SMALL URBAN RIVERS OF CHERNIVTSI: LEVEL OF ORGANIC POLLUTANTS CONTENT, MAIN SOURCES AND EFFECTIVE GREEN SOLUTIONS

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Abstract. This paper provides results of systematic monitoring of the organic pollutants content in small urban rivers of Chernivtsi, Ukraine. It has been found that this content continuously exceeds maximum concentration limit for any weather conditions. We supposed that unorganized and spontaneous urban effluents provided main part of this pollution. One year long monitoring proved that organic pollutants level lowered significantly even after partial elimination of unorganized effluents of residential waste water (RWW). We suppose that further elimination of RWW effluents would bring organic pollutants content under maximum concentration limit even in the presence of the organized sources of urban rainwater and wastewater.

Keywords: small urban rivers; organic pollutants; maximum concentration limit; residential waste water

1. Introduction

Problem of pollution of small urban rivers with various pollutants including most dangerous xenobiotics is going more and more severe for many European cities and megapolises. While main rivers are being systematically monitored by numerous official and non-government environment protection organizations controlling many parameters of the water condition, small rivers usually remain unmonitored and out of attention. Main rivers are very important as water

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sources, water-transportation lines, recreation areas, etc. However, antropogenic loadinging on the small rivers often exceeds loading level for the main rivers. Small urban rivers often flow just through the most populated and industrial heart of modern cities and take organized rainwater, industrial and residential wastewater discharges. Various emergency effluents also often get into local small rivers.

As a result, water condition of many small rivers can be estimated as disastrous. Ecological systems are seriously misbalanced and many living species are missed or almost missed.

Urban ground waters are also in a very poor condition. Modern chemistry and other industries produce tons of toxic products and dangerous xenobiotics, which finally get into waste and ground water. We regularly use about 100 thousand of various chemical compounds, according to a very approximate estimation[1]. Most of these compounds are xenobiotics, which do not meet any appropriate mechanism of natural compensation. In that way toxic compounds get into small rivers and accumulate in the tissues of plants, fishes and other organisms. This process seriously damages normal life cycle and causes diversity depletion leading to gradual extinction of the small river's ecosystems.

We can classify the following aspects of negative urban influence on the water condition of the small rivers[2]:

- Hydrological regime trouble (river-bed cutoff or digging the rivers into underground pipes, excessive regulation of the river flow;
- There are many artificial ponds on the small rivers. Their total volume can be much larger than the river-flow;
- Incorrect and excessive antropogenic activity in the water protection areas;
- Incomplete or even missed land recreation and melioration actions;
- Numerous municipal and industrial objects are usually placed near small rivers causing significant discharge of wastewater;
- Riverbanks are often littered within city limits with numerous unapproved scrap-heaps, which seriously pollute river water (see Figure 1);
- Old and poor city sewerage lines can cause small but numerous effluents of RWW, which finally get to the local small rivers;
- There are many old municipal rainwater drainage lines, which bring collected water directly to the local small rivers. Non-cleaned rainwater brings to the rivers road-washed grease, oil products and suspended dirt particles.

Four latter problems are considered[3] as the severest for the small urban rivers.

Figure 1. Littered riverbanks of Molnitsa within the city of Chernivtsi, Ukraine

Various rivers suffer of various problems. Sometimes one or two of the above mentioned troubles can provide main part of the river pollution. Therefore, finding such major problems and aiming environment protection efforts to relieve or eliminate those problems can significantly improve condition of the small urban rivers and bring them back to life.

Our project was aimed to determination of the water condition of the small rivers of Chernivtsi. There are several small rivers in the city and we selected one of them, river Molnitsa as an example. This river can be taken as a characteristic one since it has several branches, which join within the city. The branches flow through industrial and municipal parts of the city and there are several municipal rainwater drainage line outlets to Molnitsa.

2. Experiment

2.1. RIVERBANKS AND SAMPLING AREA

River Molnitsa flows to Prut, which is a tributary of Danube. Molnitsa flows within the city of Chernivtsi for about 11 kilometers. It has two sources outside of the city and two branches, which enter Chernivtsi in the upper flow.

Right branch (A) is fuller-flowing and runs through the low-populated part of the city. There are several ponds on this branch. Some of them are still functioning and they also collect organized and irregular wastewater discharges. Other ponds have been drained out and formed small abandoned marshy areas.

Left branch (B) is much shorter and shallower than A. It runs through heavy populated area of the city, partially through the underground pipes. Several rainwater lines have outlets ending to the B branch. These lines collect rainwater from the downtown area with very tough traffic. Obviously, this water can bring some amount of the transport-related organic compounds and other water impurities.

Both branches join within the city limits, further Molnitsa flows through other heavy populated areas, some industrial objects, small woodland area and finally flows into river Prut.

There is also old municipal sewerage collector, which was built along the river-bed of Molnitsa about fifty years ago. We found several damaged places where the sewerage water overflowed from the technical access gulley and run directly to Molnitsa.

We located sampling area at the junction place of A and B and were taking samples simultaneously from the A and B branches and below the junction point. Previous investigations proved that water of Molnitsa is very poor of living organisms while its riverbanks are seriously littered[4]. River water was found yellowish, turbid (especially after atmospheric precipitations), and with rather strong smell. Therefore, one can conclude that the water from Molnitsa fails to meet sanitary requirements towards regular river water.

Finding main source of the organic pollution and developing of effective solution for its reduction was the main aim of our investigation.

2.2. EXPERIMENTAL DETERMINATION OF THE OXIDIZING FACTOR

Organic compound content can be found through determination of the modified permanganate oxidizing factor[5]. We were taking sets of three simultaneous samples. Each set consisted of one sample from the A branch, another one – from B, and the other sample (C) was taken below the junction point of A and B. All the samples were taken irregularly, at different weather conditions during 3–4 months of the winter/spring season of 2004/2005 and then of 2005/2006. More than 40 sets of the samples have been taken.

3. Results and Discussion

Our results prove that the oxidizing factor was constantly over its limit value of 5 mg O/l for all the samples taken (See Table 1). Oxidizing factor of the

B-samples was always higher than that of the A-samples and the values of oxidizing factor of the C-samples had been found between the A and B values. Oxidizing factor of the B-samples was higher than that of the A-values even for the samples taken at the dry weather when there should be no rainwater effluents to the B branch. This fact proved that there were some additional sources of organic pollutants flowing into the B branch water. Initially we supposed that it could be RWW effluents from the damaged city sewerage lines, which got into the ground water and then gradually infiltrated to the nearby branch B.

TABLE 1. Average permanganate oxidizing factor (mg O/l) for the samples taken in 2004/2005 and 2005/2006

Sampling Point	Atmospheric Precipitations	Oxidizing Factor
Season 2004/2005		
A	No	8.0
A	Yes	8.5
B	No	15.2
B	Yes	20.0
C	No	9.6
C	Yes	16.8
Season 2005/2006		
A	No	7.5
A	Yes	7.8
B	No	11.1
B	Yes	12.7
C	No	8.1
C	Yes	11.4

Experimental measurement error was 3–7%.

On other hand, one can see that the precipitations-taken samples always show higher oxidizing factor than those taken in the dry weather. This result is correct for all the samples and can prove that some amount of traffic-related organic compounds is actually being washed out of the city roads to the rainwater drainage and then to the water of Molnitsa. Obviously, this kind of impurities can get to the river through irregular, non-drainage waters too. This result proved our assumption of the influence of traffic-related organic compounds on the overall level of organic impurities in the water of Molnitsa.

Comparing data for 2004/2005 to 2005/2006 one can see that oxidizing factor for the A-samples changed insignificantly while the B-samples factor became almost twice smaller in 2005/2006 series. Since there were some fixing works on the nearby buildings sewerage lines in the meantime between two series of our measurements, we can conclude that wastewater effluents really bring significant part of the organic impurities of the B branch. B-branch water is the most polluted, therefore further fixing of the sewerage system can significantly improve quality of the water in the B branch and, consequently, water quality of Molnitsa.

Basing on our results, we can conclude that RWW effluents bring main part of the organic impurities of Molnitsa. Left branch of Molnitsa is the most polluted one and main water improvement efforts should be directed to the nearby buildings sewerage system fixing, which can bring water quality closer to the sanitary conditions. Traffic-related organic compounds provide another part of the water impurities, however, their influence is smaller than the one of RWW.

References

1. Isaeva L. K. Chemical and Biological Control of the Environment Parameters (Soyuz, Saint-Petersburg, 1998) (In Russian).
2. International Enviromental Association of River Keepers, Chisinau, Moldova (August 12, 2005); http://www.eco-tiras.org/osce-dniester-forsite-chapters_7_8_9.doc
3. Timchenko Z. V. Water Resources and Ecological Conditions of the Small Rivers in Crimea (Dolya, Simferopol, 2002) (In Russian).
4. Zhulkovska T. I., Winkler I. A., in: Youth in Resolving of Regional and International Ecological Problems. Proceedings of the Fifth Int. Conf. (Zelena Bucovyna, Chernivtsi, 2006), pp. 440–443 (In Russian).
5. Muraviev A. G., Field Measuring of the Water Quality Parameters Manual (Christmas$^+$, Saint-Petersburg, 2004) (In Russian).