environmental policy instruments aimed at reducing the effect on the environment, achieving social improvements as well as saving funding (Iepirkumu uzraudzības…, 2015) (Procurement Monitoring .... 2015).

Green public procurement (GPP) has become an environmental policy cornerstone at EU and national levels (Tukker et al., 2008). Since the international conference on the environment and development in Rio de Janeiro in 1992, the understanding of the role of GDP in sustainable consumption and production patterns has significantly improved, and now government institutions use it both as a policy instrument and as a technical tool (Testa et al., 2012).

Green public procurement is an instrument that directly stimulates and ensures increases in sales of local food. Making a public procurement contract in accordance with the GPP principles means that one can be sure that the goods or services purchased make the smallest effect on the environment and a positive social impact. Therefore, the choice of food products plays a significant role in reducing the effect on the environment and maintaining human health.

GPP as one of the national priorities is also addressed in other government policy documents and legal acts, which sets high quality standards for food supplies, stating that priority has to be given to the food products complying with the quality standards set in legal acts concerning the national food quality scheme or the organic farming scheme (Cabinet of Ministers, 2012).

Conclusions

Purchasing local products has become a popular trend both in Latvia and in the world; yet, no single definition is available regarding what may be regarded as local products. The term local product is interpreted based on one's geographic affiliation, personal opinions and other factors.

Food systems refer to a full cycle from production to sales, whereas local food systems, which are characterised by a short distance between the producer and the consumer and mutual trust. The research has found that food systems may be regarded as sustainable and provide economic benefits to the local community.

Local products are sold through traditional channels – food products are marketed through wholesale and retail networks – and through those popularising local products – short supply chains and direct sale channels, when products are purchased directly from the producer.

An essential role in increasing the sales of local products is also played by the public sector, as local products are purchased through municipal public food procurements. Even though the EU legislation stipulates that municipal public procurements may not require bidders to supply only local products because it contradicts the principles of free trade in the EU, yet, food products produced in the local region are preferred if sustainability criteria are integrated in procurement requirements.

References

1. Adams D.C., Adams A.E. (2011) De-placing Local at the Farmers' Market: Consumer Conceptions of Local Foods. *Journal of Rural Social Sciences*, 26 (2), pp. 74-100.
2. Adams D.C., Salois M.J. (2010) Local Versus Organic: A Turn in Consumer Preferences and Willingness-to-pay. Renewable Agriculture and Food Systems, 25 (4), pp. 331-341.
3. Agustina D., Lee C.K.M., Piplani R. (2014) Vehicle Scheduling and Routing at a Cross Docking Center for Food Supply Chains. *Int. J.Production Economics*, 152 (2014), pp. 29-41.
4. Ala-Harja H., Helo P. (2015) Reprint of 'Green Supply Chain Decisions – Case-based Performance Analysis from the Food Industry'. Transportation Research, Part E 74 (2015), pp. 11-21.
5. Allen P., FitzSimmons M., Goodman M., Warner K. (2003) Shifting Places in the Agrifood Landscape: the Tectonics of Alternative Agrifood Initiatives in California. *Journal of Rural Studies*, 19, pp. 61-75.
6. Blake M.K., Mellor J., Crane L. (2010) Buying Local Food: Shopping Practices, Place, and Consumption Networks in Defining Food as ''Local''. Annals of the Association of American Geographers, 100 (2), pp. 409-426.
7. Cabinet of Ministers of the Republic of Latvia (2012) Cabinet Regulation No.172 'Noteikumi par uztura normām izglītības iestāžu izglītojamiem, sociālās aprūpes un sociālās rehabilitācijas institūciju klientiem un ārstniecības iestāžu pacientiem' (Regulations Regarding Nutritional Norms for Educatees of Educational Institutions, Clients of Social Care and Social Rehabilitation Institutions and Patients of Medical Treatment Institutions). Available at: http://likumi.lv/doc.php?id=245300, 21 February 2015.
8. Cleveland D.A., Nora M., Müller N.M., Tranovich A.C., Mazaroli D.N., Hinson K. (2014) Local Food Hubs for Alternative Food Systems: A Case Study from Santa Barbara County, California. *Journal of Rural Studies*, 35 (2014), pp. 26-36.
9. Europe 2020. A Strategy for Smart, Sustainable and Inclusive Growth, COM (2010) 2020 final, Brussels, 3.3.2010a. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri= COM:2010:2020:FIN:LV:PDF, 21 February, 2015
10. Feagan R. (2007) The Place of Food: Mapping out the 'Local' in Local Food Systems. Progress in Human Geography, 31, pp. 23-42.
11. Feldmann C., Hamm U. (2014) Consumers' Perceptions and Preferences for Local Food: A review. Food Quality and Preference, 40 (2015), pp. 152-164.
12. Ghosh J. (2010) The Unnatural Coupling: Food and Global Finance. *Journal of Agrarian Change* 10 (1), pp. 72-86.
13. GRACE Communications Foundation (2015) Local & Regional Food Systems. Available at: http://www.sustainabletable.org/254/local-regional-food-systems, 21 February, 2015.
14. Hinrichs C. (2003) The Practice and Politics of Food System Localisation. *Journal of Rural Studies*, 19, pp. 33-45.
15. Iepirkumu uzraudzības birojs (2015) Zaļais iepirkums (Green public procurement). Available at: http://www.iub.gov.lv/node/61, 28 February, 2015. (in Latvian).
16. Ilbery B., Maye D. (2005) Food Supply Chains and Sustainability: Evidence from Specialist Food Producers in the Scottish/English borders. Land Use Policy, Vol. 22 No. 4, pp. 331-44.

17. Jackson M. (2010) Making the Most of Public Sector Spend: Procurement as Local Economic Activism. Centre of Local Economic Strategies, Briefing. Available at: http://www.cles.org.uk/wp-content/uploads/2011/01/Procurement-as-local-economic-activism.pdf, 28 February, 2015.
18. Jarosz L. (2008) The City in the Country: Growing Alternative Food Networks in Metropolitan Areas. *Journal of Rural Studies*, 24, pp. 231-244.
19. Kas ir tiešās pirkšanas pulciņi (2015) (What are Direct Sale Interest Groups). Available at: http://tiesapirksana.lv/kas.html, 28 January, 2015.
20. Khan F., Prior C. (2010) Evaluating the Urban Consumer with regard to Sourcing Local Food: A Heart of England Study. *International Journal of Consumer Studies*, 34 (2), pp. 161-168.
21. Kirwan J., Maye D. (2013) Food Security Framings within the UK and the Integration of Local Food Systems. *Journal of Rural Studies*, 29 (2013), pp. 91-100.
22. Knight A.J. (2011) Evaluating Local Food Programs: The Case of Select Nova Scotia. Evaluation and Program Planning, 36 (2013), pp. 29-39.
23. Latvijas Lauku foruma Kompetenču centrs (2012) Pētījums par vietējās pārtikas ražošanas nozares attīstības iespējām un vietējo pārtikas ražotāju atbalsta iespējām Aizkraukles rajona partnerības teritorijā (Study on Development Opportunities for the Local Food Industry and Support Opportunities for Local Food Producers in Aizkraukle District Partnership Territory). Available at: http://www.llf.kompetences.lv/resource/1332339488_Petijums_Aizkraukles_partneriba.pdf, 12 February 2015. (in Latvian).
24. Lehtinen U. (2012) Sustainability and Local Food Procurement: a Case Study of Finnish Public Catering, British Food Journal, Vol. 114 Iss: 8, pp.1053-1071.
25. Lerhe R. (2013) Vietējo pārtikas produktu īpatsvara palielināšanas iespējas vietējā patēriņā (Opportunities for Raising the Share of Local Food in Local Consumption). Available at: http://www.lps.lv/images/objects/committee_files/sittings/f164eee518dd9ad975451eb30afa17ca5_Prezentacija_Rujiena_ZM_050413.ppt, 29 January 2015. (in Latvian).
26. LLU (2013) Latvijas pārtikas nozares konkurētspējas rādītāju salīdzinošā analīze. (Comparative Analysis of Latvian Food Industry Competitiveness Indicators). 262. lpp. (in Latvian).
27. Manzini R., Accorsi R. (2012) The New Conceptual Framework for Food Supply Chain Assessment. *Journal of Food Engineering*, 115 (2013), pp. 251-263.
28. Martinez S., Hand M., Da Par M., Pollack S., Ralston K., Smith T., Vogel S., Clark S., Lohr L., Low S., Newman C. (2010) Local Food Systems. Concepts, Impacts, and Issues. United States Department of Agriculture, Economic Research Service. Economic Research Report Number 97, May 2010, p. 87.
29. Morgan K., Sonnino R. (2007) Empowering Consumers: the Creative Procurement of School Meals in Italy and the UK. *International Journal of Consumer Studies*, Vol. 31 No. 1, pp. 19-25.
30. Morgan K. (2007) Greening the Realm: Sustainable Food Chains and the Public Plate. Regional Studies, Vol. 42 No. 9, pp. 1237-1250.
31. Pearson D., Henryks J., Trott A., Jones P., Parker G., Dumaresq D., Dyball R. (2011) Local food: Understanding Consumer Motivations in Innovative Retail Formats. *British Food Journal*, 113 (7), pp. 886-899.
32. Publisko iepirkumu likums (2006) (The Public Procurement Law). Available at: http://likumi.lv/doc.php?id=133536, 8 March 2015. (in Latvian).
33. Rimmington M., Carlton Smith J., Hawkins R. (2006) CSR and Sustainable Food Procurement, British Food Journal, Vol. 108 No. 10, pp. 824-37.
34. Selfa T., Qazi J. (2005) Place, Taste, or Face-to-face? Understanding Producer-Consumer Networks in "Local" Food Systems in Washington State. Agriculture and Human Values, 22, pp. 451-464.
35. Sharma A., Moon J., Strohbehn C. (2014) Restaurant's Decision to Purchase Local Foods: Influence of Value Chain Activities. International Journal of Hospitality Management, 39 (2014), pp. 130-143
36. SKDS (2010) Pārtikas produktu patēriņš (Consumption of Food Products). Nord Latvijas Barometrs Nr.24. Available at: https://www.dnb.lv/sites/default/files/dnb_latvian_barometer/documents/2010/ 301.dnb-nord-latvijas-barometrs-24.pdf, 6 March 2015. (in Latvian).
37. Smithers J., Lamarche J., Joseph A.E. (2008). Unpacking the Terms of Engagement with Local Food at the Farmers' Market: Insights from Ontario. *Journal of Rural Studies*, 24, pp. 337-350.
38. Testa F., Iraldo F., Frey M., Daddi T. (2012) What Factors Influence the Uptake of GPP (green public procurement) Practices? New Evidence from an Italian Survey. Ecological Economics, 82 (2012), pp. 88-96.

39. Tukker A., Emmert S., Charter M., Vezzoli C., Sto E., Andersen M.M., Geerken T., Tischner U., Lahlou S. (2008) Fostering Change to Sustainable Consumption and Production: an Evidence Based View. *Journal of Cleaner Production*, 16, pp. 1218-1225.
40. Walker H., Brammer S. (2009) Sustainable Procurement in the United Kingdom Public Sector. Supply Chain Management: *An International Journal*, Vol. 14 No. 2, pp. 128-137.
41. Wilkins J.L., Bowdish E., Sobal J. (2000) University Student Perceptions of Seasonal and Local Foods. *Journal of Nutrition Education*, 32 (5), pp. 261-268.
42. ZAĻĀ GRĀMATA par ES publiskā iepirkuma politikas modernizāciju. Virzība uz efektīvāku Eiropas iepirkuma tirgu (Green Paper on the Modernisation of EU Public Procurement Policy Towards a More Efficient European Procurement Market), COM (2011) 15 final, Brussels, 27.1.2011. Available at: http://eur-lex.europa.eu/ LexUriServ/ LexUriServ.do?uri=COM:2011:0015:FIN:LV:PDF, 1 March 2015.
43. Zemkopības ministrija (2014) Latvijas Republikas Zemkopības ministrijas Darbības stratēģija 2014.-2016. gadam (Latvia's Ministry of Agriculture Operational Strategy 2014 - 2016). Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/39/38/ZM_darbibas_strategija_2014_2016.pdf, 6 March 2015. (in Latvian).
44. Zepeda L., Deal D. (2009). Organic and Local Consumer Behaviour: Alphabet Theory. International *Journal of Consumer Studies*, 33, pp. 697-705.
45. Zepeda L., Leviten-Reid C. (2004) Consumers' Views on Local Food. *Journal of Food Distribution Research*, 35 (3), pp. 1-6.

THE IDENTIFICATION OF LOCAL FOOD AT BRAND FEATURES: A REVIEW

Aivis Biķernieks
Latvia University of Agriculture
aivis.bikernieks@gmail.com

Abstract
This review paper discusses possibilities of the identification of local food products at brand features. Initially, it was examined whether the identification of food products is possible at brand features, after it was established what type of brand could be used for the identification of local food products – store brand or national brand. Local food meets both definitions: national brand products and store brand products. The scientific literature does not provide an answer to the question about the use of imported raw materials in manufacturing process of national level and store brand products. The answer is not provided if the food products, which contain imported raw materials, are considered to be local food. The methodology used for the research is based upon a literature review – a monographic method.
Key words: brand, store brand, national brand.

Introduction

Not only a traditional national and local product can symbolize affiliation to nation or local ethnic group. This sense of belonging can provide the product that is associated with a particular country, ethnic group or local area. Products related with the identity of a national and local ethnic group are recognizable by brands. Great importance is given to the quality of the product, and whether the product is noticeable. Food products can be recognized by its manufacturer, the place of origin and product brand. Product branding existed for centuries as a way to distinguish one product from others. Brand concept, we refer to nowadays, appeared around the 19th century. Under this concept a brand can be seen as a legal instrument, logo, company, system identification, personality, character, or added value (Konecnik and Gartner, 2007). The aim of this review paper was to summarize the research conducted previously, identify variables that must be considered in this review paper, identify gaps in knowledge and provide the evaluation of the problem to identify food origin site at brand feature.

Materials and Methods

Primary sources are scientific papers, monographs, fundamental documents that are closely related to the subject, which could be found in the scientific databases and as free sources on the Internet. Papers were selected by the search terms and from references in the studies that were found. The methodology used for the research is based upon a literature review – monographic method.

Results and Discussion

The brand is a symbol of a specific product, service or company. A brand can take many forms, including a name, sign, symbol, colour combination or slogan. A legally protected brand name is also called the trademark. The American Marketing Association describes the brand as ‘a name, term, sign, or look, or a combination of all these elements, the purpose of which is to identify the goods and services that distinguish them from other manufacturers and service providers. The brand’s most important feature is the promise of consumer goods’ (Tiwari, 2012). The brand has several functions that must be performed in relation to consumers, the brand should provide information about the origin, the definition of producer’s responsibility, risk reduction, cost reduction and a virtual agreement with product manufacturers (promise, warranty) (Kuhar and Tič, 2008). Some scientists believe that the ethnic-based representatives of the subculture could create a commune level brand (Algesheimer et al., 2005). Brand community is a community of people that combines emotional affection for a specific product or brand. In this case, there is a close link between the brand and individual cultures (Veloutsou and Moutinho, 2009). The manufacturer and retailer’s cornerstone of growth strategies are the main association of brand with a specific product.

Manufacturers and distributors of branded products also recognise that a highly valued brand image significantly improves the consumer’s assessment of the new product if one is good for the brand and product compliance link. It must be admitted that this method also has a possible negative effect (Lane and Jacobson, 1997).

A brand and an image can be understood as the relationship between a consumer and a product. The consumer gets this link from his preconceptions about the marketing program, which also includes advertising and other branding activities; however, the consumer’s main attention is focused on whether the product is able to meet the needs of the consumer (Roth, 1992). Consequently, the consumer and the identification of brand are linked, as well as the unity of the consumer and brand is the search expression of an identity (Stokburger-Sauer et al., 2012). The brand is a way to make a concrete product visible to the eyes of the consumer. It is believed that consumers usually tend to buy famous brand products, or

consumers are loyal to a brand and are willing to pay more for a product with a brand than equivalent products without a brand if consumers see the advantages of brand products (Paasovaara, 2012). A brand in many markets creates uniquely identifiable products and is addressed to a concrete audience. From a psychological point of view the acquisition and use of products, in addition to the information provided about the brand's product quality and distinctive added value, are promoting the rise of consumer's self-esteem and bring confidence about itself. Specific brand manufacturers who have audience for their production should not spend resources for marketing their products (Shirazi et al., 2013).

The usage of a brand creates a cover charge to products; hence, the consuming of the brand is used to promote the added value of agricultural produce. Local brands traditionally benefit from a high level of visibility and have close links with consumers in their countries (Özsomer, 2012). The scientific literature suggests that brand products are valuable because consumers combine those products with the best performance in three areas: 1) quality and reliability, 2) appearance and 3) prestige (Jin et al., 2008).

Brands are listed by three-point measurement scale at their programmed information significance which is based on the brand's positioning as a good price and a good balance of the product's value, the highest level of private brands and lower-level of national level brands (Oliveira-Castro, 2008).

There are several levels of brand classification: national brands, brands of a store and supply chain, and discount brands. Generally, a consumer gets an offer of two types of products – national brand products and store brand products (Nenycz-Thiel et al., 2010).

National brand

A national brand is used for the identification of products, which are distributed at national level, and the brand owners are manufacturers or distributors. Unlike a store brand that is distributed across specific retail chains or stores, or some areas of the country where the stores or supply chains are running, national brand products are distributed in the territory of the country. National brand products must compete with store brand, local brand and private brand products. National brand products are manufactured, widely disseminated by the manufacturer's established brand. Retailing of national brand products across distribution chains is paid by a manufacturer or the owner of the national brand (Nenycz-Thiel et al., 2010).

Manufacturers are divided into two groups – companies that produce their own national brand items but offer them to a private label, and companies that produce their own national brand products and private label products.

The first category includes companies that manufacture only the highest quality brand products, they usually are leaders of a specific product category, and companies producing branded products. The second category includes manufacturers that produce private label or store brand products keeping separate production and marketing power, and possibly the associated logistical capacity of its national brand or store brand products, and companies that use the same traders, the national brand and private label sale (Zippel et al., 2013).

From the manufacturer's point of view, the use of private brand can offer the manufacturer an opportunity to attack the rival national brand products. Manufacturers, of course, can also choose to become exclusive producers of familiar store brands. The retailer has a strong position in the competitive situation between store brands and national brands, because the retailer directly allocates storage space and promotional materials and determines the level of advertising products in their brand assortment. The relative position of the manufacturer is based on the control of the brand equity. Numbers of national brands usually are big enough that retailers may not obscure national brand products with store brand products; moreover, consumers want to see in retail the greater number of national brand products (Juhl et al., 2006). In addition, the store brand products are sold at a lower price compared to the national brand products; usually this production generally is of good quality. By using the prestige and quality of the national brand, a store brand developer can offer to its clients various levels of production according to the customer and the purchasing power of audience (Labeaga et al., 2007). A large part of national producers perceive store brand products as other national brands, directed against a national brand and created a sharp competition. A leading national brand is strong enough financially to be able to introduce significant brand equity through long-term advertising campaigns and ensuring the quality of production (Bandyopadhyay et al., 2009).

Although the retailer industry remains increasingly important in determining the price of products, changes of store brand products' prices are still limited by the producer's conditions, creating an optimization problem; some manufacturers of national brand products set their retail prices of production (González-Benito et al., 2010). However, it should be noted that the scientific literature does not discuss cases in which national brand manufacturers are producing their products from imported raw materials. In such a case the question remains unanswered whether a national brand product, produced from imported raw materials, is considered as a local product, in this case, local

food. If the problem is considered from the view of the national brand product, this kind of product is of local origin, but from the point of view of the product's raw materials the product is no longer universally judged as a local product.

Store brand

A store brand is a product line that has been assembled by a retailer or distributor (Dawes and Nenycz-Thiel, 2013). There is also a perception that store brands are just sub-brands and the retailer is the only supplier of the goods (Liljander et al., 2009).

Store brand products belong to a store or a store chain, or a retailer, a wholesaler or a distributor of this product has acquired it, and this kind or products are distributed only in a specific store or a store chain (Nenycz-Thiel et al., 2010).

The concept of a store brand is also related to terms that are used in different countries: a home brand, a private-label brand in the United States, the own brand in the UK, a home brand in Australia and most other brands. The difference between a store brand and other brands is that a store brand is owned by a specific store or shop that has created this brand (Juhl et al., 2006).

The distributor, in this case the store or the store chain, develops packaging and appearance of the product and performs marketing activities to create a link to the store's customers. This type of brand products is mostly cheaper than the national level or name brand products (Bandyopadhyay et al., 2009), while the shop or the store chain can optimise the production according to customers' demand and simultaneously reduce the cost advertising.

In addition, by changing consumers' habits, the manufacturer's brand product value gradually and surely is overshadowed by the store brand product popularity, because store brand products, in terms of quality, are equivalent to the national brand production, but they are cheaper in the long-term, and the use of store brand products may cause appreciable savings (Woodside and Ozcan, 2009).

Store brand products are subject to the same regulatory oversight as other products. Store brand distribution is a ripe industry, and some stores even develop a brand as a premium or luxury class brand. Thanks to their quality, identity and developed positive image, store brand products have become the main brand consumption (Semeijn et al., 2004).

A store brand is considered as a private label, a trademark or the brand of a distribution chain. A good brand should provide consumers with a product's image and the added value of brand products. The brand should highlight the most important features of the product, the product's value and quality. Brands of stores or distribution chains are the most successful brands in the world. Companies that are owners of specific brands and trademarks belong to the area of the largest and most successful companies, while less attention is given to a specific product manufacturer. For today 'Tesco', 'Carrefour' and 'Wal-Mart' are considered as the most successful store brand companies, as well as other companies that do not manufacture products but distribute other manufacturers' products, produced by the distributor's request (Abdullah et al., 2012).

Store brands are regarded as a strategic tool while a retailer can get greater control over products distributed through the supply chain (Juhl et al., 2006). In addition, many product categories and store brand products produce more revenue compared to national brand products (Juhl et al., 2006; Ngobo, 2011). Store brand products are widely available in supermarkets (Semeijn et al., 2004). A food brand can identify the origin of a product, as well as a particular manufacturer, which operates in a specific country and supplies the country with its products. Such products are also considered as local food, if they are manufactured in a particular country, but it is not possible to consider this kind of products as local food products, if they are distributed through an international supply chain, while store brand products are not associated with the product's place of origin or manufacturer.

Conclusions

The brand is a way to make a concrete product visible to the eyes of the consumer.

The brand should highlight the most important features of the product, the product's value and quality.

A brand in many markets creates uniquely identifiable products and is addressed to a concrete audience.

National brand products are manufactured, widely disseminated by the manufacturer's established brand.

The store brand is owned by a specific store or shop that has created this brand.

The information about brand provides to a consumer a notion about the product, manufacturer and products' origin site, and it is possible to identify whether the product is local or not.

The scientific literature does not give the answer to the question about the use of imported raw materials in the manufacturing process of national level and store brand products. The answer is not provided, whether food products produced from imported raw materials are considered to be local food products.

References

1. Abdullah R. bin, Ismail N.B., Abdul Rahman A.F.B., Mohd Suhaimin M.B., Bte Safie S.K., Mohd Tajuddin M.T.H., Noor Armia R., Nik Mat N.A., Derani N., Samsudin M.M., Adli Zain R., Sekharan Nair

G.K. (2012) The Relationship between Store Brand and Customer Loyalty in Retailing in Malaysia. *Asian Social Science,* 2, pp. 171-184.
2. Algesheimer R., Dholakia U.M., Herrmann A. (2005) The Social Influence of Brand Community Evidence from European Car Clubs. *Journal of Marketing*, 69, pp. 19-34.
3. Bandyopadhyay S., Rominger A., Basaviah S. (2009) Developing a framework to improve retail category management through category captain arrangements. *Journal of Retailing and Consumer Services*, 16 (4), pp. 315-319.
4. Dawes J., Nenycz-Thiel M. (2013) Analyzing the intensity of private label competition across retailers. *Journal of Business Research*, 66 (1), pp. 60-66.
5. González-Benito Ó., Martínez-Ruiz M.P., Mollá-Descals A. (2010) Retail pricing decisions and product category competitive structure. *Decision Support Systems*, 49 (1), pp. 110-119.
6. Jin Y.H., Zilberman D., Heiman A. (2008) Choosing Brands: Fresh Produce versus Other Products. *American Journal of Agricultural Economics*, 90 (2), pp. 463-475.
7. Juhl H.J., Esbjerg L., Grunert K.G., Bech-Larsen T., Brunsø K. (2006) The fight between store brands and national brands—What's the score? *Journal of Retailing and Consumer Services*, 13 (5), pp. 331-338.
8. Konecnik M., Gartner W.C. (2007) Customer-based brand equity for a destination. *Annals of Tourism Research*, 34 (2), pp. 400-421.
9. Kuhar A., Tič T. (2008) Attitudes towards private labels - example of a consumer sensory evaluation of food in Slovenia. *Acta agriculturae Slovenica*, 91, pp. 379-390.
10. Labeaga J.M., Lado N., Martos M. (2007) Behavioural loyalty towards store brands. *Journal of Retailing and Consumer Services*, 14 (5), pp. 347-356.
11. Lane V., Jacobson R. (1997) The Reciprocal Impact of Brand Leveraging : Feedback Effects from Brand Extension Evaluation to. *Marketing Letters*, 8, pp. 261-271.
12. Liljander V., Polsa P., van Riel A. (2009) Modelling consumer responses to an apparel store brand: Store image as a risk reducer. *Journal of Retailing and Consumer Services*, 16 (4), pp. 281-290.
13. Nenycz-Thiel M., Sharp B., Dawes J., Romaniuk J. (2010) Competition for memory retrieval between private label and national brands. *Journal of Business Research*, 63 (11), pp. 1142-1147.
14. Ngobo P.-V. (2011) Private label share, branding strategy and store loyalty. *Journal of Retailing and Consumer Services*, 18 (4), pp. 259-270.
15. Oliveira-Castro J. (2008) Individual differences in price responsiveness within and across food brands. *The Service Industries Journal*, 28 (6), pp. 733-753.
16. Özsomer A. (2012) The Interplay Between Global and Local Brands: A Closer Look at Perceived Brand Globalness and Local Iconness. *Journal of International Marketing*, 20 (2), pp. 72-95.
17. Paasovaara R. (2012) Understanding consumers' brand-induced food taste perception: A comparison of 'brand familiarity'–and 'consumer value–brand symbolism (in) congruity'–accounts. *Journal of Consumer Behaviour*, 20 (April 2011), pp. 11-20.
18. Roth M.S. (1992) Depth Versus Breadth Strategies for Global Brand Image Management. *Journal of Advertising*, 21, pp. 25-36.
19. Semeijn J., van Riel A.C.R., Ambrosini A.B. (2004) Consumer evaluations of store brands: effects of store image and product attributes. *Journal of Retailing and Consumer Services*, 11 (4), pp. 247-258.
20. Shirazi A., Lorestani H.Z., Mazidi A.K. (2013) Investigating the Effects of Brand Identity on Customer Loyalty from Social Identity Perspective. *Iranian Journal of Management Studies*, 6, pp. 153-178.
21. Stokburger-Sauer N., Ratneshwar S., Sen S. (2012) Drivers of consumer–brand identification. *International Journal of Research in Marketing*, 29 (4), pp. 406-418.
22. Tiwari K. (2012) Perceived Impact of Ingredient Branding on Host Brand Equity. *Journal of Marketing & Management*, 3, pp. 60-77.
23. Veloutsou C., Moutinho L. (2009) Brand relationships through brand reputation and brand tribalism. *Journal of Business Research*, 62 (3), pp. 314-322.
24. Woodside A.G., Ozcan T. (2009) Customer choices of manufacturer versus retailer brands in alternative price and usage contexts. *Journal of Retailing and Consumer Services*, 16 (2), pp. 100-108.
25. Zippel C., Wilkinson J., Vogler T. (2013) The influence of private labels on retailer cooperation. *Australasian Marketing Journal (AMJ)*, 21 (4), pp. 271-277.

POTENTIAL AREAS OF LOW PRODUCTIVITY AGRICULTURE LANDS FOR SRC ENERGY WOOD PRODUCTION IN VIDZEME REGION

Kristaps Makovskis, **Dagnija Lazdina**
Latvian State Forest Research Institute 'Silava'
kristaps.makovskis@silava.lv

Abstract
Aim of the paper is to identify low productivity lands distribution in Vidzeme region, identify enterprises that could use wood chips from willow plantations established on these lands as the main resource in electricity and heat production and calculate produced wood ash amount from these enterprises that could be used as fertilizer and could be recycled in SRC plantations.
For better soil fertility evaluation and economic turn predictions all agricultural lands are evaluated in quality units, where one quality unit in money is equal to 5.38 EUR or 70 kg of rye. According to studies, traditional farming in lands, which are below 38 quality units could be unproductive. In Vidzeme region are 501,880 ha of agriculture lands from which 206,574 ha (52%) are lands with quality assessment under 38 units. According to local farmers opinion, the real quality unit, below which economically profitable farming is impossible are 25 quality units. There are 87,900 ha of agricultural lands under 25 quality units, which represent 18% from all agricultural lands in region. These lands could be used by growing SRC plantations in 2013, the region has 48 enterprises that used wood chips, with total amount of 170,500 oven-dried tones per year. Wood chips from SRC plantation could be used in these enterprises. To fulfil the wood chip demand in the region, about 17,000 – 34,000 ha of agricultural land should be planted with SRC plantations. To increase the yields from these lands, fertilization is recommended. In this region are more than 300 enterprises, which use wood as the main resource for electricity or heat production leading to 14,000 oven-dried tons of wood ash production every year.
Key words: SRC, Vidzeme, SRC plantations, soil quality –fertility, biomass.

Introduction

From all renewable resources in Europe, almost 70% are biomass that makes it the largest renewable resource (EAA...2007). Short rotation coppice (SRC) is a part of biomass resources, and according to European renewable energy targets, its share in total energy consumption in future will grow (Styles et al., 2007). To meet the EU targets to increase the amount of renewable energy, SRC is considered to be a very promising system not only to meet the energy targets, but also social and economical EU targets (Dimitriou et al., 2014) Low productivity agriculture land use in SRC plantation establishment leads to new employment opportunities in the regions and carbon neutral energy source production (Volk et al., 2004; Campbell et al., 2011). Comparing to biofuel of food production SRC has lower carbon footprint (Heller et al., 2004).

Some studies show that SRC establishment on bare soils and in lands with high groundwater level could be more profitable than agriculture crops on the same lands, because of high and stable yields, despite poor soil quality (Stolarski et al., 2011). Lack of technical knowledge, high establishment costs and missing financial capital are main reasons (Marron et al., 2012) why many farmers are not involved in SRC plantation establishment on poor quality soils. SRC establishment needs high investments, which would pay back after some years. Cash flow is divided between harvest cycles, compared to traditional agriculture, where incomes are possible every season.

Vidzeme planning region covers 24 % of the territory in Latvia and is the biggest planning region with 15,257 km^2. Region has 25 local municipalities and one national "development center" city - Valmiera. According to the information from Rural Support Service (RSS), in 2013 more than 450 ha of short rotation coppice (SRC) plantations were applied for subsidies from EU funds, more than 230 ha were from Vidzeme region. Although the lands that could be available for SRC establishments are more than 90,000 ha, most of them are abandoned and not used in agriculture or any other activities. Long-range management plan could bring these lands in production and make them profitable. In the region, there are more than 300 enterprises that use wood as the main burning material for heat and electricity production, or use it in manufacturing; more than 40 enterprises from them use wood chips as the main burning material. If the SRC end product would be wood chips, it is possible to fulfil demand for it in the region. SRC is an option how to produce additional woody biomass efficiently in short time and sustainable way (Liesebach et al., 1999; Bentsen & Felby, 2012). SRC establishment would lead to more efficient land use in the region.

Materials and Methods

For better soil fertility evaluation and economic turn predictions, all agricultural lands are evaluated in quality units, where one quality unit in money is equal to 5.38 EUR or 70 kg of rye. Soil quality units for every single land area are estimated by State Land

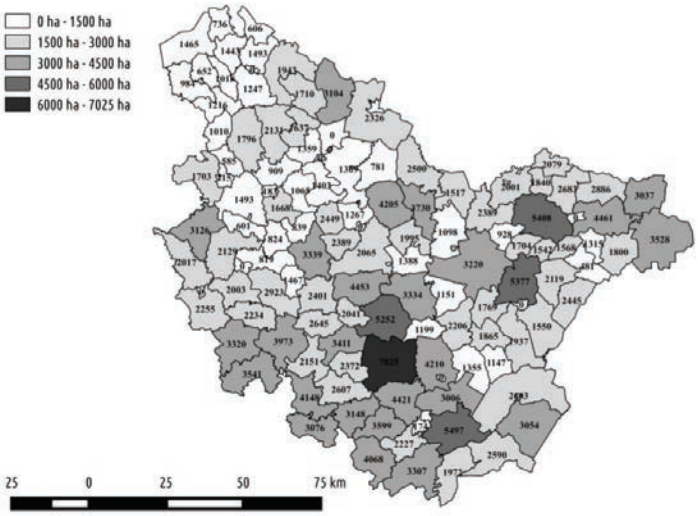

Figure 1. Agriculture lands in Vidzeme region with quality assessment under 38 units.

Service (SLS) specialists according to cartographic materials - agricultural land quality assessment base maps and soil maps. Assessment is made using maps without compulsory attendance in nature.

Soil quality units depend on many aspects related to a particular land area. Indicators that are taken into account for land quality unit determination are land amelioration conditions, soil type (clay, loam, sand), composition, microrelief and stoniness of the area, field contours and naturally existing obstacles that interfere land mechanical processing. From the year 2012 all agricultural lands according to quality units are divided in seven quality groups. Each group has a certain quality land base value in EUR per ha, which are used to calculate the land value and compare different agricultural land areas in different regions.

The base factors that affect land use for a certain economic activities are climatic conditions, land quality, location and infrastructure. Average weighted soil quality in Latvia is equal to 38 quality units (maximum rate is 100 quality units), which according to studies, taking into account the climatic conditions in Latvia is the minimum fertility level for agricultural land in order to ensure commercially viable farming. Farming in lands under this certain quality unit level may be unproductive and unprofitable (Zemes politikas..., 2008) (Land policy...., 2008). According to forestry experts evaluation, afforestation could be provided on agriculture uneconomic areas and unused agricultural lands if the land quality is under 25 units (Ex-ante novērtējums..., 2013) (E-ante assessment..., 2013. These two thresholds are taken into account to calculate availiable unused agricultural lands that could be used for Short Rotation Coppice (SRC) plantation establishment in Vidzeme region. Data for calculations are taken from Latvian Land Service (LLS) database about the year 2013.

All enterprises that have specific permission related to fuel using in manufacturing or energy production should give annual report to Latvian Environment, Geology and Meteorology Centre (LEGMC) about fuel amount and other requestet information. Data about enterprises that use wood chips for heating or electricity production are taken from LEGMC datbase.

Results and Discussion

In Latvia total agriculture land area in 2013 was 2,353,936 ha, from which 363,778 ha were lands below 25 quality units (15%) and 1,049.729 ha were lands below 38 quality units (45%).

In Vidzeme region, there are 501,880 ha of agriculture lands from which 206,580 ha (52%) are lands with quality assessment under 38 units. Large land areas with agriculture land quality assessment under 38 units are in Liezeres parish (7,025 ha), Alsviku parish (5,408 ha), Belavas parish (5,377 ha) and Jaunpiebalgas parish (5,497 ha). (Fig.1).

Not all these lands are abandoned and not used in agriculture. Some of them, especially slightly below 38 quality units are used in traditional agriculture, like arable lands and pastures. If the lands are close to existing agriculture fields, in most of the cases they are used in traditional farming in spite of low productivity. In many cases, because of good agricultural land lack in some regions, some poor soil lands are also used in agriculture. Many farmers tend to increase continuous agriculture lands adding to the existing fields nearest bare soil lands.

Some land owners presumption is that not all lands under 38 quality units are unproductive. Some owners consider that lands a bit under 38 units, under good management plan and latest management techniques, still could be enough productive to be profitable. According to their observations, the threshold under

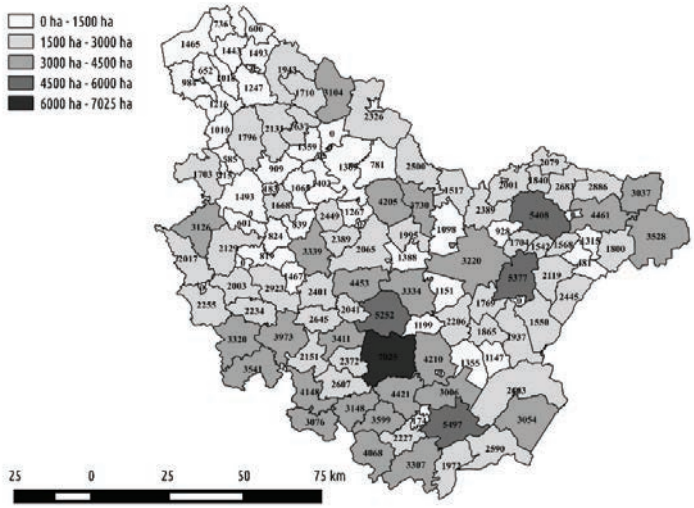

Figure 2. Agriculture lands in Vidzeme region with quality assessment under 25 units.

which the land could be called unproductive in traditional farming is below 25 quality units. Also, according to forestry experts' recommendations, land afforestation could be provided if the land quality is under 25 quality units. In response to these allegations, lands under these particular quality units in Vidzeme region were calculated.

In Vidzeme region, there are 501,880 ha of agriculture lands from which 87,900 ha (18%) are lands with quality assessment under 25 units. Large land areas with agriculture land quality assessment under 25 units are in Liezeres parish (3,190 ha), Alsviku parish (2,735 ha), Jaunpiebalgas parish (2,638 ha) and Skujenes parish (2,533 ha) (fig.2.).

Lands under 25 quality units are more available for SRC plantations, because there is higher possibility that they are not currently used as agriculture lands.

To obtain incomes from lands that are not used in agriculture and are abandoned, SRC willow plantations for wood chips production could be established on these lands. Average SRC plantation yields in Latvia are close to 5 – 10 odt^{-1} of wood chips per year from 1 ha (Kunze et al., 2006; Lazdina et al., 2010; Mola-Yudego, 2010; Lindegaard et al., 2011).

In Vidzeme region, there are 48 enterprises that use wood chips as the main burning material for heat and electricity production. Wood chip consumption in enterprises differs from15 odt^{-1} in the smaller boiler houses till 32,745 odt^{-1} in the biggest enterprises per year. Small scale enterprises are local boiling houses that supply heat to local municipalities, middle class enterprises are boiler houses that are located in the biggest cities and provide heat to city municipalities. The biggest companies are cogeneration plants (CHP)

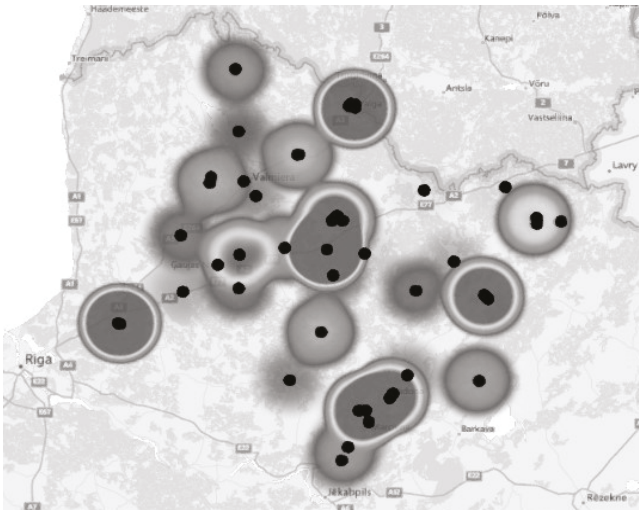

Figure 3. Heat map with enterprises that use wood chips as burning material for heat and electricity production in Vidzeme region.

and pellet factories. Total wood chips consumption in Vidzeme region is about 170,000 odt^{-1} per year.

Although enterprise distribution in the region is quite even, there are some spots on the map, where enterprises with the biggest wood chip demand are located. Biggest enterprises are located in Valka (CHP plant), Incukalns (pellet factories, woodworking enterprises, CHP plants), Smiltene (pellet factories, woodworking enterprises, CHP plants), Madona (big scale boiler houses for city and municipalities) and Gulbene (pellet factory, woodworking enterprises, big scale boiler house for city) (Fig.3).

To meet the wood chip demand in the region, about 17,000 - 34,000 ha of low productivity agricultural land should be planted with SRC plantations if the average yields are 5-10 odt^{-1} per hectare. To fulfil the regional demand for wood chips, 8 - 12 % of all agriculture lands under 38 quality units and 19 - 39 % of agriculture lands under 25 quality units should be planted with SRC willow plantations.

To increase the yields from low quality lands, fertilization is recommended. According to previous studies, wood ash is one of accessible fertilizer for low quality lands (Lazdina et al., 2011). Fertilization with wood ashes simultaneously solves soil fertility problems and ash waste problem. Boiler houses could offer ashes as fertilizer for farmers and share the utilization expenses with them instead of paying the storage and deposition costs themselves. Total amount of produced ashes in Vidzeme region only from wood chips in 2013 was 6,800 odt^{-1}. With this amount of ashes it is possible to fertilize 680 - 1,360 ha of low productivity agriculture lands if the fertilizer dose is 5 - 10 odt^{-1} ha. (Kārklu plantācijas...2005) (Willow planations…2005). If all ashes from wood-chips used enterprises would be used as fertilizer, it would be possible to fertilize less than 1% of all lands under 38 quality units about 1% of all lands under 25 quality units.

Total amount of ashes, produced in the whole Vidzeme region from all kinds of wood products (wood chips firewood, pellets, wood residues, etc.) used in manufacturing, heating and electricity productions in 2013 were 14,000 odt^{-1}. With this amount of ashes it is possible to fertilize 1,400 - 2,700 ha of low productivity agriculture lands, which is slightly above 1% of all lands under 38 quality units and about 3% of all lands under 25 quality units.

SRC plantation establishment on non-used agriculture and bare soil lands gives a possibility to manage these lands in a profitable way, meet the wood chip demand in region and help local entrepreneurs get rid of wood ashes, which could be used in a sustainable way as fertilizer in acid or poor soil lands.

Conclusions

In Vidzeme planning region, there are more than 87,000 ha of agriculture lands with quality assessment under 25 units and 206,580 ha of agriculture lands with quality assessment under 38 units. In the region 48 enterprises use wood chips as the main burning resource for heat and electricity production with total consumption of 170,000 odt^{-1} per year. To fulfil the wood chips demand in the region, depending on the average yields (5-10 odt^{-1} per hectare), 34,000 - 17,000 hectares of SRC plantations needed to be plant.

Yearly produced wood ash amount from all enterprises in Vidzeme planning region is about 14,000 odt^{-1} (including 6,800 odt^{-1} from wood-chips) that are obtained from manufacturing processes, heat and electricity production. With that amount of ashes it is possible to fertilize about 2,700 - 1,400 ha (fertilizer dose 5-10 odt^{-1} ha) of bare agriculture land.

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References

1. Bentsen N.S., Felby C. (2012) Biomass for energy in the European Union- a review of bioenergy resource assessments. *Biotechnol Biofuels 5(1).* 25. p.
2. Campbell J.E., Lobell D.B., Genova R.C., Field C.B. (2008) The global potential of bioenergy on abandoned agriculture lands. *Environmental Science and Technology.* 42: pp. 5791-5794.
3. Dimitriou I., Fistrek Z. (2014) Optimising the environmental sustainability of short rotation coppice biomass production production for Energy. *South-east EUR for 5* (2): pp. 81-91.
4. EEA. Estimating the environmentally compatible bioenergy potential from agriculture. European Environment Agency. (2007) Copenhagen, Denmark, Technical report No 12/2007, 134 p. 2007. Available at: http://www.eea.europa.eu/publications/technical_report_2007_12, 29 January 2015.
5. Ex-ante novērtējums Lauku attīstības programmai 2014-2020. Gala atskaite. (2013) (Ex-ante Assessment of the Countryside Development Programme 2014-2020. Final report). Available at: https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/39/80/Ex_ante_gala_2014.pdf, 29 January 2015.

6. Heller M.C., Keoleinian G.A., Mann M.M.., Volk T.A. (2004) Life cycle energy and environmental benefits of generating electricity from willow biomass. *Renewable Energy 29 (7). pp. 1023-1042.*
7. Kārklu plantācijas ierīkošanas un apsaimniekošanas rokasgrāmata (2005). (Handbook of Planting and Management of Willow Plantation. 2005). Available at: http://www.silava.lv/userfiles/file/Energetiska%20 koksne%20_Dagnija/Rokasgramata%20-%20karklu%20plantacija.pdf, 29 January 2015.
8. Kunze M., Nielsen H.K., Ahlhaus M. (2006) Yield of woody biomass from southern Norway and their suitability for combustion on the harvest frequency. *Use of Bioenergy in the Baltic sea Region - Proceedings of the 2nd IBBC 2006,* Straslund, Germany, pp. 176-185.
9. Lazdina D., Zalitis T., Dzedons J., Bardulis A., Libiete-Zalite Z., Bardule A., Makovskis K. (2010) Productivity and Biomass Parameters of Annual and Biennial Plantings of Willows in Latvia's Western Coastal Area. *Proceedings of the 8th WSEAS International conference on Energy, Environment, Ecosystems and Sustainable development (EEESD'12),* Algarve, Portugal. pp. 125-129.
10. Lazdina D., Bardule A., Lazdins A., Stola J. (2011) Use of waste water sludge and wood ash as fertiliser for Salix cultivation in acid peat soils. *Agronomy Research 9*, pp. 305-314.
11. Liesebach M., Wuehlisch G., Muhs H.J. (1999) Aspen for short- rotation coppice plantations on agricultural sites in Germany: effects of spacing and rotation time on growth and biomass production of aspen progenies. *Forest Ecology Management 121(1-2).* pp. 25-39.
12. Lindegard K.N., Carter M.M., McCracken A., Shield I.F., Macalpine W., Hinton Jones M., Valentine J., Larsson S. (2011) Comparative trials of elite Swedish and UK biomass willow varieties 2001-2010. *Aspects of applied biology 112*, pp. 57- 66.
13. Marron N., Beimgraben T., Bes de Berg L., Broddeck F., Eltrop L., Focke J., Haid S., Haerdtlein M., Nahm M., Pelz S., Sauter U.H., an den Kerchove L., Weinreich A. (2012) Cost reduction and efficiency improvement of short rotation coppice.In: *CREF Final Report.*
14. Mola-Yudego B. (2010) Regional potential yields of short rotation willow plantations on agriculture land in Northern Europe. *Silvia Fennica 44(1)*, pp. 63-76.
15. Stolarski M.J., Szczukowski S., Tworkowski J., Klasa A. (2011) Willow biomass production under conditions of low-input agriculture on marginal soil. *Forest Ecology and Magagement 262 (8)*. 00. pp. 1558-1566.
16. Styles D., Jones M. (2007) Energy crops in Ireland: Quantifying the potential life-cycle greenhouse gas reductions of energy-crop electricity. *Biomass Bioenergy. pp.* 759-772.
17. Volk T.A., Verwijst T., Tharakan P.J., Abrahamson L.P., White E.H. (2004) Growing fuel: Sustainability assessment of willow biomass crops. *Frontiers in Ecology and the Environment*. pp. 411-418.
18. Zemes politikas pamatnostādnes 2008.-2014. gadam (informatīvā daļa). (2008) Available at: https://www.zm.gov.lv/public/files/CMS_Static_P age_Doc/00/00 /00/22/86/zemes_politikas_pamatnostadnes.pdf, 29 January 2015.

EVALUATION OF THE REGIONAL TOURISM ATTRACTIVENESS

Rimantas Dapkus[1], Kristina Dapkute[2]
[1]Aleksandras Stulginskis University, Lithuania
[2]Vilnius University, Lithuania
Rimantas.Dapkus@gmail.com; Kristina.Dapkute@gmail.com

Abstract
The paper covers theoretical analysis of the tourism development in rural regions as well as the public administration role in tourism sector management in order to evaluate, plan and maintain tourism resources in the region. In the paper, there is presented a discussion on some proposed methodologies for the tourism structure and resources evaluation, in order to compare attraction potential of territories for the tourism development (competitiveness between regions). The tourism planning and management process should be proceeded at various levels of public administration institutions in order to avoid negative influence from different branches of the economy, preserve nature, historical and cultural heritage, ingeniously and cost-effectively use EU Structural funds and national budget resources for the tourism infrastructure development in order to prevent unwanted competition between local and regional public administrations, stimulating them to act jointly in order to achieve synergy attracting tourists to visit neighbouring regions. How to achieve mentioned goals the questioning of the tourism development experts has been performed, and some results of it are presented in the paper. Conclusions on the performed research and proposed methodologies as well as some suggestions for the better tourism development management at the regional level have been presented.
Key words: Rural regions, regional development, tourism infrastructure and products, regional tourism attractiveness and competitiveness, public management.

Introduction

Tourism is relatively new, rapidly growing economy sector, extremely important for many less developed counties, including new member States of European Union. Therefore, governments of these countries in their programs and the State long-term development strategies indicate tourism sector development as one of the most important priority, as this can be very beneficial for the country and its regions - promote employment, investment growth, infrastructure development and so on. Tourism as a stand-alone system incorporates many sectors of the economy. This shows the complexity of the tourism system. In order to attract tourists to a region, a systematic approach to tourism as a phenomenon and in tourism management, as the process is required. A regional specific of sustainable tourism development is based on the available tourist resources and conditions (environment and management). Tourism potential depends on the specific features of local, regional and state tourism development opportunities. Therefore, it is very essential to have good quantitative and qualitative assessment of the characteristics of a tourist area, in order to compare them with other competing regions' and implement innovative projects with a goal to increase attractiveness and reduce negative influence from seasoning. The long-term growth of tourism must be regulated and controlled in relation to the processes of globalization and competition in different market segments, and it is based on a partnership between the public and private sectors. The main problems associated with the development of tourism, particularly in the socio-economic indicators are lagging behind in rural regions, in many cases caused by public institutions and private sector interests' incompatibility. The public sector, including municipalities, is responsible for the tourism planning process, assuring sustainability of regional development. Therefore, more attention has to be paid for the investigation of the potential of the tourism resources in the region, evaluate influence from other economy branches and encounter local societies and tourists' interests. Big attention should be focused for the preservation of nature and local cultural-historical heritage. These goals are very costly and require smart management in order to make region competitive for the tourists today, and sustain it not less attractive for the next generations. Nevertheless, at the same time tourism sector should generate sufficient profit for the private sector, which is responsible for the services and products for tourists. Presently many authors (Cooper et al., 1998; Bieger, 2002; Armaitiene, 2009; Vaitekunas and Povilauskas, 2011) already have described tourism sector development by examining local tourism products and defining territorial characteristics. Lithuanian and foreign authors (Mill and Morrison, 1985; Melnikas, 2002; Martin, 2003; Brykova, 2006; Navickas and Malakauskaite, 2007, 2009, 2010; Beniusiene and Svirskiene, 2008) have analysed the tourists' attraction determinants. Rational tourism planning and management system improvement at the local, regional and national levels has also been investigated by different researchers (Dapkus and Gaizauskiene, 2009; Bagdzeviciene et al., 2002), who have stressed the importance of strategic planning for the tourism sector competitive growth. Dapkus (2009) has described regional development policy, its implementation models and institutions'

role, Wafaa and Myrian (2012) have investigated sustainability of the tourism development.

However, there is a lack of methodological instruments to evaluate tourism products and their management at local and regional level, in order to prepare reasonable tourism development programs and implement necessary projects, seeking sustainability and synergy in tourism sector development, especially in rural regions. Without such instruments tourism sector development has a chaotic character and brings unwanted competition between the regions, instead of their cooperation for the tourists' attraction with jointly implemented projects (with much less financial expenditures). In particular, there is a lack of comprehensive, scientifically based research that would help to address sufficient support and reduce the unevenness in the development of the tourism sector in the rural regions. In this context, the importance of good public governance is crucial. New tasks for various institutions, including municipalities, should be addressed in order to upgrade strategic planning and attract private investment and the EU Structural Funds support. But after the periods of 2004-2006 and 2007-2013 when there was the EU Structural Funds substantial support for the tourism sector development, there arises a question why some areas, having and/or newly obtained a sufficient critical mass of resources suitable for the development of tourism, are still unable to attract more tourists' flows. This raises the scientific and practical interest to determine what factors influence the flow of tourists and significance of the tourist areas to have a competitive advantage.

The object of the research is development of the tourism sector. The research overall goal is to propose methodological instruments for the tourism products evaluation, carry out research at the rural regions' and provide suggestions for the public administration institutions in order to support strategic planning and ensure sustainable development of tourism sector. Tasks are as follows: 1. Analyse the peculiarities of the tourism sector through regional tourism competitiveness (attractiveness) prism. 2. Perform tourism policy formulation and implementation analysis. 3. Perform rural regions' tourist resources and tourism industry analysis. 4. Investigate the opinion of the tourism sector specialists'. 5. Provide recommendations for strengthening the attractiveness of the region for the local and international tourists.

Materials and Methods

Monographic method has been used for this research. Available scientific literature (journals, monographs, etc.) have been studied with the aim to define best practices for the tourism sector evaluation and good governance implementation at local and regional levels in order to increase the tourism sector competitiveness. The tourism sector's internet sites conceptions are analysed; the tourism structure, the characteristics of tourist infrastructure and products, the factors which determine the attraction (competitiveness) of tourist areas and its public management are investigated from secondary information resources, legal documents and statistical data; the principles of Lithuania's tourism policy formation and management are examined from strategic planning, regulating documents and financial support programs. The expert survey was performed in order to determine main problems and long-term goals of the tourism sector development in the rural regions. Based on the results of this research recommendations were proposed, addressing them to public management institutions.

Results and Discussion

Scientists do not have consensus, what the smallest object or a territorial unit, which has the ability to become a tourist location is. Cooper et al. (1998) considers that the territorial object, as for example, National Park, may be a tourist location. In the meantime, Beunders (2008) indicates that the National Park is a landmark, or a place for visiting, but not in a tourist area. Cooper et al. (1998) provide the tourist area or territory examples: the shore areas, cities, business and meeting areas & villages, heritage and historical & cultural sites, locally created territories with theme parks, resorts, SPA centres, sports and gambling facilities. It is obvious that the identification of the territory depends on the international, national, regional or local scale. Therefore, depending on the destination and travel purposes, there can be different amounts of tourist object & products in order to treat the territory as a tourist location. Bieger (2002) considers that tourist destination depends on the distance of travel – the greater the distance, the higher requirements for the touristic attractiveness objects should be in the package. Hence, the analysis of different levels (national, regional or local level) locations, can be referred to the combination of tourism products and infrastructure at different location levels, which can be treated controversially – increasing attractiveness (creating synergy between the tourism attractive products in neighbouring territories), or creating unwanted competition between these neighbouring territories.

Performed analysis of different authors' publications about tourist destination territories, it is possible to present several most common definitions (table 1). Results of this analysis enables us to agree on the common territory for the further investigation of tourism products and infrastructure as well as focus on the public management institutions with their territorial (spatial) and strategic planning and program

Table 1

Definitions of a tourist destination territory

Author, year	The definition of tourist destination territories (site, area, region)
Cooper et al., 1998, p. 102-103	Tourist area is a site with the infrastructure and services, designed to meet the needs of tourists.
Buhalis, 2000, p. 97-116	Tourist site, which can be characterized by six A: attractions, accessibility, amenities, available packages, activities, ancillary services.
NEST, 2010	Tourist site is a product that identifies itself with the tourist, where they organize their holidays. Destinations of the target depend on the definition of the tourism market.
Bieger, 2002, p. 56	Tourist site - geographical area (location, region, country, continent), where visitor(s) (or visitor segment) choose to travel. It combines all the necessary services - accommodation, meals, entertainment and activities. This competitive element of inbound tourism, which has to act as a strategic business unit.
Carter and Fabricius, 2007	Tourist site is the physical place where tourists spend at least one night. There are tourist attractions, products and services that are necessary to provide for the tourists, who are staying in the area for at least one day. Tourist area has the physical and administrative boundaries, given by the public management institutions', as well as its image and perception. There are many related items, which can create a network or a network itself built-up by several tourist areas in order to attract more tourists.
Vaitekunas and Povilauskas, 2011, p. 21	Any area to which a tourist arrives can be considered as a tourist site, if this place for him/her is important only for a tourism purposes and is located out of natural and usual environment. The natural and usual environment - the geographic territory in which the person lives, works and travels for daily affairs.

implementation. In addition to the tourist destination territories definitions, there could be noticed that all tourist areas are created by natural nature, historical-cultural and artificially designed tourist attraction products and services concentration in a particular territory, acknowledged by tourists themselves or defined by governmental authorities independently or with the agreement from local society and tourism business companies.

Tourist areas are not static, they are changing, because tourists and service providers in the market may appear and disappear. In addition, tourism in all cases is affecting these areas in a positive and a negative way. Tourism planning and management are necessary in order to maintain the integrity of tourist destination areas' unique properties, to preserve them and maintain necessary infrastructure and tourism products.

Tourism development planning documents, applications, preparation of feasibility studies and the implementation of the methodological recommendations for the monitoring of them states that, in order to identify tourism development opportunities for the particular territory, it is necessary to investigate the potential of such a territory by evaluation of the infrastructure and tourism products & services:

- Tourism objects and the environment (which can be as a tourists interest objects and/or recreational resources);
- Transportation means and accommodation objects;
- Objects of the services (information, catering, trade (gift), artisan workshops, art, hiring, banks and currency exchange points, health care and public service institutions, vehicle service objects);
- Land, air and water vehicles renting points and stations;
- The institutional arrangement (tourism legislation and norms, public and private tourism structures, systems and incentives to attract investment in tourist facilities, training programs and the structure of education and training, public education and the promotion of tourism and eco-training programmes, marketing (promotion) activities and measures);
- General infrastructure (road network, power supply, communal infrastructure, etc.).

A similar structure can be used to perform evaluation of the attractiveness of the tourism potential of the territories or assessments. In addition to the previously mentioned characteristics for the tourism area, attractiveness evaluation can be some of those indicators:

- Tourism resources (natural, historical-cultural, social/human, artificial) and infrastructure (tourist industry components);
- Accommodation, catering, transport, entertainment, information, management, tour quantity and quality, educating programs;
- The route and flow of tourists;
- Status (for example, a UNESCO World Heritage site, National resort place and etc.);
- Tourism stakeholders, tourism specialists and managing staff in the area;
- Accessibility and situation of tourism network in the area;

- The tourism business attractiveness for the investors and perspective for the tourism development in the area;
- The national tourism development policy and geo-political situation of the region.

Thus, tourism development potential can be characterized by complex of tourism products' and services' parameters and tourist area potential, characterized by tourism management, resources, status and image parameters.

Tourism is gaining greater and greater importance to regional development promotion. Special attention has recently been devoted to this branch of economy as in the majority of cases tourism is beneficial to states' since it promotes employment, investment growth and infrastructure development. For the regions (especially rural) and individual districts tourism development is one of the key economic areas that may help them deal with the issues of ensuring more rapid development of their economies and social welfare and, due to their specificity, make a significant impact on the development of a number of other economic activity sectors and significantly contribute to the creation of the gross domestic product due to the effect of synergy. This is especially relevant seeking to reduce dependence on the primary agricultural activities, industries using natural resources and imported raw materials.

The vision of the World Tourism Organization (UNWTO) on the tourism sector covers the following key areas:

- Induce governments to accept tourism and travel as a strategic priority for economic development and employment;
- Referral to open competitive markets by supporting the implementation of the GATS (general agreement on trade in services);
- Remove barriers to tourism growth, which implies the expansion and improvement of tourism related infrastructure - such as increased airport capacity, construction and modernization of airports, roads and tourist facilities (Nasser and Donsimoni, 2012).

Tourist competitiveness of Lithuania and its individual regions depends on the local tourist potential and efficient management. With a view to attracting tourists to a certain region, a systematic approach to tourism and its management is needed. One of the main stages of efficient management is a tourism planning process at the local level, which must be based not only on the analysis of the tourism sector, evaluation of the tourist potential but also on the established competitive position with regard to other tourist regions on the grounds of sustainable development concepts. A long-term tourism growth must be regulated and governed taking into account globalisation processes and competition in various segments of the market and be based on the principle of partnership between the public and private sectors (Mowforth and Munt, 2003).

World Tourism Organization, which is subsidiary division of the United Nations (UN), is responsible for the UNEP (United Nations Environmental program), and it has produced a set of policy guidelines, including the Principles for Implementation of Sustainable Tourism, widely distributed to governments and local authorities and used as an input to some of the multi-lateral environmental agreements. The UNEP's principles on the implementation of sustainable tourism include:

- Legislative Framework: Support the implementation of sustainable tourism through an effective legislative framework that establishes standards for land use in tourism development, tourism facilities, management and investment in tourism;
- Environmental Standards: Protect the environment by setting clear ambient environmental quality standards, along with targets for reducing pollution from all sectors, including tourism, and by preventing development in areas where it would be inappropriate;
- Regional Standards: Ensure that tourism and the environment are mutually supportive at a regional level through the cooperation and coordination between States, to establish common approaches to incentives, environmental policies, and integrated tourism development planning (Nasser and Donsimoni, 2012).

The concept of sustainable tourism can be underpinned by a range of underlying principles, including the following:

- Sustainable tourism is not just about protecting the environment; it is also concerned with long-term economic viability and social justice.
- Initiatives designed to achieve sustainable tourism brings benefits to some people and costs to others. It is thus a highly political, rather than just a technocratic field.
- Sustainable tourism cannot be separated from the wider debate about sustainable development in general.

In order to maximize the exploitation of tourist resources available in the region and at the same time ensuring sustainable tourism development principles, strategic planning and public administration must be properly carried out. At local level tourism development issues are defined in regional and district strategic development plans. Some regions have developed separate locality attractiveness and image enhancement, local trademark formation and tourism development strategies, operational programmes,

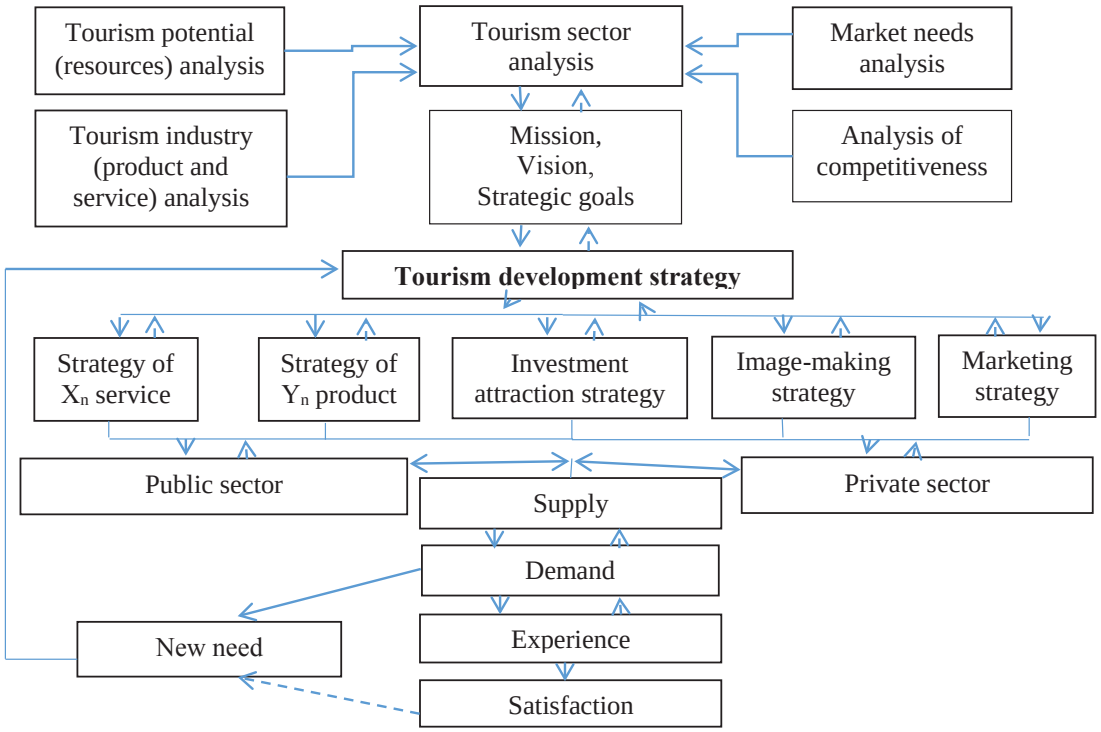

Figure 1. Recommended tourism strategic management model.

feasibility studies and other programming documents. Development of territorial planning documents, i.e. general and special plans, were worked out together with strategic planning, which focuses on the prospects of tourism development. However, in the majority of cases these are fragmentally works, covering single regions, which hardly match among themselves and are insufficiently synchronised with the functions and implemented by local authorities' projects. "Misunderstanding" among public administration institutions, farmers and private businesses, local populations and their communities is observed. Another problem is non-compliance of more serious research-based documents regulating tourism development in districts with the spirit of the programmes of neighbouring districts, the entire region, and the country. There are frequent cases when tourism is developed in districts without having a clear and long-term tourism development strategy and a consistent programme for its implementation based on the appropriate financial and human resources as well as the local tourism infrastructure and products. Tourism sector development planning is very sensitive to a private initiative and personal relationships; however, this does not always correlate with the public interest when short-term narrow political goals and/or personal business interests begin to compete with long term interests of regional society and tourists' needs. Consequently, the works that contribute to the rational tourism planning and management system improvement at the local, regional and national levels (Dapkus and Gaižauskienė, 2009) are especially relevant.

After analyses of legislative documentation and scientific papers, new methodological approach for the tourism sector long term strategic planning could be presented (Figure 1).

In order to discuss functionality of the proposed model and evaluate the tourism potential (products, services, infrastructure and management) of rural areas, a survey by questioning experts working in the tourism sector was carried out. Some of this investigation results are presented in Figures 2 – 4.

From the experts' questioning it is very clear (Figure 2) what priorities according to their opinion should be included in the municipal strategic planning documents. The main focus should be placed on increasing facilities for active tourism, but less interesting is historical and cultural heritage sites' development (mounds' and churches' arrangement).

In many cases there are heated debates between policy makers and tourism sector developers about what forms of tourism to promote in the region. The proposed methodology enables decision makers to investigate quantitatively the tourism products in the region and later on to evaluate qualitatively their relevance and importance for the tourism sector sustainable development in the particular region. Based on these evaluations, a feasibility study of the possible tourism sector competitiveness could be done. In further strategic planning process it is important to take into account the neighbouring

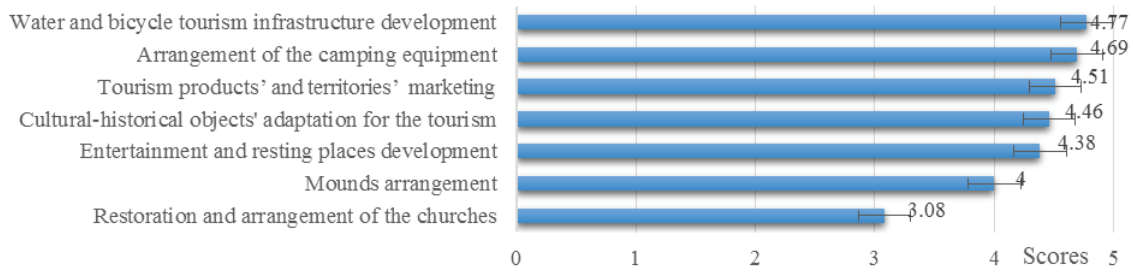

Figure 2. In the tourism sector, necessary work priorities to be carried out for 2014-2020 time period (in scores).

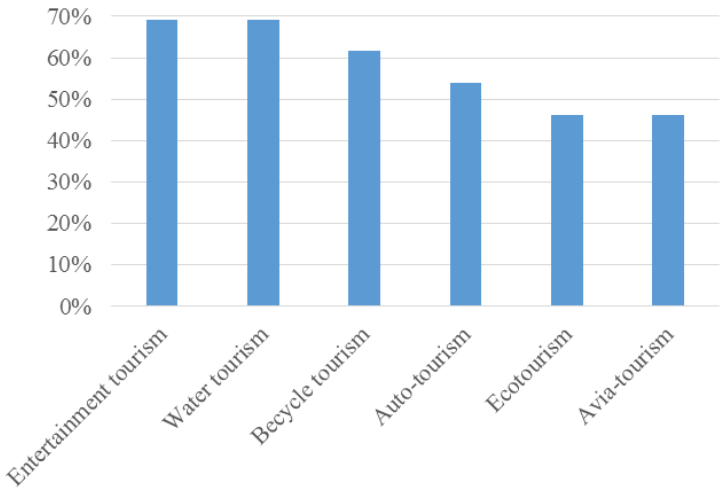

Figure 3. Viable forms of tourism development in rural regions.

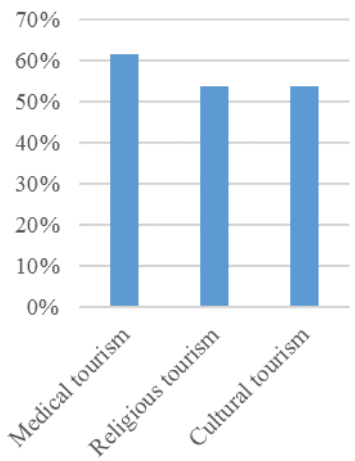

Figure 4. Non viable forms of tourism development in rural regions.

regions tourist attraction and achieve synergy in terms of joint tourism development projects. An example of proposed methodology implementation was used for the investigation of Taurage rural region tourism development perspectives. Some of obtained results are presented in Figure 3 and Figure 4. Perceptiveness of various tourism forms was expressed in percentage scale. In Figure 3, there are presented viable forms of tourism development in Taurage rural region particularly, and accordingly, non viable forms of tourism development in the same region are presented in Figure 4. All respondents have had a possibility to select unlimited amount of viables for their answers.

Continuing the strategic planning process in accordance with the methodology shown in Figure 1, it is appropriate to carry out further investigation even of the individual parts of the same region in order to define most promising tourism development directions. The same methodology could be used but in opposite manner – it is possible to determine the identity of tourism products and services, which should be provided in this territory of the region in order to achieve desired tourism development direction.

This ensures the versatility of the proposed method. Further refinement of this methodology already is planned - to incorporate Information and Telecommunication Technologies with GIS and visualization applications for further tourism sustainable development under the territorial and strategic planning for the better public management and regional competitiveness growth.

Conclusions

1. Tourism is a complex branch of the national economy having a complicated structure. It is important to recognise tourism as a product, a service and a phenomenon, to be well aware of the specificity of each component of the tourism structure as well as their interaction, problems and possibilities.
2. Tourism is a productive sector distinguished by a tendency of growth. Therefore, every public authority or district municipality administration seeking to derive economic benefit from the tourism sector should deliberate on a tourism development policy or strategy, take care of its

natural, cultural and historical heritage and be capable of efficient management thereof.

3. With a view to achieve sustainable tourism development, effort of the public sector aimed at ensuring a clear tourism development policy as well as the involvement of the private sector offering competitive tourism products and services and mutual collaboration are needed.
4. The methodology for the evaluation of the regional tourism attractiveness was proposed and examined. It is enough sufficient instrument, useful in the public management process for the territorial and strategic planning, ensuring sustainable tourism sector development and regional competitiveness.

References

1. Armaitiene A. (2009) *Turizmo terminų žodynas* (Tourism Glossary). 165 p. Available at: http://www.tourism.lt/uploads/documents/Naudinga_informacija/turizmo_terminu_zodynas/Turizmo_zod.pdf, 5 March 2015. (in Lithuanian).
2. Bagdzeviciene R., Rimas J., Venckus A. (2002) *Regionų ekonomikos plėtros strategija* (Regional Economy Development Strategy). pp. 30-36. Available at: www.lrti.lt/veikla/RP_RegEkonPlet.doc, 5 March 2015. (In Lithuanian).
3. Beniusiene I., Svirskiene G. (2008) Konkurencingumas: teorinis aspektas (Competitiveness: Theoretical Aspect). *Ekonomika ir vadyba: aktualijos ir perspektyvos*, 4 (13), pp. 32-40. (in Lithuanian).
4. Beunders N. (2008) The role of destination management in facing the challenges for protected area tourism development. In *Management for Protection and Sustainable Development* (Vol. MMV 4 - Proceedings, pp. 71). Montecatini Terme, Italy: Research Centre for Leisure, Tourism and Landscape, Institute for Landscape and Open Space, University of Applied Sciences Rapperswil.
5. Bieger T. (2002) *Management von Destinationen* (Management of destinations). (5th edn) (München/ Wien/ Oldenburg, S. 56-57. (in German).
6. Brykova I. (2006) The International Competitiveness of National Regions: Conceptual and Practical Dimensions. pp. 31-56. Available at: http://www.kneu.kiev.ua/journal/eng/article/2006_1_Brykova_eng.pdf, 5 March 2015.
7. Buhalis D. (2000) Marketing the competitive destination of the future. *Tourism Management: Special Issue – the Competitive Destination*, 21(1), pp. 97-116. Available at: http://www.academia.edu/164837/Marketing_the_competitive_destination_of_the_future, 5 March 2015.
8. Carter R., Fabricius M. (2007) Destination Management – an Overview. Creating Competitive Advantage for your Destination. UNWTO Conference '*Creating competitive advantage for your destination'*, Budapest, pp. 1-33. Available at: http://www.climateaudit.info/data/mask/TREN/TRen%203p13%20Branding/chart%20for%20thesis.pdf, 5 March 2015.
9. Cooper C., Fletcher J., Gilbert D., Shepherd R., Wanhill S. (1998) *Tourism Principles and Practice* (2 ed.). Harlow: Pearson Education Limited, pp. 102-103.
10. Dapkus R. (2009) *Regioninė politika* (Regional Policy). Mokomoji knyga. [CD-ROM], Kaunas, Technologija, (in Lithuanian).
11. Dapkus R., Gaižauskienė E. (2009) Turizmo plėtros perspektyvos vietos savivaldos lygmeniu (The Perspectives of Tourism Development in Local Municipalities). // *Ekonomika ir vadyba: aktualijos ir perspektyvos*. Mokslo straipsnių rinkinys / Šiaulių universitetas. Šiauliai: Šiaulių universiteto leidykla. pp. 60-72. (in Lithuanian).
12. Lietuvos statistikos departamentas. *Atvykstamojo turizmo rinkos statistika* (Inbound Tourism Market Statistics). Available at: http://www.stat.gov.lt/, 5 March 2015. (in Lithuanian).
13. Martin R.L. (2003) A Study on the Factors of Regional Competitiveness. *A draft final report for the European Commission Directorate-General of the Regional Policy*. 184 p. Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/3cr/competitiveness.pdf, 5 March 2015.
14. Navickas V., Malakauskaitė A. (2007) Lietuvos turistinio įvaizdžio vertinimo algoritmas (The Evaluation of Lithuanian Tourism Image). *Ekonomika ir vadyba: aktualijos ir perspektyvos*, 1 (8), pp. 187-191. (in Lithuanian).
15. Navickas V., Malakauskaitė A. (2009) The Possibilities for the Identification and Evaluation of Tourism Sector Competitiveness Factors. *Engineering Economics*, 1 (61), pp. 37-44.
16. Navickas V., Malakauskaitė A. (2010) Konkurencingumo vertinimo metodologinės problemos ir ribotumas (Methodological Problems and Limitations of Competitiveness Evaluation). *Verslas: teorija ir praktika*, 11 (1), pp. 5-11. (in Lithuanian).

17. NEST (2010) *A Guide to the NEST Destination Management Tool*. 8 p. Available at: https://business.wales.gov.uk/dmwales/sites/dmwales/files/documents/International_Examples_A_Guide_to_the_NEST_Destination_Management_Tool.pdf, 5 March 2015.
18. Melnikas B. (2002) *Transformacijos* (Transformation). Vilnius: Vaga. 750 p. (in Lithuanian).
19. Mill R.C., Morrison A.M. (1985) *The Tourism System*. New Jersey: Prentice Hall. 358 p.
20. Mowforth M. and Munt I. (2003) *Tourism and sustainability: Development and new tourism in the third world*. (2nd ed.) London: Routledge. 345 p.
21. Vaitekunas S., Povilauskas R. (2011) *Turizmo ir kelionių geografija* (Tourism and travel geography). Vilnius: Mokslo ir enciklopedijų leidybos centras, pp. 21; 279. (in Lithuanian).
22. Nasser W., Donsimoni M. (2012) Sustainable Tourism Development: the Role of International Organizations // *European Journal of Tourism, Hospitality and Recreation*, Vol. 3, Special Issue – ITC'11, pp. 167-187, Polytechnic Institute of Leiria, Portugal. ISSN: 2182-4916.

IMPACT OF AGRICULTURAL LANDHOLDING SIZE ON THE LAND FRAGMENTATION

Kristiin Sikk, **Siim Maasikamäe**
EstonianUniversity of LifeSciences
kristiin.sikk@emu.ee

Abstract
Land fragmentation is a problem in Europe, and Estonia is not an exception in this respect. Parcel size is widespread characteristic to describe the level of fragmentation. The aim of the study is to find out if there is difference of fragmentation among different groups of landholdings by size. In order to characterise land fragmentation, were calculated the Januszewski and Schmook indexes, average parcel size and average distance from the gravity centre of each landholding to its parcels. Results showed a high level of fragmentation of Estonian agricultural landholdings. There is a high variety of fragmentation inside and among the investigated groups. The average value of Januszewski index for all groups is 0.626, and the average value of Schmook index for all groups is 0.462. The average parcel size for all groups is 7.02 hectares and average distance from the gravity centre of each landholding to its parcels for all groups is 1.57 kilometres.
Key words: Januszewski index, Schmook index, parcel, arable land.

Introduction

The rational use of agricultural land is influenced by land use limitations. One of the obstacles for agricultural development is land fragmentation (Hristov, 2009; Austin et al., 2012; Vijulie et al., 2012). Land fragmentation is defined as the situation in which a single farm or ownership consists of numerous spatially separated plots (Bentley, 1987). Dominant problem associated with land fragmentation is the small size, irregular shape and dispersion of parcels (Dijk, 2000; Gonzalez et al., 2007; Demetriou et al., 2013).

Increasing population entails fall in the landholding size and fragmentation into small parcels (Bizimana et al., 2004; Aslan et al., 2007). Parcel size is the primary characteristic to describe the land use conditions and to evaluate the land fragmentation. The simplest method is to calculate the average size of the landholding or parcel. Although, this method is considered to be easy and comfortable, the main disadvantage is the fact that it does not describe the distribution of parcels by size (Demetriou et al., 2013). When landholdings are fragmented into several small parcels which are spatially scattered and the distance from the farmhouse is varying, it hampers agricultural development in many ways (Niroula and Thapa, 2005; Kakwagh et al., 2011).

The landholding or parcel size and its influence on land fragmentation and/or agricultural productivity is an overall problem around the world. For example, in Nigeria and China, the impact of land fragmentation and landholding size has been investigated to rice farming. Ben-Chendo et al. (2014) found out that landholding size of the rice farmers is relatively small and it can discourage the practice of rice framing. Therefore, the option would be enhancement of landholding size. Tan et al. (2008) study showed that farmers with more and smaller plots tend to use fewer modern technologies and reduction of the average distance to plots and an increase in farm size decreases the total production costs per ton. Also, researchers found that solution would be consolidation of landholdings into holdings consisting of fewer plots with larger average size. Several authors agree that small landholdings and tiny parcels affect agricultural development negatively and land consolidation would be the option to solve these problems (e.g. Kopeva et al., 2002; Travnicek, 2002; Niroula and Thapa, 2005; Pašakarnis et al., 2012).

In Estonia, the land fragmentation has been briefly investigated, but there are some studies that can be named. For example, Maasikamäe (2005) analysed the aspects of land fragmentation (average parcel size, the shape of the parcels and land use conditions, internal fragmentation) in general. Aasmäe and Maasikamäe (2014) investigated the existence and extent of internal fragmentation of agricultural parcels. As land fragmentation is an ongoing process, investigation of landholding structure in Estonia is vital to get more complex information about the land use patterns. The study was carried out among Estonian agricultural landholdings. The aim of the study is to find out if there is difference of fragmentation among different groups of landholdings by size. Research tasks are: a) to evaluate land fragmentation by calculation of Januszewski and Schmook indexes; b) to compare land fragmentation characteristics in different groups.

Materials and Methods

In the study, data from Estonian Agricultural Registers and Information Board (ARIB) was used. The data for the study were digital map of borders of parcels on what the subsidy was applied for in 2014. Landholdings were divided into four groups based on the area of landholding. In this study, each application area was considered as one landholding. The group

formation criterion was based on the summary report of farmers' economic indicators of 2013 (Aamisepp et al., 2014). Groups are as follows: less than 40 hectares; 40 to 100 hectares; 100 to 400 hectares and more than 400 hectares. In this way large and small landholdings were distinguished. Landholding was considered to be large if the total area of landholding was 400 hectares or more. In further text the groups are named A, B, C and D.

The study consists of three steps: firstly, to evaluate land fragmentation of Estonian landholdings; secondly, to calculate average distance from the gravity centres of each landholding to its parcels; thirdly, to compare land fragmentation characteristics in different groups, based on the area of landholdings. All calculations were made in GIS environment with ArcGIS software.

To form the groups, the total area of each landholding was calculated using the Summary Statistics tool in ArcGIS. The main characteristics of land fragmentation were calculated for each group: average Januszewski index, average Schmook index, average parcel size and average distance from the gravity centre of each landholding to its parcels. In order to evaluate land fragmentation, the Januszewski index (Januszewski 1968), whose formula is shown in equation 1 and reciprocal of Schmook index, whose formula is shown in equation 2 were calculated. In further text the reciprocal of Schmook index is called just Schmook index. The Januszewski index is the ratio of the square root of the total area of landholding to the square root of the sum of the areas of the land parcels. It changes in the interval from zero to one. Low index value indicates higher fragmentation.

$$K_j = \frac{\sqrt{S}}{\Sigma\sqrt{s_i}} \quad (1)$$

where

K_j is the Januszewski index,
S is the total area of the landholding,
s_i is the area of i-th parcel.

The Schmook index is the ratio of the area of one landholding to the area of imaginary polygon which circumscribes all of the parcels of that holding. The index also ranges from zero to one. It equals to one if the landholding consists of a single compact unit of land. When the parcels are highly fragmented index value approximate to zero.

$$k = \frac{\Sigma s_i}{S} \quad (2)$$

where

k is Schmook index,
S is the imaginary polygon drawn around the area of land parcels,
s_i is the area of i-th parcel.

For calculating the area of imaginary polygon (S) which circumscribes all of the parcels of one landholding was used the Minimum Bounding Geometry tool in ArcGIS. To create the polygons, the command Convex Hull was used and then the area for each constructed polygon was calculated. Figure 1 demonstrates the Convex Hull for one farmer's land use.

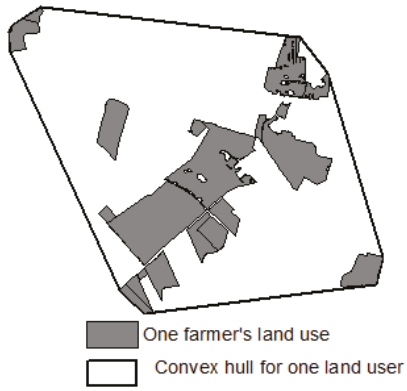

Figure 1. Land parcels of one landholding and surrounding Convex Hull for them.

The next task was to calculate the average distance from the gravity centre of each landholding to its parcels. The Mean Centre tool in ArcGIS was used for calculation of gravity centres for each landholding. Then, the Pythagoras´s formula was used to calculate the distance between the gravity centre and the parcels for each landholding.

The average parcel size was calculated for all investigated groups of landholdings. To find out if there is statistically significant difference between mean areas of parcels of the groups of landholdings, Kruskal-Wallis Test was used. This test allows comparing two or more samples that are independent.

Results and Discussion

The main results of the study are presented in Table 1 and Table 2. Landholdings are divided into four groups depending on the area of landholding. Table 1 shows that the number of investigating landholdings is 17 104. The total area of landholdings is 916 009.3 hectares which consist of 129 598 parcels.

The data in Table 1 show that the ratio of number of landholdings varies notably among groups. The number of landholdings of group A (< 40 hectares) form 81% of the total land use. In group B the ratio of the number of landholdings is 9 times smaller than in group A. The ratio of number of landholdings in group C and D is respectively 11 and 29 times smaller compared to group A.

The ratio of the total area of landholdings varies among groups. Landholdings of the group D (≥ 400 hectares) form 47.2% of the total area of land use.

Table 1

General description of investigated landholdings

Characteristics	Landholding size(ha)				Total or average
	< 40	40 - < 100	100 - < 400	≥ 400	
The number of landholdings	13 859	1485	1277	483	17 104
Ratio of the number of landholdings by groups (percent)	81.0	8.7	7.5	2.8	100.0
Total area of landholdings by groups (ha)	140 447.4	93 272.8	249 960.9	432 328.2	916 009.3
Ratio of total area of landholdings by groups (percent)	15.3	10.2	27.3	47.2	100.0
Average landholding size (ha)	10.1	62.8	195.7	895.1	53.6
The total number of parcels by groups	44 279	16 214	33 403	35 702	129 598
Ratio of total number of parcels by groups (percent)	34.2	12.5	25.8	27.6	100.0
Average number of parcels per landholding	3.2	10.9	26.2	73.9	7.58

Followed by landholdings of the group C (100 - < 400 hectares) which form 27.3% of the total area of land use. Landholdings of the groups A and B (< 40 - < 100 hectares) form 25.5% of the total area of land use. The total area of landholdings of the group A is three times smaller compared to the group D. Comparing the number of landholdings and total area of landholdings in each group one can see that the number of small landholdings (all landholdings less that 400 hectares) are dominating, but the difference between the total area of small and large landholdings is only 5.6%.

The average landholding size by groups varies from 10 to 895 hectares. The difference between the group A and the group B is six times and the difference between the group A and group C is 19 times. The most remarkable difference is between the group A and D, about 88 times. The average landholding size for all groups is 53.6 hectares.

The ratio of the number of parcels does not vary considerably among groups. The biggest difference is between the group A and the group B, about three times. One can see some differences in the average number of parcels per landholding. In the group A landholding on average consists of 3.2 parcels, in the group B and C the respective values are 10.9 and 26.2 parcels per landholding. The landholdings of the group D consist on average of 73.9 parcels. This is about 25 times bigger compared to the group A. The average number of parcels per landholding for all groups is 7.58.

The main characteristics of land fragmentation are presented in Table 2. The average parcel size increases among the groups. For all groups the average parcel size is 7.02 hectares. Average parcel size ranges from 3 to 12 hectares. The difference between the groups A and D is almost four times. The maximum parcel size of the group A is about three times smaller than in the group C and five times smaller than in the group D. Also, there are big differences in the minimum size of the parcel, for example the minimum parcel size in the group A is 22 times smaller than in the group D.

The average distance from the gravity centre to the parcels for all groups is 1.57 kilometres. The average distance from the gravity centre to the parcels varies from 1 to 6 kilometres. The minimum distance varies from 0.01 to 1.04 kilometres and the maximum distance varies from 87.34 to 135.59 kilometres. In the groups A, B and C were 3727 landholdings that consist of only one parcel. This means that it was not possible to calculate the average distance and therefore the corresponding value was zero.

The average value of Januszewski index for all groups is 0.626. The comparison of the minimum and maximum values of the Januszewski index in all groups shows a high variety of land fragmentation. The degree of fragmentation is remarkably smaller in the group A where the landholding size is less than 40 hectares, but holdings on an average consist of three parcels. Landholding size in the other groups (B, C, D) is bigger, but also the number of parcels in landholding is 11 to 74 times bigger compared to the first group. Therefore, the value of Januszewski index decreases as the number of parcels increases.

The average value of Schmook index shows the spatial dispersion of parcels. The average value of Schmook index for all groups is 0.462. For some landholdings the minimum value of Schmook index is very small (approximate to zero), difference between minimum and maximum values is up to 1000 times. The spatial dispersion of parcels is smaller in the group A where the value of the Schmook index is higher. The degree of fragmentation increases when the landholding size is more than 40 hectares. Also, the average distance increases when the landholding size is more than 40 hectares which indicates higher spatial dispersion.

Table 2

Average field size, average distance to the centre of gravity and average values of Januszewski and Schmook's indexes by the size of landholding

Characteristics		Landholding size (ha)				Total or average
		< 40	40 - < 100	100 - < 400	≥ 400	
The number of landholdings		13 859	1485	1277	483	17 104
Parcel size (ha)	Avg	3.17	5.75	7.48	12.11	7.02
	Min	0.14	1.02	1.94	3.12	
	Max	38.06	72.50	102.31	197.60	
Distance of the centre of gravity (km)	Avg	1.03	2.86	4.12	6.33	1.57
	Min	0.01	0.15	0.32	1.04	
	Max	135.59	89.08	87.34	91.21	
Januszewski index	Avg	0.702	0.390	0.250	0.149	0.626
	Min	0.177	0.117	0.101	0.065	
	Max	1.00	1.000	1.000	0.653	
Schmook's index	Avg	0.534	0.212	0.115	0.105	0.462
	Min	0.000	0.000	0.000	0.000	
	Max	1.000	0.956	0.873	0.702	

Kruskal-Wallis Test was used to find out if there is statistically significant difference between mean areas of parcels of the groups of landholdings. The results of the test (Figure 2) showed that the difference between the investigated groups is statistically significant. In the Figure 2, one can see that confidence intervals do not overlap and this means that there is a significant difference between groups. Also, there are big differences between minimum and maximum size of parcels. Parcel size varies from 0.14 to 197.60 hectares. The difference between the minimum parcel size of the groups A and D is about 22 times. The difference between the maximum parcel size of the groups A and D is 5 times.

The results showed that there is a high level of fragmentation of agricultural landholdings. But the current study did not reflect all aspects of fragmentation. Therefore, the further study of spatial characteristics (e.g. parcels shape and internal fragmentation) is needed. For example an important research question in future is spatial location of landholdings in respect of each other.

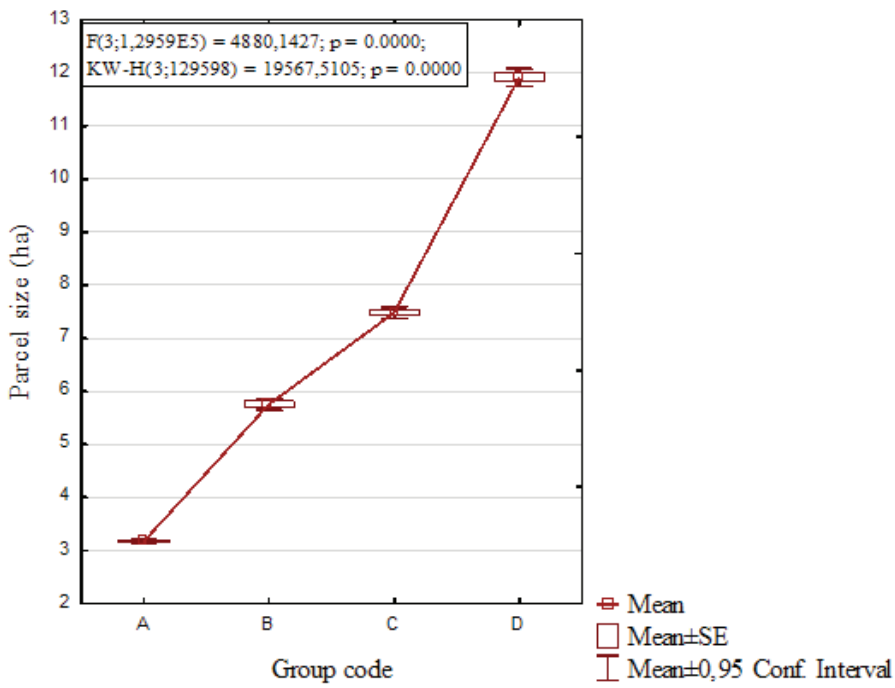

Figure 2. Comparison of mean areas of parcels by investigated groups of landholdings.

Conclusions

1. Results showed that agricultural landholdings of Estonia are fragmented and spatially dispersed. The average value of Januszewski index for investigated landholdings is 0.626. The average value of Schmook index for investigated landholdings is 0.462.
2. Landholdings which size is more than 40 hectares are highly fragmented and spatially dispersed. The average value of Januszewski index is less than 0.400. The average value of Schmook index is less than 0.200.
3. The average parcel size for investigated landholdings is 7.02 hectares. Study showed that there is statistically significant difference between mean areas of parcels by investigated groups of landholdings. Parcel size varies from 0.14 to 197.60 hectares.
4. The average landholding size for investigated landholdings is 53.6 hectares. It varies notably among the groups of landholdings from 10 to 895 hectares.
5. The number of landholdings which are less than 400 hectares form 97.2% of the total land uses, while they manage 52.8% of the total area of investigated landholdings. The number of landholdings that are more than 400 hectares form 2.8% of the total land uses, while they manage 47.2% of the total area of investigated landholdings. This clearly shows that land is concentrated to large producers.

References

1. Aamisepp M., Varendi A., Järvis A., Matvejev E. (2014) Põllumajandustootjate majandusnäitajad 2013 (FADN Farm Return 2013). Available at: http://www.maainfo.ee/data/trykis/aastaraamat/FADN2013.pdf, 11 February 2015.
2. Aasmäe K., Maasikamäe S. (2014) Internal Fragmentation of Agricultural Parcels. *Research for Rural Development 2014, Annual 20th International Scientific Conference Proceedings*., Volume 2, Book 2, Jelgava, pp. 278-282.
3. Aslan Akkaya S.T., Gundogdu K.S., Arici I. (2007) Some Metric Indices for the Assessment of Land Consolidation Projects. *Pakistan Journal of Biological Sciences*, 10(9), pp. 1390-1397.
4. Austin O.C., Ulunuma A.C., Sulaiman J. (2012) Exploring the Link between Land Fragmentation and Agricultural Productivity. *International Journal of Agriculture and Forestry*, 2(1), pp. 30-34.
5. Ben-Chendo G.N., Korie O.C., Essien U.A., Uhuegbulem I.J. (2014) Determinants of Land Holding Size among Rice Farmers in Southeast, Nigeria. *Asian Review of Environmental and Earth Sciences*, 1(3), pp. 56-60.
6. Bentley J.W. (1987) Economic and Ecological Approaches to Land Fragmentation: in Defence of a Much Maligned Phenomenon. *Annual Review of Anthropology*, 16, pp. 31-67.
7. Bizimana C., Nieuwoudt W.L., Ferrer S.R.D. (2004) Farm Size, Land Fragmentation and Economic Efficiency in Southern Rwanda. *Agrekon*, 43(2), pp. 244-262.
8. Demetriou D., Stillwell J., See L. (2013) A New Model for Measuring Land Fragmentation. *Computers, Environment and Urban Systems*, 39, pp. 71-80.
9. Gonzalez X.P., Marey M.F., Alvarez C.J. (2007) Evaluation of Productive Rural Land Patterns with Joint Regard to the Size, Shape and Dispersion of Plots. *Agricultural Systems*, 92(1-3), pp. 52-62.
10. Hristov J. (2009) Assessment of the Impact of High Fragmented Land upon the Productivity and Profitability of the Farms - The Case of the Macedonian Vegetable Growers. Available at: http://stud.epsilon.slu.se/472/1/Hristov_J_010909.pdf, 23 February 2015.
11. Januszewski J. (1968) Index of Land Consolidation as a Criterion of the Degree of Concentration. *Geographia Polonica*, 14, pp. 291-296.
12. Kakwagh V.V., Aderonmu J.A., Ikwuba A. (2010) Land Fragmentation and Agricultural Development in Tivland of Benue State, Nigeria. *Current Research Journal of social Sciences*, 3(2), pp. 54-58.
13. Kopeva D., Noev N., Evitmov V. (2002) Land Fragmentation and Land Consolidation in the Agricultural Sector. Case Study from Bulgaria. Available at: http://www.fao.org/fileadmin/user_upload/Europe/documents/Events_2002/Land2002/bulgaria_paper.pdf, 4 March 2015.
14. Maasikamäe S. (2005) Assesment of land fragmentation. *Vagos*, 67 (20), pp. 75-82.
15. Niroula G.S., Thapa G.B. (2005) Impacts and Causes of Land Fragmentation, and Lessons Learned from Land Consolidation in South Asia. *Land Use Policy*, 22, pp. 358-372.
16. Pašakarnis G., Morley D., Maliene V. (2012) Rural Development and Challenges Establishing Sustainable Land Use in Eastern European Countries. *Land Use Policy*, 30, pp. 703-710.
17. Raghbendra J., Nagarajan H.K., Prasanna S. (2005) Land Fragmentation and its Implications for Productivity: Evidence from Southern India. ASARC Working Paper. Available at: https://digitalcollections.anu.edu.au/bitstream/1885/43002/2/WP2005_01.pdf, 23 February 2015.

18. Simion G. (2008) Geographical Analysis of the Land Fragmentation Process Based on Participatory Mapping and Satellite Images. Case Studies of Ciorogarla and Vanatorii Mici from the Bucharest Metropolitan Area. *Journal of Studies and Research in Human Geography*, 2(1), pp. 83-84.
19. Tan S., Heerink N., Kruseman G., Qu F. (2008) Do Fragmented Landholdings Have Higher Production Costs? Evidence from Rice Farmers in Northeastern Jiangxi Province, P.R. China. *China Economic Review*, 19, pp. 347-358.
20. Travnicek Z., Stolbova M., Nemec J., Horska H., Drlik J., Koutny R., Spesna D., Fiser Z., Cihal L., Hemelik T. (2002) Land Fragmentation and Land Consolidation in Agricultural Sector. Case Study from the Czech Republic. Available at: http://www.fao.org/fileadmin/user_upload/Europe/documents/Events_2002/Land2002/czech_paper.pdf, 4 March 2015.
21. Vijulie I., Matei E., Manea G., Octavian C., Cuculici R. (2012) Assessment of Agricultural Land Fragmentation in Romania, a Case Study: Izvoarele Commune, Olt County. *Acta Geographica Slovenica*, 52(2), pp. 403-430.

SOCIAL CAPITAL IN RURAL AREAS AND THE DEMAND FOR LAND CONSOLIDATION MEASURES

Małgorzata Dudzinska, Katarzyna Kocur-Bera, Cezary Kowalczyk
University of Warmia and Mazury in Olsztyn, Poland
gosiadudzi@uwm.edu.pl; katarzyna.kocur@uwm.edu.pl; cezary.kowalczyk@uwm.edu.pl

Abstract
Spatial modifications should be introduced in areas where members of the local community actively participate in consolidation projects. Social acceptance is the key prerequisite for successful land consolidation. How should the sequence of land consolidation measures be planned in a rural area whose inhabitants have not expressed their opinions about the project? Are the existing criteria, which are applied to evaluate land consolidation measures mostly in agricultural regions, sufficient?
Scientists and practitioners have been developing criteria that should be taken into account in the process of planning land consolidation measures. This article analyzes the criteria for planning land consolidation measures in Poland. Most of them are based on economic parameters, such as farm fragmentation, average land plot area, average farm area, shape of farm fields, proportion of plot sides. A criterion that is disregarded in the planning process is the local community's attitude to the undertaking.
This article attempts to define additional criteria for planning land consolidation measures based on the local community's attitude to the project. The study was carried out in the Lublin Region, which is characterized by the highest number of land consolidation schemes in Poland. Attempts were made to describe social activity levels in the region's rural municipalities. The selection of variables characterizing the local community was a key stage of the study. Variables that were indirectly indicative of social activity were included in the analysis: voter turnout in elections, municipal councilors' level of education, number of non-governmental organizations, and number of local action groups.
Key words: consolidation, farm size, land fragmentation.

Introduction

Land fragmentation considerably impairs agricultural practices, reduces technical and economic efficiency of production, contributes to environmental degradation and obstructs or inhibits the use of modern agricultural equipment (Dudzińska and Kocur-Bera, 2014).

Land consolidation is undoubtedly a key prerequisite for comprehensive restructuring and reform in the countryside. The spatial structure of farms is improved to lower the number of land plots with an irregular shape, shorten the distance between settlements and farm fields, provide plots with access to public roads and drainage systems, make farmland more accessible to agricultural machines, reduce the acreage of idle and neglected land (Tworzydło, 2012)

Land consolidation measures should promote all dimensions of development. According to Dacko (2006), the main goal of land consolidation should be not only to increase agricultural production, but also to improve the quality of rural life. Land consolidation measures should be initiated to revive the countryside by encouraging continuous economic and political development of the local community, while protecting and rationally managing natural resources. The local community should participate democratically in land consolidation and in defining new forms of land use that make most of local potential. Land merger projects should be initiated as a part of holistic and multi-sectoral approach; they should integrate developmental goals at the local and regional level and account for the linkages between rural and urban areas. The goals of comprehensive land consolidation testify to the social dimension of the undertaking, and this aspect should not be disregarded in the planning process.

The relevant literature was analyzed in search of evidence that social collaboration and acceptance are highly important aspects of land consolidation. The indicators and parameters used in land consolidation projects in Poland were described. In successive parts of the study, indicators of social activity were analyzed and parameters that are indirectly indicative of social engagement were selected. Correlations between social activity indicators and land merger projects were determined. The applied research methods were literature analysis and spatial statistical analysis.

Social attitudes to comprehensive land consolidation projects in rural areas

Active public participation is indispensable for the success of any land consolidation program. Past experiences have revealed that mustering public participation in such programs is very difficult, as it entails some compromise in terms of gain or loss of land. Any externally induced land consolidation program is unlikely to produce a desirable result. Forced consolidation never succeeded in Europe (Riddell and Rembold, 2000).

Although land consolidation is conducive to agricultural development, small farmers may perceive it as interference in their internal matters that would

reduce their profits (King and Burton, 1982; Niroula and Thapa, 2005).

In south Asia, farmers did not participate in land consolidation because they were afraid of being evicted and losing high-quality land in the process of land swapping. Local elites, most of whom happened to be the landlords, were not interested in land consolidation due to the threat of losing their influence over the local population. The program could achieve some success in several provinces of India characterized by low levels of variation in land quality (Niroula and Thapa, 2005).

The impacts and implications of land consolidation programs are not yet clear, therefore, a cautious approach should be exercised to avoid and mitigate negative externalities (Riddell and Rembold, 2000). The success of any land consolidation program rests on how well farmers' needs, capabilities and aspirations are reconciled and integrated into it. A program will be able to achieve success only when appropriate incentives, institutional flexibility and necessary infrastructure are in place, and the end users are genuinely involved in designing it (Conway and Barbier, 1990).

The future of local space should be decided by all people who influence the direction and rate of local development and are willing to cooperate with the local authorities in the process of solving local problems (Kołodziejczyk, 2003). The social aspects of the planned undertaking should be always taken into consideration in determining the demand for comprehensive land consolidation measures.

Indicators of social attitudes, which should be used in the process of assessing the demand for land mergers, are particularly difficult to identify because they have to be formulated at the stage of initial planning rather than during consolidation measures. Individual attitudes are also increasingly likely to differ from group behaviors (Skowroński, 2006). Despite those difficulties, social attitudes have to be taken into account in the process of planning land consolidation projects.

Indicators of demand for comprehensive land consolidation projects in Poland

At present, different indicators of demand for land consolidation measures are applied in Polish regions. There are no global standards that define criteria for evaluating the demand for land consolidation measures. In most cases, the criteria deployed by scientists and practitioners reflect the economic functions and productivity of rural areas.

In Poland, the demand for land consolidation is evaluated by local departments responsible for land management and rural area development. Each department develops unique criteria and individual guidelines for assessing the type of consolidation measures required in a given region. The Lower Silesian Department of Geodesy and Rural Areas in Wrocław defines the demand for land mergers based on the recommendations formulated by the Minister of Agriculture and Food Economy in Instruction No. 1 on land consolidation. In line with those provisions, areas characterized by ineffective checkerboard patterns, high-class soils, relatively large average farm area, extensive stretches of checkerboard land between villages and linear infrastructure that leads to fragmentation of agricultural production have priority in consolidation projects. The demand for land consolidation is also assessed based on the initial interest expressed by landowners. However, there are no general guidelines for evaluating that interest.

Instruction No. 1 has been developed in view of the provisions of the Land Consolidation Act of 1982. The Act has been amended several times, but Instruction No. 1 has never been modified accordingly and became legally obsolete. At present, consolidation projects are based on the provisions of amended regulations, which, however, lack detailed standards for land mergers (Woch and Głażewski, 2014)

Akincza (2014) proposed a set of indicators for determining the demand for land consolidation measures in local departments responsible for land management and rural development in Polish regions of Beskidy, Częstochowa and Lower Silesia.

Parameters for identifying the demand for land consolidation measures are as follows:

- checkerboard land,
- high-class soils,
- farms with relatively large average area,
- linear infrastructure that obstructs agricultural production,
- farm enlargement resulting from land consolidation,
- extensive checkerboard land between villages,
- initial interest expressed by land owners,
- farm fragmentation,
- shape of farm fields,
- proportions of plot sides,
- farmers' interest in expanding their estates,
- land ownership by non-local actors,
- planned linear infrastructure of supralocal significance, allocation of land plots for infrastructure development, afforestation,
- farmers' interest in land consolidation,
- infrastructure upgrades,
- differences in data found in the real estate cadaster and the land and mortgage register

Most of those indicators were based on production data, including farm fragmentation, shape of land plots, proportions of plot sides, checkerboard patterns, linear infrastructure of supralocal significance, allocation of

land plots for infrastructure development, afforestation, land ownership by non-local actors, farmers' interest in expanding their estates, infrastructure upgrades, differences in data found in the real estate cadaster and the land and mortgage register. In previous studies, the social parameters directly or indirectly indicative of social participation (including voter turnout in elections, municipal councilors' levels of education, number of non-governmental organizations and number of local action groups social organizations in rural areas created under the LEADER axis of the Rural Development Program) were not taken into account.

Selected indicators, including the shape of land plots and farm fragmentation, are included in every analysis, whereas other factors, such as allocation of land plots for infrastructure development or planned investments of supralocal significance, are taken into consideration only when applicable. The department in Częstochowa additionally analyzes the demand for land mergers resulting from afforestation projects. It also evaluates the farmers' interest in land consolidation. Most reports do not examine the local community's attitudes to consolidation projects. Local opinions should be one of the most important criteria determining the sequence in which land plots will be merged.

Social aspects of land consolidation

The map of rapidly developing urban areas in Poland will change subject to local community's active participation in the process of shaping the local environment. According to studies of social capital, economic success is determined by free market mechanisms in 80% and by social capital in 20% (Bańsk et al., 2009).

In urban areas, there are many more institutions that cater to the needs of the local community and release the residents from responsibilities associated with managing local affairs. Rural inhabitants are more dependent on their ability to self-organize. Lower availability of central institutions and shared interests mobilize collective action in rural areas (Szafraniec, 2006).

The following social components have been identified by Stanny (2011) in the process of sustainable development at the municipal level (in Poland, land consolidation measures are initiated at the level of municipalities or cadastral districts): demographics, education, social engagement, local governance and living conditions. Population characteristics (age, gender, level of education) and location of economic activities can inhibit or stimulate diversification of income and structural transformations in Polish agriculture (Sikorska, 2011).

The most important element of social activity is adaptability to change and the ability to use the resulting opportunities to change local attitudes, thinking patterns and to create new incentives for members of the local community (Kołodziejczyk, 2003). In the analysis of Polish reports describing the demand for land consolidation measures, Akincza (2014) observed that although scientists and practitioners are aware of the importance of social attitudes, this aspect is not taken into consideration in the developed documents. The reports contain information about demographics, education, living conditions and characteristic features of local populations. There are no indicators that measure social attitudes towards land consolidation or the efforts undertaken by members of the local community and the authorities.

A review of published sources suggests that the parameters analyzed by researchers in evaluations of demand for land consolidation are often related to the spatial features of a given area (such as mountain regions), the availability of certain types of data and the applied analytical methods. Most researchers focus on three factors that influence land fragmentation: number of land plots, plot size and farm size. Practitioners also account for other aspects of rural development, including linear infrastructure of supralocal significance, farmers' interest in land consolidation and demand for infrastructure upgrades. Several analyses of local demand for land consolidation cite the opinions voiced by members of the local community and list the participants of social consultation meetings without evaluating the presented criteria. Social participation levels of rural residents should be the most important parameter determining the sequence of land mergers in a given municipality.

Social attitudes are very difficult to survey in the process of planning consolidation projects in Poland. Questionnaire surveys are very expensive and sometimes impossible to conduct in large regions. Questionnaires should be filled out by a representative group of respondents to elicit reliable responses. This seemingly modest requirement is often very difficult to fulfill in practice. It requires the selection of a representative group from the entire population and the estimation of the analyzed features with the use of statistical methods. Reliable responses may be difficult to elicit, in particular when local policies stifle the respondents' opinions and when the surveyed subjects are afraid of losing their anonymity. It should also be remembered that questionnaire surveys are valid only at the place and time they are conducted. Questionnaires should be only one of many research tools, and their results should be confronted with the outcomes of other methods.

The above clearly demonstrates the need for unique parameters describing social attitudes to land consolidation measures. An interesting approach was

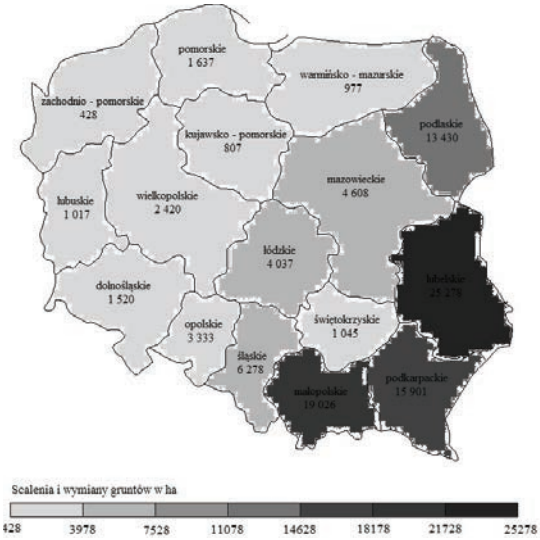

Figure 1. Scope of land consolidation and land exchange measures across Polish regions in 1999 – 2010.

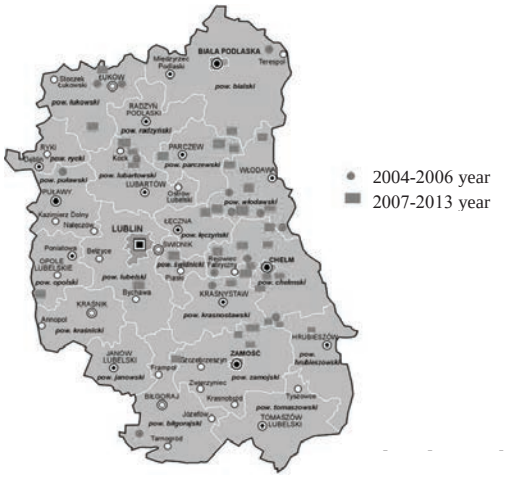

Figure 2. Land plots consolidated in the Lublin Region in 2004-2013.

adopted by the Regional Department of Geodesy in Lublin, which began planning land consolidation measures for 2014-2020 by requesting social feedback from the constituent counties.

In rural areas, spatial transformation projects generate the best results in regions characterized by high levels of social participation. For this reason, analyses of demand for land consolidation should be based not only on economic factors, but also on social parameters and indirect criteria that testify to community involvement in local affairs. Quantitative analyses of social capital and the relevant phenomena rely on public statistics and are often performed by economists and geographers. The evaluated parameters include the number of non-governmental organizations, voter turnout in elections, membership in teams and clubs, local newspaper readership, entrepreneurship, number of organized events, crime rates, religious affiliation and blood donorship. The main drawback of those parameters is that they fail to satisfy the main principles for the selection of variables in quantitative research: significance and normal distribution. They are generally used for the lack of other, more reliable indicators (Bednarek-Szczepańska, 2013).

Materials and Methods

The main objective of this study was to identify social criteria, including social attitudes and social participation, in the process of evaluating the demand for land consolidation measures. The study was performed in the Lublin Region which runs the highest number of land consolidation projects in Poland.

The geographic location of the Lublin Region and the scope of land consolidation and land exchange measures conducted in the region are presented in Figure 1. The applied research methods were literature review and spatial statistical analyses. Indicators of social participation were verified in areas covered by land consolidation projects. The evaluated problem is complex, and it was analyzed based on data from various sources, including the Regional Data Bank (Central Statistical Office), National Election Commission and the Ministry of Agriculture and Rural Development.

The analysis was performed in rural municipalities of the Lublin Region. In the evaluated region, 13 consolidation measures (7468 ha) were conducted in 2004-2006 and 39 consolidation measures (27,502 ha) – in 2007-2013. The Lublin Region comprises 171 rural municipalities, and land consolidation projects covered 31 municipalities in 2004-2013 (Figure 2). The highest numbers of four consolidation measures were carried out in the municipalities of Chełm and Urszulin each. The municipalities of Łuków, Ostrówek and Wojsławice performed three consolidation measures each.

Rural municipalities were selected for the analysis by eliminating municipalities featuring a town or city by the same name (due to problems associated with the distribution of selected attributes between those units). A total of 157 municipalities were included in the analysis. Social activity levels were described in the evaluated municipalities.

The selection of variables describing the examined sites was the key stage in the study. In quantitative analyses, variables are generally selected based on the availability of data and the researchers' arbitrary decisions, but they should always be justified by facts. In this study, variables were selected based on the authors' experience and the results of an expert survey.

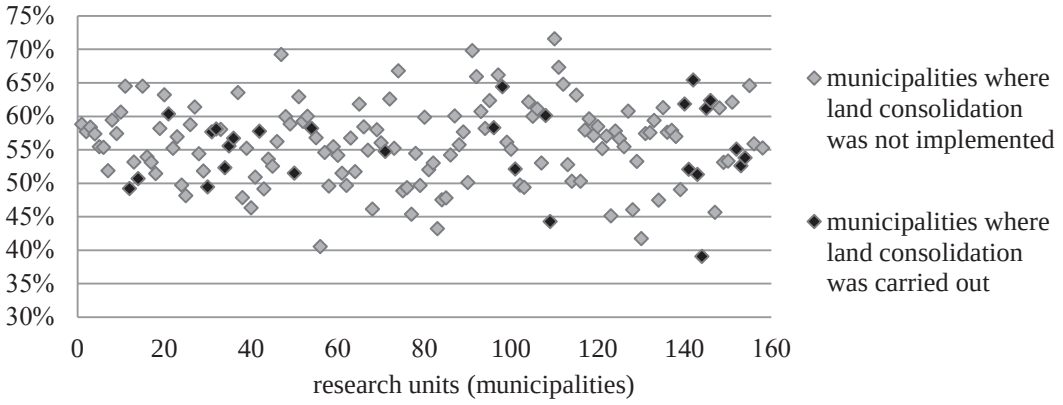

Figure 3. Voter turnout in local elections in rural municipalities of the Lublin Region.

The analyzed parameters were indirectly indicative of social participation, including voter turnout in elections, municipal councilors' levels of education, number of non-governmental organizations and number of local action groups (social organizations in rural areas created under the LEADER axis of the Rural Development Program).

Results and Discussion

The first attribute, which is indicative of social participation and civic attitudes, is voter turnout in elections. Voter turnout is one of the most significant measures of civic engagement which applies only to the part of the local population represented by eligible voters (Stanny and Czarnecki, 2011). The value of this attribute was determined based on the results of local elections that took place on 5 December 2010. Average voter turnout in the Lublin Region was 39.64%, and it was significantly higher in rural municipalities at 55%. The lowest voter turnout of 39% was reported in the municipality of Wola Uhruska, but the highest voter turnout of 72% was noted in Sosnowica. Voter turnout was similar in municipalities where land consolidation projects had been carried out, and it was determined at 55% on average, in the range of 39% to 64% (figure 3).

The following parameter describing social engagement was the education level of municipal councilors. Councilors should have the required qualifications because their decisions influence the development and economic performance of municipalities and counties. Their competence levels are particularly important in the process of obtaining EU funds. According to Bański and Stola (2000), the value of PHARE funds absorbed by Poland in 1995-2000 was clearly correlated with the education levels of municipal councilors. Similar observations were made by Ciok and Raczyk (2006) who investigated fund absorption rates in the INTERREG IIIA program covering Polish-German trans-border regions. Local authorities should be characterized by the highest level of education in order to be able to accurately identify the demand for and acquire EU funds (Janc, 2009).

Municipal councilor's average education levels were determined across gender and age groups based on statistical data for 2011. In the Lublin Region, an average of 23% councilors had college and university degrees, and those values ranged from 7% to 67% across municipalities. Similar results were noted in municipalities that had undergone land consolidation measures, where councilors with college and university education accounted for 20% of local administration staff on average, in the range of 7% to 60%. On average, the Lublin Region employed 41% councilors with secondary school education and 36% councilors with vocational education, and the municipalities where land mergers had taken place – 43% and 35%, respectively (figure 4).

The number of non-governmental (NGO) organizations is one of the most robust indicators of social engagement and the local community's willingness to participate in finding solutions to local issues (Stanny, 2011). In Poland, this indicator should be applied with caution because statistical data concerning NGOs is often narrowed down to formal registration details, and it does not account for the number of members, completed projects, the organization's activity profile or year of foundation (Stanny, 2011). The number of non-governmental organizations was estimated based on a database of Polish NGOs. The average number of NGOs was determined at 12 in the Lublin Region and 11 in municipalities that had undergone land consolidation.

Another criterion for measuring social engagement levels, including the EU, is the number of Local Action Groups (LAGs) in a given area. LAGs are public-private partnerships that are created in areas of particular importance for the community (Borowska, 2008). LAGs play a very important role in reviving social bonds, promoting dialogue between various social and cultural groups, integrating the local

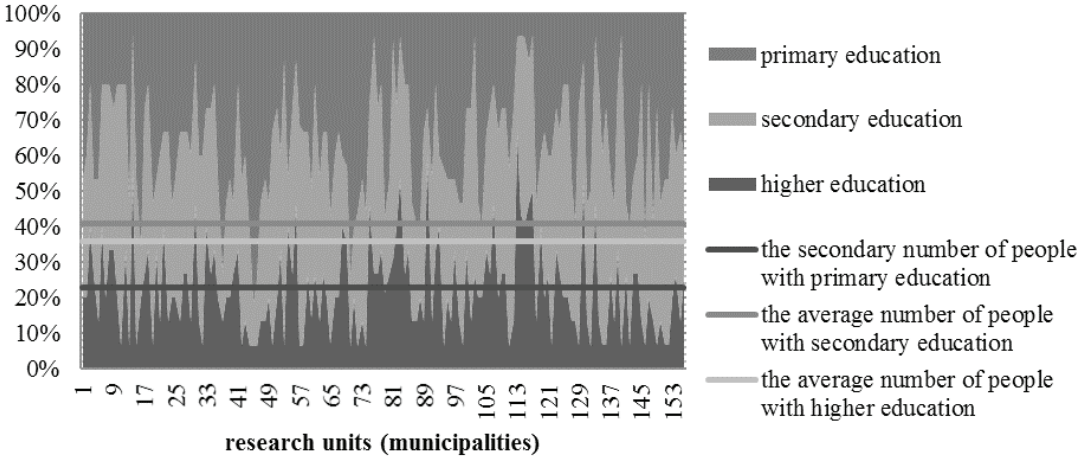

Figure 4. Education levels of councilors in rural municipalities of the Lublin Region.

community and verbalizing local development needs (Borowska, 2008). At present, there are 337 LAGs in Poland**.** The operations of Polish LAGs cover 278,235.7 km^2, which accounts for 93.22% of the area eligible for support under the Rural Development Program 2007-2013. The average area covered by one local strategy is 823.18 km^2. The areas covered by Local Development Strategies are inhabited by a total of 16,877,180 people, i.e. 91.29% of Poland's rural population and 44.27% of Poland's overall population. On average, one Local Development Strategy influences the lives of 49,930 people (Kamiński, 2010). In many Polish regions and municipalities, local governments play the key role in the operations and decisions of LAGs (Kamiński, 2010).

The LAG criterion may not be an effective parameter for estimating social engagement levels because the available statistical data does not account for those organizations' activities. Analyses of Local Development Strategies could provide more comprehensive information. Pursuant to the provisions of the Act on support for rural development with the involvement of the European Agricultural Fund for Rural Development, every LAG is under obligation to adopt a Local Development Strategy. The strategy is one of the key requirements that have to be fulfilled by a LAG in order to become eligible to funding from the Rural Development Program 2007-2013 (Axis 4 of the Leader program).

The results of the analysis indicate that the evaluated parameters of social participation, i.e. voter turnout in elections, education levels of municipal councilors, number of non-governmental organizations and local action groups in the surveyed municipalities, are not effective criteria for determining local demand for land consolidation measures. The analyzed parameters assumed very similar values in municipalities where land consolidation projects had been initiated as well as in the remaining municipalities of the Lublin Region. The proposed attributes were not correlated with social activities initiated in support of land mergers.

Conclusions

1. Comprehensive land consolidation measures promote sustained development in rural areas, therefore, social attitudes to such projects should be taken into consideration in the planning process.
2. The article attempts to define social engagement criteria, which are important for identifying the demand for land consolidation in spatial-statistical analyses. Municipalities where land consolidation projects had been implemented and municipalities where no such measures had been carried out were compared in the study. The analyzed parameters assumed very similar values in municipalities where land consolidation projects had been initiated as well as in the remaining parts of the Lublin Region.
3. An absence of correlations could be attributed to the fact that social engagement is a complex and qualitatively varied phenomenon which cannot be accurately described in a quantitative analysis.
4. The formal assumptions for formulating synthetic indicators of social engagement should also be revised. The relevant assumptions have to be significantly simplified if the levels of social engagement, honesty and trust are to be effectively described with the use of limited statistical data.
5. Further research is needed to develop social participation criteria that should be taken into account in the process of planning land consolidation measures. This goal can be achieved through local surveys, which are based on structured questionnaires addressed to representative members of the local community,

or monographic surveys which describe specific communities in quantitative-qualitative or qualitative field research.

6. The results of the analysis indicate that the single parameters of social participation are not effective criteria for determining local demand for land consolidation measures. This article is the first stage of research on parameters which are describing social engagement. The obtained results allow authors to undertake further studies. Construction of synthetic parameter of social activity should be based on parameters described before.

References

1. Axis 4 of the Rural Development Program 2007-2013. (2009) Local Action Groups and Local Development Strategies, Ministry of Agriculture and Rural Development, Warsaw, 33 p.
2. Akińcza M., Maruk D. (2014) Ocena mierników stosowanych do określania zapotrzebowania na zabiegi urządzenioworolne. (Evaluation of indicators used to test the demand for rural management works). *Wielofunkcyjny i zrównoważony rozwój obszarów wiejskich,* pp. 19-28. (in Polish).
3. Bański J., Janicki W., Bednarek-Szczepańska M., Czapiewski K., Mazur M. (2009) Ocena wpływu instrumentów polityki spójności oraz wspólnej polityki rolnej na rozwój społeczny i gospodarczy obszarów wiejskich w województwie małopolskim (Assessment of the impact of cohesion policy instruments on the social development rural areas in Malopolska province). Warsaw, Poland 82 p. (in Polish).
4. Bański J., Stola W. (2002) Przemiany struktury przestrzennej i funkcjonalnej obszarów wiejskich w Polsce (Transformation of the spatial and functional structure of rural areas in Poland). *Studia Obszarów Wiejskich*, 3, Warszawa, Poland 120 p. (in Polish).
5. Bednarek-Szczepańska M. (2013) Wiejski kapitał społeczny we współczesnej Polsce (Rural social capital in contemporary Poland). *Folia Geographica Socio-Oeconomica.* pp. 19-40. (in Polish).
6. Borowska A. (2008) Lokalne grupy działania czynnikiem stymulującym rozwój obszarów wiejskich w Polsce (Local Action Groups as a Stimulating Factor in the Development of Rural Areas in Poland). *Acta Scientiarum Polonorum, Oeconomia*, 8, pp. 13-22. (in Polish).
7. Ciok S., Raczyk A. (2006) An Evolution of the Implementation of Polish-German Cross-border Cooperation within INTERREG IIIA. Conference paper presented at Towards Sustainable Border Regions – Analyses, Strategies and Approaches for Transboundary Spatial Development, Warsaw, Poland, pp. 33-47.
8. Conway G.R., Barbier E.B. (1990) After the Green Revolution: Sustainable Agriculture for Development. Earthscan, *Futures*, 20, pp. 651-670.
9. Dacko A. (2006) Tworzenie warunków do rozwoju terenów wiejskich poprzez scalanie gruntów – aspekt teoretyczny (Creating Conditions for Developing Rural Areas by Use of Land Consolidation – Theoretical Aspect). *Infrastructure and Ecology of Rural Areas,* 2, pp. 29-39. (in Polish).
10. Dudzińska M., Kocur-Bera K. (2014) Land consolidation as the driving force behind ecological and economic development of rural areas. The 9th International Conference Environmental Engineering – Selected Papers, Vilnius, III, 1-7. Available at: http://leidykla.vgtu.lt/conferences/ENVIRO_2014/Abstracts/5/204.html, 16 November 2014.
11. Instrukcja Nr 1 Ministra Rolnictwa i Gospodarki Żywnościowej o scalaniu gruntów z dnia 24 marca 1983 r. (Instruction No. 1 of the Minister of Agriculture and Food of Land Consolidation). GZ-g-630-1/83, Warszawa, Poland 130 p. (in Polish).
12. Janc K. (2009) Przestrzenne zróżnicowanie kapitału ludzkiego i społecznego na Dolnym Śląsku (Spatial differentiation of human and social capital of Lower Silesia). *DAWG,* pp. 38-63. (in Polish).
13. Kamińska W. (2010) Przestrzenne zróżnicowanie kapitału ludzkiego i społecznego na obszarach wiejskich województwa Świętokrzyskiego (Spatial differentiation of human and social capital in rural areas of the Świętokrzyskie province). *Studia KPZK PAN,* CXXVI. pp. 129-167. (in Polish).
14. King R., Burton S. (1982) Land fragmentation: notes on fundamental rural spatial problem. *Progress in Human Geography,* 5 (6) pp. 475-494.
15. Kołodziejczyk D. (2003) Kapitał społeczny w rozwoju obszarów wiejskich w Polsce (Social capital in the development of rural areas in Poland). *Studia Obszarów Wiejskich*, 4, pp. 27-38. (in Polish).
16. Niroula G.S., Thapa G.B. (2005) Impacts and causes of land fragmentation, and lessons learned from land consolidation in South Asia. *Land Use Policy, 22*, pp. 358-372.
17. Riddell J., Rembold F. (2000) Farmland Rationalization and Land Consolidation: Strategies for Multifunctional use of Rural Space in Eastern and Central Europe Food and Agriculture Organization, Rome. Available at http://www.fao.org/sd/ltdirect/ltan0018.htm, 16 November 2014.

18. Skowroński A. (2006) Zrównoważony rozwój perspektywą dalszego rozwoju cywilizacyjnego (Sustainable development as the perspective of further civilisation development). *Problems of Sustainable Development*, 1, pp. 47-58. (in Polish).
19. Stanny M., Czarnecki A. (2011) Zrównoważony rozwój obszarów wiejskich Zielonych Płuc Polski (Sustainable rural development - Polish Green Lungs). Warsaw, Poland 245 p. (in Polish).
20. Szafraniec K. (2006) Jednostkowe i społeczne zasoby wsi (Individual and Social Potential of Rural Poland). Warsaw, Poland 321 p. (in Polish).
21. Tworzydło J. (2012) Wpływ sektorowych programów operacyjnych Unii Europejskiej na prace urządzeniowe terenów wiejskich (Influence of utilities operational Programs of the European Union to rural land management). *Infrastruktura i Ekologia Terenów Wiejskich,* 2, pp. 199-206. (in Polish).
22. Woch F., Głażewski E. (2014) Scalanie gruntów w Polsce na obszarach chronionych (Land consolidation on protected areas in Poland). B*ariery i stymulanty rozwoju obszarów wiejskich,* pp. 90-102. (in Polish).