

VILNIUS UNIVERSITY

JURGITA DAUBARIENĖ

THE FUNCTIONAL DIVISION OF LITHUANIAN LAKES

Summary of doctoral dissertation

Physical Sciences, Physical Geography (06P)

Vilnius, 2012

The doctoral dissertation was prepared during the years 2007–2012 in Vilnius University.

Scientific supervisor: doc. dr. Gintaras Valiuškevičius (Vilnius University, Physical Sciences, Physical Geography – 06P)

Scientific advisor: prof. habil. dr. Kęstutis Kilkus (Vilnius University, Physical Sciences, Physical Geography – 06P).

The defence of the dissertation will be held in Physical Geography Studies Council of Vilnius University:

Chairman:

prof. dr. Arūnas Bukantis (Vilnius University, Physical Sciences, Physical Geography – 06P);

Members:

prof. habil. dr. Algimantas Česnulevičius (Lithuanian University of Educational Science, Physical Sciences, Physical Geography – 06P);

doc. dr. Donatas Pupienis (Vilnius University, Physical Sciences, Physical Geography – 06P);

dr. Julius Taminskas (Nature Research Centre, Institute of Geology and Geography, Physical Sciences, Physical Geography – 06P);

dr. Jonas Satkūnas (Lithuanian Geological Survey under the Ministry of Environment, Physical Sciences, Geology – 05P)

Opponents:

doc. dr. Darijus Veteikis (Vilnius University, Physical Sciences, Physical Geography – 06P);

prof. dr. Arvydas Povilaitis (Aleksandras Stulginskis University, Technological Sciences, Environmental Engineering and Land Use Management – 04T)

The dissertation will be defended at the public session held by Physical Geography Studies Council at 14 p.m. on October 26, 2012 in the 214 Auditorium of the Faculty of Natural Sciences of Vilnius University. Address: M. K. Čiurlionio st. 21/27, LT-03101 Vilnius, Lithuania.

The summary of dissertation was distributed on September 25, 2012.

The dissertation is available at the libraries of Vilnius University and Natural Science Centres, Institutes of Geology and Geography.

VILNIAUS UNIVERSITETAS

JURGITA DAUBARIENĖ

LIETUVOS EŽERŲ FUNKCINIS SKIRSTYMAS

Daktaro disertacija

Fiziniai mokslai, fizinė geografija (06P)

Vilnius, 2012

Disertacija rengta 2007–2012 metais Vilniaus universitete.

Mokslinis vadovas:

doc. dr. Gintaras Valiuškevičius (Vilniaus universitetas, fiziniai mokslai, fizinė geografija – 06P).

Konsultantas:

prof. habil. dr. Kęstutis Kilkus (Vilniaus universitetas, fiziniai mokslai, fizinė geografija – 06P).

Disertacija ginama Vilniaus universiteto Fizinės geografijos mokslo krypties taryboje:

Pirmininkas:

prof. dr. Arūnas Bukantis (Vilniaus universitetas, fiziniai mokslai, fizinė geografija – 06P);

Nariai:

prof. habil. dr. Algimantas Česnulevičius (Lietuvos edukologijos universitetas, fiziniai mokslai, fizinė geografija – 06P);

doc. dr. Donatas Pupienis (Vilniaus universitetas, fiziniai mokslai, fizinė geografija – 06P);

dr. Julius Taminskas (Gamtos tyrimų centro Geologijos ir geografijos institutas, fiziniai mokslai, fizinė geografija – 06P);

dr. Jonas Satkūnas (Lietuvos geologijos tarnyba prie Aplinkos ministerijos, fiziniai mokslai, geologija – 05P)

Oponentai:

doc. dr. Darijus Veteikis (Vilniaus universitetas, fiziniai mokslai, fizinė geografija – 06P);

prof. dr. Arvydas Povilaitis (Aleksandro Stulginskio universitetas, technologijos mokslai, aplinkos inžinerija ir kraštotvarka – 04T).

Disertacija bus ginama viešame Fizinės geografijos mokslo krypties tarybos posėdyje 2012 m. spalio 26 d. 14 val. Gamtos mokslų fakulteto Didžiojoje auditorijoje (214 kab.).

Adresas: M. K. Čiurlionio 21/27, LT– 03101 Vilnius, Lietuva.

Disertacijos santrauka išsiuntinėta 2012 m. rugsėjo mėn. 25 d.

Disertaciją galima peržiūrėti Vilniaus universiteto ir GTC Geologijos ir geografijos instituto bibliotekose.

INTRODUCTION

Lakes are one of the most essential elements of Lithuanian landscape, forming its aesthetical, recreational, cultural economic, environmental and commercial value, therefore, their suitable usage is very important.

The results of modern research show that lakes have been especially significant for people since the beginning of their settlement in the territory. Not only the territory of lake shores, where the first mounds were established, but also the aquatic part of lakes, where polar villages were built even before 3000 years, were actively used. In ancient times, the settlement near lake helped people to guarantee a more successful food security, to protect their livestock from predators and protect themselves from enemies.

Living conditions, economic and technical level determined the main functional possibilities of using a lake. During initial stage the Lithuanian lakes were usually used as direct potential of natural resources: water was used for drinking, livestock was watered, while the natural shore grasslands implemented the function of pasture, it was actively fished and aquatic animals were hunted in lakes. What is more, lakes often were very comfortable transport means. In order to use the aforementioned functions of lakes, no special preparation was required.

As economy developed and modernization of technology took place, the possibilities of usage of lakes also expanded. At the same time, the structure of functional usage of lake changed dramatically. The functions of lakes as of direct potential of natural resources started to fade away slowly both in the world and in Lithuania. The water of lakes has increasingly been used in industry, energy sector, fields have been started to be irrigated with it. The usage of lakes for commercial fishing, energy production and cooling (by installing power stations), field irrigation, poultry farming, communication and recreation was especially highlighted in Lithuania during Soviet period. It was significantly more difficult to use the mentioned functions than to use the benefits, provided by lakes, directly. One had often to dam, deepen the lakes, to install pump stations or to construct other special equipment near them. Furthermore, commercial fishing often required an artificial stocking of lakes, which stimulated the development of fishery. While using water for industrial needs and in large agricultural companies, the sewage was also sometimes released to lakes.

Recently, the usage of lakes for recreation has significantly increased in Lithuania as well as in most European countries. Under our conditions, this function of lakes has become especially relevant for some reasons. First, Lithuania is quite lakey country, however, its lakes are relatively small, when assessing at international scale, therefore, it is not worth to use their water for large industrial and energy objects and commercial fishing. Second, a significant part of country's lakes is located in the zone of picturesque landscape, they are easy to be accessed, therefore, recreation is to be considered as priority function of their usage. Recreation in lake shores, swimming, recreational fishing, sailing by small boats – currently, these are the most popular methods of using the lakes in Lithuania. The implementation of aforementioned functions often does not require large investments, however, a clear and logical legal mechanism, determining the possibilities and limits of development of specific areas of lake usage, is necessary.

The subject of Research – functions of Lithuanian lakes.

Aim of the Research – to explore the functions of Lithuanian lakes and to classify lake according to functional possibilities.

The goals of the Research:

1. Categorize the functions of Lithuanian lakes;
2. Determine the morphometric parameters of lakes, which could be optimally used in various fields;
3. Assess the functional possibilities of lakes, taking into account the accessibility by roads and structure of shore landscape;
4. Analyze functional possibilities of lakes, present in different river basins, sub-basins and in protected territories;
5. Classify Lithuanian lakes, according to functional possibilities.

Defended statements:

1. It is possible to assess a functional potential of lakes only after carrying out complex research of morphometric parameters of lakes, landscape of lake shores, etc.
2. Using Lithuanian lakes of smaller area, a special significance is gained by accessibility by roads and landscape of lake shores.
3. The spectrum of functions of bigger area Lithuanian lakes and lakes presented near residential areas, in protected territories to be optimised.

Scientific Novelty of Research and Significance

The theme of paper is a new one in Lithuania – functional complex categorization of lakes has not been analyzed yet. The present paper for the first time: 1) categorizes the functions of lakes in Lithuania, 2) determines the lakes with certain morphometric parameters that are most suitable to be used in various fields, distinguishes the key issues of using a lake, related with lake functions and morphometric parameters; 3) the possibilities of accessibility of lake by roads are explored; 4) the peculiarities of landscape structure of lake shores are identified and the possibilities of lake usage are assessed, taking into account the accessibility by roads and shore landscape; 5) the possibilities and problems of using the lakes, present in different river basins and sub-basins, are determined; 6) determines the peculiarities of using the lakes, located in protected territories, and distinguishes the main usage problems; 7) lakes in Lithuania have been classified, according to possibilities of functional usage, for the first time.

Relevance and Adaptability of Research

A suitable usage of lakes is especially important, seeking to preserve the ecosystems of lakes. Eutrophication processes may become more intensive, valuable fish species, birds may become extinct in lakes due to unsuitable usage. Due to incorrectly selected functions lakes often lose their aesthetical image and value. The present paper analyzes the current usage of Lithuanian lakes, determines the problems of usage of lakes and identifies their solutions. What is more, the discussed problems are relevant, seeking to optimize the usage of lakes in Lithuania – to improve legal acts, related with usage of lakes, regulations of protected territories as well as management plans of river basins. Therefore, the present paper may be relevant to Water Department of Ministry of Environment, Departments of Environmental Protection Agency, related with river basin management and lake protection, State Service for Protected Areas.

Extent and structure

The doctoral dissertation is composed of: an introduction; seven main chapters; conclusions; a list of references; a list of individual publications on the dissertation subject; and an annex. The dissertation comprises 184 pages. It contains 27 tables, 30 figures and 236 references to literary sources.

Approbation of Results

The results of dissertation were presented in 4 international and 2 republican scientific events: in international scientific conference “Current issues and perspectives of natural sciences” (Šiauliai, 16th of May, 2008); international scientific conference “Economic development: problems and solutions” (Rezekne, Latvia, 15th of April, 2010); 13th conference of young Lithuanian scientists “Science – the future of Lithuania” (Vilnius, 25th of March, 2010); international conference “XXVI Nordic Hydrological Conference Nordic Association For Hydrology” (Riga, Latvia, 9–11th of August, 2010); 14th conference of young Lithuanian scientists “Science – the future of Lithuania” (Vilnius, 14th of April, 2011); 8th international scientific conference “Environmental engineering” (Vilnius, 19–20th of May, 2011).

Publications

2 articles on the theme of dissertation were published in refereed scientific journals, 5 articles were published in publications under review. Moreover, 1 conference thesis was published.

Acknowledgement

The author of dissertation would like to thank all persons and organizations, which helped to prepare this paper. The author would like to thank the academic supervisor the associate professor Dr. G. Valiuškevičius, scientific advisor Prof. Dr. hab. K. Kilkus, team of Department of Hydrology and Climatology of Vilnius University for advice and assistance, while preparing the dissertation paper. The author of paper would like to thank N. Misiūnas, the project manager of Landscape and Spatial Planning Division of State Land Fund for consultations, D. Baumilienė for edit of dissertation text, as well as the Planning and Cadastre Division of State Service for Protected Areas, Pollution and Waste Management Department of Environmental Protection Agency for presented data, which were useful for preparation of dissertation. The author would like to thank administration and colleagues of Utena College, as well as family, friends – for understanding, assistance and support in preparation of paper.

METHODS AND DATA OF RESEARCH

The present paper analyzes the functional categorization of Lithuanian lakes, bigger than 0,5 ha. These lakes were selected due to higher level of their research – a sufficient amount of morphometric and other data about these lakes has already been collected.

There are 2835 lakes, bigger than 0.5 ha, in Lithuania. Since there is a great number of lakes, in order to distinguish their patterns, lakes were grouped into 7 area classes: 0.5–1 ha; 1.1–5 ha; 5.1–10 ha; 10.1–50 ha; 50.1–100 ha; 100.1–500 ha; >500 ha.

Following Lithuanian legal acts and papers of scientists from various countries **morphometric parameters, which are important for usage of lakes** in main and additional functions, were identified, it was determined by what morphometric parameters characterized lakes are the most optimum to be used in various fields: nature conservation, recreation, communication, commercial fishing, industry and energy, agriculture and home. The morphometric parameters, used in the present paper, were taken from the Catalogue of Lithuania SSR lakes (1964), while bathymetric parameters were taken from list with bathymetric data (1964). After analyzing the usage of lakes in different fields in Lithuania, the key problems, related with functions of lakes and usage of lakes with different morphometric parameters, were identified.

One of tasks of paper was to find out **the possibilities of accessing the lakes by roads of various types**, what is essential, while using lakes in various fields. In order to determine the accessibility of lakes, ArcGis10 software was used. It was worked with GDB10LT database (updated in January, 2008). The data of lakes was taken from layer “Areas”. The lakes were separated from artificial water container facilities, bigger than 0,5 ha lakes were selected and grouped into 7 area classes. This layer of lakes was recovered with layers of “Roads” and “Railways”. The roads of five types were distinguished, i.e., those, which are specified in “Roads” and “Railways” layers: K_I – motorway, highway, K_{II} – asphalted road, K_{III} – gravelled road, K_{IV} – unsurfaced road, K_V – railway.

Seeking to assess the accessibility of lakes by roads of various types, search for roads was implemented at the radius of 10, 50, 100, 200 and 500 metres around lakes. Buffers were drawn around the explored lakes and the search for roads of mentioned

types was implemented there. The results of searches were systemized and analyzed. The possibilities of accessibility of lakes from different are classes by various types were identified, the factors, conditioning the accessibility, were determined. The paper looked for relations among lake accessibility by roads and lake area, landscape of lake shores, number and distribution of roads in the Republic of Lithuania.

The paper sought to determine **the landscape structure of various size shores of Lithuanian lakes**. The distribution of forests, swamps, grasslands, residential areas and other landscapes (garden arrays, rivers, streams, channels, drainage ditches, lakes, pools, ponds) in lake shores was analyzed. These landscapes were analyzed in buffers, drawn at the radius of 500 m around lakes. Forests, swamps, residential areas and other landscapes were taken from GDB10LT layer “Locations”. After drawing the buffers of 500 m radius around lakes, the area of forests, swamps, residential areas and other landscapes was calculated.

Since lakes are not necessarily surrounded by landscape of only one type, the paper also determined what combinations of landscape elements prevail in different lake area classes. As layers of landscapes and lakes were re-covered, the lakes, near which there are forests, swamps, etc., were selected. These data was processed by *SPSS Statistics* and it was determined that the shores of explored lakes are surrounded by the following combinations of landscape elements: forest; forest, swamp; forest, grassland; forest, grassland, residential areas; swamp, residential areas; residential areas (villages, towns). It was examined, how the explored lakes are distributed, according to the surrounding combinations of landscape elements, what is the most popular combination of landscape in the shores of explored lakes. A typical landscape structure of 500 m shore line of smaller than 50 ha and bigger than 50 ha Lithuanian lakes was determined.

Seeking to determine **the structure of residential areas** of shores of various size Lithuanian lakes (at the radius of 500 m), the spread of various size residential areas in lake shores was analyzed. For this purpose GDB10LT layer “Areas” was used, from which residential areas were selected. Residential areas of 6 types were distinguished, which are presented in the latter layer: G_{1000} – towns and villages with population of 1000 and more, G_{500} – towns and villages with population of 500–999, G_{100} – towns and villages with population of 100–499, G_{20} – towns and villages with population of 20 – 99, G_0 – towns and villages with population of up to 20, G_M – cities – capital, centres of

districts. As the layers of residential areas (selected from layer “Locations”) and lakes (from layer “Areas) were re-covered, searches at the radius of 500 m around lakes were implemented. The results of searches were analyzed and it was determined how various residential areas distribute near different size lakes.

The search for lakes at the radius of 10 km from 15 largest Lithuanian cities (with more than 25 thousand residents) was implemented, by re-covering the layers of lakes and residential areas in ArcGIS. Seeking to identify the extent of anthropogenic loads, the index of anthropogenic loads *AAR*, defining, how many residents (potential holidaymakers) are for 1 ha of lakes, was calculated:

$$AAR = \frac{g * 0,55}{\sum f_{10}}$$

where: $\sum f_{10}$ – total area of lakes, present at the radius of 10 km around city, ha; *g* – number of residents in a city; 0.55 – coefficient. (The assumption of this coefficient is based on Consent to Pay Study in Neris and Nevėžis Sub-basins, performed by Center for Environmental Policy, where it was assessed that approximately 55 % of respondents have rest near water in one way or another).

Seeking to assess the possibilities of using the lakes of each area class, taking into account the lake accessibility by roads and structure of shore landscape, a complex indicator of lake usage (*EP*) was calculated:

$$EP = (K * 10) + P + G - PE - M$$

where:

K – average number of roads; average area of residential areas (*G*), grasslands (*P*), swamps (*PE*), forests (*M*) (ha) for 1 km shore line of lakes (at the distance of 500 m from lake shore); 10 – coefficient (the latter was introduced, taking into account the importance of roads in usage of lakes).

The higher is *EP* indicator, the greater are the possibilities of using the lakes: *EP* < than 20 - the possibilities of using the lakes are very limited; *EP* – 20–40 - limited; *EP* – 40–60 – average; *EP* – 60–80 – good; *EP* > 80 – very good. The latter indicator was used for assessing the possibilities of using the lakes of all area classes.

The paper sought to determine **the possibilities of using the lakes, present in different river basins and protected territories, in various fields**. Since river basins

and sub-basins are quite different, according to number and relative basin of lakes, first of all, they were divided into three groups. It was determined, in what river basins and sub-basins there are most lakes, possible to be used in recreational and commercial fishing, sailing by various sailing means, in recreation and other fields.

All river basins and sub-basins are divided into 3 categories, according to the possibilities of using the lakes, present in them, the sub-basins, characterized by the greatest possibilities of using the lakes, present in them, are distinguished. At the same time the basins and sub-basins, where the usage of lakes does not correspond with their purpose, is not balanced and uncoordinated in domestic, agricultural, industrial, recreational and nature conservation fields most, are revealed.

The present paper assessed the possibilities of using the lakes, present in protected areas. While writing the paper, the following problem was faced – there are no lakes, bigger than 0.5 ha, in protected territories. It was found out how many and what lakes are present in different types of protected territories in ArcGIS software by recovering the layers of “Lakes” (taken from GDB10LT land use layer “Areas”) and “Protected territories”). The paper discussed how many lakes are present in different protected territories and how they distribute by size. The relative basin of protected territories was also calculated. Following legal acts and scientific literature, the usage of lakes, present in protected territories, in various fields – recreation, recreational and commercial fishing, sailing by various sailing means (the lakes, present in protected territories, were grouped into three levels, according to possibilities of using the sailing means), industry – was analyzed. The possibilities of using the lakes were provided, taking into account the current usage of lakes, morphometric parameters of lakes and type of protected territories.

CATEGORIES OF LAKE FUNCTIONS

In the present paper the functional usage of lakes is considered as usage of lakes in various fields, therefore, it was necessary to determine, what functions currently best meet the purpose of Lithuanian lakes. By distinguishing the functions of lakes it was attempted to use the most often presented classification versions of foreign and out researchers by coordinating them with the most popular activities in Lithuanian lakes.

Table 1. The categories of lakes function

The category	The function	The area of activities	The importance of the function
I	Conservation	Protection of ecosystems	Basic functions of lakes
	Recreation	Rest on lake shores	
		Swimming	
		Recreational fishery	
II	Communication	Sailing by non self-propelled sailing means	
		Sailing by self-propelled sailing means	
III	Commercial fishing	Fishing, pisciculture	Additional functions of lakes
	Industry and energetics	Extraction of energy Cooling Water usage in production processes	
	Agriculture and domestic use	Production of drinking water Irrigation, watering Wastewater discharges Livestock watering	

The most important six functions of Lithuanian lakes are the following: nature conservation, recreation, communication, commercial fishing, industry and energy, agriculture and domestic needs. According to importance, the functions of lakes were grouped to main and additional ones. When categorizing the functions of Lithuanian lakes, the most important ones were considered those, which have the lowest and the most easily managed impact on lake ecosystem, i.e., nature conservation, recreation and communication (water tourism). All others are additional ones. According to effectiveness, functions were divided into three categories – I – nature conservation and recreation, II – communication and commercial fishing, III – industry and energy, agriculture and domestic needs.

IMPACT OF MORPHOMETRIC INDICATORS ON FUNCTIONAL POTENTIAL OF LAKES

One of tasks of research was to determine by what morphometric parameters characterized lakes it is optimum to use in various activity fields.

It was determined that morphometric parameters are significant for possibilities of lake usage in all researched fields.

Nature conservation function is implemented by all lakes, irrespective of their morphometric parameters, since no matter, in what fields the lake is used, it must be coordinated with conservation of resources. Therefore, nature conservation function is relevant to lakes with any morphometric parameters.

The lakes with various morphometric parameters could be used for recreation, since recreation itself is very wide and includes many activities. Morphometric parameter of lakes – shore line length – is important for planning recreational resources, structured and equipment. A shore line of smaller than 50 ha lakes is shorter than 3 km, therefore, their recreational infrastructure is characterized by limited possibilities. The best conditions for development of recreational infrastructure are near bigger than 100 ha lakes, which shore line length is about 11 km on average (147 lakes). There are more favourable conditions to develop recreational infrastructure near lakes of bigger area, what provides conditions for mass recreation. About 22 % of researched lakes are of possible very intensive or intensive usage for mass recreation.

For passive recreational activity – environmental monitoring – the attractiveness of lakes is important, which is relatively reflected by morphometric parameters of lakes – number of islands and tortuosity of shore line. There are 262 islands in explored lakes, the total area of which is 615.7 ha. More than 90 % of islands are in bigger than 100 ha lakes. As lake area increases, the Nagel ratio (N), showing the tortuosity of shore line, also increases. $N = 1.17$ of 5.1–10 ha lakes; $N = 2.6$ of bigger than 500 ha lakes. Thus, in respect of number of islands and tortuosity of shore line, the most attractive for recreation are bigger than 100 ha lakes.

The morphometric parameters as shallow width, nature of lake shore and lake bed, which are important, when using the lakes for swimming, depend on lake origin. It is determined that the most attractive for recreation are the lakes with complex basins

due to abundance of islands and peninsulas, tortuous shores, wide shallows. The least attractive are shallows of glacial lakes, since they are often surrounded by swamps and moors.

Area and average depth of lakes are important for using the lakes in fishing, since they determine the prevailing fish species. Smelt, vendace (whitefish) – the most valuable lake fish – prevail in 100 ha and deep lakes (average depth is more than 10 m). There 27 such lakes in Lithuania. Among bathymetrically explored lakes there are 150 lakes of 20–100 ha area and 4–10 m average depth, where are many bream, pike, perch. Small and shallow lakes are less valuable due to prevailing low-value fish species (perch, crucian carp). Bigger than 50 ha lakes are the most attractive for commercial fishing. There are 287 such lakes in Lithuania (10 % of explored lakes).

Lake area is important parameter for sailing by various sailing means. In Lithuania it is allowed to sail by self-propelled sailing means in bigger than 10 ha lakes, i.e., 33 % of explored lakes (943 lakes); if a lake bigger than 200 ha (80 lakes), it is allowed to sail by more powerful self-propelled sailing means, while in bigger than 500 ha lakes water motorcycles can be used (9 lakes).

In Lithuania, lake water is used in the following water sectors: utility, industry, agriculture, energy and fishery. While supplying water for industry the most important morphometric indicator is the volume of lake water, which is closely related with the area and depth of a lake. The biggest, bigger than 500 ha lakes may be used in the most rational way for water usage for energy needs. There are 32 lakes, and the volume of 2 824,037.9 thousand m³ water volume (on average 88,251.18 thousand m³ water in each). On the other hand, these resources are especially localized, therefore, higher investments to ecologic measures should be made in case of intensive their usage. All bigger than 5 ha lakes could be used in all other industries (in total 1,283 lakes).

It is determined that lake area is the most important morphometric parameter, describing optimum possibilities of functional usage of lakes.

Five problem groups were identified in usage of lakes. They are related with morphometric parameters of lakes and functions of lakes. First of all, wastewater release to lakes. It should not be a function of lakes, developed in the future, especially in lakes of small area (< 100 ha). Wastewater is released to 14 lakes (from 149 lakes; 10 %), which are bigger than 100 ha and valuable for development of fishing function. In the

lakes of bigger area (> 100 ha) more attention should be paid on tests of water quality in places, where wastewater is released. It is necessary to monitor the conditions of water of these lakes constantly and in case of changes, to provide measures to eliminate them or to give up this activity.

Table 1. The most important morphometric indicators, determining the possibilities of usage of functional potential of lakes, and optimum values of these indicators (f – lake area, h_{vid} – average depth, l – lake shore length, l_a – average shallow area, W – water volume, N – tortuosity of shore line, k_I – number of islands)

The function	The area of activities	The most important morphometrics parameters	Optimally morphometrics parameters
Conservation	Protection of ecosystems	All	All
Recreation	Rest on lake shores	f, l, l_a, k_I, N	$f > 100$ ha; $l > 10$ km
	Swimming	f, h_{vid}, l, l_a	$f > 100$ ha; $l_a > 10$ m;
	Recreational fishery	f, h_{vid}	$f > 20$ ha; $h_{vid} > 4$ m
	Mass recreation	f, N, l	$f > 100$ ha
Communication	Sailing by non self-propelled sailing means	f	$f > 0.5$ ha
	Sailing by self-propelled sailing means	f, h_{vid}	$f > 100$ ha, $h_{vid} > 6$ m
Commercial fishing	Fishing, pisciculture	f	$f > 50$ ha
Industry and energetics Agriculture and domestic use	Extraction of energy Cooling	f, W, h_{vid}	$f > 500$ ha $W > 30,000$ thou.m ³
	Production of drinking water Irrigation, watering Wastewater discharges Livestock watering		$f > 100$ ha $W > 30,000$ thou.m ³

Similar problems exist in case of using the lakes in various industries. There are almost no data about impact of specific industrial companies on water ponds, therefore tests of lakes, the water is taken from, should be carried out, the condition of lakes should be monitored, in case of changes, measures to eliminate them should be provided or the activity should be given up.

One more activity, which, according to research of foreign researchers, is harmful to lake ecosystems is the use of self-propelled sailing means in lakes. No research has

been carried out in Lithuania, which would help to determine the damage of these sailing means to lakes, to ground, in lakes of what morphometric parameters and means of what power could be used. It is worth noting the sailing by water motorcycles, since legal acts allow sailing by increasingly more powerful means, and their number is not limited. Since sailing by water motorcycle is allowed only in few lakes, their concentration during season appears. Therefore, the research on impact of self-propelled sailing means on lakes should be carried out and, taking into account the obtained results, the sailing by water motorcycles should be limited.

As lake area increases, the possibilities of their usage in various fields also expand – new functions appear. It is especially truth for bigger than 100 ha lakes. Abundance of various activities starts affecting negatively the development of the most important functions of lakes (recreation, swimming, recreational fishing). The activities, developed in the biggest Lithuanian lakes should be reviewed and arrange them, according to the following priorities: recreation, swimming → recreational fishing → communication → additional functions.

IMPACT OF LAKE ACCESSIBILITY AND SHORE LANDSCAPE ON THEIR FUNCTIONAL USAGE

The possibilities of using the lakes increase along with lake area, however, it is also necessary to consider the accessibility and landscape of lake shores.

The accessibility of lakes by roads is especially relevant to holidaymakers, fishermen and other lake users. The possibility to approach the lake shore is particularly appreciated. For example, for those, wishing to sail by sailing means, it is very important to approach the lake as close as possible, in order to lower the sailing mean to water.

The results of the research showed that not all the explored lakes can be accessed closer than at a 500 m distance to the lake shore. 1,441 lakes (i.e. 51 % of total explored lakes) can be reached at such a distance. 5,366 road sections of various types were found near explored lakes. Near one lake there are 1.9 of roads on average. It was noticed that the accessibility of lakes increases, if the lake area category is bigger, there are more lakes which can be reached closer than 500 m. Near smaller than 10 ha lakes there are 1–1.6 of roads, while near bigger than 100 ha lakes – about 6 roads (Table 2). The

research data shows that unsurfaced roads (69.4 % of all lakes can be reached by these roads) and gravelled roads (57.6 %) predominate. Only 1.4 % of explored roads are accessed by motorways and highways. It is caused by the fact that there are more asphalted roads, unsurfaced roads and gravelled roads in Lithuania, while there are only few motorways and highways.

Table 2. Average number of various type roads in different classes of lake area

Class of a lake area, ha	Type of road					Total
	Asphalted road	Motorway	Railway	Unsurfaced road	Gravelled road	
0.5–1	0.16	0.01	0.04	0.46	0.33	1.00
1.1–5	0.25	0.01	0.04	0.47	0.30	1.07
5.1–10	0.36	0.01	0.06	0.64	0.56	1.63
10.1–50	0.64	0.00	0.11	1.17	0.85	2.78
50.1–100	0.96	0.02	0.11	1.49	0.96	3.54
100.1–500	1.64	0.03	0.15	2.36	1.47	5.66
> 500	1.47	-	0.28	2.63	1.75	6.13
Total	0.44	0.01	0.07	0.80	0.57	1.89

The possibilities of usage of small lakes (< than 50 ha), present in forests and grasslands, are largely dependent on their accessibility by roads. The best accessibility is of lakes, present in residential areas or near them, thus, their usage possibilities increase even more.

It was revealed that lake accessibility is determined by two groups of factors – internal factors, related with lake features (lake area and lake shore length, surrounding landscape, functional usage of lake), and external factors, which do not depend on lake features (number and distribution of certain type roads in the territory of Lithuania).

It was determined that the landscape structure of Lithuanian lake > 0.5 ha (at the radius of 500 m from its shore) is the following: 60 % grasslands, 36 % – forests, 3 % – residential areas, 0.1 % – swamps and 1 % – other landscapes.

It was noticed that the landscape structure of smaller than 50 ha lakes and bigger than 50 ha lakes differs insignificantly. In comparison with smaller lakes, a larger area of shores of bigger lakes is occupied by grasslands and swamps. In case of landscape structure of shores of smaller lakes, there are more elements of other landscape – garden arrays, streams, channels, drainage ditches, ponds. The change of forests is also noticed

– the areas of forests in shores of smaller than 50 ha lakes are larger than in shores of bigger than 50 ha lakes. This pattern was determined by the fact that more lakes are present in forests, i.e., they are surrounded one type of this landscape.

Among bigger (bigger than 50 ha) lakes there are a few lakes, surrounded only by one type landscape element, therefore, the accessibility of lake itself and, thus, its usage possibilities increase. The landscape in shores of bigger lakes is more diverse, consisting of 3–4 landscape elements.

The most popular landscape combination in shores of explored lakes – “forest, grassland, residential areas”, which surrounds 65 % of all lakes. At 500 m line of 13 % of lakes there are forests, 9.3 % – residential areas, and 9.1 % – “forest, grassland, swamp, residential areas”.

Table 3. Distribution of number of lakes with different area, according to combination of surrounding landscape elements, in percent.

Combinations of landscape types	Area of lakes, ha						
	0.5–1	1.1–5	5.1–10	10.1–50	50.1–100	100.1–500	> 500
Forests	35.6	25.9	12.2	8.7	6.5	0.0	0.0
Forests, swamps	0.9	2.3	1.4	0.2	0.0	0.0	0.0
Forests, grasslands, swamp, populated areas	3.0	2.9	5.0	5.9	6.5	13.5	26.9
Forests, grasslands	2.7	2.3	4.1	5.9	1.9	4.5	0.0
Forests, grasslands, populated areas	38.3	49.1	63.3	69.4	78.5	80.2	73.1
Swamps, populated areas	0.6	0.2	1.4	0.8	0.9	0.0	0.0
Populated areas	18.9	17.3	12.7	9.1	5.6	1.8	0.0
Total	100	100	100	100	100	100	100

The present paper sought to determine the spread of residential areas in shores of various size Lithuanian lakes (at the radius of 500 m), since lakes, present near residential areas, are intensively used for recreation, wastewater is released to them, while agricultural utilities increase the inflow of biogenic deposits to ponds. Therefore, more attention should be paid on nature conservation function in case of lakes, present near residential areas.

It was revealed that near 51 % (1,456 lakes) of explored lakes there are some residential areas at the radius of 500 m from lake shores. As the class of lake area increases, the number of lakes, near which there are residential areas at the distance of 500 m from shore, also increases.

Most lakes (50 %) are present near small villages with less than 20 residents. This fact is influenced by number of these villages in Lithuania – there are 8,640 villages, what is 34 % of total number of residential areas. Although residential areas are found near half of all explored lakes, the area, occupied by them in lake shores, is very small and form only 3 % of area of lake shores (at 500 m distance from lake).

The search for lakes, present at the radius of 10 km from 15 largest Lithuanian cities (with more than 25 thousand residents), was implemented in the present paper. Seeking to identify the extent of anthropogenic loads, the index of anthropogenic loads AAR, defining, how many residents (potential holidaymakers) are for 1 ha of lakes, was calculated. It varies from 2 to 12,418 persons / 1 ha. High number of lakes around cities does not guarantee a low AAR – the area of lakes around cities is also important. For example, there are 8 lakes near Panevėžys, however, they are very small – up to 5 ha. These lakes are not most attractive for recreation or fishing. 4,587 residents are for 1 ha of lakes. Similar situation is near Kaunas (AAR – 1,299) and Klaipėda (1,548). The lowest anthropogenic loads are experienced by lakes around Visaginas (2), Utena (8), Telšiai (20), Šiauliai (40), Ukmergė (45).

It was revealed that in case of small lakes (<50 ha), in the shores of which the forests and grasslands prevail, only the main lake functions and activity fields – recreation, fishing, sailing by various sailing means – are often developed. Therefore, these lakes meet their real purpose. In case of lakes of bigger area and lakes, present near residential areas, more additional functions are implemented – lake water is used for domestic needs, different economy sectors, wastewater is released to them. Thus, these are the most vulnerable lakes in Lithuania.

The possibilities of using the lakes (EP) in each class of lake area are defined by possibilities of lake accessibility by roads and landscape, surrounding the lake. The higher is EP indicator, the greater are possibilities of using the lakes.

Table 4. Possibilities of functional usage of lakes (EP) of different classes of area, considering lake accessibility by roads and landscape structure of lake shores.

Area of lakes, ha	Average number of roads per 1 lake	Landscape area (500 m radius from the shore) ha per 1 km lake shoreline				EP
		Forests	Swamps	Grasslands	Populated areas	
0.5–1	1	73.8	0.1	99.1	5.7	41.0
1.1–5	1.07	69.2	0.0	96.8	5.5	43.7
5.1–10	1.63	55.9	0.1	69.1	4.4	43.9
10.1–50	2.78	35.8	0.0	54.6	3.2	49.8
50.1–100	3.54	23.4	0.1	44.2	3.0	59.1
100.1–500	5.66	22.2	0.1	49.1	2.8	86.3
> 500	6.13	25.3	0.1	61.0	1.8	98.7

As the class of lake area increases, the possibilities of using the lakes also increase, taking into account the landscape of lake shores and lake accessibility by roads (Table 4). Smaller than 100 ha lakes are characterized by average possibilities of using the lakes. The usage of these lakes is decreased by larger forest areas and poorer accessibility by roads. The possibilities of using bigger than 100 ha lakes are very good. These are the lakes most attractive in recreation, recreational fishing, due to valuable fish species that prevail there. They are characterized by the greatest possibilities to sail by various sailing means, therefore, they are also important for communication. Neither landscape, nor communication decreases the possibilities of using the aforementioned lakes.

POSSIBILITIES OF FUNCTIONAL USAGE OF LAKES IN RIVER BASINS AND PROTECTED TERRITORIES

All river basins and sub-basins could be grouped into three groups, according to the number of lakes:

I) sub-basins, where there are > than 500 lakes – these are sub-basins of Šventoji, Žeimena and small tributaries of Nemunas. There are 60 % of all bigger than 0.5 ha Lithuanian lakes;

II) sub-basins, where there are 100–500 lakes – these are sub-basins of Dauguva, Merkys, Šešupė. There are 28 % of all bigger than 0,5 ha Lithuanian lakes.

III) basins and sub-basins, where there are < 100 lakes (other basins and sub-basins). There are 12 % of bigger than 0.5 ha Lithuanian lakes.

River basins and sub-basins are grouped into six ranks, according to attractiveness to recreation. Sub-basins of Šventoji, Žeimena and small tributaries of Nemunas are the most attractive in respect of recreation, since there are many official bathing places (in comparison with lakes of other sub-basins), they are attractive in the fields of water tourism, recreational fishing. These sub-basins are attributable to first rank, according to attractiveness to recreation.

Table 5. The most attractive river basins and sub-basins for recreation (A – Most of the official baths in the lakes; B – appointed national water tourism route; C– abundance of lakes which dominated by valuable species of fish; D – abundance of lakes which is the possibility to use the self-propelled sailing means; E – abundance of lakes which is the possibility to use the motorcycles; F – abundance of lakes suitable for mass recreation)

<i>Rank of recreational attractiveness</i>	<i>River basins and sub-basins</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
1	Šventoji						
1	Nemunas						
2	Žeimena						
3	Dauguva						
4	Neris						
5	Šešupė						
6	Dubysa						
6	Minija						
6	Jūra						

There are few official bathing places in Žeimena sub-basin, therefore, it is attributable to lower position than mentioned sub-basins (rank 2) in respect of recreation. The lakes of basin of Dauguva tributaries (rank 3) are attractive in the fields of water tourism and recreational fishing, there are the greatest possibilities to use water motorcycles. The lakes of sub-basin of small tributaries of Neris (rank 4) are also attractive for water tourism and there are many official swimming places. Šešupė sub-basin is attributable to rank 5 due to abundance of lakes, which are attractive in respect of fishing. Other sub-basins (Dubysa, Minija, Jūra) have rank 6 due to national water

tourism routes, installed therein. All other basins and sub-basins have not been mentioned and ranked due to low number of lakes therein.

However, the attractiveness of lakes of Šventoji, Žeimena, Nemunas, Neris sub-basins and Dauguva basin in recreation is minimized by human economic activity and unsuitable usage of lakes (water usage in industries, wastewater release). Here lakes are the most vulnerable due to the greatest possibilities of usage for mass recreation (especially in sub-basin of small tributaries of Nemunas) and for sailing by self-propelled sailing means.

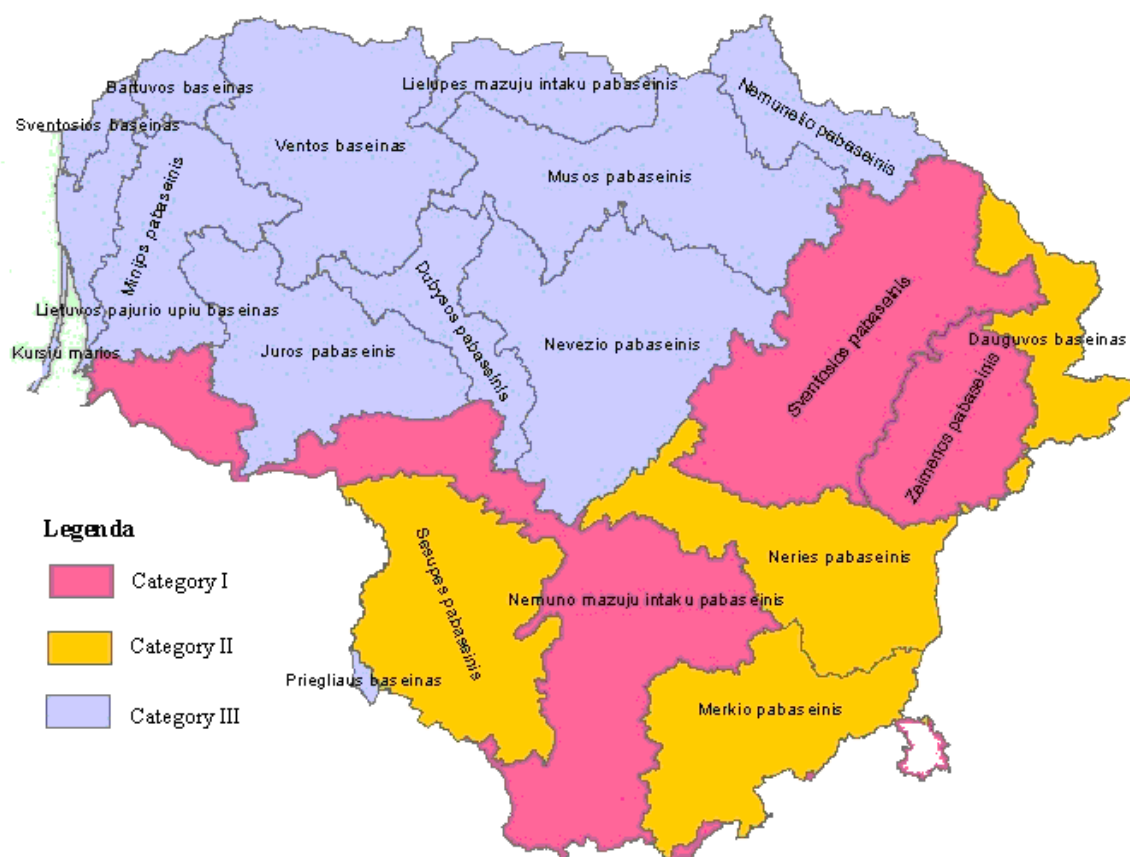


Fig. 1. Categorisation of river basins and sub-basins by possibilities of using the lakes

According to possibilities of using the lakes, all river basins and sub-basins can be divided into the three categories (Fig. 1):

I) river basins and sub-basins, characterized by the greatest possibilities of using the lakes therein, i.e., sub-basins of Šventoji, Žeimena and Nemunas small tributaries. The lakes, located there, are widely used in recreation, fishing, sailing by various sailing

means, etc. It is determined by abundance of lakes, present in these sub-basins (> than 500 lakes in each) and number of big, bigger than 100 ha lakes (60 % of all bigger than 100 ha lakes);

II) river basins and sub-basins, characterized by average possibilities of using the lakes therein, i.e., sub-basins of Dauguva, Neris, Merkys and Šešupė. There are more than 100 lakes in each sub-basin and almost 7 % of bigger than 100 ha lakes;

III) river basins and sub-basins, characterized by very low possibilities of using the lakes therein (other basins and sub-basins). There are < than 100 lakes and only 1 % of bigger than 100 ha lakes.

From all sub-basins one could distinguish the sub-basins of Šventoji, Žeimena and small tributaries of Nemunas, which are characterized by the greatest of using the lakes therein. However, the more lakes are in basin or sub-basin, the greater are the usage possibilities in various fields. While managing water resources in aforementioned sub-basins, it is necessary to balance and arrange water usage for domestic, agricultural, industrial, recreational and nature conservation needs.

The lakes in **protected territories** are used in the same fields as the ones in unprotected territories, however, there is an increasing number of restrictions. The possibilities of using the lakes in various fields depend not only on area, but also on status of protected territory or functional zone in protected territory (economic, recreational, conservative, etc.).

The highest possibilities to use the lakes of protected areas are in recreation – rest, fishing and sailing by non self-propelled sailing means. One of the most restricted activities is sailing by self-propelled sailing means. It is determined that the activities as wastewater release to lakes and usage of lake water in various economic sectors, are implemented in lakes in regional and national parks and state reserves. These are the activities that should be given up. Of course, the possibilities of using the lakes increase together with lake area, therefore, the greatest possibilities are to use bigger than 500 ha lakes, present in recreational and economic functional zones in national and regional parks.

Type of protection territory	Groups of lake area		<u>Lake functions and activities in them.:</u>
	< 50 ha	> 50 ha	
Recreational and economics functional areas of National and Regional parks	EA R MŽ PN PS ŽŪB P NI	EA R MŽ VŽ PN PS ŽŪB P NI	EA – preservation of ecosystems R – recreation (rest, swimming) MŽ – recreational fishery PN – sailing by non self-propelled sailing means PS – sailing by self-propelled sailing means VŽ – commercial fishery ŽŪB – water usage for domestic needs and agriculture P – lake usage for industry E – lake usage for energetics NI – wastewater discharges
Biosphere Polygons Biosphere Reserves National sanctuaries	EA R MŽ PN ŽŪB NI	EA R MŽ VŽ PN PS ŽŪB NI	
Conservation and protective functional areas of National and Regional parks Nature Reserves	Limited usage EA		

Fig. 2 Possibilities of using the lakes depending on type of protected territory and lake area.

CLASSIFICATION OF FUNCTIONAL USAGE OF LITHUANIAN LAKES

One of the tasks of present paper was to classify Lithuanian lakes, according to possibilities of their functional usage, in a complex manner. However, before classifying, it was important to determine the impact of lake area, landscape of lake shores and status of territory protection as well as lake accessibility by roads on development of spectrum of potential lake functions selection (fig.3).

The main factors, determining the functions of using Lithuanian lakes, can be divided into some ranks. The most important factors (of rank 1), having the greatest impact on limits of potential possibilities of using a lake, are considered to be lake area and landscape of lake shore. The spectrum of possibilities of functional usage of lakes

expands as lake area increases and landscape of lake shores changes in the following sequence: swamp → forest → grassland → residential areas.

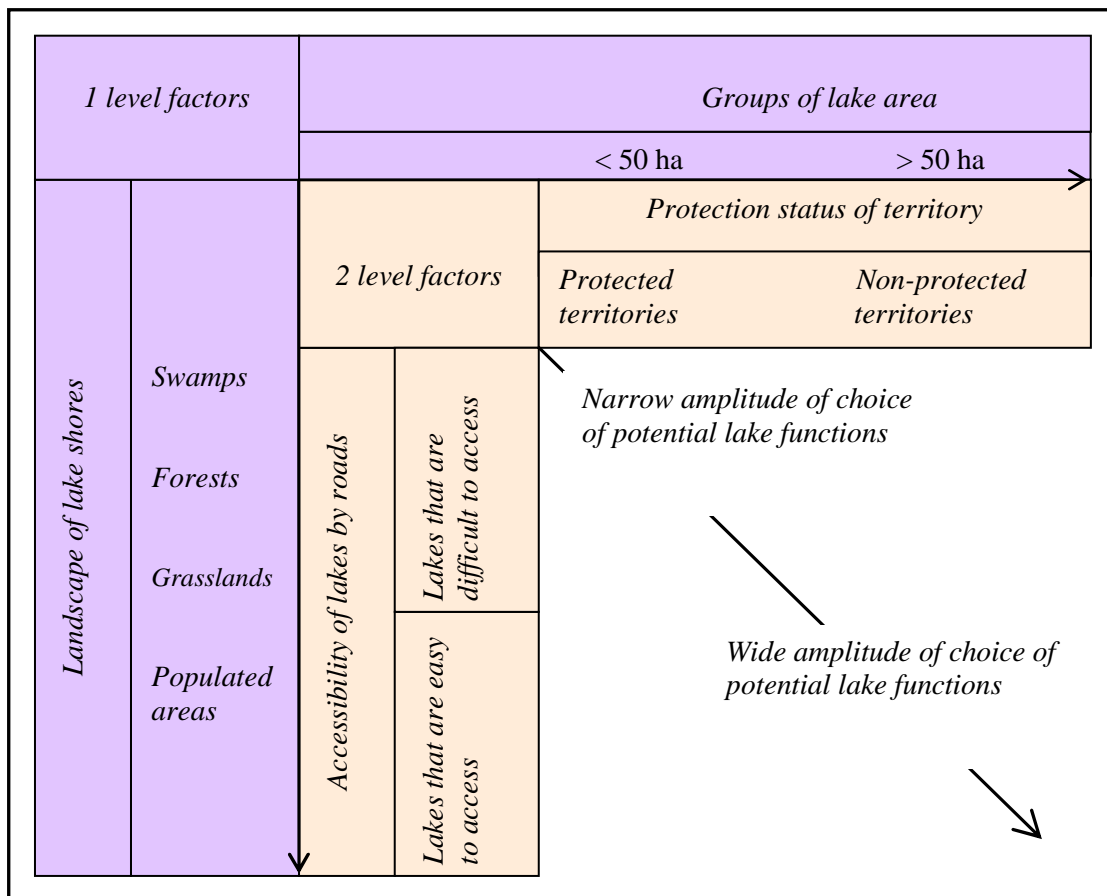


Fig. 3. The impact of lake area and the landscape of lake shores (1 level factors) and the conservation status of territory and accessibility of lakes by roads (2 level factors) on the development of spectrum of potential choice of lake functions

The main factors of second rank are protection status of lake and surrounding territory and lake accessibility by roads. According to territory protection status, lakes are divided into lakes, present in protected and unprotected territories. In case of general grouping of Lithuanian lakes, according to accessibility, they can be classified into easily and hardly accessible. Accessibility often increases in case of easily passed landscape and as lake area increases.

Taking into account the data about lake area, the main landscape elements, present at 500 m distance from lake shore (forests, grasslands, towns, villages and swamps), road network structure and their density at the radius of 500 m around lake shore, as well as lake protection status, 5 groups of Lithuanian lakes, characterized by different

possibilities of functional usage, were identified. The groups of lakes were identified, taking into account the lake area and landscape of lake shores (factors of rank 1). Each group includes two sub-groups: lakes are divided into those, present in protected and unprotected territories.

In summary, the following groups and sub-groups of lakes were identified (fig.4):

Group 1. Lakes with swampy lake shores. It is the only group of lakes, which functional usage is not influenced by area. *Subgroup 1a. Lakes with swampy lake shores in unprotected territories* – lakes or their swampy parts, characterized by the most limited usage (it is hard to access the shore, landscape is not attractive). Sometimes, they can be used for recreational and commercial fishing. *Subgroup 1b. Lakes with swampy lake shores in protected territories.* Usually, the only possibility of functional usage of these lakes – protection of ecosystem or its individual elements.

Group 2. Smaller than 50 ha lakes in forests. The possibilities of using the lakes from this group are largely dependent on accessibility by roads. It is possible to develop more activities, corresponding with recreational function, in more easily accessible lakes. *Subgroup 2a. Smaller than 50 ha lakes in forests in unprotected territories.* Depending on accessibility, they can be used for: a) recreational fishing b) recreation in shores, c) swimming, d) sailing by non self-propellant and self-propellant sailing means. *Subgroup 2b. Smaller than 50 ha lakes in forests in protected territories.* The main function – protection of lakes due to valuable components of ecosystem. If there is a possibility, recreational activities, which do not harm the protected flora and/or fauna species, should be developed near these lakes.

Group 3. Smaller than 50 ha lakes with grasslands in lake shores. As in case of lakes in forests, this group of lakes is characterized by large dependence of usage possibilities on accessibility by roads. *Subgroup 3a. Smaller than 50 ha lakes in unprotected territories with grasslands in lake shores* – these are one of the most attractive lakes for various recreational activities. Precisely recreation is considered as priority function of this group of lakes. *Subgroup 3b. Smaller than 50 ha lakes in protected territories with grasslands in lake shores.* These lakes lose a part of usage possibilities due to protection status, however, they acquire a quite important function of protecting ecosystem or its individual elements.

Group 4. Smaller than 50 ha lakes near residential areas. This group of lakes is distinguished by the best accessibility possibilities among smaller than 50 ha lakes. *Subgroup 4a. Smaller than 50 ha lakes near residential areas in unprotected territories.* Recreational activities can be developed in lakes of this subgroup. What is more, they can be used for irrigation, communication, etc. On the other hand, forbidden activities, related with agricultural and domestic functions (livestock watering, wastewater release, uncontrolled extraction of drinking water), are often carried out in lakes of this subgroup. *Subgroup 4b. Smaller than 50 ha lakes near residential areas in protected territories.* Real usage possibilities in this subgroup are similar to those of lakes from subgroup 4a (plus ecosystem protection function).

Group 5. Bigger than 50 ha lakes. Big lakes are rarely surrounded by landscape of one type, thus, their usage possibilities are greater not only because of big area (and volume, shore line length, depth and other morphometric characteristics), but also because of landscape diversity. What is more, it is determined that accessibility of bigger lakes by various type roads is better. Therefore, this group of lakes is definitely characterized by the widest possibilities of functional usage. *Subgroup 5a. Bigger than 50 ha lakes in unprotected territories.* These are the lakes, characterized by the best usage possibilities. In fact, they can be used in all fields. *Subgroup 5b. Bigger than 50 ha lakes in protected territories.* The lakes, attributable to this subgroup, can also be used in various fields, however, their usage is limited by status of protected territory. In part, this subgroup is characterized by the same problems as problems in lakes from subgroup 4a, arising due to invalidity of protection status, however, here they are not so significant, since lakes are considerably bigger.

Three types of lakes, characterized by different possibilities of functional usage, distinguish among explored groups. The first type includes the lakes from group 1 (lakes with swampy lake shores), which are characterized by especially limited usage possibilities, irrespective of area. The second type includes groups 2 and 3 (smaller than 50 ha lakes with forests or grasslands in lake shores). The third type includes groups 4 and 5 – these ponds are characterized by the widest spectrum of usage possibilities, however, they often do not meet territory protection status and general environmental provisions.

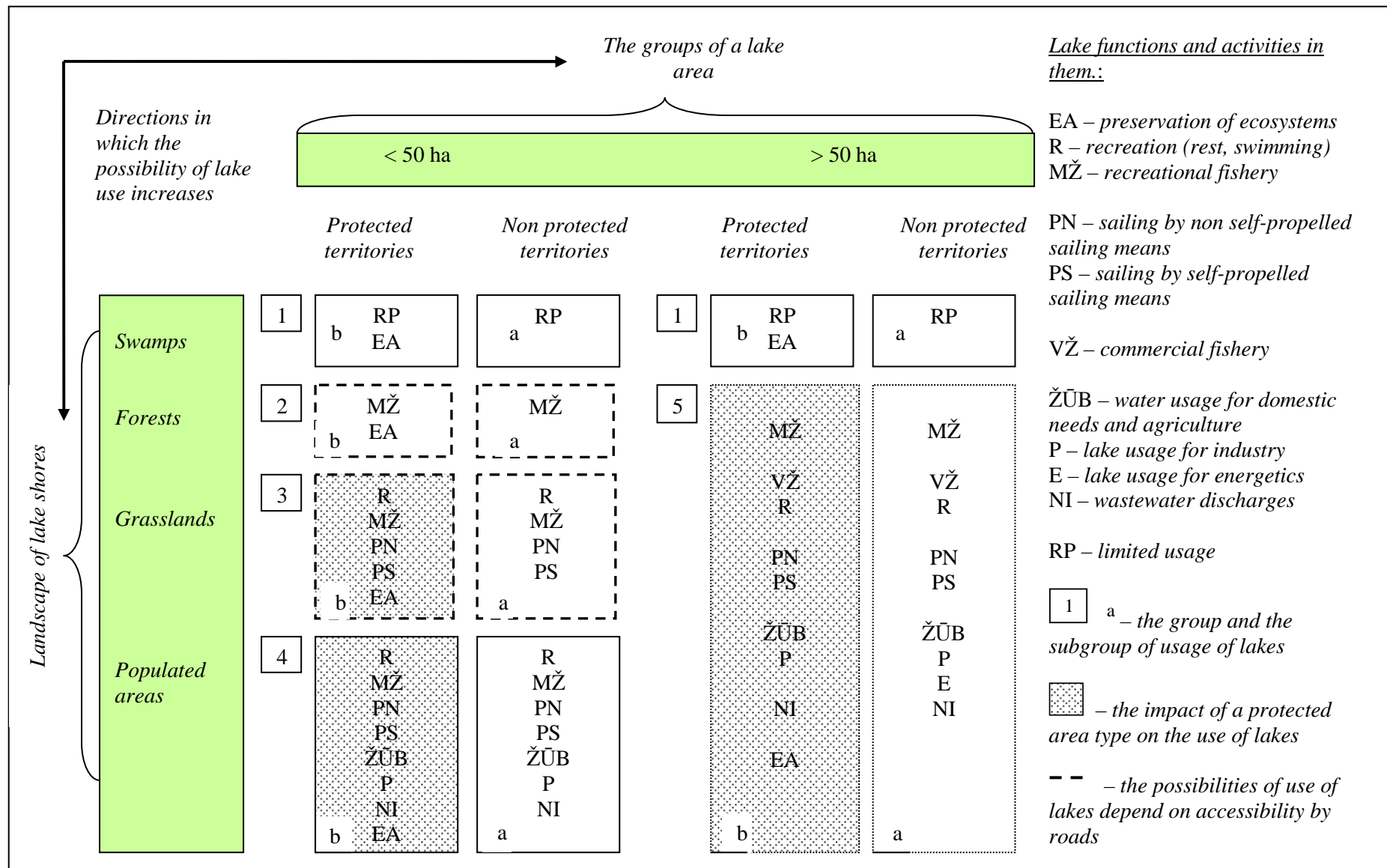


Fig. 4. The classification scheme of functional use of Lithuanian lakes

CONCLUSIONS

1. Currently, the main functions of Lithuanian lakes are considered: nature conservation, recreation and communication (water tourism). They have the lowest (or the most easily managed) impact on lake ecosystem; what is more, most lakes of country are usually used for these functions. Possibility to use lakes for commercial fishing, industry, energy, agriculture and domestic needs is considered as additional function.
2. After categorizing the functions of lakes, according to their effectiveness, three categories of functions were identified: effective functions (category I), functions of average effectiveness (category II) and ineffective functions (category III). Category I include lakes, where nature conservation and recreational activity fields are developed; II – lakes, used for communication and commercial fishing; III – lakes, used for industry, energy, agriculture and domestic needs.
3. The main factors, determining the functions of Lithuanian lakes and adaptation of specific activity fields, when using them, are lake area, landscape of lake shore, possibilities of lake accessibility and territory protection status. The impact of aforementioned factors on spectrum of potential functions of lake is not unambiguous (factors are often interrelated and affect the possibilities of functional usage of lake indirectly).
4. Lake area is the most important morphometric parameter, describing optimum possibilities of functional usage of lakes. Bigger than 100 ha lakes are characterized by widest spectrum of lakes, however, some conflicting activities, which decrease the value of main functions of lakes, are implemented there.
5. The accessibility of lakes of bigger area by roads is better: there are 6 roads on average at the distance of 500 m from shore of bigger than 100 ha lakes, while there are 1–1.6 of roads in case of smaller than 10 ha lakes. A poor accessibility of small lakes aggravates their usage possibilities in many fields, especially in recreation.
6. Under Lithuanian conditions, the possibilities of functional usage of lake increase with the change of landscape of lake shores: swamp → forest → grassland→

- residential areas. Lakes near residential areas, especially towns, are characterized by the widest usage spectrum and experience the highest anthropogenic loads.
7. Functional possibilities of smaller than 100 ha Lithuanian lakes are decreased by areas of forests in lake shores and poorer accessibility by roads. The possibilities of usage of bigger than 100 ha lakes usually do not depend on landscape of lake shores and accessibility.
 8. Sub-basins of Šventoji, Sub-basins Žeimena and small tributaries of Nemunas are characterized by greatest possibilities of using the lakes therein. (The greatest attention in sub-basins of this category should be paid on balancing the functions of lakes). Basin of Dauguva and sub-basins of Neris, Merkys and Šešupė are characterized by average possibilities of using the lakes therein. Number and area of lakes are very limited the spectrum of lake potential functions of other basins and sub-basins.
 9. The possibilities of using the lakes in protected territories are largely dependent on type of protected territory: the lakes of state parks are characterized by the widest spectrum of functions, while nature reserves – by the narrowest one. Officially, the main functions of lakes in protected territories should be recreation and protection of ecosystems, however, in fact, they perform a lot of additional functions.
 10. According to functional usage, Lithuanian lakes can be grouped into three types. The first type includes lakes with swampy lake shores, characterized by very limited usage possibilities. The second type includes smaller than 50 ha lakes, in the lake shores of which there are forests or grasslands. The lakes of this type are most suitable for development of recreational activities. The third type includes smaller than 50 ha lakes near residential areas and bigger than 50 ha lakes. These ponds are characterized by the widest spectrum of usage possibilities, however, they often do not meet territory protection status and general environmental provisions.
 11. Seeking to develop the functional usage of Lithuanian lakes in an orderly manner, it is necessary:

- a) consider the functions of lakes, which have the lowest and the most easily managed impact on lake ecosystem (recreation, fishing, communication), as priority ones;
- b) regulate the spectrum of functions of lake in the way that they would not conflict with each other. It is essential to lakes in protected territories, near residential areas and towns, as well as to big lakes, which currently perform a lot of functions;
- c) regulate the lake management and protection system, taking into account the existing condition of using the lakes in Lithuania.

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Publications in journals referred in international databases

1. **Daubarienė J.**, Valiuškevičius G. 2009. Lietuvoje naudojamos ežerų klasifikacijos : sistema ir pritaikymo galimybės, *Geografija* 45(2): 111–121
2. **Daubarienė J.**, Valiuškevičius G. 2012. Lietuvos ežerų funkcinio panaudojimo klasifikacija, *Geografija* 48 (1): 44–54.

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1. **Daubarienė J.** 2008. Ežerų ir tvenkinių funkcinio panaudojimo reglamentavimas Lietuvoje. *Jaunųjų mokslininkų darbai* 3 (19): 29–36
2. **Daubarienė J.** 2010. The influence of Lakes on the Tourism development in Utena County. *Latgale National Economy research*, 1(2): 62–70
3. **Daubarienė J.**, Valiuškevičius G. 2010. Plaukiojimo priemonių naudojimo galimybės Lietuvos saugomų teritorijų ežeruose. *Aplinkos apsaugos inžinerija: 13-osios Lietuvos jaunųjų mokslininkų "Mokslas - Lietuvos ateitis" straipsnių rinkinys*: 80–85
4. **Daubarienė J.**, Valiuškevičius G., Asijavičiūtė V. 2011. The structure of the landscape of Lithuanian lake shores of various sizes. *Aplinkos apsaugos inžinerija: 14-osios Lietuvos jaunųjų mokslininkų "Mokslas - Lietuvos ateitis" straipsnių rinkinys*:100–107.
5. **Daubarienė J.**, Valiuškevičius G., Asijavičiūtė V. 2011. The influence of morphometric characteristics on the functional usage of Lithuanian lakes. *Environmental engineering: proceedings of 8th International Conference*: 543–548.

CURRICULUM VITAE

Jurgita Daubarienė (Noreikaitė) was born on 22nd of August, 1977, in Molėtai District. She graduated Utena Krašuona Secondary School and entered the Faculty of Natural Sciences of Vilnius University. Jurgita graduated the Bachelor studies by paper “The summer low-water level dependence of the high-water level in the spring in the lakes”. In 1999, she acquired the Bachelor degree in geography. Jurgita Daubarienė continued the studies in Department of Hydrology and Climatology of Faculty of Natural Sciences of Vilnius University from 1991 to 2001. It is worth mentioning that she went to study geography at Lille University of Science and Technology in France, according to Socrates/Erasmus exchange programme during 2000–2001. What is more, at the same time she studied French language at European University “Lille Nord –Pas de Calais” and acquired the first-degree diploma. Upon coming back to Lithuania in 2001, Jurgita Daubarienė defended her Master thesis “The composite ebb curves of water and their hydrological content” and acquired the Master degree in geography (hydrometeorology direction).

Jurgita Daubarienė entered the doctoral studies of geography at Vilnius University in 2007. During studies 2 articles on the theme of dissertation were published in refereed scientific journals, 5 articles were published in publications under review. Moreover, the results of dissertation were presented in 4 international and 2 republican scientific events.

Jurgita Daubarienė has been working as lecturer of tourism and recreation subjects in Faculty of Business and Technologies of Utena College of Applied Sciences since 2002 (in position of associate professor since 2010). She has participated in a lot of trainings and projects, implemented in Lithuania and other countries, she has lectured at foreign universities. What is more, Jurgita supervised the academic papers of students at Vilnius University during postgraduate studies.

LIETUVOS EŽERŲ FUNKCINIS SKIRSTYMAS

SANTRAUKA

Ivadas

Ežerai – vienas esminių Lietuvos kraštovaizdžio elementų, formuojančių jo estetinę, rekreacinę, kultūrinę, ūkinę, gamtosauginę ir komercinę vertę, todėl jų tinkamas panaudojimas yra labai svarbus.

Šiuolaikinių tyrimų rezultatai rodo, kad ežerai buvo itin reikšmingi žmonėms nuo pat jų įsikūrimo šalies teritorijoje pradžios. Aktyviai buvo naudojama ne tik ežerų pakrančių teritorija, kur kūrėsi pirmieji piliakalniai, bet ir akvatorinė ežerų dalis, kur jau beveik prieš 3000 metų buvo statomos polinės gyvenvietės (Kola ir kt., 2004; Baubonis ir kt., 2009). Senovėje įsikūrimas prie ežero padėdavo žmonėms sėkmingiau apsirūpinti maistu, apginti savo auginamus gyvulius nuo plėšrūnų bei apsiginti nuo priešų patiemis.

Gyvenimo sąlygos, ekonomikos bei technikos lygis lėmė ir pagrindines ežerų panaudojimo funkcines galimybes. Pradiniame etape Lietuvos ežerai dažniausiai naudoti kaip tiesioginis gamtos išteklių potencialas: vanduo naudotas gėrimui, juo girdyti gyvuliai, natūralios pakrančių pievos atliko ganyklų funkciją, ežeruose aktyviai žvejota bei medžioti vandens gyvūnai. Dažnai ežerai buvo ir itin patogūs susisiekimo keliai. Norint panaudoti šias ežerų funkcijas nereikėjo ypatingo pasirengimo. Dauguma naudotų įrankių buvo pakankamai primityvūs, juos mokėjo pasigaminti daugelis bendruomenės narių, todėl pakakdavo prieiti arba kuriam laikui įsikurti prie ežero (Motuzaitė – Matuzeviciūtė, 2008).

Vystantis ūkiui ir vykstant technikos modernizacijai ežerų panaudojimo galimybės prasiplėtė. Kartu žymiai pasikeitė pati ežerų funkcinio panaudojimo struktūra. Ežerų, kaip tiesioginio gamtos išteklių potencialo, teikiamos funkcijos tiek visame pasaulyje, tiek Lietuvoje ėmė iš lėto blankti. Ežerų vanduo vis dažniau imtas naudoti pramonėje, energetikoje, juo pradėta drėkinti laukus. Sovietmečiu Lietuvoje ypač akcentuotas ežerų panaudojimas verslinei žvejybai, energijos išgavimui bei aušinimui (įrengiant elektrines), laukų drėkinimui, paukščių auginimui, susisiekimui ir rekreacijai (Mališauskas, 1985). Panaudoti šias funkcijas buvo žymiai sudėtingiau nei tiesiogiai naudotis ežerų teikiamomis gėrybėmis. Dažnai ežerus tekdavo patvenkti, gilinti, įrengti

prie jų siurbles ar statyti kitokius specialius įrenginius. Verslinė žvejyba neretai reikalavo dirbtinio ežerų įžuvinimo, kas skatino žuvininkystės plėtrą. Naudojant vandeni pramonės reikmėms bei stambiose žemės ūkio įmonėse, į ežerus kartais būdavo išleidžiamos ir nuotėkos.

Pastaraisiais metais Lietuvoje, kaip ir daugumoje Europos šalių, itin išaugo ežerų panaudojimas rekreacijai. Mūsų sąlygomis ši ežerų funkcija tapo ypač aktualia dėl kelių priežasčių. Pirma, Lietuva – gana ežeringa šalis, tačiau jos ežerai, vertinant tarptautiniu mastu, – santykinai maži, todėl jų vandens neverta naudoti stambiems pramonės ir energetikos objektams bei verslinei žvejybai. Antra, nemenka dalis šalies ežerų išsidėstę vaizdingo kraštovaizdžio zonoje, juos nesunku pasiekti, todėl būtent rekreacija laikytina prioritetine jų panaudojimo funkcija. Poilsis ežerų pakrantėse, maudymasis, mėgėjiška žvejyba, plaukiojimas nedideliais laivais šiuo metu yra patys populiariausi ežerų panaudojimo būdai Lietuvoje. Šioms funkcijoms įgyvendinti dažnai nereikia itin didelių investicijų, bet būtinas labai aiškus ir logiškas teisinis mechanizmas, nustatantis konkrečių ežero panaudojimo sričių plėtros galimybes bei ribas.

Darbo objektas – Lietuvos ežerų funkcijos.

Darbo tikslas – ištirti Lietuvos ežerų funkcijas ir suskirstyti ežerus pagal jų funkcines galimybes.

Darbo uždaviniai:

1. Kategorizuoti Lietuvos ežerų funkcijas;
2. Nustatyti, kokių morfometrinių parametų ežerus optimaliausia panaudoti įvairiose srityse;
3. Įvertinti ežerų funkcines galimybes, atsižvelgiant į pasiekiamumą keliais ir pakrančių kraštovaizdžio struktūrą;
4. Išanalizuoti skirtinguose upių baseinuose ir pabaseiniuose bei saugomose teritorijose tekšančių ežerų funkcinį potencialą;
5. Suklasifikuoti Lietuvos ežerus pagal funkcines galimybes.

Ginami teiginiai:

1. Ežerų funkcinį potencialą galima įvertinti tik atlikus kompleksinius ežerų morfometrinių parametų, apyežerio kraštovaizdžio bei kitus tyrimus.
2. Panaudojant mažesnio ploto Lietuvos ežerus, ypatingą reikšmę įgyja pasiekiamumas keliais bei apyežerio kraštovaizdis.

3. Daugumos didesnių Lietuvos ežerų ir telkšančių šalia gyvenamųjų vietovių bei saugomose teritorijose ežerų atliekamų funkcijų spektrą reikia optimizuoti.

Mokslinis darbo naujumas ir jo reikšmė. Darbo tema yra nauja Lietuvoje – ežerų funkcinis skirstymas kompleksiskai nėra analizuotas. Šiame darbe pirmą kartą Lietuvoje: 1) kategorizuotos ežerų funkcijos; 2) nustatyta, kokių morfometrinių parametrų ežerus tinkamiausia panaudoti įvairiose srityse, kartu išskirtos pagrindinės ežerų panaudojimo problemos, susijusios su ežerų funkcijomis bei morfometriniais rodikliais; 3) ištirtos ežerų pasiekiamumo keliais galimybės; 4) nustatyti apyežerio kraštovaizdžio struktūros ypatumai bei įvertintos ežerų panaudojimo galimybės, atsižvelgiant į pasiekiamumą keliais ir pakrančių kraštovaizdį; 5) nustatytos skirtinguose upių baseinuose ir pabaseiniuose telkšančių ežerų panaudojimo galimybės bei problemos; 6) išnagrinėti ežerų, išsidėsčiusių saugomose teritorijose, panaudojimo ypatumai; 7) Lietuvos ežerai pirmą kartą suklasifikuoti pagal funkcinio panaudojimo galimybes.

Darbo aktualumas ir pritaikomumas. Ežerų tinkamas panaudojimas yra labai svarbus siekiant išsaugoti ežerų ekosistemas. Dėl netinkamo naudojimo ežeruose gali suintensyvėti eutrofikacijos procesai, išnykti vertingos žuvų rūšys, paukščiai. Dėl netinkamai parinktų funkcijų ežerai dažnai gali prarasti savo estetinį vaizdą ir vertę. Darbe išanalizuotas esamas Lietuvos ežerų panaudojimas, nustatytos ežerų panaudojimo problemos bei numatyti jų sprendimo būdai. Aptariamos problemos yra aktualios siekiant optimizuoti ežerų panaudojimą Lietuvoje – tobulinti teisės aktus, susijusius su ežerų panaudojimu, saugomų teritorijų reglamentus, upių baseinų valdymo planus. Dėl to darbas gali būti aktualus Aplinkos ministerijos Vandenių departamentui, Aplinkos apsaugos agentūros skyriams, susijusiems su upių baseinų valdymu bei ežerų apsauga, Valstybinei saugomų teritorijų tarnybai.

Darbo rezultatai

Darbe ežerų funkcinis panaudojimas traktuojamas kaip ežerų naudojimas įvairiose srityse, todėl reikėjo nustatyti kokios funkcijos šiuo metu geriausiai atitinka Lietuvos ežerų paskirtį. Buvo išskirtos šešios svarbiausios Lietuvos ežerų funkcijos: gamtosauga, rekreacija, susisiekimas, verslinė žvejyba, pramonė ir energetika, žemės ūkis ir butis. Pagal svarbą ežerų funkcijos buvo suskirstytos į pagrindines bei papildomas. Kategorizuojant Lietuvos ežerų funkcijas, svarbiausiomis laikytos tos, kurios turi mažiausią arba lengviausiai suvaldomą poveikį ežero ekosistemai – tai, gamtosauga, rekreacija ir susisiekimas (vandens turizmas). Visos kitos yra papildomos. Pagal efektyvumą funkcijos suskirstytos į tris kategorijas – I – gamtosauga ir rekreacija, II – susisiekimas ir verslinė žvejyba, III – pramonė ir energetika, žemės ūkis ir butis.

Vienas iš darbo uždavinių – nustatyti, kokių morfometrinių parametru ežerus optimalu panaudoti įvairiose veiklos srityse. Nustatyta, jog rekreacijai patraukliausi didesnio nei 100 ha ploto ežerai dėl ilgos kranto linijos, didesnio kranto linijos vingiuotumo, ežerų salingumo. Ežeruose, turinčiuose platesnius kaip 10 m atbradus, palankiausia įrengti maudyklas. Mėgėjiškai žvejybai optimaliausia panaudoti didesnius nei 20 ha (vidutinis gylis > 4 m), o verslinei žvejybai – didesnius nei 50 ha ploto ežerus. Pramonėje ir žemės ūkyje optimaliausia panaudoti didesnius nei 100 ha, energetikoje ir plaukiojimui savaeigėmis plaukiojimo priemonėmis (kadangi jų variklių galingumas labai įvairus) – didesnius nei 500 ha ploto ežerus. Taigi, ežero plotas yra svarbiausias morfometrinis parametras, apibūdinantis ežerų funkcinio panaudojimo optimalias galimybes.

Išanalizavus ežerų panaudojimą išskirtos pagrindinės problemos, kurios susiję su ežerų funkcijomis bei skirtingų morfometrinių parametru ežerų panaudojimu: 1) nuotekų išleidimas į ežerus, 2) ežerų vandens naudojimas ūkio šakose, 3) plaukiojimas savaeigėmis plaukiojimo priemonėmis bei vandens motociklais, 4) didesnių nei 100 ha ežerų panaudojimas (tokio dydžio ežerai panaudojami daugelyje veiklos sričių, o tai neigiamai veikia ežerų vertę rekreacijoje).

Vienas iš darbo uždavinių buvo išsiaiškinti privažiavimo iki ežerų galimybes įvairaus tipo keliais, kas yra labai svarbu panaudojant ežerus įvairiose srityse. Nustatyta, jog didėjant ežero ploto klasei didėja ir ežerų pasiekiamumas, daugėja ežerų, prie kurių

galima privažiuoti arčiau nei 500 m. Šalia mažesnių nei 10 ha ežerų aptinkama 1–1,6 kelio, o šalia didesnių nei 100 ha ežerų – apie 6. Šalia ežerų dominuoja gruntkeliai (69,4 % visų ežerų pasiekiami šiais keliais) bei žvyrkeliai (57,6 %). Autostradomis ir greitkeliais yra pasiekiami tik 1,4 % tiriamųjų ežerų. Taip yra todėl, kad asfaltuotų kelių, gruntkelių ir žvyrkelių Lietuvoje yra daugiau, o autostradų ir greitkelių vos keletas.

Nuo pasiekiamumo keliais labai priklauso nedidelių ežerų (< nei 50 ha) telkšančių miškuose ir pievose panaudojimo galimybės. Pats geriausias ežerų, telkšančių gyvenamosiose vietovėse ir šalia jų pasiekiamumas, kas dar labiau padidina jų panaudojimo galimybes.

Nustatėme, jog ežerų pasiekiamumą nulemia dvi veiksnių grupės – vidiniai veiksniai, kurie susiję su ežero ypatumais (ežero plotas ir kranto linijos ilgis, supantis kraštovaizdis, ežero funkcinis panaudojimas) ir išoriniai veiksniai, kurie nuo ežero ypatumų nepriklauso (tam tikro tipo kelių skaičius ir pasiskirstymas Lietuvos teritorijoje).

Šiame darbe siekta išsiaiškinti įvairaus dydžio Lietuvos ežerų pakrančių kraštovaizdžio struktūrą. Nustatyta, jog Lietuvoje ežero > 0,5 ha (500 m spinduliu nuo jo pakrantės) kraštovaizdžio struktūra yra tokia: 60 % šio pakrantės ruožo sudaro pievos, 36 % – miškai, 3 % – gyvenamosios vietovės, 0,1 % – pelkės ir 1 % – kiti kraštovaizdžiai. Pastebėta, kad mažesnių nei 50 ha ežerų ir didesnių nei 50 ha ežerų kraštovaizdžio struktūra skiriasi nežymiai. Palyginus su mažesniais ežerais, didesnių ežerų pakrantėse daugiau ploto užima pievos bei pelkės. Mažesnių ežerų pakrantės kraštovaizdžio struktūroje daugiau tokių kraštovaizdžio elementų, kaip sodų masyvų, upelių, kanalų, drenažo griovių, kūdrių. Pastebimas ir miškų pokytis – mažesnių nei 50 ha ežerų pakrantėse miškų užimami plotai yra didesni nei didesnių negu 50 ha ežerų pakrantėse. Taip yra todėl, kad beveik 20 % mažesniųjų ežerų telkšo miškuose.

Didelių (didesnių nei 50 ha) ežerų tarpe yra labai mažai ežerų, kuriuos suptų tik vieno tipo kraštovaizdžio elementas. Didžiųjų ežerų pakrantėse kraštovaizdis yra įvairesnis, sudarytas iš 3–4 kraštovaizdžio elementų, todėl paties ežero prieinamumas, o tuo pačiu ir panaudojimo galimybės didėja.

Darbe buvo siekta nustatyti gyvenamųjų vietovių paplitimą įvairaus dydžio Lietuvos ežerų pakrantėse (500 m spinduliu), nes šalia gyvenamųjų vietovių telkšantys ežerai intensyviai panaudojami rekreacijai, į juos išleidžiamos gyvenviečių nuotekos, o

žemės ūkio naudmenos didina biogenų prietaką į telkinius. Dėl to, telkšantiems šalia gyvenamųjų vietovių ežerams turi būti skiriamas didesnis dėmesys gamtosauginei funkcijai.

Nustatyta, jog šalia 51 % (1456 ežerų) tirtų ežerų yra gyvenamųjų vietovių 500 m spinduliu nuo ežerų pakrančių, tačiau jų užimamas plotas yra labai nedidelis ir sudaro tik 3 % apyežerio ploto. Didėjant ežerų ploto klasei daugėja ežerų šalia kurių, 500 metrų atstumu nuo kranto, aptinkama gyvenamųjų vietovių. Daugiausiai ežerų (50 %) telkšo šalia nedidelių kaimų, kuriuose mažiau nei 20 gyventojų.

Siekiant nustatyti antropogeninių apkrovų, kurias patiria ežerai telkšantys 10 km spinduliu aplink didžiuosius Lietuvos miestus, mastą buvo apskaičiuotas antropogeninių apkrovų rodiklis AAR – 1 ha ežerų ploto tenkantis potencialių poilsiautojų (gyventojų) skaičius. Jis svyruoja nuo 2 iki 12418 žm. / 1 ha. Didžiausias antropogenines apkrovas patiria ežerai telkšantys aplink Panevėžį (AAR = 4587), Kauną (1299), Klaipėdą (1548), mažiausias – ežerai aplink Visagino (2), Utenos (8), Telšių (20), Šiaulių (40), Ukmergės (45) miestus.

Didėjant ežerų ploto klasei didėja ir ežerų panaudojimo galimybės atsižvelgiant į apyežerio kraštovaizdį bei ežerų pasiekiamumą keliais. Vidutinėmis ežerų panaudojimo galimybėmis pasižymi mažesni nei 100 ha ežerai. Šių ežerų panaudojimą sumažina didesni miškų plotai bei prastesnis pasiekiamumas keliais. Didesnių nei 100 ha ežerų panaudojimo galimybės yra labai geros. Tai ežerai, kurie yra patraukliausi rekreacijoje, mėgėjiškoje žvejyboje, dėl juose dominuojančių vertingų žuvų rūšių. Juose didžiausios galimybės plaukioti įvairiomis plaukiojimo priemonėmis, todėl svarbūs ir susisiekimė. Nei kraštovaizdis, nei pasiekiamumas šių ežerų panaudojimo galimybių nesumažina.

Darbe buvo siekta nustatyti skirtinguose upių baseinuose bei saugomose teritorijose telkšančių ežerų panaudojimo galimybes įvairiose srityse.

Išanalizavus ežerų, telkšančių skirtinguose upių baseiniuose ir pabaseiniuose funkcines galimybes (rekreacijoje, susisiekimė, verslinėje žvejyboje, pramonėje, žemės ūkyje ir buityje), upių baseinus ir pabaseinius suskirstėme į tris kategorijas. I kategorijai priskirti Šventosios, Žeimenos ir Nemuno mažųjų intakų pabaseiniai. Juose telkšantys ežerai pasižymi plačiausiomis ir įvairiapusiškiausiomis ežerų panaudojimo galimybėmis. Čia jie galimi plačiai panaudoti rekreacijoje, susisiekimė, verslinėje žvejyboje. Tai nulemia šiuose pabaseiniuose telkšančių ežerų gausa (daugiau nei 500 ežerų

kiekviename) bei didelių, didesnių nei 100 ha, ežerų skaičius (60 % visų didesnių nei 100 ha ežerų). Kita vertus, būtent šių pabaseinių ežerų patrauklumą rekreacijoje dažnai menkina žmogaus ūkinė veikla ir netinkamas ežerų panaudojimas. Tvarkant vandens išteklius šiuose pabaseiniuose, reikia subalansuoti ir suderinti vandens naudojimą buities, žemės ūkio, pramonės, rekreacijos ir gamtosaugos tikslams.

Kiek siauresniu ežerų funkcinio panaudojimo galimybių spektru rekreacijoje, susisiekime bei verslinėje žvejyboje pasižymi Dauguvos baseinas bei Neries, Merkio ir Šešupės pabaseiniai, kuriuos priskyrėme II kategorijai. Čia kiekviename baseine ir pabaseinyje telkšo daugiau nei 100 ežerų ir beveik po 7 % didesnių nei 100 ha ežerų. Šiuose baseinuose ir pabaseiniuose, taip pat yra ežerų į kuriuos išleidžiamos nuotekos, imamas vanduo ir naudojamas pramonės įmonių reikmėms o didesnių nei 100 ha ežerų panaudojime reikia išskirti prioritėtines funkcijas. III kategorijai priskirti visi likusieji baseinai ir pabaseiniai, kur ežerų panaudojimo galimybių spektrą labai riboja menkas jų skaičius. Juose telkšo mažiau nei 100 ežerų ir vos po 1 % didesnių nei 100 ha ežerų.

Saugomose teritorijose telkšantys ežerai panaudojami tose pačiose srityse, kaip ir telkšantys ne saugomose teritorijose, tačiau čia atsiranda daugiau ribojimų. Ežerų panaudojimo galimybės įvairiose srityse priklauso ne tik nuo ploto bet ir saugomos teritorijos, kurioje telkšo ežeras, statuso ar funkcinės zonos saugomoje teritorijoje (ūkinė, rekreacinė, konservacinė ir kt.). Didžiausios galimybės panaudoti saugomų teritorijų ežerus yra rekreacijoje – poilsis, žvejyba bei plaukiojimas nesavaeigėmis plaukiojimo priemonėmis. Ežerų panaudojimo galimybės didėja didėjant ežero plotui, todėl didžiausios galimybės yra panaudoti didesnius nei 500 ha ežerus, telkšančius rekreacinės ir ūkinės funkcinės paskirties zonose nacionaliniuose ir regioniniuose parkuose. Labiausiai ribojamas iš visų veiklų yra plaukiojimas savaeigėmis plaukiojimo priemonėmis. Nustatyta, jog tokios veiklos, kaip nuotėkų išleidimas į ežerus bei ežerų vandens naudojimas įvairiose ūkio šakose vykdomos regioniniuose bei nacionaliniuose parkuose ir valstybiniuose draustiniuose telkšančiuose ežeruose. Tai veiklos, kurių derėtų atsisakyti.

Vienas iš šio darbo uždavinių buvo kompleksiškai suklasifikuoti Lietuvos ežerus pagal jų funkcinio panaudojimo galimybes. Atsižvelgiant į duomenis apie ežero plotą, pagrindinius 500 m atstumu nuo ežero kranto esančio kraštovaizdžio elementus (miškus, pievas, miestus, kaimus bei pelkes), kelių tinklo struktūrą bei jų tankumą 500 m

spinduliu aplink ežero krantą bei ežero apsaugos statusą, išskirtos 5 skirtingomis funkcinio panaudojimo galimybėmis pasižyminčios Lietuvos ežerų grupės. Ežerų grupės išskirtos atsižvelgiant į ežero plotą ir apyežerio kraštovaizdį. Kiekvienoje grupėje yra po du pogrupius: ežerai suskirstyti į telkšančius saugomose ir nesaugomose teritorijose.

Apibendrinus duomenis buvo išskirtos tokios ežerų grupės ir pogrupiai :

1 grupė. Ežerai su užpelkėjusiu apyežeriu. Tai vienintelė ežerų grupė, kurios funkciniam panaudojimui neturi poveikio plotas. *1a pogrupis. Ežerai su užpelkėjusiu apyežeriu nesaugomose teritorijose* – labiausiai ribotu panaudojimu pasižymintys ežerai ar jų užpelkėjusios dalys (pakrantė sunkiai pasiekiamą, kraštovaizdis nepatrauklus). Kartais gali būti naudojami mėgėjiškai bei verslinei žvejybai. *1b pogrupis. Ežerai su užpelkėjusiu apyežeriu saugomose teritorijose.* Dažniausiai vienintelė šių ežerų funkcinio panaudojimo galimybė – ekosistemos ar atskirų jos elementų apsauga.

2 grupė. Mažesni nei 50 ha ežerai, telkšantys miškuose. Šios ežerų grupės panaudojimo galimybės labai priklauso nuo pasiekiamumo keliais. Lengviau pasiekiamuose ežeruose galima vystyti daugiau rekreacijos funkciją atitinkančių veiklų. *2a pogrupis. Mažesni nei 50 ha ežerai, telkšantys miškuose nesaugomose teritorijose.* Priklausomai nuo pasiekiamumo gali būti naudojami: a) mėgėjiškai žvejybai, b) poilsiui pakrantėse, c) maudymuisi, d) plaukiojimui nesavaeigėmis ir savaeigėmis plaukiojimo priemonėmis. *2b pogrupis. Mažesni nei 50 ha ežerai, telkšantys miškuose saugomose teritorijose.* Pagrindinė funkcija – ežerų apsauga dėl vertingų ekosistemos komponentų. Prie šių ežerų, esant galimybei, būtina stengtis plėsti rekreacinio pobūdžio veiklas, nekenkiančias saugomoms floros ir/ar faunos rūšims.

3 grupė. Mažesni nei 50 ha ežerai, kurių apyežeryje vyrauja pievos. Kaip ir miškuose telkšantiems ežerams, šiai ežerų grupei būdinga didelė panaudojimo galimybių priklausomybė nuo pasiekiamumo keliais. *3a pogrupis. Mažesni nei 50 ha ežerai nesaugomose teritorijose, kurių apyežeryje vyrauja pievos* – tai vieni patraukliausių įvairioms rekreacinėms veikloms ežerų. Būtent rekreacija laikytina prioritetine šios ežerų grupės funkcija. *3b pogrupis. Mažesni nei 50 ha ežerai saugomose teritorijose, kurių apyežeryje vyrauja pievos.* Šie ežerai praranda dalį panaudojimo galimybių dėl apsaugos statuso, tačiau įgyja gana svarbią ekosistemos ar atskirų jos elementų apsaugos funkciją.

4 grupė. Mažesni nei 50 ha ežerai, telkšantys šalia gyvenamųjų vietovių. Ši ežerų grupė tarp mažesnių nei 50 ha ežerų išsiskiria geriausiomis pasiekimo galimybėmis

(ežerui telkšant šalia miesto ar kaimo, privažiuoti bei prieiti prie ežero dažniausiai yra nesunku). Todėl ežero panaudojimo funkcijos šioje ežerų grupėje ribojamos tik teritorijos apsaugos statuso. *4a pogrupis. Mažesni nei 50 ha ežerai, telkšantys šalia gyvenamųjų vietovių nesaugomose teritorijose.* Šio pogrupio ežeruose galima vystyti visas rekreacinio pobūdžio veiklas, be to, jie gali būti naudojami drėkinimui, susisiekimui ir pan. Kita vertus būtent šiame ežerų pogrupyje dažnai pasitaiko neleistinų veiklų, susijusių su žemės ūkio ir buitės funkcijomis. *4b pogrupis. Mažesni nei 50 ha ežerai, telkšantys šalia gyvenamųjų vietovių saugomose teritorijose.* Realios panaudojimo galimybės šiame pogrupyje panašios kaip ir 4a pogrupio ežerų (prisideda tik ekosistemos apsaugos funkcija). Tai liudija, kad saugomų teritorijų statuso suteikimas tokiems ežerams – ne visada veiksni priemonė. Siekiant to išvengti būtina: a) peržiūrėti Lietuvos saugomų teritorijų kadastro duomenis ir atsisakyti dalies tokio tipo ežerų apsaugos (nes patirtis rodo, kad jų vis vien neįmanoma apsaugoti nuo pašalinio poveikio), b) sugriežtinti saugomų teritorijų statusą turinčių ežerų apsaugą.

5 grupė. Didesni nei 50 ha ežerai. Didelius ežerus retai kada supa vieno tipo kraštovaizdis, tad jų panaudojimo galimybės yra didesnės ne tik dėl didelio ploto (ir tūrio, pakrantės linijos ilgio, gylio bei kitų morfometrinių charakteristikų), bet ir dėl kraštovaizdžio įvairovės. Be to, nustatyta, jog didesnių ežerų pasiekiamumas įvairaus tipo keliais yra daug geresnis. Todėl ši ežerų grupė neabejotinai pasižymi plačiausiomis funkcinio panaudojimo galimybėmis. *5a pogrupis. Didesni nei 50 ha ežerai nesaugomose teritorijose.* Tai – geriausias panaudojimo galimybes turintys ežerai. Kadangi realiai juos galima panaudoti visose srityse (rekreacijai, susisiekimui, verslinei žvejybai, pramonei ir energetikai, žemės ūkiui ir buičiai), funkcijas konkrečiais atvejais derėtų paskirstyti atsižvelgiant į vietinius prioritetus. *5b pogrupis. Didesni nei 50 ha ežerai saugomose teritorijose.* Šiam pogrupiui priskirtini ežerai taip pat gali būti panaudojami įvairiose srityse, tačiau jų panaudojimą riboja saugomos teritorijos statusas. Iš dalies šiam pogrupiui būdingos problemos, primenančios 4a pogrupio ežeruose kylančius nesklandumus dėl apsaugos statuso neveiksnumo, tačiau čia jos – ne tokios ryškios, nes ežerai žymiai didesni.

Tarp išskirtų grupių aiškiai išryškėja trys, skirtingomis funkcinio panaudojimo galimybėmis pasižymintys, ežerų tipai. Pirmam tipui priskirtini 1 grupės ežerai (ežerai su užpelkėjusiu apyežeriu), nepriklausomai nuo ploto pasižymintys itin ribotomis

panaudojimo galimybėmis. Antro tipo ežerai apima 2 ir 3 grupes (mažesnius nei 50 ha ežerus, kurių apyežeryje vyrauja miškai arba pievos). Šio tipo ežerai labiausiai tinkami rekreacinio pobūdžio veikloms vystyti. Trečias tipas apima 4 ir 5 ežerų grupę – šie telkiniai pasižymi plačiausiu panaudojimo galimybių spektru, bet jis itin dažnai neatitinka teritorijos apsaugos statuso bei bendrų aplinkosauginių nuostatų. Apibendrinus duomenis buvo išskirtos tokios ežerų grupės ir pogrupiai :

Išvados

1. Pagrindinėmis šiuo metu ir perspektyviausiomis ateityje Lietuvos ežerų funkcijomis laikytinos: gamtosauga, rekreacija ir susisiekimas (vandens turizmas). Jos turi mažiausią (arba lengviausiai suvaldomą) poveikį ežero ekosistemai, be to, dauguma šalies ežerų dažniausiai naudojami būtent šioms funkcijoms. Papildomomis ežerų funkcijomis laikytina galimybė panaudoti juos verslinės žvejybos, pramonės ir energetikos bei žemės ūkio ir buities reikmėms.
2. Pagal efektyvumą Lietuvos ežerų funkcijos šiuo metu išsiskiria į tris kategorijas. Efektyviomis (I kategorijos) funkcijomis laikytinos veiklos sritys, susijusios su rekreacine ir gamtosaugine veikla. Šių funkcijų taikymo ežeruose efektyvumas ateityje turėtų dar labiau didėti. Vidutinio efektyvumo (II kategorijos) funkcijomis laikytinos su susisiekimu ir versline žvejyba susijusios veiklos. Neefektyvios (III kategorijos) funkcijos – ežerų panaudojimas pramonei ir energetikai bei žemės ūkiui ir buičiai.
3. Pagrindiniai veiksniai, lemiantys Lietuvos ežerų funkcijas bei konkrečių veiklos sričių pritaikymą jas išnaudojant, yra ežero plotas, apyežerio kraštovaizdis, ežero pasiekiamumo galimybės ir teritorijos apsaugos statusas. Šių faktorių poveikis ežero potencialių funkcijų pasirinkimo amplitudei nėra vienareikšmis (dažnai faktoriai susiję tarpusavyje ir veikia ežero funkcinio panaudojimo galimybes netiesiogiai).
4. Ežero plotas yra svarbiausias morfometrinis parametras, apibūdinantis ežerų funkcinio panaudojimo optimalias galimybes. Didesni nei 100 ha ežerai pasižymi plačiausiu funkcinio panaudojimo galimybių spektru, tačiau juose dažnai yra

vykdoma veiklų, prieštaraujančių viena kitai ir trukdančių šiuose ežeruose plėtoti veiklas, susijusias su pagrindinėmis jų funkcijomis.

5. Lietuvos ežerams būdinga aiškiai išreikšta priklausomybė tarp ežero ploto ir jo pasiekiamumo keliais galimybių: didesnio ploto ežerų pasiekiamumas keliais yra daug geresnis (500 m atstumu nuo didesnių nei 100 ha ežerų pakrantės vidutiniškai aptinkami 6 keliai, o mažesnių nei 10 ha ežerų – 1–1,6 kelio). Prastas mažų ežerų pasiekiamumas apsunkina jų panaudojimo galimybes daugelyje sričių, o ypač rekreacijoje.
6. Lietuvos sąlygomis, ežero funkcinio panaudojimo galimybės didėja keičiantis apyežerio kraštovaizdžiui tokia seka: pelkė → miškas → pieva → gyvenamosios vietovės. Šalia gyvenamųjų vietovių, ypač miestų, telkšantys ežerai pasižymi plačiausiu panaudojimo galimybių spektru, tačiau kartu patiria ir didžiausias antropogenines apkrovas (kurios dažnai apriboja svarbių veiklos sričių vystymą šiuose ežeruose).
7. Daugelis potencialių funkcijų mažesniuose nei 100 ha Lietuvos ežeruose menkliau išnaudojamos esant didesniems miškų plotams apyežeryje bei prastam pasiekiamumui keliais. Apyežerio miškingumas bei pasiekiamumas laikytini svarbiausiais veiksniais, ribojančiais šių ežerų funkcinio panaudojimo galimybių spektrą. Didesnių nei 100 ha ežerų funkcinio naudojimo potencialui šie faktoriai įtakos dažniausiai neturi.
8. Skirstant teritoriškai, plačiausios ir įvairiapusiškiausios ežerų panaudojimo galimybės būdingos Šventosios, Žeimenos ir Nemuno mažųjų intakų pabaseiniuose telkšantiems ežerams (kita vertus, būtent šių pabaseinių dažnai pasižymi nesubalansuotomis funkcijomis). Kiek siauresniu ežerų funkcinio panaudojimo galimybių spektru pasižymi Dauguvos baseinas bei Neries, Merkio ir Šešupės pabaseiniai. Kituose pabaseiniuose ežerų panaudojimo galimybių spektrą labai riboja menkas jų skaičius bei plotas.
9. Saugomose teritorijose telkšančių ežerų panaudojimo galimybės labiausiai priklauso nuo saugomos teritorijos tipo: plačiausiu funkcijų spektru pasižymi valstybinių parkų ežerai, siauriausiu – gamtinių rezervatų. Saugomose teritorijose telkšančių ežerų pagrindinės funkcijos formaliai turėtų būti rekreacija ir ekosistemų apsauga, tačiau realiai jie atlieka daug papildomų funkcijų.

10. Lietuvos ežerus pagal funkcinį panaudojimą galima suskirstyti į tris tipus. Pirmam tipui priskirtini ežerai su užpelkėjusiu apyežeriu, pasižymintys itin ribotomis panaudojimo galimybėmis. Antram tipui priskirtini mažesni nei 50 ha ežerai, kurių apyežeryje vyrauja miškai arba pievos. Šio tipo ežerai labiausiai tinkami rekreacinio pobūdžio veikloms vystyti. Trečias tipas apima mažesnius nei 50 ha ežerus, telkšančius prie gyvenamųjų vietovių ir didesnius nei 50 ha ežerus. Šie telkiniai pasižymi plačiausiu panaudojimo galimybių spektru, bet jis itin dažnai neatitinka teritorijos apsaugos statuso bei bendrų aplinkosauginių nuostatų.

11. Siekiant tvarkingai plėtoti Lietuvos ežerų funkcinį panaudojimą, būtina:

a) prioritetinėmis ežerų funkcijomis laikyti tas, kurios turi mažiausią arba lengviausiai suvaldomą poveikį ežero ekosistemai (rekreacija, žvejyba, susisiekimas);

b) sureguliuoti ežero atliekamų funkcijų spektrą taip, kad jos neprieštarautų viena kitai. Tai itin svarbu ežerams, telkšantiems saugomose teritorijose, prie gyvenviečių ir miestų bei dideliems ežerams, kurie šiuo metu atlieka daug funkcijų;

c) suderinti ežerų valdymo ir apsaugos sistemą atsižvelgiant į susidariusią ežerų panaudojimo padėtį Lietuvoje.

Gyvenimo aprašymas

Jurgita Daubarienė (Noreikaitė) gimė 1977 metų rugpjūčio 22 d. Molėtų rajone. 1995 metais baigė Utenos Krašunosos vidurinę mokyklą ir įstojo studijuoti į Vilniaus universiteto Gamtos mokslų fakultetą. Bakalauro studijas baigė darbu „Ežeruose vasaros žemiausio vandens lygio priklausomybė nuo aukščiausio vandens lygio pakilimo pavasarį“. 1999 metais jai buvo suteiktas geografijos bakalauro laipsnis. Nuo 1999 iki 2001 metų tęsė studijas Vilniaus universiteto Gamtos mokslų fakulteto Hidrologijos ir klimatologijos katedroje. 2000–2001 metais pagal Socrates/Erasmus mainų programą buvo išvykusi studijuoti geografijos mokslų į Lilio Mokslo ir Technologijų universitetą Prancūzijoje. Tuo pačiu metu universitete „Lille Nord – Pas de Calais“ studijavo prancūzų kalbą, kur įgijo pirmo laipsnio diplomą. 2001 metais grįžusi į Lietuvą apgynė magistro darbą „Kompozicinės vandens slūgio kreivės ir jų hidrologinis turinys“ ir įgijo geografijos mokslų (hidrometeorologijos krypties) magistro kvalifikacinį laipsnį.

2007 metais Jurgita Daubarienė įstojo į Vilniaus universiteto geografijos krypties doktorantūros studijas. Per studijų laiką disertacinio darbo tema paskelbti 2 straipsniai referuojamuose mokslo žurnaluose, 5 straipsniai recenzuojamuose leidiniuose. Disertacijos rezultatai buvo pristatyti 4 tarptautiniuose ir 2 respublikiniuose moksliniuose renginiuose.

Jurgita Daubarienė nuo 2002 metų dirba Utenos kolegijos Verslo ir technologijų fakultete turizmo ir rekreacijos dalykų dėstytoja (nuo 2010 m docentės pareigose). Dalyvavo daugelyje Lietuvoje ir kitose šalyse vykdomų mokymų, projektų, skaitė paskaitas užsienio aukštosiose mokyklose. Studijų doktorantūroje metais Vilniaus universitete vadovavo studentų moksliniams darbams.