ОБЩИЕ ВОПРОСЫ ЭКОЛОГИИ И ПРИРОДОПОЛЬЗОВАНИЯ

УДК 556.551

LAKE GEOECOSYSTEM AS AN INDICATOR OF NATURAL LAKE CHANGES

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Lakes constitute the main element of hydrographic network of young glacial areas. They differ in morphometric parameters of their basins, size of drainage area and their role in hydrological cycle. In terms of hydrography, they often constitute the main element of river-lake network, many of them are blind reservoirs. Despite the fact that they mainly simultaneously came into existence, the rate of eutrophication of their waters is significantly diverse. It results from both natural and antrophogenic reasons.

It is worth noting that a lake is not only a component of young glacial landscape but also an ecosystem functioning mainly due to matter flow from the area drained by the lake. This is the drainage area that functions as a constant supplier of various forms of matter. The rate of natural eutrophication of a lake i.e. slow, natural process of ageing and declining, depends on the structure of the basin, reservoir morphometric parameters and its hydrological regime.

The drainage area structure may provide a favourable environment for area flows or may limit them, whereas all lake natural properties may be more or less favourable for the preservation of the\present state of trophy.

The resultant of all factors favourable for eutrophication has a different value for each lake. The same strength of drainage area influence expressed in the amount of biogenic substances carried from the drainage area into the lake, have a different effect when the natural lake resistance to degradation is high, and different when the lake is subjected to the outside influence. And vice versa, in case of the same category of lake resistance to degradation, differences in the state of trophy should be expected when their drainage areas have different influence on the lakes.

The lake ecosystem together with the drainage area enriching it in matter constitutes an ecological setting within which there is a constant flow of energy and matter. Such system can be called, as A. Kostrzewski (1991) proposed, a lake geoecosystem. The functioning of a system understood in such a way is based on a constant transport of different forms of matter from the drainage area and its accumulation in the lake. The structure of the lake geoecosystem determines the course of eutrophication process.

System of evaluation of natural eutrophication of lakes

Lake geoecosystem susceptibility to eutrophication can be evaluated on the basis of the system suggested by the author of this article (Bajkiewicz-Grabowska 1981, 1987, 1992, 2002), whereas lake natural resistance to the influence of the drainage area according to the modifies proposal of the System of Evaluation of Lakes Quality (Kudelska et al. 1983, 1994; Bajkiewicz-Grabowska 1992, 2002). In this system, on one hand, the drainage area is evaluated as a suoolier of the biogenic matter to the reservoir, on the other hand, the lake is evaluated as a recioient of the matter. The degree of the drainage area influence on the lake is evaluated on the basis of features characterizing lake total drainage area as well as its direct drainage area.

The characteristics describing the degree of the total drainage area influence on the lake include: lake index, also called Ohle`s index (quotient of total drainage area and lake area), type of lake water balance (throughflow, outflow, no-outflow). Ohle`s index informs of the degree of reservoir dependence on the drainage area, whereas type of lake water balance informs of the lake role in the system of surface discharge, therefore it informs of possible point source of matter supply and also of possibilities of lake "rinsing".

The degree of influence of the direct drainage area of which the surface load is carried into the lake, depends on those features of physical-geographic environment which accelerate this load or inhibit it. In the conditions of young glacial landscape these are:

– the size of drainage area actively participating in the matter supply; it is measured by the degree of depression of the land (no-outflow areas);

– average slope of the drainage area ($J = \frac{\Delta H}{\sqrt{A}}$; ΔH – denivelation in the direct drainage area in meters, A – direct drainage area in km^2); its volume conditions intensity of water erosion and the volume of area runoff;

– channel network density ($D = \frac{\Sigma l}{A}$; Σl – the length of all streams in the direct drainage area, A – direct drainage area in km^2); this parametr is a measure of direct and fast transport of matter to the lake;

– surface burdens and soil conditions indicating land permeability, therefore describing the possibility of matter transport to the groundwaters;

– land use reflecting the volume of the biogenic elements load to the lake.

Above characteristics are determined on the basis of topographic, soil and agricultural maps of the scale 1:25,000.

The influence of the drainage area on matter activation and transport to the lake is evaluated by bonitation of each characteristics stated above at 0 do 3 points scale, where 0 stands for very little influence on matter activation and lack of possibility of its transport to the lake, and 3 stands for great possibility of matter activation and its fast transport to the reservoir (Table 1).

Table 1 *– Point criterion for the evaluation of the drainage area – supplier matter to the lake*

Characteristics	**Number of points**			
	0	**1**	**2**	**3**
Ohle`s index	< 10	10 – 40	40 – 150	> 150
Type of lake water balance	-	outflow	no-outflow	throughflow
Morphometry of direct drainage area: – channel network density (km·km^{2}) – average slope of the basin (m·km^{-1}) – share of depressions (%)	 < 0,5 < 5 > 60	 0,5 1,0 5 – 10 45 – 60	 1,0 – 1,5 10 – 20 20 – 45	 > 1,5 > 20 < 20
Geological type of the basin	loamy, peaty	sand-loamy	loam-sandy	sandy
Lande use type of the basin	forest, swampy, agricultural-forest, pasture-forest-agricultural	forest-agricultural, pasture-agricultural	agricultural, pasture-forest-agricultural with settlements, forest with settlements	forest-agricultural with settlements, pasture-agricultural with settlements, agricultural with settlements

The final evaluation constitutes an arithmetic mean of the points given for evaluation of each individual characteristics and on its basis the drainage area is classified to one of the 4 groups of susceptibility to the supply of the surface load to the lake:

group 1 – mean value is lower or equal to 1,0; the drainage area strongly limit the area flow, and demonstrates practically no possibility to deliver matter to the lake;

group 2 – mean value amounts from 1,1 to 1,4; the drainage area demonstrates little susceptibility to the activation of the area load stored in its area and little possibility to deliver it to the lake;

group 3 – mean value amounts from 1,5 to 1,9; the drainage area demonstrates average susceptibility, thus it has average possibility to deliver the matter to the lake;

group 4 – mean value is equal or higher than 2,0; the catchment demonstrates great possibility to activate the are load and quickly deliver it to the lake.

These evaluations also indicate which of the given characteristics is favourable for fast matter supply to the lake (for instance: dense channel network, high slope, not many shares of depressions, catchment with settlement) and which inhibits this process (for instance: lack of water courses, low slope, many shares of depressions, loamy forms in the ground, many forests).

The lake natural resistance to the outside influence is evaluated according to the modified proposal of the System of Evaluation of lakes Quality (Kudelska et al. 1983). The lake natural resistance to the drainage area influence is determined by the following characteristics:

– mean lake depth; shallow lakes of the same biogenic compounds overloading are more fertile than deep lakes (Kajak 1979);

– quotient of lake volume and its shoreline length; the higher value it has, the more resistant the lake is to the outside influence (Sylwester et al. 1974);

– thermal stratification; it is expressed in the percentage of meta- and hypolimnion in the overall water mass (the higher value, the lower the lake productivity);

– quotient of bottom surface within epilimnion and epilimnion volume being the measure of recirculation of biogenic substances; the lower the value, the more favourable for the state of water transparency, as the contact with the bottom is lesser, thereby less phosphorus from the bottom sediments gets to epilimnion (Fee 1979)

– mean rate of annual water exchange (quotient of mean annual lake runoff and the volume of the lake); it demonstrates the intensity of reservoir “rinsing”. Lake of faster water exchange may accumulate higher biogenes load than the lake of slower water exchange even at the same mean depth (Vollenweider 1976);

– Schindler`s index (quotient of the are receiving pollution, thus of total drainage area, and the amount of water that thin it, thus lake capacity).

Above characteristics are estimated on the basis of lakes bathymetric plans; the volume of the runoff from the lake is obtained from the data of Institute of Meteorology and Water Management (IMGW).

Points from 0 (high resistance) to 3 (lack of resistance) are given to each individual characteristics defining the lake resistance to the outside influence.

Table 2 – *Point criterion for the evaluation of the lake resistance to the outside influence*

Characteristics	Number of points			
	0	1	2	3
Mean lake depth (m)	> 10	5 – 10	3 – 5	< 3
Lake volume (hm^3) to shoreline length (m)	> 5	3 – 5	1 -3	< 1
Thermal stratification (%)	> 35	20 – 35	10 – 20	< 10
Active bottom surface (m^2) to epilimnion volume (m^3)	< 0,10	0,10 – 0,15	0,15 - 0,30	> 0,30
Rate of annual water exchange	> 10	5 – 10	1 – 5	< 1
Schindler`s index (m^{-1})	< 10	10 – 30	30 – 100	> 100

The final evaluation constitutes an arithmetic mean of the points given for evaluation of the influence of each individual lake characteristics (Table 2). The mean lower than or equal to 0,8 indicates that the lake belongs to category I (the lake is highly resistant to the outside influence), from 0,9 to 1,6 – category II (average resistance), from 1,7 to 2,4 – category III (low resistance) and more than 2,4 – category IV (no resistance, the lake is highly subjected to the outside influence).

The combination of the drainage area susceptibility and lake resistance groups allows to indicate 4 types of lake geoecosystems of different rate of natural eutrophication.

The first type constitutes such a lake geoecosystem in which natural lake characteristics (I or II resistance category) as well as the drainage area characteristics (1 or 2 susceptibility group) are not favourable for lake waters eutrophication; the lake is resistant to the outside influence and its drainage area is slightly active in delivering the area load to the lake. Thus, such geoecosystem has a chance to maintain the trophy on a low level.

The second type represents such lake geoecosystem in which unfavourable for the lake drainage basin conditions (strong possibility of delivering the area load to the reservoir – 3 or 4 susceptibility group) are compensated by high lake resistance to the outside influence (I or II resistance category). As a result, the rate of their natural eutrophication should be moderate.

The third type constitutes such a lake geoecosystem in which there are favourable lake drainage basin conditions (the basin is slightly active in delivering the area load to the reservoir – 1 or 2 susceptibility group) but the lake itself is subjected to the outside influence (III or IV resistance category). The lake eutrophication develops gradually, however, the interference in drainage area conditions (e.g. the development of tourism) may lead quickly to an increase in its rate.

The fourth type is a lake geoecosystem, which natural conditions are favourable for very fast water eutrophication. The lake is subjected to the outside influence (III or IV resistance category).

The results of the evaluation

50 lake geoecosystems were selected from Mazurian Lakeland and Kashubian Lakeland. On the basis of the evaluation presented above, it was determined with respect to the rate of natural eutrophication, which type of lake geoecosystem they represent (Table 3). The lake geoecosystems were selected so that the lake drainage basins demonstrated varied susceptibility to the matter supply, and lakes varied resistance to the degradation (Table 3).

***Table 3** – Types of the lake geoecosystems depending on the natural degradation rate*

Group of drainage basins as a supplier of master to the lake	Categories of degradation ability of lakes			
	I	II	III	IV
1	Hańcza Kierzlińskie Duże	Szurpiły Kołowin Bobięcińskie Wielkie	Bądze Sędańskie	Łąkie Wielkie
2	Mamry Wigry Piłakno	Rekowo Kamienne Osuszyno	Duś Łuknajno Lubowisko	Junno
3	Czos Głębokie Raduńskie Górne Raduńskie Dolne	Łapalickie Wobel Żarnowieckie Wielki Ocypel	Branickie Rańskie Lubygość Stężyckie	Bąckie Iławskie Kretyńskie Tuchel
4	Ełckie Juno Kłodno, Charzykowskie	Brodno Wielkie Dąbrowskie Ostrzyckie Sianowskie	Liwieniec Puchlin Potęgowskie Patulskie	Kraksy Duże Trzebno Święte Kałębie

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УДК 620.9

ОБРАБОТКА ЭНЕРГЕТИЧЕСКИХ РАСТЕНИЙ НА ПАХОТНЫХ ЗЕМЛЯХ В ПОЛЬШЕ

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The article gives an outline of the issues of the use of arable land in Poland under the energy crops-annual and perennial. The main objective of this research was the spatial analysis and evaluation of the development of energy crops in Poland, taking into consideration natural, historical and urban conditions.

Введение

Директива Европейской Комиссии 28/2009/ВЕ устанавливает увеличение участия возобновленных источников энергии в окончательном использовании энергии для целого Евросоюза на уровне 20%. Для отдельных членских стран эта цель определена на разном уровне [1]. В соответствии с акцессионным трактатом с Евросоюзом с 2004 года, Польша обязалась увеличить участие энергии созданной из возобновленных источников в энергетике до 7,5% в 2010 году и до 14% в 2020 году. Производство биомасы на энергетические цели может быть, затем, главным причиняющим фактором для достижения этих целей. Считается, что потенциал биомасы Польши принадлежит к самым высоким в Европе и выносит 895 ПЙ [2].

Термин «энергетические растения» подчиняется как и к одногодичным, так и к многолетним обработкам на пахотных землях с исключительным предназначением для энергетических целей. Растительная биомасса, добываемая из