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LEGAL AND MANAGERIAL SOLUTIONS OF PUBLIC SECTOR AUTHORITIES FOR PRESERVING ECOSYSTEM SERVICES OF THE LAKES

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Abstract
Although the problem of ecosystem diversity loss is of a global nature, the measures to solve it must be implemented at the national level. As a member of the European Union, Lithuania needs to have a clear position regarding the application of proposed socio-economic measures. The problems of lake ecosystem utilisation analysed in the article are based on the scientific knowledge which complies with the specifics of regional natural environment. The aim of the article is to systematize scientific knowledge about modern lake ecosystem services by explaining the fundamental adaptation patterns of ecosystems and their components. The article provides a complex assessment of the services provided by lake ecosystems, reveals management problems related to optimization of the use of lake ecosystems, presents recommendations on the improvement of legislation related to lake ecosystem services, regulations for protected areas, management plans, etc.
Key words: ecosystem services, lakes, management, public sector.

Introduction

It is generally assumed that the majority of research papers which analyse the use of lakes for various agricultural activities are related to the impact of agriculture on the quality of water in lakes. Generally, researchers focus on the analysis of specific lakes and the impact of agriculture on them. Eutrophication and concentration of certain chemicals (phosphorus, nitrates, etc.) in lake water are investigated (Nakano *et al*., 2008; Dirbock *et al*., 2017; Scholes, 2016; Downing & Heathcote, 2012). There are not many works that analyse the utilisation of lakes in the socio-economic field. The majority of research papers mainly describe only the industrial impact on lake ecosystems (Holopainen *et al.*, 2003) and the use of lakes in the energy sector.

Research papers that focus on the analysis of lakeside landscape should also be mentioned because it is also relevant in the use of lakes. Other works investigate the change of lakeside landscape within a certain period of time using maps and satellite images (Ke *et al*., 2018; Smith, 2014). Additionally, it is worth highlighting publications by foreign researchers related to the determination of the value of lake area, which affects the sale price of residential houses and land lots as well as the rent prices of residential houses (Lake Classification…, 1996).

The aim of the research - to analyze public sector management solutions in different countries to preserve lakes ecosystem services and to provide socio-economic insights on the nature conservation policy.

Materials and Methods

The following data collection and analysis methods were used for the study: 1. Document Analysis. Taking into account the object of scientific research (ecosystem services of lakes), the aims and objectives of the research, this method is considered the most important method of data collection (obtaining). Sources of data to be collected: national, European Union and international legislation, scientific books and magazines, press publications; official statistics (statistics provided by the Department of Statistics, municipalities, protected areas); official government publications; documents from private, public, professional and other non-governmental organizations. 2. Qualitative content analysis. The analysis material consisted of text obtained using various data collection methods (written surveys, interviews, document analysis, etc.). The text was worked on as the main analytical material and analyzed only in a specific context. The results of the analysis were used to substantiate the results of the analysis. The above analysis was carried out on the basis of methodologically based principles of analysis: 1) reading of text and separation of main aspects (phrases, sentences, words, etc.) and categories; 2) breakdown of categories into elements; 3) subdivision of meaningful elements into sub-categories; 4) including categories in the context of the research phenomenon. 3. Comparative analysis. It allowed researchers to discover differences and similarities not only in the practice of phenomena (eg ecosystem (biodiversity) preservation) in Lithuania, but also in "good practice" examples in different countries. Using this method, it was imperative to deepen / empathize with another cultural perspective to learn to understand the thinking processes of other cultures and see it from the inside, not from the outside (through the eyes of the insider), as well as to evaluate the research phenomena taking place in their country in the eyes of an impartial observer.

Results and Discussion

In scientific literature, the concept of *lake ecosystems* is used to describe the functioning of lakes (flows of energy, nutrients) and sometimes is associated with the benefit to people from the

properties and the processes of ecosystems (food production, sewage storages). *The function of lake ecosystems* is a set of natural processes and components which satisfy human needs without harming lakes (de Groot, 1992). The most important aspects of the environmental protection function of lakes are as follows: 1) regulation (this function more or less regulates the possibilities of lake use in all other areas, i.e. recreation, fishing, communication, etc.; 2) maintenance of living environment stability (this function aims to maintain typical habitat for lake flora and fauna and to ensure their constant abundance and diversity. This is achieved through water quality control and supervision of lake resource usage (de Groot, 2002).

To summarise the definitions given in the scientific literature, *functional usage of lakes* can be described as the use of lake resources for various human needs and maintenance of stability of ecosystems and their services. It has been observed (Daubarienė, 2012) that the majority of studies on lake functions focus on the use of lakes to satisfy human interests. There are almost no studies in which the possibilities of protecting natural ecosystems are attributed to the functions of lakes, although a lake, as a natural ecosystem, performs this as its most important function. The usage of lakes needs to be balanced and coordinated not only for domestic, agricultural, industrial, or recreational purposes, but also for environmental needs. Balancing economic and environmental priorities and meeting the needs of different interest groups can only be achieved through a complex or sustainable management of water resources.

Proper use of lakes is essential to the preservation of lake ecosystems. Misuse of lakes can lead to increased eutrophication processes and extinction of valuable fish or bird species. As a result of improperly selected ecosystem services, lakes can often lose their aesthetic image and value. Essential functions of a lake ecosystem are described in Table 1 below.

It is often impossible to separate one function of a lake ecosystem from another because some activities can be carried out by performing several functions at once. In lakes, it is difficult to separate recreation from transport (the latter is strongly connected to water tourism), industry from energy, and agriculture from domestic use (when performing these functions, the majority of activities are almost identical) (Global.., 2018; Hung, 2005; Scholte, 2016). Notably, resting by the lakeside, swimming, recreational fishing, and sailing on small vessels are currently the most popular uses of lake ecosystem services. *The implementation of these services often does not require huge investments; however, a very clear and logical management framework is needed, which would determine the possibilities and limits of the development of specific lake usage areas.* The importance of ecosystem services for human welfare is certainly unquestionable but has not been fully assessed yet. It has been estimated that Natura 2000, a network of protected sites, generates EUR 200–300 billion annually, while its management costs are only

Table 1

Usage functions of a lake ecosystem
(Beklioglu, 2016; Cunning, 2014; Hamilton, 2013; Millenium…, 2005)

Usage function	Description
Main usage functions	
Nature conservation	Protection of ecosystems (conservation of fauna and flora habitats, promotion of bio-diversity, conservation of habitats for migrating animals, regulation of water, air and microclimate.
Recreation	Resting by the lakesides (camping), swimming, recreational fishery, fishing of crayfish and molluscs, observation of living nature, organization of artistic and religious events, supply of materials for research and awareness-raising.
Transport	Sailing by self-propelled and not-self-propelled vessels
Agriculture and domestic needs	Irrigation and watering (water for fields of crops, kitchen gardens, pastures, recreational places (parks, etc.)) Livestock watering and feeding (forage for livestock: fish, crayfish, molluscs, etc.) Wasteater discharge
Additional usage functions	
Commercial fishing	Fishing, fisheries
Commercial fishing of crayfish and molluscs	Cultivation and sales of crayfish and molluscs
Industry and energy	Water for production, cleaning, cooling, energy generation, etc.

Table 2

Environmental Performance Index Results, 2018 (Environmental.., 2018)

Country	EPI Ranking	Environmental Performance Index	Environmental Health	Ecosystem Vitality
Switzerland	1	87.42	93.57	83.32
France	2	83.95	95.71	76.11
Denmark	3	81.60	98.20	70.53
Malta	4 ...	80.90	93.80	72.30
Lithuania	29 ...	69.33	72.57	67.18
Bangladesh	179	29.56	11.96	41.29

EUR 6 billion a year (about EUR 15 billion of the European agricultural production depends on insect pollinators and about EUR 4.4 billion jobs in the EU directly depend on 'healthy' ecosystems). Such fundamental knowledge, as well as socio-economic assessment of ecosystem services, are necessary for effective environmental protection in order to ensure public welfare.

After the scientific literature analysis, it was found that the Environmental Quality Index of Yale and Columbia Universities was used to assess Lithuania's environmental situation. The index is made up of 9 different environmental indicators and areas of activity, with a score between 0 and 100 for each indicator. According to the data of Lithuania, Lithuania ranks 29th out of 179 countries included in the index (estimate about 69.33) Table 2.

Lithuania's highest performance is dominated by environmental protection (72.57) and ecosystem conservation (67.18). The worst rated is the performance of Lithuanian companies, the public and the government in the areas of fisheries, forestry and agriculture in a sustainable way Table 3 (Environmental Performance Index, 2018).

It should be emphasized that a lot of state organizations and institutions participate in the management of water resources (including lakes) in Lithuania. The Ministry of Environment is the main authority responsible for the management of water resources in the country. Also noteworthy are Joint Research Centre, Lithuanian Geological Survey, Hydrometeorological Service and the Department of Fish Resources. Regional Environmental Protection Departments established in the administrative centers of Lithuania are responsible for the implementation of environmental legislation and policies. Some water management functions are delegated to the Ministry of Health and its subordinate institutions (State Hygiene Inspectorate, Public Health Center, National Nutrition Center). Territorial management of water resources is also conducted in districts and municipalities. Sometimes even the long-term managers of

Table 3

Environmental Performance Index Results (Issue Categories), 2018 (Environmental., 2018)

Issue Categories	Country and Rank			
	Switzerland (1)	France (2)...	Lithuania (29)...	Bangladesh (179)
Environmental Health	93.57	95.71	72.57	77.96
Air Quality	91.06	95.97	77.97	4.12
Water & Sanitation	99.99	97.22	58.51	28.47
Heavy Metals	87.77	83.29	86.63	14.72
Ecosystem Vitality	83.32	76.11	67.18	41.29
Biodiversity & Habitat	84.20	96.25	93.83	53.58
Forests	47.40	25.08	7.75	12.13
Fisheries	-	57.71	57.83	66.86
Climate & Energy	90.55	70.46	62.46	46.95
Air Pollution	98.70	96.82	59.73	40.22
Water Resources	*99.67*	*95.56*	*93.46*	*0.00*
Agriculture	43.87	67.77	62.01	37.82

environmental organizations find it difficult to keep up with the editions of legislation projects and proposals (related to environmental protection), or with the functions performed by the aforementioned institutions. The analysis of the prepared documents on state development and branch strategies, regional policy, and municipal strategic development (related to environmental protection) shows that there is a confusion between numerous priorities and initiatives. Strategic development plans ranging from 85 to 200 pages can be found in each municipality. These plans include a lot of tasks, which vary from the renovation of water and heating networks to the maintenance of tourist attractions and provision of bicycle paths. It may be noted that, when the authorities are lost in the 'overabundance of priorities', the society is also confused about the systems of values and goals (the documents comply with the 'fill in' requirements of the EU, but their practical applicability in a specific territory is forgotten).

Protecting natural water resources is one of the most important tasks today, not only in the European Union, but also in the world. The world is taking not only political but also legal measures to ensure the protection of natural water and biodiversity and our right to clean water resources.

European Union policy has established two very important and main legal frameworks for the protection and management of marine and freshwater resources in the EU – the Marine Strategy Framework Directive and Water Framework Directive. The main target of Water Framework Directive is to prevent and reduce pollution, promote sustainable water use in everyday life, protect and improve the aquatic environment and mitigate the effects of floods and droughts in EU countries. In the EU we have more targeted legal acts (directives) related to water resources protection: the Floods Directive, the Nitrates Directive, the Bathing Water Directive, the Groundwater Directive, the Drinking Water Directive, the Urban Waste Water Treatment Directive and the Environmental Quality Standards Directive (Water protection and management, 2018). The requirements of these legal acts are implemented in the national legislation of the Member States. Member States also regulate the protection and use of water resources in their national legislation by programmes, strategies, action plans and laws. It should be noted that the protection of natural water resources is regulated not only by direct legal regulation of the water resources, but also of other legal acts, which ensure environmental protection, pollution reduction and long-term state members strategies oriented towards sustainable use of natural resources. The table below provides basic legislation in separate states to ensure legal protection of water resources. Examples of various foreign legal documents governing the supervision of water resources (including the supervision of lakes) are described in Table 4.

It should be noted that each lake's shores, area, water, flora, fauna, sapropel, etc. can be used for various purposes (Brink, 2013; Caceres, 2015; Delgado, 2015). Every lake is unique and distinctive because of its ecosystem and its services; therefore, it is possible for one lake to be used in just one

Table 4

Examples of foreign legal documents governing the supervision of water resources
(An introduction., 2008; Danish., 2008; Denmark., 2007; du Bray, 2019; Polhill, 2016)

Documents	Goals and Objectives
Italy	
Regulations for water emergencies	To address water crises, providing technical and financial support for emergency measures.
Law 267/19982 ('Legge Sarno'):	Requires water basin authorities to detect risk areas, set prevention plans and establish regulations to avoid additional risk.
Directive 2007/60/CE implemented in Italy with Decree 152/2006:	Aims to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community.
The Legislative Decree No. 49/2010	Requires flood risk management plans to be established and approved by June 2015 (under implementation).
National Action Plan	To combat drought and desertification includes measures to address water and ground water protection and water efficiency through planning instruments and water protection plans.
National Plan for Biodiversity	Includes measures to address biodiversity protection, including water ecosystems protection.

Documents	Goals and Objectives
Denmark	
Action Plan for the Aquatic Environment III (till 2015)	Contains initiatives for improving the aquatic environment and nature and to reduce agricultural impacts on the aquatic environment and nature.
Water Supply Act (No. 125 of 2017)	To ensure the use and protection of water bodies by implementing a comprehensive planning and following assessment of water supply (quality water supply, environmental protection, conservation of nature, using mineral resources; to coordinate existing water supply for prudent use of water; implementing a planned expansion and operation of adequate and satisfactory quality of water supply; to ensuring quality of drinking water for the protection of human health.
Danish Water Sector Reform Act (2009)	This legal act is regulating municipal water and wastewater utilities as well as private waterworks and requires drinking water and wastewater utilities to collect specific performance parameters, including water loss.
Scotland	
The Water Environment Regulations (2011) and amendments in 2013 and last in the year 2017	This legal act applies regulatory controls over activities which may affect Scotland's water environment.
Water Environment and Water Services (Scotland) Act 2003	This legal act covers protection of rivers, lochs, transitional waters (estuaries), coastal waters groundwater, and groundwater dependent wetlands.
Poland	
Draft National Strategy for Management of Water Resources 2030 (2010)	The strategic goal of implementing an integrated water management system is to provide the population with access to clean and healthy water, and reduce the risks related to floods and droughts.
Water Act (2017)	This legal act regulates water management in accordance with the principle of sustainable development, in particular shaping and protection of water resources, use of waters and management of water resources in Poland.
Lithuania	
The National Sustainable development strategy (2009)	The document sets a long-term objective in the field of Landscape and Biological Diversity 'to preserve landscape and biological diversity, nature and cultural heritage values, promote restoration of damaged natural elements and ensure rational use of landscape and biological diversity'.
Law on protected areas (2011)	The main purpose of the Law: to specify the public relations regarding protected areas, the system of protected areas, the legal basis for the establishment, protection, management and control of protected areas as well as regulates the carrying out of activities therein.
Law on water (2003)	This law regulates the ownership of the internal bodies of water of the Republic of Lithuania, the management, use and protection of their water resources and the rights and obligations of legal and natural persons using internal bodies of water and their resources.
Law on drinking water (2001)	This law establishes the conditions of ensuring the safety and quality of the drinking water.

area and for another one to be utilized for multiple purposes (Reynaud, 2017; Scottish…, 2018). *Factors that are relevant to lake usage are very diverse and may be related to: the morphometric and water mass properties of the lake itself; the lake's geographical position; lake management (ownership) type; anthropogenic activities on the shores of lakes; legal regulation; other factors*. The research has revealed that 80 percent of cultural and active leisure services offered in Lithuania are not adapted for all seasons. The majority of accommodation homesteads offering accommodation near lakes (85%) work only during the warm season. Alternatively, *parallel business (which would help to reduce the seasonality of ongoing activities) related to the services of lake ecosystem* may be offered, such as: business related to biofuel production (recycling of felled reeds, trees, tree branches or tree falls for biofuel); business related to the extraction and use of sapropel (sludge) (fertilizers and substrates, feed additives for birds and livestock,

etc.); business related to the production of building materials (usage of reeds for roofing, usage of sludge for the production of expanded clay, etc.); business related to bio-humus production, etc., but there is a lack of theoretical or practical information on how to apply these alternatives to their farms or homesteads. Recommendations could be the development of educational activities in the municipality, special seminars with good practice examples (not only in Lithuania, but also in foreign countries), provision of specialized informational material which would not only specify the laws or regulations to be followed, but would also provide a summary of detailed information about possible alternative businesses in order to avoid the seasonality of activity and reduce the unemployment rate.

The majority of European countries have already prepared strategies for various sectors focusing on the impact of climate change on biodiversity, including water ecosystems.

Significantly, as a result of climate change, the range areas of different species will change, and some of the species specific to a particular region will also be lost. This is widely discussed in the strategies in other countries. Poland is planning to expand its monitoring system for ecosystem changes, with particular emphasis on invasive species (Poland…, 2011).

A broader monitoring network is also necessary in Lithuania, so that timely measures are undertaken to protect important ecosystems in the event of negative changes. In Ireland, it is estimated that 20 percent of local species will be very vulnerable and no less than 52 percent of species are under threat of extinction before 2050 due to climate change. No such forecasts have been made in Lithuania, but they would contribute to the planning of strategies for the adaptation of ecosystems to climate change. In the United Kingdom, a lot of attention is paid to the restoration of degraded habitats, especially the swamps.

To summarize, the ability of lake ecosystems to adapt to changing climatic conditions can reduce potential losses and even benefit from new climate opportunities. *However, considerations of adaptation methods should not ignore the fact that universal technological adaptation measures that would be appropriate for the entire EU territory do not exist, because different measures are appropriate in different local conditions* (Kairu, 2001; Laas, 2012; Angeler, 2015; Cheruvelil, 2008). In order to plan effective measures, it is necessary to carry out a feasibility study for a specific area and then prepare a project for the implementation of socio-economic measures.

It should be emphasized that effective measures that can be proposed for a large area are related to improving the adaptation environment: preparation of legal framework and funding mechanisms for implementation of adaptation policy, scientific research of sensitivity and vulnerability of various sectors, information, education, risk maps, etc. (Gadkowski, 1980; Heathcote, 2012; Kopf, 2015; Schallenberg, 2013).

Effective measures that can be proposed for a large area are related to the improvement of environment adaptation: preparation of the legal framework and funding mechanisms for the implementation of adaptation policies, scientific research on sensitivity and vulnerability of different sectors, provision of information, education, risk maps, etc. (Karamauz, 2003; Mays, 2001; Polish…, 2013).

Such measures are proposed in national and regional programs and strategies of many countries. Specific measures are usually taken at the local level, e.g. for the coastline, river delta, port, etc.

Conclusions

1. Research on ecosystems and the variety of services they provide is insufficient in Lithuania. One of the reasons is that research must be long-term (for several years), it has to inventorize the ecosystems, assess the quality of their services, establish and support a system for the collection and updating of scientific information about important ecosystem functions.
2. One (rather than 10–12 segmented institutions) institution is required to be responsible at the national level for the regular collection and analysis of ecosystem service data, the development of specialized information systems, and the usage of data for the preparation and coordination of business plans and projects at the national and international levels.
3. In order to preserve the rare fauna of the protected areas, the following socio-economic measures must be applied: promotion of alternative businesses (related to lake ecosystem services) (by reducing the seasonality of the conducted activities); preparation of special free seminars with examples of good practices (not only in Lithuania but also in foreign countries); specialized (according to education, age, performed activities, etc.) distribution of practical information (according to the specifics of actual locations or farms), etc.
4. Currently, there are no common methods that would help to make a qualitative assessment of the impact of changing lake ecosystems on natural resources or individual industries. Therefore, the planning, organization and implementation of adaptation measures for lake ecosystems and the services they provide, including preventive adaptation, are based on nature protection policy while taking into account the specifics of the farm and the local area.

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