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HYDROMORFOLOGICAL VALORISATION OF THE BOCHOTNICZANKA RIVER VALLEY AS A POTENTIAL VALUABLE ECOLOGICAL CORRIDOR IN THE LUBLIN REGION

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Summary. Systems of river valleys are one of the most complex and complicated natural – landscape systems acting as a natural stripes of increased displacement of matter, energy and biological information in the landscape. Natural and unconverted by man they often fulfill the role of a multi-species ecological corridors, but in today's world of strong anthropogenic transformations it is difficult to achieve a good hydromorfological condition of water. Requirements imposed under the provisions of the Water Framework Directive by the European Union on membership countries postulate achieving at least a good ecological state of rivers by 2015. The aim of the study was a hydromorphological valorization of valley of upland Bochotniczanka river, which can be a potentially valuable ecological corridor in the region, using the British method – River Habitat Survey (RHS). As a result of field research two numerical indicators HMS (Habitat Modification Score) and HQA (Habitat Quality Assessment) were identified. The river did not fulfill the requirements of the Water Framework Directive, because in most its state was defined as poor or moderate, and only in one river stretch a good condition was shown. Application of the ecological state of the river highlighted the need of improvement of the Bochotniczanka river's ecological state for 86% of the river length.

Key words: Bochotniczanka river valley, ecological corridor, hydromorfology, River Habitat Survey, RHS, HQA, HMS

INTRODUCTION

Systems of river valleys are one of the most complex and complicated natural – landscape systems. River valleys fulfill a few important functions, most often as a place where a variety of habitat types is concentrated, that's why natural and unconverted by man often fulfill the role of a multi-species ecological corridors [Cieszewska 2004, Chmielewski 2012]. River valleys act as a natural stripes of increased displacement of matter, energy and biological information in the landscape (among others, flow of water and erosion material, the movement the air mass, species migration) [Chmielewski 2004a]. In order to fulfill functions as ecological corridor, it should maintain natural or semi-natural character, lead water not excessively polluted, be permeable and not cutted by barrier structures [Chmielewski 2004b, 2005]. Itself stream of the river has the biggest importance for fish and amphibians. Their presence depend heavily on water quality and lack of structures that prevent free migration. Additionally, the diversity of river habitats is affected by the presence of hollows, spurs, smart, deeps, side arms, etc., as well as the flow rate, depth and diversity of the substrate [Żurek and Stag 2007]. Natural or semi-natural character of the river valley' habitats favors the occurrence of many flora and fauna species.

The changing character of aquatic ecosystems with a change of the physical parameters of the valley and its flowing river emphasize the concept of the river continuity – so-called river continuum. From the water spring to the estuary, in a continuous way physical factors such as the width and depth of the trough, flow speed, water amount and temperature change [Hestir 2007].

Status of water purity in Poland is still unsatisfactory, whereas almost 97% of monitored rivers represent conditions rated as negative for the existence of fish [Chmielewski 2012, Domańska 2009]. Requirements imposed under the provisions of the Water Framework Directive [Directive 2000] by European Union on membership countries postulate achieving at least a good ecological status of rivers by 2015. In order to reach intended results by planned re-naturalization river treatments, a unified system of morphological assessment of rivers to allow their comparison on the local or regional level was introduced [Newson *et al*. 1998, Szoszkiewicz *et al.* 2009a] – it is more and more frequently used in Poland version of the British method called the River Habitat Survey (RHS) [River... 1997, 2003], modified and adapted to the Polish conditions in the Department of Ecology and Environmental Protection, at University of Life Sciences in Poznań. River Habitat Survey allows the characteristics of rivers and their classification based on hydromorphology. It is a method based on registration of well-defined elements of the environment, additionally easy to implement, inexpensive and the obtained results are precise and repeatable [Osowska and Kalisz 2011].

The aim of the study was a hydromorphological valorization of upland Bochotniczanka river valley, which can be a potentially valuable ecological corridor in the region, using the British method – the River Habitat Survey (RHS).

STUDY AREA AND METHODS

The object of the study was the Bochotniczanka river, with a total length of 8.5 km and water spring in Czeslawice. This is one of the most attractive land-scape areas on the Nałęczów Plateau (62.9 km^2). This area is located in the central – eastern part of the Nałęczów municipality. Nałęczów Plateau lies within the macro-region of the Lublin Upland, extends between the Vistula and Bystrzyca rivers, and its surface is approx. 615 km^2. This region is covered with a thick layer of loess and strongly dissected river valleys, as well as gorges [Nowacka 1992]. Nałęczów Plateau is one of the most valuable natural and landscape physico-geographical mesoregions located within upland landscapes of Poland [Michalik-Śnieżek and Chmielewski 2012]. Within the Plateau the Kazimierz Landscape Park and its buffer zone, as well as Natura 2000 sites are distinguished. The Bochotniczanka river is a right-hand tributary of the Bystra river, with a continuous flow of water, while its tributaries are balancing on the border of flowing and periodically solid rivers. Bochotniczanka is a river with a highland character.

The River Habitat Survey classification was carried out along the entire length of the river, divided into 7 river stretches. In each river stretch 10 control profiles were isolated, spaced from each other by approx. 100–120 m.

Fieldworks were conducted between July and August 2012. They included a standard set of analyzes covered by the RHS method, which included filed work RHS form, as the basis [Szoszkiewicz *et al.* 2009b].

Analysis started at the water spring of the river in Czesławice (N:51°18'42.81', E:22°14'59.84') and finished in the estuary to the Bystra river (N:51°17'16.02', E:22°12'13.95').

The study included two standard steps:

1) The first step – the characteristics of the basic morphological features of trough and banks of the control profiles. Physical attributes (building material, modifications and natural morphological elements of banks and bottom of trough, the flow type), the structure of aquatic and shoreline flora, as well as the use of banks were included.

2) The second step – a concise description conducted for the whole tested river stretch. It took into account the various morphological forms, anthropogenic transformation and forms of land use, which were not registered in the first step, and a lot of additional information (including valuable natural elements of the river environment, plantings, size of trough, the presence of invasive plants and degrading environmental factors) [Szoszkiewicz *et al.* 2009a, b].

Simultaneously, a photographic documentation on each individual river stretch was created.

Then, the results of the above steps have been postponed into numerical values allowing for assessment of hydromorphological status of surveyed river stretches of the river and their classification [Szoszkiewicz *et al.* 2009a]. For this purpose, the indicators that are the result of many individual parameters were used, i.e. indicator of watercourse naturalness (Habitat Quality Assessment – HQA), based on the presence and diversity of the natural elements of the stream and the river valley, as well as indicator of habitat transformation (Habitat Modification Score – HMS), defining the scope of transformation in the stream morphology [Raven *et al.* 2000].

Table 1. Classification of synthetic values of HQA and HMS indexes

Quality classes	HQA	Hydromorphological status	HMS	Hydromorphological status
I	≥ 57	very high	0–2	natural
II	56–50	high	3–8	slightly modified
III	49–37	moderate	9–20	moderate modified
IV	36–31	poor	21–44	significantly modified
V	≤ 30	very poor	> 45	degraded

For HQA and HMS synthetic indexes limits of five classes of the hydromorphological status were specified [Raven *et al.* 1998; Ławniczak and Gebler 2011]. For HQA the following ranges of each class were proposed: I: ≥ 57, II: 56–50, III: 49–37, IV: 36–31, V: ≤ 30, whereas for HMS index: I: 0–2, II: 3–8, III: 9–20, IV: 21–44, V: > 45 (Tab. 1).

RESULTS AND DISCUSSION

The studies carried out by the RHS method allowed to obtain two numerical indicators: HQA and HMS, as well as to determine the hydromorphological state of the river.

Assessment of watercourse and the river valley's naturalness on the basis of HQA index

Conducted field measurements allowed to collect data to assess naturalness of the watercourse and the river valley (Tab. 2).

Values of HQA index for the Bochotniczanka river ranged from 20 to 42. Relatively the highest values of this index were achieved in river stretches No. III, IV and V, what is related to, among others, the occurrence of natural material bottom of trough, the natural morphological elements of bottom and banks, plantings in the immediate surroundings and other precious natural elements of the river environment, that's why in these river stretches of the river there is the highest naturalness. The lowest value of the index indicated in river stretches No. II and VI, in which the river flows through the city and was included into a complex of ponds in Czesławice.

Table 2. Results of ranking of each hydromorphological parameters in the calculation of the HQA natural habitat index

Hydromorphological parameters	River stretches under study						
	I	II	III	IV	V	VI	VII
Type of flow	9	7	5	7	9	3	5
Natural material of trough' bottom	5	5	5	4	8	6	6
Natural morphological elements of trough	6	2	3	2	7	0	0
Natural morphological elements of banks	5	3	3	3	3	3	3
Meander scroll ridges	0	0	0	0	1	0	0
Structure of shoreline vegetation	3	8	10	9	10	4	8
Groups of aquatic plants	1	1	2	3	0	4	4
Land use in 50 m Belt from banks	0	1	1	2	1	0	1
Plantings and accompanying morphological elements	3	4	6	6	3	0	3
Valuable natural elements of the river environment	5	0	5	5	0	0	5
Sum = HQA	37	31	40	41	42	20	35
Naturalness of the river and river valley	moderate	poor	moderate	moderate	moderate	very poor	poor

Assessment of the anthropogenic transformation degree of the watercourse and the river valley on the basis of HMS index

Values of HMS index of the Bochotniczanka river ranged from 1 (river stretch IV) to 38 (river stretch I) (Tab. 3).

Values of HMS index for the river fluctuated in the range between 1 and 38. Four segments showed a natural or slightly modified character of the river, i.e. in river stretch no. IV the summed value of 1 indicated its very natural character, as well as river stretches No. II, III and VII reaching value that allows them to qualify as a poorly modified. Most modified river stretch flow through the city, as a consequence of transformations introduced there (regulated, embanked trough, many water structures, greenery, etc.).

Studies on basic morphological parameters and control profiles (step I of RHS methodology) showed that the valley almost along the entire length had asymmetrical profile, only the last two river stretches had the profile with a flat bottom character. In contrast, the profile of waterside river varied, gradually from the water spring angle of the river banks decreased from 85 degrees in river stretches No. VI and VII to 45 degrees (river stretches IV and V). In other sections of banks had mild profile. Soil was a material of two banks on the entire length of the river, with small fragments of concrete structures. Clay and river sediment were dominant bottom material, whereas sand only in control profile no. IV. Banks transformations on the entire length of the river were very few. On several river stretches of the riverbed trash occurred. Water structures were present on each river stretch under the study, and water culverts were one of the most common elements. Rapids were present on the entire length of the river (11). In river stretch No. V a small island occurred. On almost the entire length of the river smooth flow type dominated. The exception was small waterfalls in river stretches No. II and V.

Table 3. Results of ranking of each antropoghenic modifications in the calculation of the HMS habitat modification index

Hydromorphological parameters	River stretches under study						
	I	II	III	IV	V	VI	VII
Transformations observed in the control profiles	13	0	0	0	8	1	2
Water structures not recorded in the control profiles	22	4	3	1	11	8	4
Transformations observed during the assessment of synthetic profiles, not registered in the control	3	0	0	0	0	1	2
Sum = HMS	38	4	3	1	19	10	8
Degree of river' modification	significantly modified	poorly modified	poorly modified	natural	moderately modified	moderately modified	poorly modified

Typical aquatic flora existed only in four river stretches. The biggest number of liverworts and mosses occurred in fourth river stretch of the river, whereas on the shore in river stretch No. III rooted plants with shoots trailing in water occurred. In sixth river stretch submerged plants with floating leaves and emergent narrow-leaved were identified.

Evaluation of hydromorphological status of studied river river stretches

On the basis of numerical indexes HQA and HMS the final classification of the hydromorphological status of the river [Bielak *et al.* 2012] was made. In Arabic numerals numbers of studied river stretches were designated (Tab. 4).

The analysis showed that investigated river was characterized by poor hydromorphological state in river stretches No. 1 and 6, which can be associated with the type of catchment's land use – in turn urban and meadows transformed into intensively managed ponds. Moderate hydromorphological condition performed in the vast majority – i.e. in river stretches No. II, III, V and VII. The highest status, among analyzed river stretches – that is good status determined only in river stretch No. 4. Moderate status was set on 57.1% of the length of investigated river, poor state on 28.6%, whereas only on 14.3% as a good.

Table 4. Hydromorfological classification of river stretches under the study synthetic on the background of RHS classification diagram

Value of HMS index	Categories of HQA index values				
	≥ 57	56–50	49–37	36–31	≤ 30
0– 2	I	II	II 4	III	III
3–8	II	II	III 3	III 2.7	IV
9–20	III	III	III 5	IV	IV 6
21–44	III	IV	IV 1	IV	V
45–100	IV	IV	V	V	V

I – very good state, II – good state, III – moderate state, IV – poor state, V – very poor state.
1–7 – river stretches under study [According to Bielak *et al.* 2012].

The poorest status in the ranking reached river stretches No. I (estuary to Bystra river) and VI, which is associated with the biggest influence of anthropogenic transformation.

The biggest threats to the Bochotniczanka river were point pollution emitters situated along the entire length of the river. The sanitary conditions should be improve that simultaneously affect on the aesthetics of riparian areas. Although the main threat were ponds used for fishing and agriculture pollution, as well as water and windy erosion of slopes of the valley. Among the ways to prevent water pollution of the river is mainly exclusion it from within the hydrological run with ponds, reduction of fisheries management and the implementation of trees on steep slopes to reduce surface runoff from agricultural fields.

Similar to the other rivers, for example the Kłodnica river [Osowska and Kalisz 2011] field observations of the Bochotniczanka river made a significant impression of its naturalness, not strongly anthropogenically transformed, however, HQA index values proved that this was only a visual naturalness.

The obtained results indicated a need to improve the hydromorphological conditions of the river, at least on a good [Regulation 2011], but it is doubtful that this watercourse will be under renaturalization proccess in the neareast future.

On the basis of conducted analyzes an assessment of Bochotniczanka river as a valuable ecological corridor was also carried out. RHS index pointed out that only fragments of the river can perform such functions, while others would need to take remedial action, restoration of natural or semi-natural status, removal of barrier structures limiting the permeability of the river. Particularly a critical place for free migration of fish fauna species was a river stretch of the river enter to Bystra river in Nałęczów, whose ecological status was rated as the poorest one.

CONCLUSIONS

1. The Bochotniczanka river does not fulfill requirements of the Water Framework Directive, cause in most river stretches its state was identified as poor or moderate, and only in one river stretch was shown a good (satisfactory) status.

2. Application of the ecological state of the river highlighted the need of improvement of the Bochotniczanka river's ecological state for 86% of the river length.

3. Appropriate methods of re-naturalization should be undertaken to enhance the naturalness of the watercourse so that it could be a permeable ecological corridor.

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WALORYZACJA HYDROMORFOLOGICZNA DOLINY RZEKI BOCHOTNICZANKI JAKO POTENCJALNIE CENNEGO KORYTARZA EKOLOGICZNEGO W REGIONIE LUBELSKIM

Streszczenie. Systemy dolin rzecznych są jednym z najbardziej złożonych i skomplikowanych systemów przyrodniczo-krajobrazowych, stanowiąc naturalne pasma wzmożonego przemieszczenia się materii, energii i informacji biologicznej w krajobrazie. Naturalne i nieprzekształcone przez człowieka często spełniają rolę wielogatunkowych korytarzy ekologicznych, jednak w dzisiejszej dobie silnych przekształceń antropogenicznych trudno o dobry stan hydromorfologiczny wód. Wymogi nałożone na podstawie przepisów Ramowej Dyrektywy Wodnej przez Unię Europejską na państwa członkowskie służą osiągnięciu przynajmniej dobrego stanu ekologicznego rzek do 2015 r. Celem pracy była waloryzacja hydromorfologiczna doliny wyżynnej rzeki Bochotniczanki, stanowiącej potencjalnie cenny korytarz ekologiczny w regionie, z zastosowaniem brytyjskiej metody River Habitat Survey (RHS). W wyniku przeprowadzonych badań terenowych określono dwa wskaźniki liczbowe: HMS (wskaźnik przekształcenia siedliska) i HQA (wskaźnik naturalności cieku). Rzeka nie spełniła wymagań Ramowej Dyrektywy Wodnej, ponieważ w większości jej stan określono jako słaby lub umiarkowany, a tylko w jednym odcinku wykazano stan dobry. Analiza stanu ekologicznego rzeki wskazała na konieczność poprawy stanu ekologicznego Bochotniczanki na 86% długości.

Słowa kluczowe: dolina rzeki Bochotniczanki, hydromorfologia, korytarz ekologiczny, River Habitat Survey, RHS, wskaźnik HQA, HMS