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PRIORITY POLLUTANTS PRESENT IN THE TISZA RIVER HYDROGRAPHIC BASIN AND THEIR EFFECTS ON LIVING ORGANISMS

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Abstract

Tisza River Basin is the largest sub-basin of the Danube Basin, which is a home for 14 million people from five countries and where the diversity of landscapes provides habitats for animal and plant life species, with a significant number of protected areas and national parks. Nevertheless, Tisza River has serious pollution problems, particularly with the next four categories: pollution by organic substances, pollution by nutrients, pollution with hazardous substances and hydromorphological alterations. However, the impacts of pollution are significant and affect human health. Endocrine disruptors are especially worrying as they can interfere with the hormonal systems of living organisms, including humans. This article has the purpose to investigate the pollutants called "Priority pollutants" identified in the Tisza River Basin, introduced by Water Framework Directive in the "List of Priority Substances for the Danube River Basin", published in the Official Journal of the European Communities. Their effects on living organisms, including people, will be discussed in detail as well.

Keywords: Tisza River, priority substances, heavy metals, toxic effects

Priority pollutants present in the Tisza River Hydrographic Basin and their effects on living organisms

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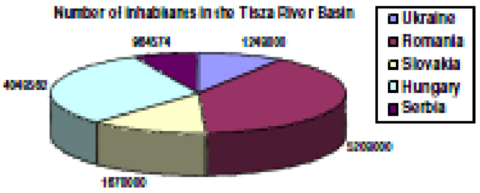
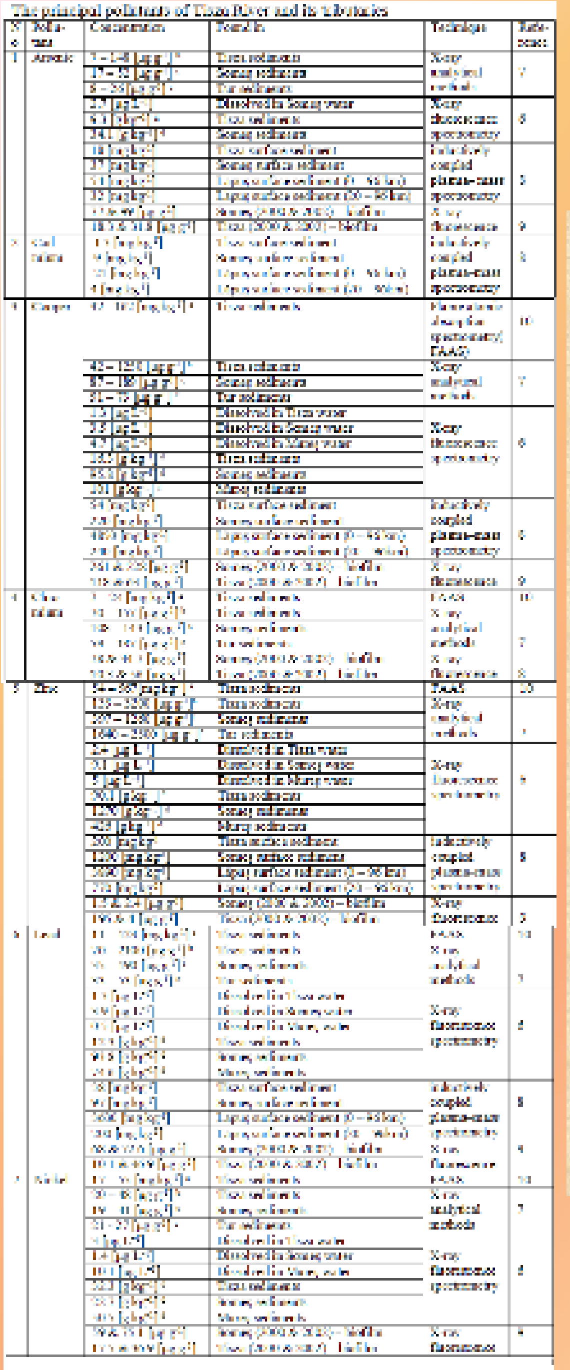
SUMARY

Tisza River Basin is the largest sub-basin of the Danube Basin, which is a home for 14 million people from five countries and where the diversity of landscapes provides habitats for animal and plant life species, with a significant number of protected areas and national parks. Nevertheless, Tisza River has serious pollution problems, particularly with the next four categories: pollution by organic substances, pollution by nutrients, pollution with hazardous substances and hydromorphological alterations. However, the impacts of pollution are significant and affect human health. Endocrine disruptors are especially worrying as they can interfere with the hormonal systems of living organisms, including humans. Among the various contaminants in this category, "priority pollutants" were included some heavy metals, which was introduced by the "Integrated Tisza River Basin Management Plan" on the priority pollutants list. This work purpose was to investigate the priority pollutants, especially encountered in the Tisza River Basin, introduced by Water Framework Directive in the "List of Priority Substances for the Danube River Basin", published in the Official Journal of the European Communities. Their effects on living organisms, including people, were studied in detail.



***Maximum allowable concentration** in surface waters (μg L⁻¹):*
arsenic – 7.2; cadmium – 0.2; cooper – 1.3; chromium – 2.5; zinc – 100; lead – 7.2; nickel – 20. (according with the government decision no. 1038 from 13/10/2010)



The principal pollutants of Tisza River and its tributaries

No	Pollutant	Concentration	Found in	Technique	Reference
1	Arsenic	7 – 148 [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		17 – 52 [μg g⁻¹]*	Szamos sediments		
		8 – 28 [μg g⁻¹]*	Tur sediments		
		2.7 [μg L⁻¹]	Dissolved in Szamos water	X-ray fluorescence spectrometry	6
		6.1 [g kg⁻¹]*	Tisza sediments		
		24.1 [g kg⁻¹]*	Szamos sediments		
		18 [mg kg⁻¹]	Tisza surface sediment	Inductively coupled plasma-mass spectrometry	5
		37 [mg kg⁻¹]	Szamos surface sediment		
		51 [mg kg⁻¹]	Lapus surface sediment (0 – 45 km)		
		32 [mg kg⁻¹]	Lapus surface sediment (20 – 65 km)		
		[illegible] [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	9
		18.5 & 31.8 [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		
2	Cadmium	[illegible] [mg kg⁻¹]	Tisza surface sediment	Inductively coupled plasma-mass spectrometry	5
		9 [mg kg⁻¹]	Szamos surface sediment		
		[illegible] [mg kg⁻¹]	Lapus surface sediment (0 – 45 km)		
		4 [mg kg⁻¹]	Lapus surface sediment (20 – 90 km)		
3	Cooper	47 – 182 [mg kg⁻¹]*	Tisza sediments	Flame atomic absorption spectrometry (FAAS)	10
		42 – 120 [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		57 – 180 [μg g⁻¹]*	Szamos sediments		
		31 – 72 [μg g⁻¹]*	Tur sediments		
		13 [μg L⁻¹]	Dissolved in Tisza water	X-ray fluorescence spectrometry	6
		2.5 [μg L⁻¹]	Dissolved in Szamos water		
		4.7 [μg L⁻¹]	Dissolved in Maros water		
		18.2 [g kg⁻¹]*	Tisza sediments		
		85.8 [g kg⁻¹]*	Szamos sediments		
		101 [g kg⁻¹]*	Maros sediments		
		54 [mg kg⁻¹]	Tisza surface sediment	Inductively coupled plasma-mass spectrometry	5
		[illegible] [mg kg⁻¹]	Szamos surface sediment		
		1860 [mg kg⁻¹]	Lapus surface sediment (0 – 45 km)		
		218 [mg kg⁻¹]	Lapus surface sediment (20 – 90 km)		
		251 & 228 [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	9
		112 & 94 [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		
4	Chromium	[illegible] [mg kg⁻¹]*	Tisza sediments	FAAS	10
		[illegible] [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		[illegible] [μg g⁻¹]*	Szamos sediments		
		[illegible] [μg g⁻¹]*	Tur sediments		
		[illegible] [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	8
		[illegible] [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		
5	Zinc	54 – 267 [mg kg⁻¹]*	Tisza sediments	FAAS	10
		125 – 2250 [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		227 – 1238 [μg g⁻¹]	Szamos sediments		
		1640 – 2300 [μg g⁻¹]	Tur sediments		
		24 [μg L⁻¹]	Dissolved in Tisza water	X-ray fluorescence spectrometry	6
		3.1 [μg L⁻¹]	Dissolved in Szamos water		
		5 [μg L⁻¹]	Dissolved in Maros water		
		260.1 [g kg⁻¹]*	Tisza sediments		
		1290 [g kg⁻¹]*	Szamos sediments		
		425 [g kg⁻¹]*	Maros sediments		
		300 [mg kg⁻¹]	Tisza surface sediment	Inductively coupled plasma-mass spectrometry	5
		1290 [mg kg⁻¹]	Szamos surface sediment		
		2690 [mg kg⁻¹]	Lapus surface sediment (0 – 45 km)		
		278 [mg kg⁻¹]	Lapus surface sediment (20 – 90 km)		
		[illegible] [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	9
		[illegible] [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		
6	Lead	[illegible] [mg kg⁻¹]*	Tisza sediments	FAAS	10
		[illegible] [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		[illegible] [μg g⁻¹]*	Szamos sediments		
		[illegible] [μg g⁻¹]*	Tur sediments		
		[illegible] [μg L⁻¹]	Dissolved in Tisza water	X-ray fluorescence spectrometry	6
		[illegible] [μg L⁻¹]	Dissolved in Szamos water		
		[illegible] [μg L⁻¹]	Dissolved in Maros water		
		[illegible] [g kg⁻¹]*	Tisza sediments		
		[illegible] [g kg⁻¹]*	Szamos sediments		
		[illegible] [g kg⁻¹]*	Maros sediments		
		[illegible] [mg kg⁻¹]	Tisza surface sediment	Inductively coupled plasma-mass spectrometry	5
		[illegible] [mg kg⁻¹]	Szamos surface sediment		
		[illegible] [mg kg⁻¹]	Lapus surface sediment (0 – 45 km)		
		[illegible] [mg kg⁻¹]	Lapus surface sediment (20 – 90 km)		
		[illegible] [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	9
		[illegible] [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		
7	Nickel	17 – 75 [mg kg⁻¹]*	Tisza sediments	FAAS	10
		20 – 68 [μg g⁻¹]*	Tisza sediments	X-ray analytical methods	7
		19 – 41 [μg g⁻¹]*	Szamos sediments		
		21 – 37 [μg g⁻¹]*	Tur sediments		
		4 [μg L⁻¹]	Dissolved in Tisza water	X-ray fluorescence spectrometry	6
		1.4 [μg L⁻¹]	Dissolved in Szamos water		
		10.1 [μg L⁻¹]	Dissolved in Maros water		
		22.3 [g kg⁻¹]*	Tisza sediments		
		[illegible] [g kg⁻¹]*	Szamos sediments		
		[illegible] [g kg⁻¹]*	Maros sediments		
		[illegible] [μg g⁻¹]	Szamos (2003 & 2005) – biofilm	X-ray fluorescence	9
		[illegible] [μg g⁻¹]	Tisza (2000 & 2003) – biofilm		

* Values measured at different points along the Tisza River, expressed in dry weight; [illegible]

Category of pollution in the Tisza River Basin :

1. pollution by organic substances
2. pollution by nutrients
3. pollution by hazardous substances
4. pollution by hydromorphological alterations [1]

Heavy metals are of particular concern due to their environmental persistence, biogeo-chemical recycling and ecological risks. Heavy metals occur in different geochemical forms, which have a distinct mobility, biological toxicity and chemical behaviour [5].

Arsenic Chronic human exposure to arsenic is associated with an increased risk of cancer. Arsenic does not directly cause DNA damage or mutations, is thought to act principally as a co-mutagen, co-carcinogen, and/or tumor promoter;

Cadmium is a pollutant associated with modern industrial processes, which can be absorbed in significant quantities from cigarette smoke. It has numerous effects on health experimental animals and humans, targeting the kidneys, liver and vascular systems in particular. However, a wide spectrum of deleterious effects on the reproductive tissues and the developing embryo has also been described;

Chromium is considered an essential nutrient and a health hazard. Health effects are categorized as: mutagenic, reproductive, hematological, cardiovascular, gastrointestinal, hepatic, renal, carcinogenic, respiratory, skin effects;

Copper naturally occurs in all plants and animals. At higher levels, toxic effects such us: acne, allergies, hair loss, anemia, anxiety, candida, depression, infections, inflammation, insomnia, panic attacks, premenstrual syndrome can appear;

Lead and its organic compounds were classified as possible human carcinogens, while inorganic compounds as probable human carcinogens; They have potential hepatotoxicity and antagonistic effects on the immune cells in rats, toxic effects on the heart and blood vessels in human populations and can present childhood neurotoxicity in humans;

Nickel and its compounds were found to have immunological and carcinogenic effects in humans after a chronic exposure Nickel chloride can affect the redox equilibrium and stimulate apoptosis in oral epithelium cells, while cancer risk is related to less soluble oxidic and sulfidic nickel species. Nanoparticle has significant toxicity in human lung epithelial cells;

Zinc is an essential nutrient in humans and animals, but overexposures have been associated with toxic effects such us: gastrointestinal, hepatic toxicity; nephrotoxicity, neurotoxicity, hepatotoxicity and hemotoxicity.

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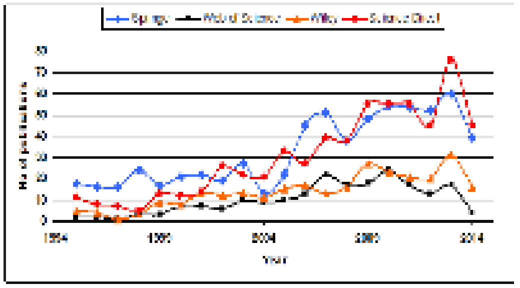
Endocrine disruptors are especially worrying as they can interfere with the hormonal systems of living organisms [2]. These chemicals have been established to disrupt endocrine systems, yet they are still unregulated and discharge carelessly into the immediate environment most especially in the developing countries where there is no stringent regulatory and legal frame work [3]. Some of the endocrine disruptors, such as bisphenol A, pesticides, organohalogens phthalates, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons are more frequently found in wastewater treatment plants than in natural environment. Others such as nonylphenol and octylphenol are more prominent in surface and groundwater [4]

The evolution of scientific publications about Tisza River along the last twenty years



Discussion & Conclusions

- In Tisza River Basin and the basins of his principal tributaries, human populations and economic development have significantly contributed to the current deterioration in water quality, including accumulation of heavy metals in the aquatic environment and sediments.
- Heavy metals are among the most harmful pollutants in aquatic ecosystems under natural conditions.
- The accumulation of heavy metals in aquatic ecosystems can lead to hazards on human and wildlife.
- Anthropogenic activities, particularly mining, have been greatly influencing the quality of Tisza waters, as well as the local and global geochemical cycles of heavy metals.
- Without any doubt, the pollution with heavy metals on Tisza River and its principal tributaries represent a problem which has stringent need a proper resolution.

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