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Water pollution

TISZA RIVER BASIN – PAST AND FUTURE

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Abstract. Factors of influences on the Tisza river biodiversity were presented. These are natural changes through the time and human impact. Different geological basis and influence of melioration works in the 19th century are pointed as a factor of biodiversity richness. The main represents of this richness were done. The general view of potent ional accidental risk spot was given. Results of some water pollution substances of Yugoslav part of Tisza river (in July 2001) were pointed. The general opinion is that Tisza is important and endangered river at the same time. Protection of this river from its well to the mouth is imperative of existence in future.

Keywords: Tisza river, biodiversity, human impact, pollution.

AIMS AND BACKGROUND

Tisza river is formed by the confluence of two streams, the Black Tisza and White Tisza, in the Carpathian Mountains of Ukraine. It winds 970 km (600 miles) northeast, southwest, and finally south, joining the Danube in the northern Serbia, after running parallel to it for 483 km (300 miles). Tisza region is one of the largest, natural riverside systems in the Central Europe. Recently, because of the poor economic conditions, these natural areas are highly threated by uncontrolled and improper development and that seriously affects these natural areas.

Natural changes. Natural turning of Tisza riverbed (as the other rivers with N–S direction) is marked due to gravitational effects. Tisza continuously digs out its eastern beach. Consequence is moving riverbed to the east. In the Roman time, during the Diocletian and Traian Tisza was round the Titelski breg from SW side. Further, the mouth of Tisza was directed toward Surduk. Roman's tower Acumincum (as a keeper of entrance of Tisza from Danube) still exist at this place. Nowadays the mouth of Tisza is 8 km further toward south, near Stari Slankamen.

Human works in the past. The main characteristics of Tisza are meanders. In 19th century Tisza was 1429 km long. The sea level of riverbanks was 74.5 m near

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Szeged and at the mouth 69.8 m. So, the fall was only 4.8 m on the 246.7 km long river. From this reason numerous meanders were formed. Extensive regulation works were started in 1823, and had been finished in 1905 (hard works especially during the period of Maria Teresa reign). Thus, the riverbanks have been shortened for 452 km. Today, meanders are extremely important plants and animal's habitats, and IBA (Important Birds Areas) sites, too.

The habitats typical for Tisza are: running water, standing fresh water, water-fringe vegetation, fens, transition mires and springs, alluvial and very wet forests and brush, humid grasslands and tall herb communities, dry grasslands and steppes, as well as improved grasslands and crops. The most interesting habitat for Tisza is salt marshes, salt steppes.

Different geological basis (crystalline schists, Triassis layer, granite layer, Torda Flysh, Mesozoic layer, etc.) are one of the reasons of habitat richness[1]. Meanders with its own specific biological system are the reason of biodiversity richness of Tisza river basin – the largest, natural riverside systems in the Central Europe. The part of this richness is present in Table 1.

Table 1. Overview of some plants and animals group on Yugoslav part of Tisza river (original)

Plants and animals	No of species	Author/s
Phytoplankton (Sea-weed)	274	G. Simic, M. Cvijan, 1997
Hydrophyta	29	S. Stojanovic, P. Kilibarda, Lj. Nikolic, D. Lazic, 1999
Vascular plants	500	V. Stojsic, 2001 (person. com.)
Zooplancton (Protozoa, Rotatoria)	68	V. Pujin, R. Ratajac, N. Dukic, 1984 and 1985
Oligochaeta	14	V. Pujin, 1999
Crustacea	35	R. Ratajac et al., 1992
Hydracarina	6	R. Ratajac et al., 1992
Odonata	23	P. Santovac, Lj. Andjus, 1995-1998
Culicidae	23	B. Bozicic, 1985
Syrphidae	91	S. Simic, A. Vujic, 1985
Pisces	51	P. Simonovic, 2001
Amphibia and Reptilia	12	I. Krizmanic, 2001 (person. com.)
Aves	270	J. Gergelj et al., 2000
Mammalia	35	J. Stetic, 2001 (person. com.)

THE HUMAN IMPACT ON TISZA RIVER TODAY

The main factors which impact natural ecological system of Tisza river basin are more than 15 million of inhabitants with their industry (especially numerous mining), agriculture, tourism, fishing and hunting, shipping and waste deposit. Table 2 shows this impact.

Table 2. Tisza river basin – overview on the water pollutant[2]

Water pollutants sources	Ukraine	Slovakia	Romania	Hungary	Yugoslavia
Mining		+	+	+	
Agriculture			+	+	+
Chemicals		+	+	+	+
Food			+	+	+
Municipal sewage			+		+
Energy		+		+	+
Machinery		+		+	
Pharmacy				+	
Pulp and paper	+	+	+		+
Oil	+		+	+	+
Metallurgy	+	+	+		
Municipal WWTP	+		+	+	+

Especially is pointed the influence of heavy metals from numerous minings and metallurgy (Tables 3 and 4).

Table 3. Tisza river basin – overview on the heavy metals as water pollutants[2]

Risk spots in	Heavy metals							
Tisza area	Pb	Zn	Cu	Mn	As	Cr	Fe	Cd
			Romania					
SC AURUL SA	+	+	+	+				
SM BAIA MARE	+	+	+	+				
CNCAF MINVEST	+	+	+	+				
RA APATERM		+	+			+		
ORADEA, BIHOR	+	+				+		
EM IARA							+	
			Ukraine					
HIDROTECH	+	+		+	+		+	+
AES BORSODI	+		+		+	+		+
			Slovakia					
ZELBA	+	+			+			
			Hungary					
HIDROTECH	+	+		+	+		+	+
AES BORSODI	+				+	+		+

Table 4. Maximum value of heavy metals and average year levels in the period of 1995-2000 in the Tisza river

Risk spots		Metals (µg/l)						
		Zn	Cd	Pb	Cu	Fe	Mn	Hg
Martonos, 163.4 km	max	34	0.2	45	23	1060	160	4.1
	AM	15.6	0.04	9	9.3	262	50	0.7
Padej, 105.4 km	max	28	0	40	30	1275	264	7.4
	AM	10.2	0	10.7	16.3	381	76	2.2
Novi Becej, 68 km	max	53	0	38	29	1212	132	4.9
	AM	9.1	0	5.7	14.3	443	50	1.2
Zabalj, 38 km	max	55	0	23	30	816	559	4.8
	AM	22.8	0	4	14	312	86	1.0
Titel, 9.7 km	max	30	0	13	80	896	221	3.6
	AM	5.7	0	4	28.6	375	58	1.0

Levels of metals show great differences between arithmetical year middle and maximum content, which is direct consequence of numerous accidents. It causes potential health and environmental problems resulting in high burdens to soil and water. Heavy metals have a toxic effect on living organisms, primarily as a result of the bioaccumulation process. Depending upon the particular metal involved (with specific toxocinetic and toxodinamic properties), the metal action manifests itself as a systemic effect that could involve any tissue or organ in the analysed organism.

EXPERIMENTAL

Our plan of investigation included sampling in a very frequent manner (every hour while moving and ever 4 h in the standing position). One billion of m^3 of water was analysed through 91 samples of the river Tisza. Sampling was done from the mouth to the Hungarian border. In an addition, a large number of samples were taken from the Tisza tributaries, collectors and channels. The following parameters were analysed immediately: oxygen concentration, pH, temperature, chemical oxygen demand (COD), biochemical oxygen demand (BOD), suspended matter content, turbidity, total organic carbon (TOC), surfactants, phenols, ammonia, nitrite and nitrate. Contents of metals were measured by flame atomic absorption spectrophotometry (AAS) and hydride system for As and Hg, after wet digestion ($HClO_4$ + HNO_3) of biological material in stationary laboratory. We presented only a part of our results. Statistical analyses were done using standard statistic methods.

Equipment consisted of: moving laboratory: apparatus "SECOMAM PASTEL UV" (TOC, COD, BOD, TSS, NO_3^-, surfactants), "HANNA" equipment for field work (t (°C), pH, turbidity, Ep, total O_2). Nitrites, ammonia and phenols were measured at the stationary laboratory using "SPECOL UV-VIS". Quantitative measurements were done using standard spectrophotometric methods: 4-AAP for phenols, nitrite – reaction with sulphuric acid and l-naphthylamine; ammonia – reaction with Nessler's reagents.

RESULTS

Statistical analyses of the results obtained presented in Table 5 shows that water quality falls into II or III category. All the parameters (except pH and NO_2^- content) show large variation, depending of the sampling place. As was expected, the largest pollution has been found near towns and industrial sites, particularly concerning the content of O_2, BOD and COD.

Table 5. Statistical values of investigation parameters with water quality data

Parameter	Min.	X	Max.	Water quality objectives (WQOs)
O_2 (mg O_2/l)	4.2	5.2	6.2	II – III
COD (mg O_2/l)	10.1	13.9	23.4	II – III
BOD (mg O_2/l)	4.3	5.75	8.8	II –III
pH	6.79	7.67	7.96	I – II
Ep	265	285	314	
Turbidity	48.51	86.5	169	
Suspended matter content (mg/l)	30	65.5	192	II – III
TOC (mg/l)	3	4.5	6.6	
NO_3^- (mg/l)	1	2.7	3.5	
NH_4^+ (mg/l)	0.11	0.225	0.34	II – III
NO_2^- (mg/l)	0.018	0.029	0.04	I – II
Phenols (mg/l)	0	0.00357	0.1662	II – III

The other results reveal that the fish can be a good biomarker for heavy metals and good bioindicator for water ecosystems. Table 6 shows that enhanced content of heavy metals in fish tissues from Tisza shows obviously high burden than other river systems.

Table 6. Content of heavy metals (mg/kg) in different fish tissues (Tisza river)

Carp		Pb	Cu	Cd	Fe	Mn	Zn	Hg	As
Skills	Tisza	0	2.46	0	60	68.17	221.13	0.119	0.102
	pond	0	2.56	0	39.7	1.03	50.4	0	0.0001
Bones	Tisza	0	0	0	110.68	58.63	286.3	0.755	0.374
	pond	0	0	0	33	47.4	328.2	0.05	0.001
Skin	Tisza	0	1.23	0	232.13	26.9	70.93	0.03	0.057
	pond	0	0.4	0	44.12	0	71.9	0.008	0.0008

The synergistic effects have been evident in the presence of cations. Examples of such interactions are numerous: additive effects – Cr and Zn; Cu and Ni; Cd and Pb enhanced toxic effect of Zn. The antagonism between Zn and Cu, Zn and Cr has been observed.

Another problem is the different sensibility of the same kations (the same concentration) for different organisms: organic Hg is more toxic for water plants (10-100 times more)[3].

DISCUSSION

What mean the present results for the living organism in the water and riverbanks?

The first consequences are proliferation of anaerobic bacteria, decrease of number of phytoplancton (alga), further changes in number of organisms (including their extinct) from ecological pyramid based on phytoplancton. These consequences are part of terrestrial organisms, which are connected with Tisza river aquatic ecosystem. Numerous literature data about these changes were presented[4-7].

One of the difficulties in attempting to estimate the risk for living organisms of exposure to toxicants in the environment is the fact that little is known about the combined effects of several of these. The study of behaviour of xenobiotics in the environment is not a trivial matter. To characterise chemical behaviour, it is necessary to measure the chemical in different environmental compartments (soil, water, biological systems) and to understand the movement and transportation. Measurements are accomplished using either species-species responses to toxicants, or impact at high level of organisation. The ecotoxicological testing is critical to ultimate development of an ecological risk assessment.

An attempt has been made to deal with this problem as to the polyhalogenated aromatic hydrocarbons that are structural analogs of TCDD. All of these are inducers of a hepatic microsomal mono-oxygenase enzyme aryl hydrocarbon hydroxylase (AHH). The potency of these agents in inducing this enzyme in cultured hepatocytes correlates well with their experimental toxicity, and this has led to the development of a set of "toxicity equivalency factors" or TEFs. The EPA has adopted the TEF method as a means of determining the toxicity of mixtures of these agents, as their effects on AHH seem to be additive. This approach, however, has limitation.

The Gaia hypothesis, formulated in 1965 by the independent British biologist James E. Lovelock and elaborated by Lynn Margulis[5], distinguished biology professor at the university of Massachusetts, proposed that certain kinds of life on the Planet grow, change and die in ways that lead to the persistence to the other life forms. In some circles, this has been interpreted as a meaning that life on Earth forms a single, complex continum, one ecosystem throughout time and space. The Earth, according to this view, can thus be considered as a single organism and its various components as cells in the organism. The name is taken from the Greek earth goddess Gaea. Similar to that, all types of habitats on the Tisza are connected themselves as one living organism.

But, human impact on environmental changes is very important.

Each period in the development of human civilisation induced some vital changes in the biosphere; each beginning and development of a civilisation designed the transformation of natural ecosystems. During all the periods of the creation and development of civilizations, population number has been permanently growing, and by the end of 20th century it has reached the amount of 6 billion, with the expected doubling during the next thirty years. In further development, ecosystem approach will be implemented which will enable the future function of the biosphere and its ecosystems along with human activities. Ecological awareness and ecological ethics are the categories of human behaviour in the environment. Ethics is a branch of philosophy dealing with human virtues and characteristics. It is closely related to the concept of morality, but it often differs in some attitudes. On the global level, ethics is reflected in the attitudes of the authority and international forums through their documents. The most significant idea for the awakening of the "new" ethics and ecological awareness is the idea of the further sustainable development of the environment.

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