CHANGE IN THE AREA OF LITHUANIAN WETLANDS (2002-2021)

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Abstract
The topic of the article is especially relevant, because not only in Lithuania, but also all over the world, due to human activities, climate change and other processes, the most natural component of the landscape - wetlands - is rapidly disappearing. Wetlands not only have a unique biodiversity, are valuable elements of the landscape, but also perform many important functions for humanity. Drainage of wetlands results in the loss of most of these functions, as well as secondary problems such as greenhouse gas emissions, water pollution by peat decomposition products, and many others.
Wetlands are declining or deteriorating in many parts of the world. More than 90% of former wetlands have been destroyed or severely damaged in Western Europe, more than 50% in Central Europe and about 70% in Southeast Asia.
The aim of this article is to determine the change in the areas of Lithuanian wetlands. Thus, the study found that wetland areas were declining in all counties of the country. The largest percentage decrease in wetlands was in Kaunas (67.43%) and Tauragė (54.33%) counties. During the period of 2002-2021, the area of wetlands in the Republic of Lithuania decreased by 50,893.11 ha (34.60%) and in 2021 accounted for 0.15% of the country's territory, while in 2002 – 2.25%.
In order to protect the wetlands, it is necessary to take special measures, carry out intensive projects and works for the restoration of wetlands.
Key words: wetland, change, landscape, biodiversity.

Introduction

According to the Universal Lithuanian Encyclopedia (Visuotinė, 2022) a wetland is an area of the Earth's surface that is constantly soaked, and withered vegetation gradually turns into peat under anaerobic conditions. Formed by landslides or by the growth of a body of water (usually a lake). Land is concentrated where groundwater is shallow, surface water or floodwater stagnates for a long time. Groundwater levels can rise, for example, when large areas of forest are cut down or burned, which then turn into wetlands.

The authors A. Povilaitis, J. Tuminskas, Z. Gulbinas, R. Linkevičienė and M. Pileckas (Povilaitis *et al*., 2011) describe the wetland as an area that is overgrown with wetland vegetation. A vibrant, unspoiled wetland is an ecosystem that accumulates peat.

For a long time, wetlands have been the least affected by human beings, but for the last 200 years, the destruction of wetlands was seen as an indicator of progress in almost every country, and every effort was made to replace wetlands as much as possible – to drain, dig, plow or reforest them. Wetlands are being destroyed rapidly even now (Pranaitis, 2018).

Wetlands are habitats rich in species that perform valuable ecosystem functions such as flood protection, water quality improvement, food chain maintenance and carbon sequestration. Wetlands around the world have been drained to become agricultural land or industrial and urban areas (Verhoeven & Setter, 2010).

Wetlands perform functions that support the creation of ecologically, economically and socially important values. European legislation increasingly recognizes the importance of preserving wetland ecosystems (Jassen *et al*., 2005).

The drainage of wetlands for agriculture, forestry, peat mining, urbanization and other purposes causes non-recurring but continuous greenhouse gas (GHG) emissions lasting decades or centuries, while natural and restored wetlands are able to store organic carbon in the form of peat (IUCN, 2017).

Wetlands are affected by many threats, including climate change, degradation, area loss, invasive species (types), over-harvesting and disease. Habitat loss and degradation caused by upstream development of water resources and the transition to agriculture, industry and transport, and urban development are the most serious ones (Kingsford, Basset, & Jackson, 2016).

Maintaining biodiversity, improving water quality, reducing floods and carbon sequestration are key functions that are disrupted when wetlands are lost or degraded. Restoration methods are evolving although the recovery of lost biodiversity is hampered by invasive species that thrive on disrupted and displaced locals. Not all wetland damage is reversible, but it is not always clear how much it can be maintained during restoration (Zedler & Kercher, 2005).

There is now more and more talk about the inevitable need to conserve wetlands, as they play a particularly important role, as no other terrestrial ecosystem on Earth does: it captures carbon dioxide

from the atmosphere in the form of peat, thus contributing to atmospheric stability and the destroyed wetlands and drained peatlands pose a great threat. By losing the water necessary for the wetlands to exist, they emit large amounts of carbon dioxide and other gases, increasing the greenhouse effect in the earth's atmosphere (Pranaitis, 2018).

Wetlands perform valuable functions that benefit humans and wildlife as well. These include groundwater recharge, food security, surface water storage, filtration and treatment, biodiversity habitat provision, global water cycle support, natural hazard management, livelihood support, flood protection, carbon mitigation, climate change mitigation, and they may also be of cultural and spiritual significance (Vincent & Owens, 2021).

Wetland restoration is particularly important for the conservation of biodiversity; climate regulation (carbon sequestration, storage of organic carbon in the form of peat); local air formation (reduces air temperature fluctuations, increases air humidity and the likelihood of fog, cleans the air); water treatment (improves water quality and accumulates biologically passive pollutants, especially in areas of intensive agriculture) and storage (prevention of floods, droughts and peat fires); to prevent soil erosion and peatland collapse; the supply of renewable natural resources that can be used for energy purposes in the production of feed, building materials, the food and pharmaceutical industries, handicrafts and more; aesthetic, recreational, health, scientific, etc. (Pelkių atkūrimo, 2022).

Inventory and monitoring of wetlands and adjacent uplands is important for the conservation and management of wetland resources (Ozesmi & Bauer, 2002).

Successful conservation and management of wetlands requires up-to-date and accurate information on the location, size, condition, functionality, type, services provided, stressors, and net changes in scale (Kayastha *et al*., 2012).

The object of article is wetlands of Lithuania.

The aim is to perform an analysis of the change in the wetland area of the Republic of Lithuania in 2002-2021.

Tasks to be resolved:

1. To describe Lithuanian wetlands.
2. To perform the analysis of the change in the area of Lithuanian wetlands in 2002-2021.
3. To examine the change of wetland area in the counties of the country.
4. To analyze the wetland restoration works and tendencies in the country.

Materials and Methods

Various methods have been used to conduct the research of this article: both theoretical and practical.

The introduction provides an overview of articles by Lithuanian and foreign researchers examining the concept of wetlands, the causes of their extinction, and the importance of conservation. It has been identified that this sensitive component of the landscape needs to be protected and restored.

The article formulates the aim and tasks for its implementation.

To achieve the aim, a comparative method was used, which determined the change of wetland areas in Lithuania and its ten counties in 2002-2021. The obtained change data are presented in hectares and percentages. The data of the Land Fund of the Republic of Lithuania for 2002-2021 were used for comparative analysis.

The method of analytical and logical analysis was used to determine the reasons for the decrease in the area of wetlands in Lithuania and its counties.

To supplement the study, 5 figures and one table were prepared. Figure 4 was made using ArcGIS program. This figure shows the percentage of the area occupied by wetlands in Lithuanian counties.

The paper analyzes the wetland restoration projects and works carried out in the country and describes the possibilities for the development of these works in the future.

Results and Discussion

Wetlands in Lithuania

Wetlands are described as viable terrestrial ecosystems in areas that are constantly soaked and overgrown with moisture-loving plants, where peat is constantly being built up, that is, peat accumulation. Areas with a peat layer thicker than 30 cm are included in wetlands. Most of the Lithuanian wetlands are located in the folded relief of the Baltic and Samogitian Uplands, in the Central Lowlands, in the valleys of the rivers of the South-Eastern Plain.

In the country, wetlands are mostly formed where there is a loamy impermeable subsoil and shallow-lying groundwater. Such low-nutrient soils tend to acidify and swamp. For this reason, wetlands in sandy areas, such as the South-Eastern Plain, can also be swamped. The most favorable conditions for the formation of wetlands are in the western part of Lithuania, where very calcareous and narrowed soils predominate, and the most unfavorable conditions in the Central Lowlands, where low-calcareous soils with carbonate subsoil predominate.

There are three types of wetlands identified (Figure 1):

1. Fens. About two thirds of Lithuanian wetlands are fens, which are widespread in lakes, river valleys, inter-hill valleys, on the outskirts of raised bogs.
2. Intermediate bogs. These are wetlands where fen and raised bog plants grow. They are widespread in habitats, where nutrients are insufficient for fen

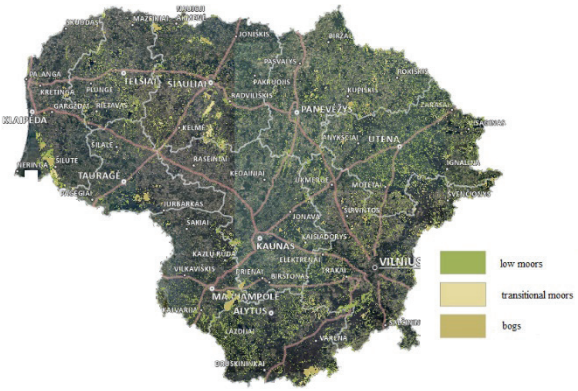

Figure 1. Distribution of wetland types in Lithuania (Lietuvos pelkių, 2022).

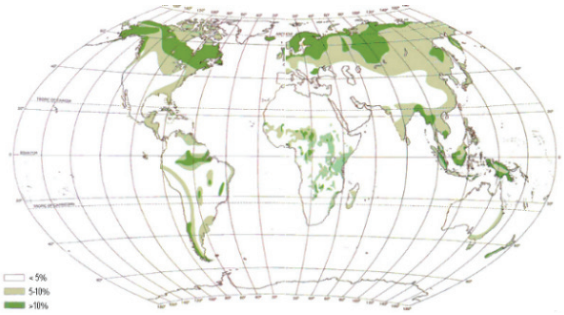

Figure 2. The % of areas covered by wetlands (Kodėl svarbu, 2022).

peat and nutrients are still too high for raised bog peatlands.

3. Raised bogs. These wetlands are fed only by rainwater and snowmelt, the excess of which flows from the raised surface of the wetland to the edges (lag).

Lakelets of various sizes and lake branches can be found in the big raised bogs.

Lithuania has 53 types of natural habitats of European Community importance (excluding those common in the Baltic Sea), which are included in the Habitats Directive (Council Directive, 1992).

Eleven of these types are associated with wetland ecosystems, i.e.: natural dystrophic lakes, active wetlands, degraded raised or intermediate bogs and marshes, bare peat bogs, calcareous springs and spring marshes, boggy marshes, boggy marshes swamp deciduous forests, swamp forests.

The largest wetlands in Lithuania are the following: Žuvinto palios – 6,847 ha, Čepkelių raistas – 5,858 ha, Didysis tyrulis – 4,717 ha, Baltosios Vokės wetland – 4,100 ha, Praviršulio tyrelis – 3,645 ha, Amalvo palios – 3,400 ha, Rupkalviai wetland – 3,410 ha, Naujienos wetland – 3,160 ha, Aukštumala – 3,020 ha, Rėkyva wetland – 2,608 ha.

The most important surviving Lithuanian wetlands are declared protected areas – state or biosphere reserves.

Changes in wetland areas.

Wetlands cover about 3% of the world's land area (Figure 2). They are mainly located in the Northern Hemisphere, in the temperate climate zone. Over the past 200 years, the area of peatlands has decreased by 10-20%. About a quarter of the surviving peatlands have been interrupted by natural processes, climate change or human activity, and peatland is currently used in about 60% of the world's former wetlands.

In Europe, more than 20% of peatlands have been destroyed, and only about 50% of all former peatlands have remained suitable for peat formation.

More than 90% of former wetlands have been destroyed or severely damaged in Western Europe, more than 50% in Central Europe and about 70% in Southeast Asia. The best condition of wetlands in North America and the Asian part of Russia. Large areas of wetlands have survived in northern Europe (Finland and Sweden). Unfortunately, climate change models predict a rise in global temperatures, which could significantly accelerate the loss of wetlands.

Wetlands in the Baltic States are a significant element of the landscape, covering a total area of 24,650 square km, but due to intensive land reclamation during the Soviet era, about 70% of Baltic wetlands are already drained and degraded (Joosten, Tanneberger, & Moen, 2017).

In Lithuania, wetlands covered about 10% of the territory, but since the beginning of larger-scale melioration works in the 19th century, about 30% of the former area remained. At present, this ratio is even more unfavorable for wetlands.

Although the country's wetlands are protected nationally, even the status of a protected area does not always ensure a favorable status and protection of natural values. There are 821 wetlands in Lithuanian state reserves, national and regional parks and reserves.

107 telmological reserves have been established in Lithuania to protect typical and unique wetland complexes. 7 Lithuanian wetland complexes are of international importance and are protected by the international Ramsar Convention.

In 2021, wetlands occupied only about 0.15% of Lithuania's territory, i.e. 96,185.73 ha (Figure 3). Most of them are small - up to 50 hectares and unevenly distributed within the country.

In 2002, the area of wetlands in Lithuania was 2.25% and occupied 147,078.84 ha. The third figure shows that between the years 2002 and 2021, the area of wetlands decreased. Thus, the examined area changed by 50,893.11 ha, which was as much as 34.60%.

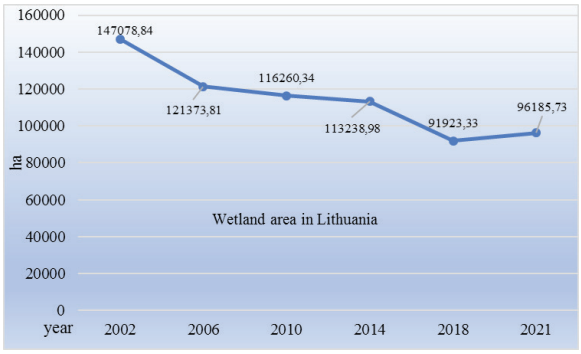

Figure 3. Wetland area change in ha in the Republic of Lithuania in 2001-2021 (Nacionalinė, 2001-2021).

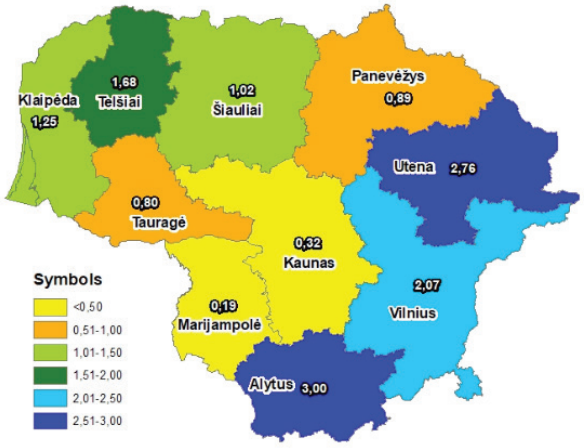

Figure 4. Wetlands in Lithuanian counties in 2021.

A small part of the wetlands disappeared due to natural landscape development processes (changes in local moisture balance, formation of river valleys, etc.). Many wetlands are disappearing due to lower groundwater levels during land reclamation and peat exploitation. Currently, wetlands are particularly threatened by the reluctance of entrepreneurs to increase peat extraction and exports.

There are ten counties in Lithuania where the areas of wetlands are unevenly distributed.

According to the data of 2021, the most wetlands in Lithuania are situated in Alytus (3.00% or 16,268.98 ha), Utena (2.76% or 19,855.37 ha) and Vilnius (2.76% or 20,179.43 ha) counties. In other seven counties, wetlands account for less than 2%. The lowest number of wetlands was found in Marijampolė county (0.19% or 4290.85 ha) (Figure 4).

After the analysis of the change of wetland areas in the counties of the Republic of Lithuania, it can be seen that in all counties this area decreased in the period of 2002-2021 (Figure 5).

Analyzing the data on the change of wetlands as a percentage, it was found that the largest decrease in this land use was in Kaunas (67.43%) and Tauragė counties (54.33%). The least change in the area of wetlands was in Telšiai County (15.07%) (Table 1).

As mentioned, some wetlands have disappeared due to natural landscape development processes, but the main cause of wetland loss is human economic activity. More than two-thirds of the wetlands in all counties of the country have become degradable peatlands. The condition of many of the surviving wetlands is gradually deteriorating due to still operating drainage systems, pollution and climate change, destabilizing the human environment and reducing the prospects for future survival.

Today, most drained wetlands are used for agriculture, forestry or peat extraction. In Lithuania, peat quarries occupy 20 thousand ha, more than half

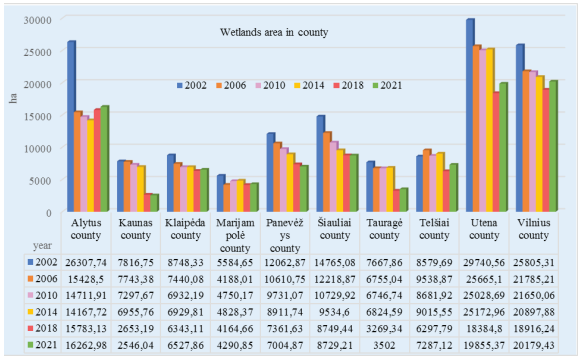

Figure 5. Wetlands area change in hectares in counties of Lithuania in 2002-2021.

Table 1

Wetlands area change in hectares and percent in counties of Lithuania in 2002-2021

County	Wetland area decreased by ha	Wetland area decreased by %
Alytus	100,44.76	38.18
Kaunas	5,270.71	67.43
Klaipėda	2,220.47	25.38
Marijampolė	1,293.80	23.17
Panevėžys	5,058.00	41.93
Šiauliai	6,035.87	40.88
Tauragė	4,165.86	54.33
Telšiai	1,292.57	15.07
Utena	9,885.19	33.24
Vilnius	5,625.88	21.80

of which are abandoned and unused. Unfortunately, their reclamation for the restoration of wetland ecosystems is still slow. Some of the areas ready for economic use have not been put to their intended use or have been used irresponsibly, and they continue to degrade. Some of the peatlands currently used on the farm are not profitable or their operation is causing difficult landscaping conflicts.

Restoration of wetlands in Lithuania.

Because wetlands are valuable elements of the landscape, with unique biodiversity and performing many functions important to humankind, i.e. regulates the local and global climate, regulates water runoff and quality, provides economic benefits, conducts research and recreation in wetlands, so it is necessary to preserve existing wetlands and restore the former ones.

The nature of the damage to wetlands can vary, leading to different methods of restoring them. Main tasks are restoration of water level and characteristic vegetation. The easiest way to restore the wetlands is to raise the water level in the drained peatlands that have retained the wetlands. In cases where vegetation is completely destroyed, the restoration of the wetland, even at high groundwater levels, can take decades or even centuries (for example, to restore raised bogs).

The following wetland restoration projects have been implemented in Lithuania:

- Restoration of the Puščia peatland (2002-2003), the aim of which is to restore the Puščia peatland in Zarasai district, restoring the water balance, renaturalising the vegetation, planting typical raised bog vegetation, removing growing shrubs and trees and invasive plant species.
- Conservation of biological diversity in Lithuanian wetlands (2004-2011). The water level was restored in Girutiškis raised bog in Švenčionys district and in a part of Kamanos raised bog in Akmenė district.
- Restoration of the raised bog in the Aukštumala Telmological Reserve (2006-2007). During the project, canals and ditches were ponded, and 100 ha of woody vegetation were cleared, thus stopping the degradation of the swamp and water evaporation. Partitions were built in the cut-out places and the water level was raised.
- Restoration of water level in the Velniabalė (Zarasai district) and Gegužinė (Vilnius district) peatlands (2008). Here, the hydrological regime of wetland ecosystems has been restored in the territory of 100 ha, as well as 388 dams have been installed, for the installation of which ecological, natural materials have been used: peat, wood, braided willow dams, etc.
- Preservation of Amalvas and Žuvintas wetlands (2009-2012). During the project, the winter polder of Amalvas was reconstructed, the water level in the southern part of the Amalvas raised bog was restored, the lock regulator was reconstructed, the drainage canals of the Žuvintas meadows were flooded, etc.
- Restoration of wetland ecosystems in Ežerėlis peatland (Kaunas district) (2020). Experimental fields have been set up here and the elements of raised bog (cumin and cranberry) and fen (reed) plants have been established.
- Renaturalization of exploited peatlands and development of plant community restoration technologies (2020). The renaturalization works carried out in the peat bog exploited by the Blind Lake (Telšiai district) are unique in that no attempt is made to artificially introduce plant species here, but to create optimal conditions for the spontaneous recovery of cumin, cranberry, rainbow and other plant species.
- LIFE project Peat Restore (2016-2021). During this project, restoration works were carried out in 5 areas (Amalva wetland, Plinkšiai, Sachara, Pūščia, Aukštumala), which cover a total area of 465 ha.
- Other projects: Restoration and management of the natural hydrological regime of Aukštasis Tyras, Užpelkiai, Paburgė, Siberia and other wetlands.

Currently, the country's conservationists offer paludiculture as an alternative to the usual use of wetland land. Paludiculture is the climate-friendly economic use of natural and restored wetlands, including the production of native wetland crops, the maintenance and/or restoration of the hydrological regime of natural wetland habitats, the promotion of peatland, the protection of wetland biodiversity to ensure the ecological stability of wetlands. Restoration of wetlands, whether targeted changes in the use of drained areas would allow to effectively achieve not only the reduction of GHG emissions, but also the improvement of surface water quality, strategic goals for the protection of biodiversity.

The Lithuanian Economic Recovery and Resilience Facility (Lithuanian Economy, 2021) provides for an amount of 16 million euros to restore 8,000 hectares of drained wetlands used in agriculture.

Farmers working in drained wetlands (peatlands) and municipalities supervising state land will be eligible for support. In particular, support will be provided to farmers in the regions and areas most affected by intensive agriculture.

The support will be used to compensate the costs of wetland restoration: assessment of water level restoration possibilities, preparation of technical design, reconstruction of drainage systems, installation of dams, locks, removal of woody vegetation; other landscaping works in the area (removal of stones, stumps, leveling of the surface). Restored wetland

ecosystems should be maintained and could be used for hay production, grazing or growing cranberries and other berries for wetland cultivation.

The measure is expected to be effective, to change land managers' attitudes towards the natural importance of wetlands and thus to conserve more wetlands in the future. The support provided to farmers in the plan "New Generation Lithuania" will encourage them to contribute to the restoration of ecosystems and climate-friendly farming in wetlands.

Conclusions

1. Most of the Lithuanian wetlands are located in the folded relief of the Baltic and Samogitian Uplands, in the Central Lowlands, in the valleys of the rivers of the South-Eastern Plain. Lithuania has 53 types of natural habitats of European Community importance (excluding those common in the Baltic Sea), which are included in the Habitats Directive. 107 telmological reserves have been established in Lithuania to protect typical and unique wetland complexes. 7 Lithuanian wetland complexes are of international importance and are protected by the international Ramsar Convention.
2. After the analysis of the change in the area of Lithuanian wetlands in 2002-2021, it was established that the area decreased by 50,893.11 ha or 34.60% and in 2021 occupied 96,185.73 ha or 0.15% of the country's territory.
3. According to the data of 2021, the most wetlands in Lithuania are situated in Alytus (3.00% or 16,268.98 ha), Utena (2.76% or 19,855.37 ha) counties. The lowest number of wetlands was found in Marijampolė county (0.19% or 4290.85 ha). After the analysis of the change of wetland areas in the counties of the Republic of Lithuania, it can be seen that in all counties this area decreased in the period of 2002-2021. Analyzing the data on the change of wetlands as a percentage, it was found that the largest decrease in this land use was in Kaunas (67.43%) and Tauragė (54.33%) counties. The least change in the area of wetlands was in Telšiai county (15.07%).
4. Various wetland restoration projects have been implemented and are being implemented in Lithuania. Currently, the country's conservationists offer paludiculture as an alternative to the usual use of wetland land. The Lithuanian Economic Recovery and Resilience Facility provides to restore 8,000 ha of drained wetlands used in agriculture.

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