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THE EFFECT OF SELECTED HYDROMORPHOLOGICAL PARAMETERS ON THE STATE OF AQUATIC VEGETATION IN THE CHECHŁO RIVER

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Abstract

The development of vegetation in lotic waters, including macrophytes, is determined by diverse factors, including bottom substrate, flow velocity, and the width and depth of a channel, which are hydromorphological parameters. Macrophytes are higher plants of terrestrial origin which have undergone numerous adaptations enabling them to live in water (Stańczykowska, 1975). The aim of the study was to assess the effect of selected hydromorphological parameters of a watercourse on the species composition of macrophytes. The subject of the study was the Chechło River, a left tributary of the Vistula. The study was carried out in two adjacent segments of the watercourse, according to guidelines in the Macrophyte Index for Rivers (MMOR) and elements of the River Habitat Survey (RHS).

The study revealed similar hydromorphological conditions in the two segments of the river, and the variation in the species composition of macrophytes in the two segments seems to be determined by other factors which were not the subject of the study. Among these, significant factors might include regulation works or the high water levels in the Chechło resulting from the construction of an impoundment. The plants identified in the two segments of the watercourse are species occurring commonly in Poland, preferring eutrophic waters and having a wide ecological tolerance.

Keywords: macrophytes, hydromorphological parameters, flowing water

INTRODUCTION

On 6 May 1968 the Council of Europe in Strasbourg, grappling with the problem of poor water quality, adopted the European Water Charter. It contained 12 principles concerning water as one of the most valuable of the Earth's resources, not only for the environment but for the human race (Orłowski 2009). For decades water quality was tested mainly on the basis of its physicochemical parameters, which only reflect the state of water at a given moment (Bedla, Misztal 2014). For this reason a search was begun for alternative means of testing that would characterize the actual state of water bodies. Researchers dealing with rivers monitoring have introduced a testing system based on observations of organisms living in aquatic ecosystems that are sensitive to changes in water quality (Szoszkiewicz et al. 2010a). Kolkwitz and Marsson developed a saprobic system involving analysis of the abundance and species composition of organisms such as: bacteria, fungi, algae, bryophytes, higher vascular plants, protozoa, triclads, rotifers, crustaceans, mayfly larvae, stoneflies, or caddisflies (Sharma, 2010). In Great Britain, Germany, France and Scandinavia researchers have begun to conduct testing based on macrophytes. Macrophytes are higher plants of terrestrial origin which have undergone numerous adaptations enabling them to live in water (Stańczykowska, 1975). This method exploits the response of this group of plants to degradation of water bodies in terms of trophic status (Szoszkiewicz et al. 2010a). The scope of adaptations of macrophytes to life in water depends in part on local conditions in their environment and its physical characteristics.

The aim of the study was to assess the impact of selected hydromorphological parameters on the development of macrophytic vegetation.

METHODS

The field work consisted of botanical identification of macrophyte species on two 100-metre stretches of the Chechło River, together with estimation of their area cover (P_i) on a 9-point scale. Each species identified was assigned a numerical index (L_i) representing its trophic status, with values ranging from 1 to 10, as well as a weighting factor (W_i) indicating ecological tolerance for trophic contamination, with values from 1 to 3. The proposed method was based on the Macrophyte Index for Rivers (MMOR) and elements of the River Habitat Survey (RHS) method (Szoszkiewicz et al. 2010b). Abiotic conditions prevailing in the analysed stretches of the Chechło River were described as well.

STUDY AREA

The study was conducted at two sites in the Chechło River near the village of Piła Kościelecka (Trzebinia Commune, Małopolska Voivodeship) in September 2013. The first site was located at km 18+520, near a small footbridge in the vicinity of the Gliniak reservoir. The other site was situated near a former railway bridge at km 17+510.

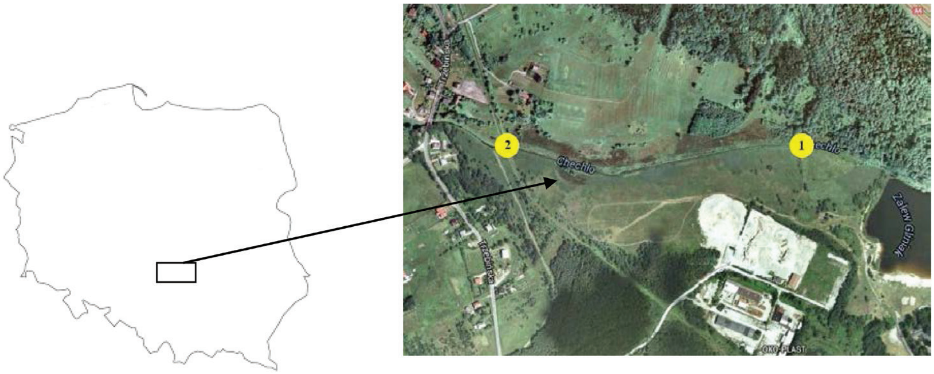

Figure 1. Location of the analysed segments of the Chechło River

The Chechło River is a left tributary of the Vistula, about 22 kilometres in length. It runs along the border between the Kraków-Częstochowa Upland and the Silesian Upland (passing through the communes of Trzebinia and Chrzanów). It forms a natural border between the communes of Libiąż and Babice. It originates in small streams flowing out of peat bogs in Dulowska Forest, situated in the Dulowsko-Chrzanowska Basin, about 260 m above sea level. It empties into the Vistula near the village of Mętków. Its catchment has an estimated surface area of 116 km^2, and its shape is irregular (Klojzy-Karczmarczyk et al. 2005).

RESULTS

The analysed segments of the Chechło River were varied to some extent in terms of land use in the neighbourhood of the river, certain hydromorphological characteristics, and the macrophyte species present.

Only three species were identified in the first site analysed, and eight at the second site (table 1). Most of the species present had an area cover index of 1. Slender tufted-sedge (*Carex acuta*) and Common reed (*Phragmites australis*) had a P_i value of 2 in the second segment, and as high as 9 in the first. Common reed (*Phragmites australis*) is not an indicator species and has no numerical index L_i or weighting factor W_i. The highest value for the area cover index (3) in the second segment was noted for Broad-leaved pondweed (*Potamogeton natans*).

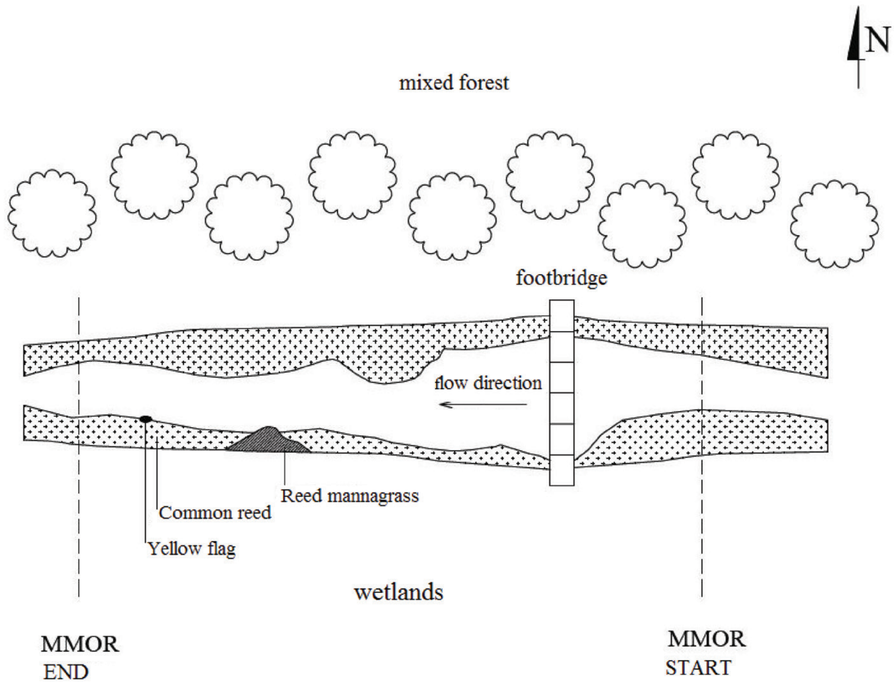

Figure 2. Schematic diagram of the first analysed site of the river, with land use and macrophyte communities

Table 1. Area cover (P_i), trophic index (L_i) and weighting factor (W_i) species identified at the both sites.

Species	First site			Second site		
	P_i	L_i	W_i	P_i	L_i	W_i
Equisetum palustre	-	-	-	1	5	2
Alisma plantago-aquatica	-	-	-	1	4	2
Carex acuta	-	-	-	2	5	1
Glyceria maxima	1	3	1	1	3	1
Iris pseudacorus	1	6	2	1	6	2
Phragmites Australis	9	-	-	2	-	-
Potamogeton natans	-	-	-	3	4	1
Rumex hydrolapathum	-	-	-	1	4	1

Source: own studies

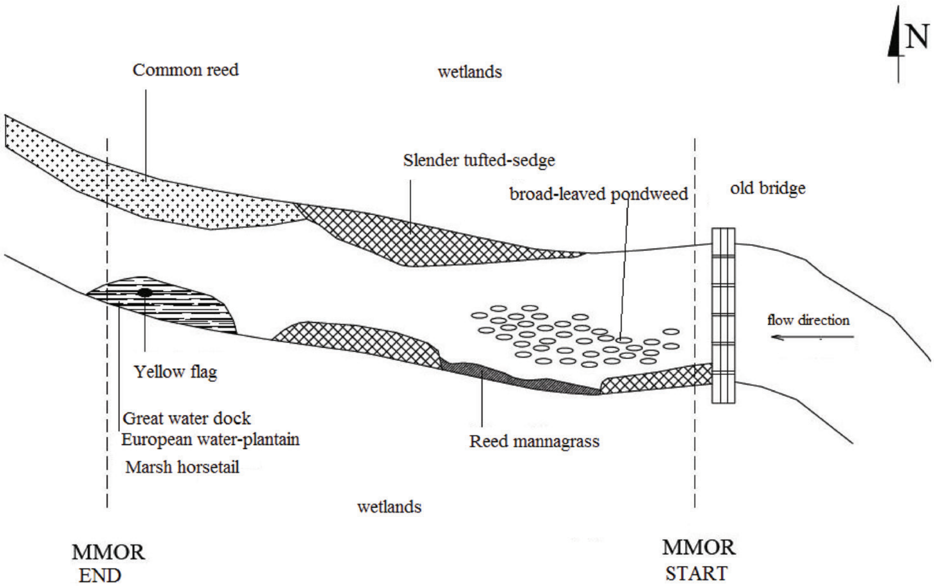

Figure 3. Schematic diagram of the second analysed site of the river, with land use and macrophyte communities

Table 2. Width of the first and second segments of the Chechło River

River width (m)	Cotribution %	
	First section	Second section
<1	-	-
1-5	90	10
5-10	10	90

Source: own studies

In examining the hydromorphological conditions, we first considered the width of the watercourse. The first site analysed was mainly between 1 and 5 m wide, and the water flow was classified as smooth. In the second one the channel was somewhat wider, predominantly from 5 to 10 metres (table 2). Due to its stagnant water, the flow was classified as imperceptible.

Another morphological element analysed in the river bed was its depth. The first site exceeded 1 m in depth in many places, while the second reached this depth in only a few locations (table 3). As emphasized by Bogdał et al. (2014), the second site of the river is in the backwater of the Chechło Reservoir, which affects its depth and gives it a slower flow.

Table 3. Depths of stream Chechło on the first and second section

River depth (m)	Cotribution %	
	First section	Second section
<0,25	-	20
0,25-0,5	25	20
0,5-1	25	33
>1	50	27

Source: own studies

Table 4. Percentages of bottom substrate types in the first and second segments of the river

Bottom substrate	Cotribution %	
	First section	Second section
Stones	-	-
Pebbles, gravel	-	-
Sand	-	-
Mud	50	50
Peat, muck	50	50

Source: own studies

We also considered the river segments analysed in terms of bottom substrate. No differences were observed between the two sites; the bottom material in both cases consisted of mud and muck (table 4).

Table 5. Forms of modification of the river bed at the first and second sites

Channel modifications	Cotribution %	
	First section	Second section
None	80	80
Profiling	20	20
Reinforcements	-	-

Source: own studies

Traces of past regulation works are visible in the two segments analysed in the river, manifested as a nearly linear course of the river channel (table 5).

Table 6. The degree of shading at the first and second sites

Shade	Cotribution %	
	First site	Second site
None	100	100
Partial	-	-
Heavy	-	-

Source: own studies

No shading of the water was observed in any fragment of the two segments analysed, and sunlight reached the river bed unimpeded (table 6).

DISCUSSION AND CONCLUSIONS

A total of 8 plant species were found in the two analysed segments of the river: Marsh horsetail (*Equisetum palustre*), European water-plantain (*Alisma plantago-aquatica*), Slender tufted-sedge (*Carex acuta*), Reed mannagrass (*Glyceria maxima*), Yellow flag (*Iris pseudacorus*), Common reed (*Phragmites australis*), Broad-leaved pondweed (*Potamogeton natans*) and Great water dock (*Rumex hydrolapathum*). These plant species are common in Poland and found in many locations, mainly on the banks of slow-flowing lowland rivers, i.e. in waters with a smooth flow (Lampert, Sommer 2001). The dominant species, especially at the first site, was Common reed (*Phragmites australis*), characterized by vast ecological amplitude. Reproducing mainly vegetatively, it produces a large amount of biomass, thereby displacing other plants with greater habitat requirements, and thus frequently forms single-species, monoculture stands, as pointed out by Ailstock (2000) and Bartoszuk (2003). On the basis of a study by Gebler (2011), which identified eutrophication as the main cause of species variation in lowland rivers, the trophic status of the water of the Chechło River may be presumed to be high.

In the analysed sites of the Chechło River the flow velocity was low, particularly at the second one, where the flow was classified as imperceptible. This enabled the development of certain groups of hydrophytes, particularly those with floating and submerged leaves. This is confirmed by reports by Ziglio (2006), who found that in rivers with low current velocity of about 0.3-0.65 $m \cdot s^{-1}$, plants of the genus *Potamogeton* find better conditions for development. One of these (*Potamogeton natans*) was observed in the second of the river site studied, where it was clearly dominant in the river bed.

The bottom substrate, consisting of mud and muck, was the same in both segments of the river. As emphasized by Fabris (2008), bottom material is an important source of nutrients for macrophytes living in water. The availability of nutrients is linked to the structure of the river bed and is determined in part by sediment grain size. Light conditions were also similar over the entire length of the watercourse, with no shading observed on the sites analysed. Lampert & Sommer (2001) report that light, and in particular insufficient light, may be a limiting factor in many aquatic ecosystems.

Tests conducted as part of a comprehensive evaluation of the water quality of the Mała Panew River (Kusza, Szoszkiewicz 2007) indicate the complexity of factors affecting the species composition of aquatic vegetation. As reported by Bogdał et al.(2014), the sites of the Chechło River in which the study was conducted had once been substantially transformed, by straightening of the river channel, reinforcement of the banks with fascines, and a dam.

Ultimately the effect of hydromorphological conditions is not the sole factor that can modify the occurrence and density of certain plant taxa.

The following conclusions were drawn from analysis of the results obtained:

1. The plants identified at both study sites in the Chechło River are common species in Poland, preferring eutrophic waters and having a wide ecological tolerance.
2. The small number of species in the part of the Chechło River studied is most likely due to environmental disturbances taking place in the past when the water course was straightened, the banks were reinforced with fascines, and a dam was constructed.
3. Most of the hydromorphological conditions analysed were similar at the two sites. Therefore the variation in macrophyte species composition in the two segments of the river seems to be determined by these conditions or by others that were not the subject of the study.

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