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EVALUATION OF ECOLOGICAL STATE OF SMALL WATER RESERVOIRS IN THE BYSTRZYCA RIVER VALLEY

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Summary. Small water reservoirs are a valuable natural objects, but often neglected in researches. However, the degradation of these ecosystems progressing rapidly hence all the activities aimed at their inhibition should be correlated. The aim of the study was to determine the ecological status of small reservoirs the Bystrzyca river valley near Lublin, as well as an indication of the factors that affect their functioning. On the basis of valorisation, small water reservoirs were classified as natural valuable. Especially valuable were two: mid-forest reservoir and oxbow lakes, connected to the Bystrzyca river. Among factors negatively affecting the assessment of the reservoirs was the way of land use in its surroundings.

Key words: small water reservoirs, the Bystrzyca river valley, ecological state, macrophytes

INTRODUCTION

This study aim is to determine the ecological status of small reservoirs located in the valley of the Bystrica river near Lublin and an indication of factors that affect their functioning. Small reservoirs are a term referring to non-deep and various in terms of size standing of surface water reservoirs [Koc *et al*. 2002, Fatyga *et al*. 2007, Ożgo 2010, Skwierawski 2010, Maślanko *et al*. 2010].

River lakes or oxbow lakes are type of small reservoir associated with river valleys with intrinsic properties. Their natural value can be determined based on the degree of vegetation cover, the surface and the type of land use in the catchment. Only the river lakes vegetation is similar to that in eutrophic and mesotrophic lakes [Wojciechowska 2006]. Oxbow lakes are a separate type of aquatic habitats because they have different dynamics than the lakes and quaint layout. One of features is a large variation in the level and quality of water, which is caused by the diversity of supply [Maślanko *et al*. 2010, Wilk-Woźniak *et al*. 2012].

The formation of old river beds is a process that occurs gradually. About time of the creation of oxbow lakes tells us shape, because those younger are easier with more regular edges. Their length considerably exceeds the width, which is also a unique feature. Also, a man by hydrotechnical transformation of riverbeds can contribute to their creation [Wilk-Woźniak *et al*. 2012].

Ecological conditions in eutrophic oxbow lakes and natural small water bodies are very similar. The high content of nutrients is caused by periodic supply, for example, fertile river waters. They characterized by high rate of primary production and significant amount of organic matter in water and in bottom sediment. Oxbow lakes are also characterized by a great diversity of plant communities. The entire surface often cover pleustophytes, which restrict development of benthic vegetation. There are large fluctuations in water reaction (pH ranged from 6.5 to 9) and electrolytic conductivity (300–900 μS cm^{3}). There are often blooms of water [Wilk-Woźniak *et al*. 2012].

Small water reservoirs increase retention of catchment area and stabilize the groundwater level. Moreover, affect microclimate as increase humidity of air and decrease temperature fluctuations. Besides these, reservoir enrich the landscape values, giving the natural character and more attractive to tourists. The sozological function of reservoirs based on the accumulation of biogenic substances from the catchment, thereby minimizing their supply to other surface waters [Koc *et al*. 2002, Mioduszewski 2006, Wagner 2005, Skwierawski 2010, Sender and Kułak 2014]. Small water reservoirs are characterized by the greatest richness of species, including those unique. In small reservoirs succession occurs extremely quickly, causing constant exchange of groups of species living there which increases biodiversity. Important fact is, that all these functions reservoirs fulfill in the early stages of succession and in good ecological status [Ożgo 2010].

Changes in small aquatic ecosystems occur very quickly and are easily noticeable; than the disappearance of small water reservoirs is notably considered as inevitable process. This process is not always consequently to the development of surroundings. Slope, land use and even the ground type, influence this process; even the vegetation type dynamics affects the transformation of the small water reservoirs [Skwierawski 2010], so in this way we can consider these small water systems as more susceptible of „burial" by organic accumulation or water input.

STUDY AREA, MATERIAL AND METHODS

The study included four river lakes, situated in the valley of the Bystrica river in Lublin and surrounding area. Location of reservoirs was varied. One of the analyzed lakes is located in the Lublin city (below Zemborzycki Reservoir). Others were above the dam reservoir near the town Prawiedniki (Fig. 1).

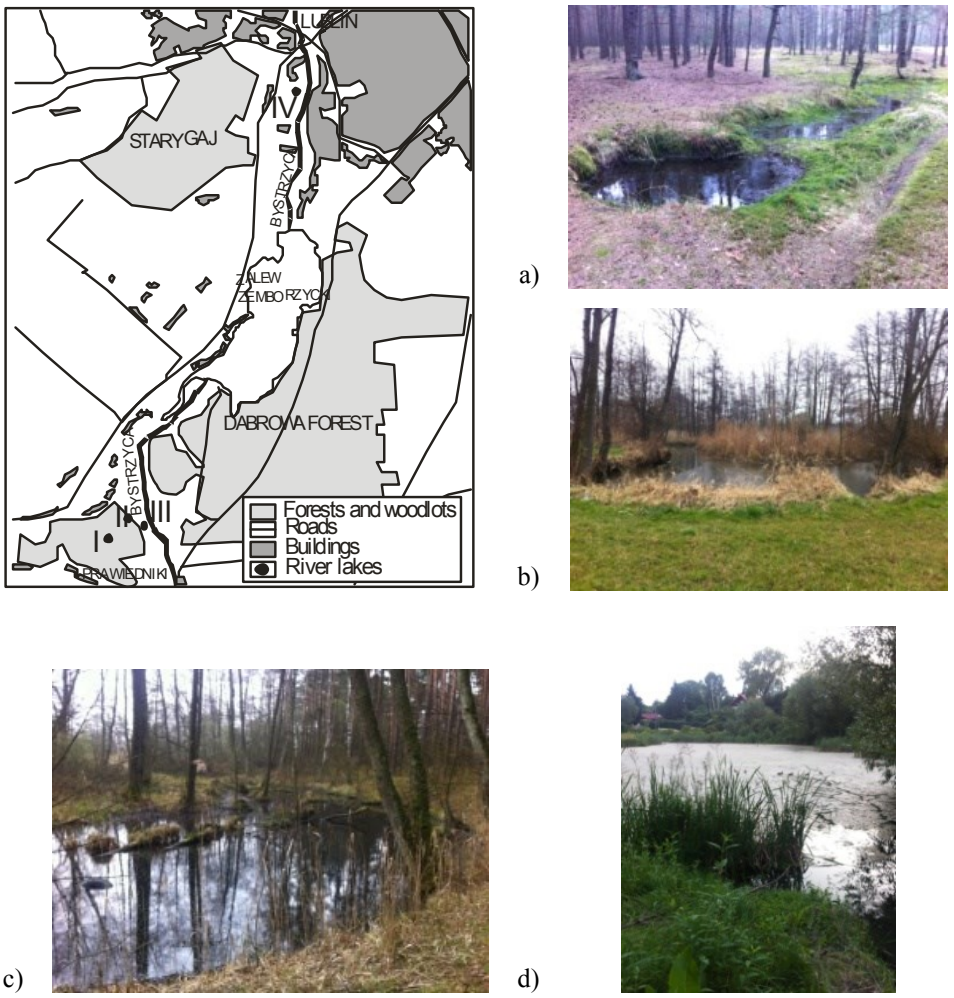

Fig. 1. Localization of investigated small reservoirs; a) mid-forest reservoir I, b) reservoir II, c) reservoir III, d) reservoir IV

Small reservoirs were varied due to the different way of their origin, type and degree of vegetation development, habitat type and distance from the river current. All of the reservoirs were persistent water bodies. The first reservoir (I)

is typical mid-forest, sand working. Next two are typical oxbow lakes, lake II lies on the border of the forest and meadows, and lake III among meadows, very close to the current of the river. The fourth lake is the result of human intervention in the urban environment. As a result of regulation of urban section of the Bystrica river, permanently waterlogged areas, has formed an artificial reservoir connected to the river (Fig. 1).

Field studies were carried out in April and August 2014. Morphometric analysis was performed using sonar LOWRENCE (depth) and rangefinder BOSCH DLE (surface). Buffer zone, covering 300 m around the oxbow lakes was determined and analyzed in terms of development. The GPS meter was used for analysis, as well as topographic and orthophoto-maps on a scale of 1: 5000. Analyses were made using ArcGIS 10.0.

Valorisation was carried out by Skwierawski's method [2005] with modifications relating catchment area of lakes. Because the lakes are located within the same catchment area, so it seems reasonable to restrict the analyzes to the buffer zone, having the greatest impact on the reservoirs [Vought *et al*. 1995, Syversen 2005]. The method of valuation of small reservoirs involves analysis of three groups of factors different reservoir zones: surroundings, the shore and littoral. A total of 19 criteria were evaluated on the basis of obtained results in the form of points then each oxbow lakes separately classified into one of four classes reflecting their ecological status. All threats have been identified.

Method of phytosociological releves was used to study vegetation [Braun-Blanquet 1951]. The degree of vegetation variation in each zones was determined using the Shannon-Wiener index [Mendes *et al.* 2008].

RESULTS AND DISSCUSION

The analyzed river lakes were differentiated in terms of surface and the way of land use in the buffer zone. The smallest lake occupied an area of 28 m^2 and it was just a typical mid-forest reservoir. The largest one covered 3656 m^2 and its surroundings was dominated by urban buildings (Tab. 1).

Analysis of particular zones allowed to identify both the most valuable areas, as well as requiring corrective action. In the assessment of waters and shores of the highest values lake river IV obtained, located in the city, others were in a group characterized by a high level of transformation and unfavorable habitat conditions. In contrast, in the assessment of the buffer zone the highest has been assessed mid-forest reservoir I (class I), and the worst, as a very strong threat, lake situated in the city IV (Tab. 2).

Table 1. Selected morphometric features and the way of land use in the buffer zone (%)

Feature	Reservoir I	Reservoir II	Reservoir III	Reservoir IV
Location	51°08'57"N 22°29'16"E	51°09'03"N 22°29'36"E	51°08'57"N 22°29'50"E	51°13'4"N 22°32'25"E
River lake surface, m^2	28	406	1080	3656
Max. Length, m	12	28	107.26	118.27
Max. Width, m	4	21	15.56	35.9
Way of land use in the buffer zone, %				
Forests	99.8	56	26	0
Wetlands and other water	0.2	11	5.4	30.9
Meadows	0	31.8	68.6	23.4
Urban buildings	0	0	0	43.3
Roads	0	1.2	0	2.4

Table 2. Evaluation of particular zones of studied reservoirs

Feature \ Reservoir	I	II	III	IV
Ewaluation of litoral zone – A				
Color, water turbidity	3	3	4	5
Water conductivity	5	3	1	1
Water surface	0	2	2	5
Stability of water level	5	5	5	5
Max depth of water in the summer	1	2	2	3
Vegetation (percentage of reservoir coverage)	2	1	3	4
Presence of floating plants and filamentous algae	3	0	1	3
Number of water plant species	2	2	3	3
Evaluation of shore zone – B				
Shores configuring	1	1	1	2
Presence of rushes	0	2	3	4
Number of rush species	1	1	3	3
Participation of communities in the reservoir surface	1	2	2	1
Number of marsh plants species around the reservoir	2	1	2	1
Forest cover and shrubs of shores	5	4	4	2
Evaluation of the buffer zone – C				
Surface of the buffer zone	2	3	2	2
Land use	5	4	4	3
The average slope	5	2	3	1
Flow rate	3	3	2	1
Presence of degrading factors	5	4	4	1

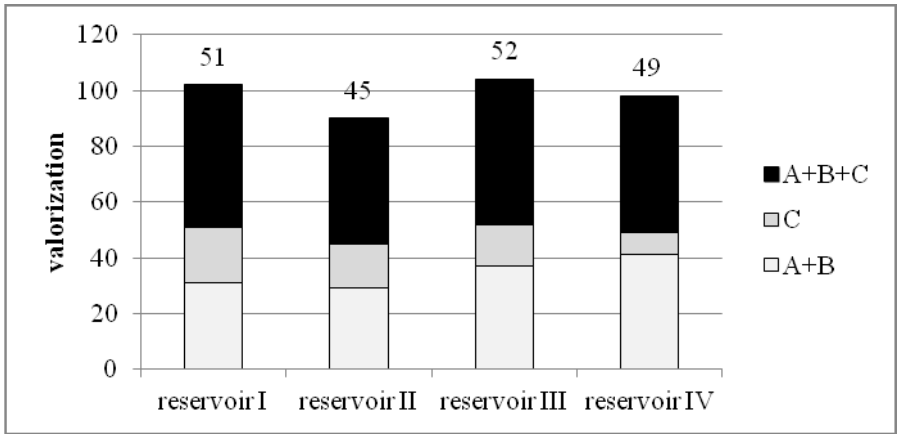

Fig. 2. Total valorization of studied reservoirs

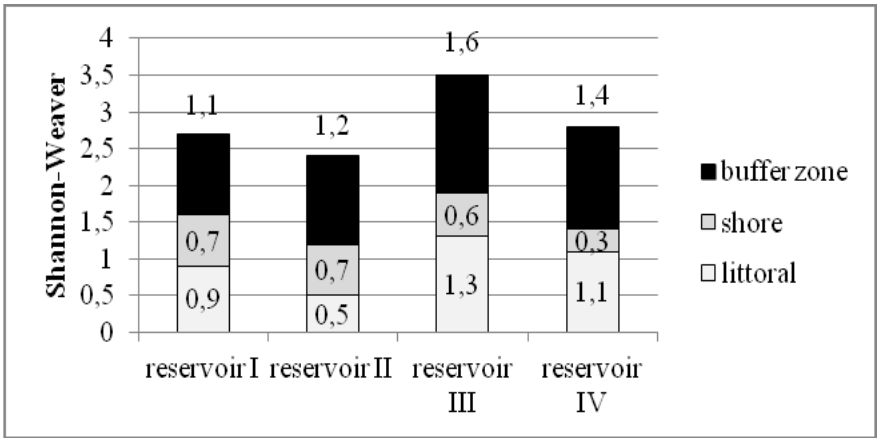

Fig. 3. Shannon-Wiener index for each zone in studied reservoirs

In the general classification of the ecological status oxbow lake, periodically connected with the Bystrica river, was the highest valorized. The greatest variety of plants, both rush and submerged appeared in it. The reservoir did not possess significant threats, and a buffer zone in most was covered with wet meadows. Equally the smallest reservoir, surrounded by forest received a high evaluation. Despite almost total lack of rushes in this reservoir, the location of reservoir and the presence of rare species had the great meaning in general valorization. The lowest rated reservoir II. The oxbow lake was situated away from the main current of the river, about 25m. Intense successional processes occurring in the reservoir leads to homogenization of plant communities. Adversely affects the functioning of the reservoir threat in the form of litter by the local population. The littoral zone

of the reservoir IV was well developed, despite the adverse impact of surroundings (Fig. 2).

A similar study conducted on a larger group of small water reservoirs of Lublin area showed that among them reservoirs with an average natural values, requiring remediation activities dominate [Sender and Kolejko 2013]. Studied small reservoirs in most belong to the valuable natural, but partly transformed, requiring protective actions to prevent their degradation.

Analysis of plant communities diversity in three studied zones of reservoirs confirmed that the large diversity of vegetation significantly increases the ecological values of aquatic ecosystems (Fig. 3). In this evaluation, reservoir IV received slightly higher values than in carried out global assessment of ecological status. The smallest diversity of plant communities was confirmed in the river lake II. Values of the Shannon-Wiener index in the studied reservoirs were higher than those obtained in the river lakes of the Bug river valley [Lorens 2006].

CONCLUSIONS

This small water reservoirs have an high natural waters value, especially that of mid-forest and oxbow lake. Analysis of plant communities diversity (S-W index) significantly reflects its ecological status.

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OCENA STANU EKOLOGICZNEGO MAŁYCH ZBIORNIKÓW W DOLINIE RZEKI BYSTRZYCY

Streszczenie. Małe zbiorniki wodne to cenne przyrodniczo obiekty, często jednak pomijane w badaniach naukowych. Zmiany w nich zachodzące są natomiast bardzo szybkie i podejmowanie decyzji co do formy i rodzaju ich ochrony powinno być skorelowane. Celem pracy było określenie stanu ekologicznego małych zbiorników doliny rzeki Bystrzycy okolic Lublina oraz wskazanie czynników wpływających na ich funkcjonowanie. Przeprowadzona waloryzacja małych zbiorników pozwoliła zaliczyć je do akwenów cennych przyrodniczo, szczególnie dwa – zbiornik leśny oraz jezioro rzeczne, a także wskazać zagospodarowanie strefy otaczającej zbiornik jako największe zagrożenie wpływające na ich degradację.

Słowa kluczowe: małe zbiorniki wodne, dolina rzeki Bystrzycy, stan ekologiczny, makrofity