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WATER QUALITY ASSESSMENTS ON A NATURAL WETLAND (IGRICE-MARSH) ON THE BASIS OF CHEMICAL PARAMETERS AND MACROINVERTEBRATE TAXA

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ABSTRACT. The basic aim of the present study is the water quality assessment of the Igrice marsh (Nature Conservation Area, situated in boundary of town of Nyíregyháza, northeastern part of Hungary) using by bioindication and chemical analysis. The phenomenon of biofiltration is well known: the different wetlands are efficient at removing nutrients and pollutants from through-flowing water by means of their plant communities (mainly reedy, tussocky and large sedge areas). Considering the thought mentioned above, the basic questions of this study were the followings: how does the quality of water flowing through the marsh change and how is it manifested in the presence or even absence of the different macroinvertebrate taxa and in the chemical parameters? The water quality assessment was made by using the *Belgian Biotic Index* (BBI), an *index* based on the presence or absence of aquatic macroinvertebrate taxa and by chemical parameters (conductivity, pH, NO_2^-, NO_3^-, NH_4^+, Cl^-, Fe^{2+}+Fe^{3+}, orthophosphate). In accordance with the expectations, the results indicated that stream water, flowing through the marsh has been improved in quality by biofiltration processes of the wetland ecosystem. It could be seen based on the presence of the taxa indicating better water quality and the positive changes in the chemical features at the outflow part of the canal. As a conclusion, it could be established that the Igrice-marsh is able to improve the quality of the through-flowing water effectively. Nevertheless, using this wetland for such a function is not possible, because the habitat of the marsh is protected and there is no information about the effective buffer capacity of the area.
Keywords: Igrice-marsh, water chemistry, Belgian Biotic Index (BBI), macroinvertebrate, water quality

INTRODUCTION

It is a well known phenomenon that wetlands can work as buffer systems and are able to eliminate organic and inorganic pollutions from the water flowing through them by their typical flora. There are a lot of artificial wetlands all over the world for only cleaning of waste waters (Verhoeven et al., 2006). In cases of natural wetlands used for water cleaning purposes the main problem on one hand is, that the buffer capacity is not preciously known and it is dangerous under or overestimation of that, and on the second other hand our knowledge is inadequate to estimate the effects of pollutions on ecosystems of the water body. Inflow of waste water into wetlands in many cases can cause severe environmental impairments such as decrease in biodiversity or enhanced emissions of greenhouse gases (Groffman et al., 1998, Machefert et al., 2002).

Knowing the facts mentioned above the purpose of our work was to appreciate the water quality of the through-flowing water on the natural wetland, Igrice-marsh (nature conservation area) situated north-east from Nyíregyháza (north-east part of Hungary). For the evaluation of water quality we used water analytical parameters and the Belgian Biotic Index (BBI) based on taxa of macroinvertebrates occurred in the investigated habitats. The ecosystem of the marsh locally is ubiquitous therefore its protection is very important in regarding to educational aspects and nature conservation.

The main question of our study was: does the quality of the water loaded with communal wastewater change during flowing through the marsh. Alterations were detected by monitoring of chemical parameters of the water and communities of macroinvertebrates at the inflow and outflow of the canal. Present paper shows the first results of a long-term study.

MATERIALS AND METHODS

Description of the area investigated

The Igrice-marsh is situated in the northern part of Nyíregyháza which is about 70 ha, and it is a wetland with high environmental aspect being a nationwide importance swamp (Fig. 1). It is handled by Hortobágy National Park and the Upper-Tisza Fund using supports of the local government and funds. The Igrice-marsh is the last residue of that wetland, which basically determined the facade of the Nyírség region long time ago. The area has unique natural values proved by more than one hundred avian and more than two hundreds plant species. The wetland is fed by two canals namely Igrice and Lukalapos which collect rainwater from the surface. The canal Lukalapos joins into the canal Igrice on the area of the marsh. There are two lakes in the central part of the marsh with about 5-5 ha open-water surface. There are different plant associations typical for the area: meadow, reed, tussocky, broom, white willow.

Sampling, chemical analysis and identification of macroinvertebrates

Five sampling sites were chosen: two of them on the canal Igrice (sampling sites 1 and 2), another two on the

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canal Lukalapos (sampling sites 3 and 4) and the last one on the canal Igrice not so far from its outflow (sampling site 5) as it can be seen on Fig. 1. Macroinvertebrates were collected with standardized scoop-net (pore size 0,5 mm) were keep in 30% ethanol on 4 °C in a cold room, and identified following the prescriptions for the Belgian Biotic Index (De Pauw & Vanhooren 1983, De Pauw et al. 1996, Gabriels et al. 2005). The pH, conductivity and temperature were measured on site, while other chemical parameters (NO_2^-, NO_3^-, NH_4^+, Cl^-, Fe^{2+}+Fe^{3+}, PO_4^{3-}) were determined in laboratory using the Nanocolor water analytical system based on colorimetric assays. The water samples for the analysis were collected in plastic flasks filling without bubbles and stored on 4 °C in a cold room. For the assessment of the water quality we used the MSZ 12749:1993 standard containing categories of water quality and threshold values.

Fig.1 The Igrice-marsh (sampling points 1-5; A – canal Igrice; B – canal Lukalapos)

RESULTS AND DISCUSSION

Water quality assessment by occurrence of macroinvertebrates

According to identified taxa of macroinvertebrates it was evident that the most sensitive species with lowest tolerance level could not be detected in the samples. Indicators of the highest water quality in the Belgian Biotic Index are species belonging to *Trichoptera, Plecoptera* and *Heptageniidae*. As a consequence the BBI calculated from the presence of the macroinvertebrate taxa did not exceeded the value 6, but in some cases the values of BBI were below 5, which is a signal of decaying water quality (a ten-grade scale is used in the BBI to assess the water quality, and 10 is the best).

The occurrence of macroinvertebrate taxa and the values of BBI calculated can be seen in the Tables 1. A-E. Table 1.A and 1.B. summarize data of canal Igrice before inflow; Table 1.C. and 1.D. show the data of canal Lukalapos before inflow; finally the Table 1.E. shows the results of the fifth sampling site on the canal Igrice following the outflow the marsh. The BBI showed (Table 1. A-D) that the water quality of the two canals inflowing the marsh highly and moderately contaminated (BBI: 3 and 5, respectively) which values are adequate to IV. and III. categories of water quality according to the Hungarian standard (a five-grade scale, V. is the best). Conspicuously, the values of BBI and the number of taxa occurred in July were lower than those found in May, which could be explained by seasonal dynamic of communities (Petri et al., 2009).

Table 1. (A-E) Taxa of macroivertebrates present at the sampling sites according to the BBI

A)	**Igrice-1**		
List of taxa for BBI	**Level of tolerance**	**Sampling 1. (May)**	**Sampling 2. (July)**
Haemopis	5		+
Helobdella	5		+
Glossophonia	5		+
Sigara	5	+	+
Baetis	3		+
Haliplidae	5		+
Chironomidae *(thummi-plumosus)*	6	+	
Number of taxa		**2**	**6**
Value of BBI		**3**	**5**
Category of water quality		**IV. heavily polluted**	**III. moderately polluted**

B) Igrice-2

List of taxa for BBI	Level of tolerance	Sampling 1. (May)	Sampling 2. (July)
Asellidae	5	+	+
Sigara	5	+	
Hemiclepsis	5	+	
Helobdella	5	+	+
Planorbarius	4		+
Bithynia	4	+	+
Daphniidae.	-	+	
Chironomidae *(thummi-plumosus)*	6	+	
Tubificidae	6	+	
Number of taxa		**8**	**4**
Value of BBI		**5**	**4**
Category of water quality		**III. moderately polluted**	**IV. heavily polluted**

C) Igrice-3

List of taxa for BBI	Level of tolerance	Sampling 1. (May)	Sampling 2. (July)
Planorbis	4	+	
Physa	4	+	
Daphniidae		+	
Notonecta	5	+	
Asellidae	5	+	
Helobdella	5	+	
Tubificidae	6	+	
Chironomidae *(thummi- plumosus)*	6		+
Sigara	5		+
Platycnemis	4		+
Number of taxa		**7**	**3**
Value of BBI		**5**	**4**
Category of water quality		**III. moderately polluted**	**IV. heavily polluted**

D) Igrice-4

List of taxa for BBI	Level of tolerance	Sampling 1. (May)	Sampling 2. (July)
Sigara	5		+
Iliocoris	5	+	
Tubificidae	6	+	
Chironomidae *(thummi-plumosus)*	6	+	
Planorbarius	4		+
Bithynia	4	+	
Baetis	3		+
Number of taxa		**4**	**3**
Value of BBI		**4**	**4**
Category of water quality		**IV. heavily polluted**	**IV. heavily polluted**

E) Igrice-5

List of taxa for BBI	Level of tolerance	Sampling 1. (May)	Sampling 2. (July)
Baetis	3	+	+
Leptophlebia	3	+	
Cordulia	4	+	
Sigara	5	+	
Plea	5	+	
Notonecta	5	+	
Tubificidae	6	+	
Asellidae	5	+	+
Culicidae			+
Chironomidae (*thummi-plumosus)*	6		+
Haemopis	5		+
Erpobdella	5		+
Number of taxa		**8**	**6**
Value of BBI		**6**	**5**
Category of water quality		**III. moderately polluted**	**III. moderately polluted**

Although difference of data obtained were not significant between sampling sites (BBI change between 4 and 6), but values signing the best water quality were got at the outflow of the canal Igrice. Nevertheless, we could gather the greatest number of macroinvertebrate taxa including two *Ephemeroptera* genus highly sensitive to environmental factors (the rate of sensitivity was 3, according to the BBI, the highest is 1). These were the most sensitive species found in our study so far. As a consequence we conclude that the water quality of the canal Igrice is more favorable at the outflow but there would be some role of the seasonal changes of the biota and special features of the microhabitat. In opposite to the chemical parameters the biological water quality control is able only to reflect the long-term alterations occurring in the status of the water and the general state of the water body.

Water quality assessment by chemical parameters

In chemical analysis six ions were measured (NO_2^-, NO_3^-, NH_4^+, Cl^-, (Fe^{2+}+Fe^{3+}), PO_4^{3-}). Ammonia is one of the first products of decomposition of organic matters. It is extremely toxic to living organisms and one of the signals of decaying water quality. Its higher amount signs the inadequate concentration of dissolved oxygen and intensive degradation of nitrogen containing organic compounds. In our samples ammonia was not detectable or it was under the detection limit (0.1 mg/l, the limit of the best quality is 0.2 mg/l).

The next product of the nitrogen cycle is nitrite (NO_2^-) which can only be rare accumulated in natural waters because of its rapid oxidation to nitrate. In our samples nitrite concentrations were mainly below the limit concerning to the best water quality. The only occasion when nitrite amount detected enhanced the limit of best quality was in May on the Igrice-3 sampling site. In this case the water body was classified into the second category of the water quality (good, II.).

Concentrations of nitrate, the final form of nitrogen during the oxidizing processes, in samples were under the limit value of the best water quality. The highest value was 4 mg/l and the generally changed between 0.5-1.4 mg/l.

The phosphate is critical compound of the water bodies investigated because its all value measured exceeded the limit not only for the best but those of contaminated category (IV. limit value is 0.25 mg/l) as well. It is interesting that the highest value (2.95 mg/l; 5. sampling site in July) was detected just at the outflow of the canal Igrice from the marsh. It seems that the biological production was not able to utilize the orthophosphate of the inflow water moreover certain processes of the mineralization enhanced the amount of the phosphate or some local pollution occurred. In average the 1-1.5 mg/l were the typical values (Fig. 2 and 3).

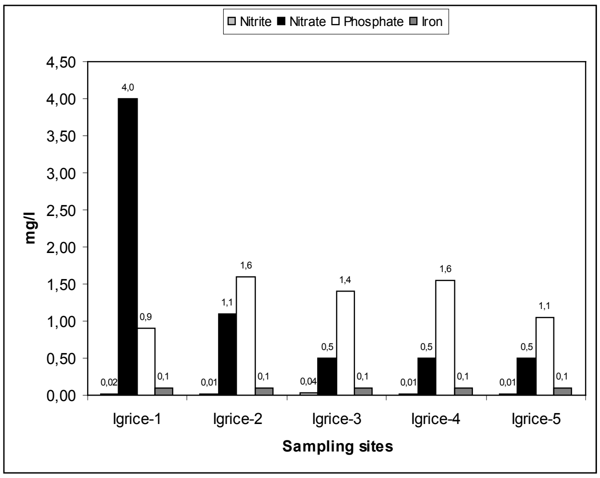

Fig. 2. Concentrations of nitrite, nitrate, phosphate and iron in sampling sites 1-5, Sampling 1. (May)

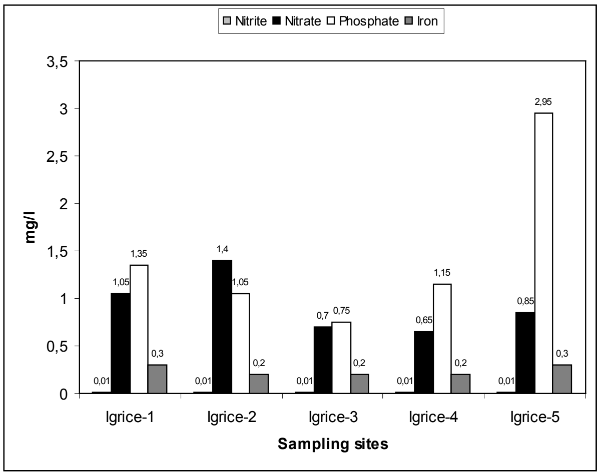

Fig. 3. Concentrations of nitrite, nitrate, phosphate and iron in sampling sites 1-5, Sampling 2. (July)

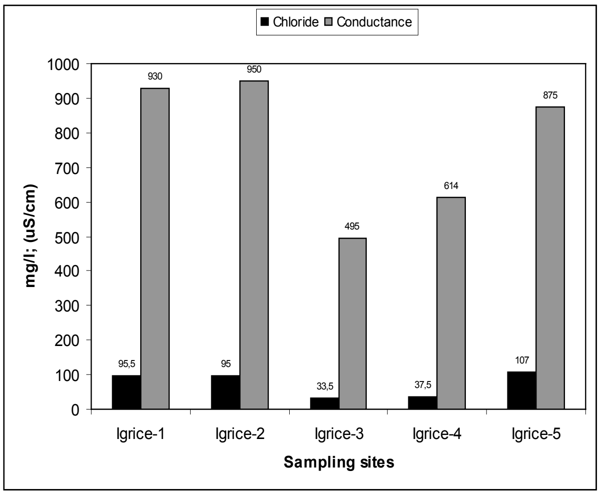

Fig. 4. Concentrations of chloride and conductivity in sampling sites 1-5, Sampling 1. (May)

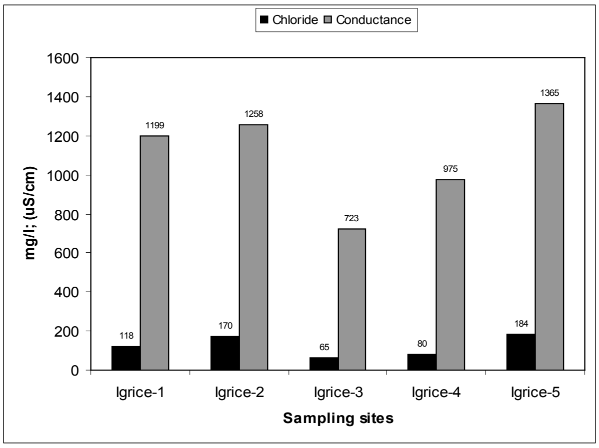

Fig. 5. Concentrations of chloride and the conductivity in sampling sites 1-5, Sampling 2. (July)

The amount of iron is mainly geologically determined. The values found in May matched to the best quality (limit value is 0.1 mg/l) but in July all results concerning to iron were higher, and the water was listed to the II. (good) and III. (moderately polluted) categories.

The chloride is a geologically determined compound of natural waters but high concentration of that would be a sign of the fecal contamination. There is no limit value for chloride content in the Hungarian Standards concerning to surface waters. There were higher values which exceeded the average value only in two occasions (Fig. 4. and 5.).

The values of electrical conductivity proportional to the salt content of the water were normal (500-1500 $\mu S\ cm^{-1}$) which matches to medium salt content. Although there were only two sampling (May and July) interesting tendencies can be seen (Fig. 4. and 5.). The values measured are high and near equal to each other in sampling sites 1. and 2., while values belonging to the sampling sites 3. 4. and 5. show rising tendency. Comparing the salt content of the two canals it can be said that the water of the canal Igrice contains higher salt concentration (Fig. 4. and 5.; Igrice-1, and Igrice-2) than the canal Lukalapos (Fig. 4. and 5.; Igrice-3, and Igrice-4). Following mixing of waters with different salt contents, the canal Igrice having higher runoff is dominant and higher values are measurable at the outflow (Fig. 4. and 5.; Igrice-5). The chloride concentrations and the conductivity show a parallelism which may sign that chloride is dominant in the conductance measurable.

CONCLUSIONS

The water quality of the Igrice-marsh and the canals flowing through it were investigated. According to the Belgian Biotic Index (BBI) the ecological status of the water bodies studied are critical because the water was moderately or sometimes highly contaminated. The ecological state is unbalanced which may cause a significant decrease in biodiversity. It is proved by the loss of most sensitive macroinvertebrates. As the outflow water showed higher BBI values so we can said its better quality. Our conclusions were partly supported by analytical data. Although the amount of some compounds (ammonia, nitrite, nitrate) did not exceed the limit of the best quality, the concentrations of phosphate were higher than the limit of highly contaminated category indicating some kind of pollution. The chloride concentrations were mainly normal, adequate to the best or good water quality and show parallel change with conductivity indicating that chloride anion is one of the ions dominant in conductance.

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