WATER CHEMICAL ANALYSIS OF THE OXBOW LAKES NEAR THE UPPER-TISZA RIVER

BEÁTA BABKA – SZILÁRD SZABÓ

Department of Landscape Protection and Environmental Geography, University of Debrecen; H-4010 Debrecen, Egyetem sq. 1. P.O.B. 9; Hungary; E-mail: szszabo@delfin.unideb.hu

Abstract
The Tisza river plays an important role in the life of Eastern Hungary. Beside the river there are several oxbow lakes, cut off meanders. In this paper the water quality of these lakes was examined from the section of Tarpa to Rakamaz. 45 oxbow lakes were sampled and the chemical parameters were determined. Sodium was used as a pollutant (sewage water) indicator and 2 lakes were found extremely polluted. The lakes outside the dam were slightly polluted because of the lack of renewal of the water body and the ones in the active floodplain had good quality parameters.

Keywords: River Tisza; oxbow lakes; water quality

1. Introduction

Humanity is coming harder and harder on the environment. During our daily life we form the relief, we change the vegetation according to our demands, we contaminate air, water and soil. In pursuance of our work we examine water samples deriving from the oxbow lakes near Upper-Tisza.

The Tisza, being the second biggest river is Hungary, plays an important role in our life, and it is of primary importance that we should get a real picture of the state of its environment. These days we can frequently hear of the environmental problems of the Tisza, however we hardly know anything about the oxbow lakes next to the river. Of the important and extensive works concerning oxbow lakes, we have to mention the works of Braun (1998), Pálfai (1995) and Wittner et al. (2004, 2005).

River controls had significant effects on the Tisza. Many oxbow lakes were formed in an artificial way. However, before the controls, oxbow lakes took shape in a natural way as well, which are called cut off meanders. Oxbow lakes can be divided into two parts: active floodplain oxbow lakes are situated between the dam and the river, and reclaimed side oxbow lakes can be found outside the dam.

A lot of cut off meanders, which evolved before the XIX. century, have already filled up and run dry. They are in the far-gone state of succession, there is water in their shallow beds only after big rainfalls and floods. The meanders which cut off in the course of river control are younger, but many of them are in the same state as the earlier cut off oxbow lakes (Wittner et al. 2004). Their number is more than 90 in the section of the river we examined between the frontier and Tokaj.

The oxbow lakes maintain significant natural and natural protective values, and improve the stability of the ecological corridors which are in the floodplain (Kerényi – Szabó, 2007). The river is surrounded by forests, which are considered as corridors. These corridors broaden near the oxbow lakes. They play an important role in the life and feeding of waterfowl because they are wetlands. The Upper-Tisza region is one of the significant areas of Ramsar Convention in Hungary. Oxbow lakes are some kind of stepping stones in the ecological network and home areas in the conservation and spread of the species.

As the danger of the break-up, isolation and species-reduction of several localities is increasing, the protection of oxbow lakes as landscape elements is vital. Therefore, it is important that we come to know their state, water balance and the factors influencing their quality, which is affected by their relative location, application, and the utilization of the lands.

The goal of this research is to give a more general description of the state, quality and the water-refill of the oxbow lakes in the Upper-Tisza region. Furthermore, we analyse the water samples taken from the river and the oxbow lakes between the border (Tiszabecs) and Tokaj. The applied analysis is water chemistry.

2. Materials and methods

We took 8 samples from the Tisza and 45 samples from 45 different oxbow lakes (Fig. 1) three times during the research: in October 2005, May 2006 and August 2006.

Some water chemical parameters such as temperature and conductivity were determined on the site, and the other parameters were determined in 24 hours in the laboratory of the Geography Institution of the University of Debrecen. These parameters were pH, NO_3^-, NO_2^-, PO_4^{3-}, NH_4^+, COD_{MnO4} and Na^+.

3. Water chemical results

Data were summarized by using median and standard deviation. During data processing we took out the most extreme ones so that they will not deform the results. For example we neglected Helmecszegi Oxbow Lake since it is utilised as sewage disposal site.

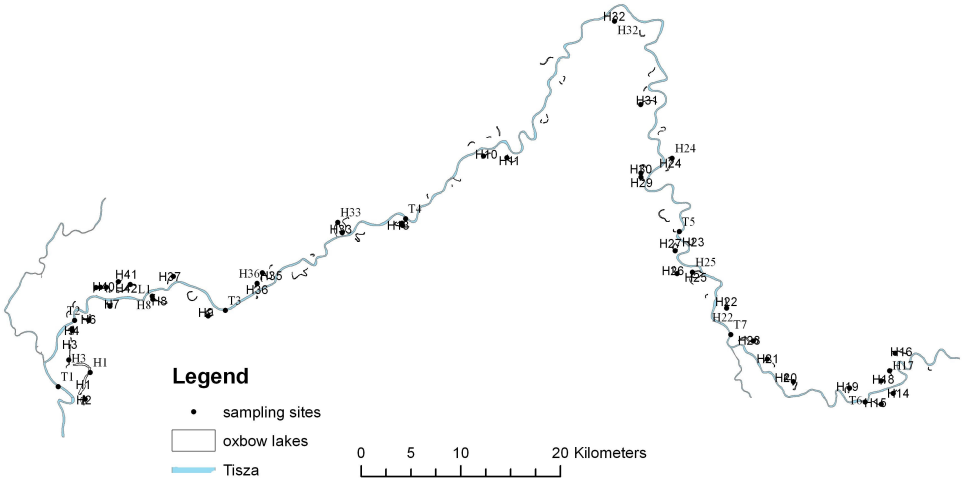

Fig.1. Sampling points of the Upper-Tisza region
Legend: 1: sampling point; 2: floodplain; 3: oxbow lake; 4: the Tisza

We found deviation between the water samples deriving from the Tisza and the oxbow lakes, and we also found deviation between the reclaimed side and the active floodplain. The Tisza floods the land inside the dams several times a year, and it fills in the oxbow lakes that are in the active floodplain. Thus their water supplementation and transfer are assured. This effect is observed on the water chemical parameters because we got lower results in the case of active floodplain oxbow lakes than the reclaimed side oxbow lakes in the course of three sampling times.

The water quality of the reclaimed side oxbow lakes is worse. This is the consequence of the regular water transfer, since in normal circumstances the Tisza never floods these oxbow lakes. Outside the dams they can get water only from the lower water conductive layers, the precipitation and the surface waters. Because of slower water transfer contaminants are enriching. Lower loading can cause higher concentration in the case of shallow oxbow lakes, while where the water body is larger the contamination will attenuate better.

The explanation of the difference between the Tisza and reclaimed side oxbow lakes is that the water of the oxbow lakes changes slowly, however, depending on

its water output, the quality of the incoming waters and the anthropogenic loading the water of the Tisza can change more rapidly.

Thus it is understandable that the Tisza can differ from the oxbow lakes in quality, and the oxbow lakes in the active floodplain have better water chemical parameters than the oxbow lakes in the reclaimed side.

In the course of the evaluation of the results we experienced that among the water chemical parameters sodium and conductivity can provide the most information (Gadallah, 1996). Boxplot diagrams were applied during the statistical analysis. The diagram is like a rolling-pin, its rolling part represents median and interquartile range, and its handle represents 1.5-fold interquartile range. The much larger and smaller results appear as prominent data like points.

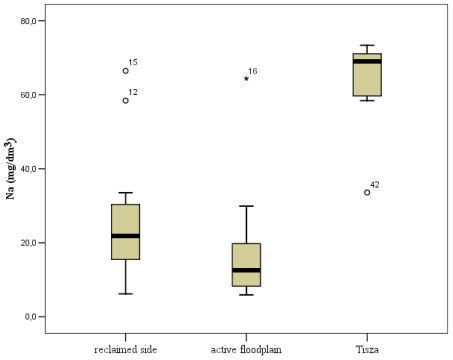

Fig. 2. The sodium concentration (mg/dm^3) of Tisza and the oxbow lakes near the Tisza in October 2005.

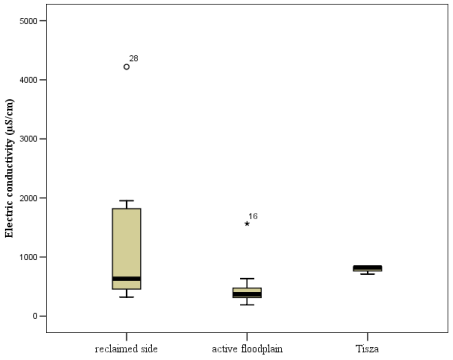

Fig. 3. The conductivity (µS/cm) of Tisza and the oxbow lakes near the Tisza in October 2005.

In Fig 2-3 it can be seen the results of sodium and electric conductivity in October 2005. Both figures show that we got quite different results in the case of reclaimed side, active floodplain and the Tisza. The results of the Tisza are very close to each other. Standard deviation is little because we took the samples in a short time (3 days) from Tiszabecs-Tokaj section. The results can lead us to conclude that the variability of sodium content and conductivity is little in the river. In the case of the Tisza we got the highest results from the three sample-taking dates in October. That could lead us to believe that the river was polluted then, but we know that the water level of the Tisza was the lowest at that time, namely the contaminants which got to the water became less diluted.

If we make the comparison between the reclaimed side and active floodplain ox-bow lakes in the case of the two parameters we can see that the reclaimed side ox-bow lakes have higher results than the active floodplain oxbow lakes. It is due to

the effect mentioned previously, that is the isolated reclaimed side oxbow lakes get water supplementation from the Tisza rather rarely, only on the occasion of large inundation. Thus if they get polluted, the contaminants become concentrated. Only heavy rainfalls and the convergent surface waters can give a chance to the dilution of the contaminants. So the pollution (conductivity) of these oxbow lakes will always be larger than the pollution of the active floodplain oxbow lakes, which are flooded year by year.

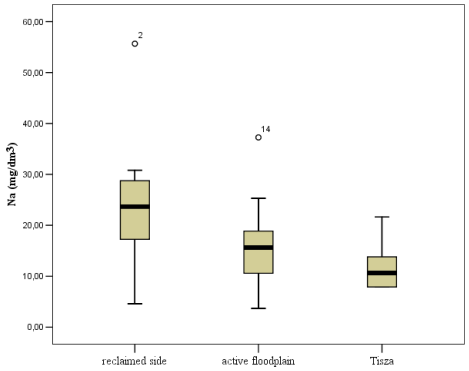

Fig. 4. The sodium concentration (mg/dm^3) of Tisza and the oxbow lakes near the Tisza in May 2006.

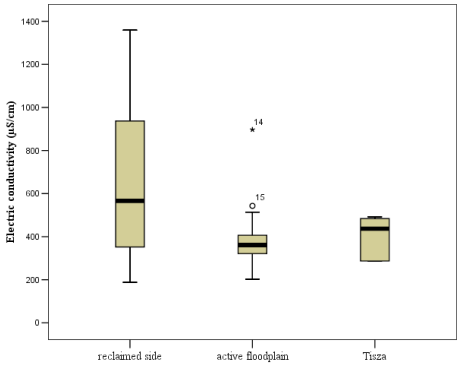

Fig. 5. The conductivity (µS/cm) of Tisza and the oxbow lakes near the Tisza in May 2006.

During our examination we managed to take samples after inundation was over. We did this in May 2006 (Fig. 4 and 5). These figures show that the results of the Tisza are much lower than in October 2005. This time we measured the lowest data of the three sample-taking dates, because the water-level of the Tisza was still high, thus the concentration of the contaminants in it decreased. In contrast with it, the results of the reclaimed side are quite high, because the Tisza could not dilute these oxbow lakes on the surface, only by infiltration in the ground. The standard deviation of the conductivity of these oxbow lakes is rather high since some oxbow lakes are in connection with the Tisza under the ground, while others aren't, so these data can be high. Moreover, different quantity of rainwater can flow into them, depending on the catchment area. Its effect on the water chemical parameters depends on the volume of the single oxbow lakes as well.

The differences of other water chemical parameters are revealed:

Orthophosphate. The highest results were measured in the reclaimed side during sampling in October and May, however, during the sampling in August the highest phosphate concentration was in The Tisza. If we make a comparison between the three sampling areas, the highest results were determined on the reclaimed side and the active floodplain in May and in the Tisza in August.

Nitrite. The highest results were in the Tisza in all the three sampling times. The results of the sampling in both May and August are approximately the same in the Tisza, active floodplain and reclaimed side oxbow lakes. Making the comparison between the single areas we can see that the data in October are the highest in the reclaimed side and the active floodplain, while in the Tisza the highest data derive from May and August.

Nitrate. We got the highest results in the Tisza in August. The results of the Tisza are higher with one order of magnitude than the others, in spite of the fact that intensive agricultural activity (artificial fertilizing) is practised near several oxbow lakes.

Ammonium. In the case of ammonium we measured the highest results on the reclaimed side in October, which is not surprising because ammonium appears in water when dissolving organic materials exist. The flora of the oxbow lakes provides the organic material, the dissolution of which can mainly cause higher ammonium concentration in those oxbow lakes which have little water supplementation in reclaimed side.

COD_{MnO4} (chemical oxygen demand). We got high results in the Tisza in October. To take the reclaimed side and the active floodplain into consideration we measured the highest results in August, while if we take the sampling times into consideration, the highest concentrations were in the reclaimed side in May and August as well.

4. Conclusions

With the help of the measured water chemical parameters we can find that most oxbow lakes are not polluted (except for, for example Helmecszegi Oxbow Lake [H16]), the most significant parameters were sodium content and conductivity because we met with the biggest difference between the oxbow lakes and the Tisza as well as the reclaimed side and the active floodplain in the course of these two parameters.

The amount of orthophosphate, nitrite, nitrate, ammonium and COD_{MnO4} reinforces our statements of water quality. Apart from some exceptions, pollution is low: the concentration of these chemicals is usually lower in the active floodplain oxbow lakes.

Summarizing the results we can say that every measured parameter is higher in the reclaimed side oxbow lakes, which mostly get rather little water supplementation

than in the active floodplain oxbow lakes, which are closely connected with the Tisza, since the included components are concentrated because of unbroken evaporation. In connection with the Tisza we can state that the concentration of the measured parameters is the lowest at the time of the highest water-level, thus if the Tisza inundates the floodplain, it dilutes the oxbow lakes.

Acknowledgement

The research was supported by the No. 68566 Hungarian Scientific Found (OTKA).

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