Joint Operational Programme "BLACK SEA BASIN 2007-2013"

Project: **INNOVATIVE INSTRUMENTS FOR ENVIRONMENTAL ANALYSIS IN NORTH WESTERN BLACK SEA BASIN (BLACK SEA e-EYE)**
Cod proiect: **MIS-ETC No 1475**

GA1: Monitoring physical-chemical and biological parameters of surface aquatic systems in North-Western Black Sea Basin

Research initiative 4

Type of correlation analysis (Danube delta)

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Tulcea, Romania
March 2014

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Introduction

Danube River represents a major pathway for the species dispersal and also for pollutants transfer. Even though, in the last period were implemented more severe laws for Danube ecosystem preserving, maintaining its natural ecological value still represents an issue which scientists, public communities and authorities should handle.

Because the ecosystem structure and functions are controlled by a variety of biotic and abiotic factors, this research initiative was conducted to an intensive monitoring in order to perform an Environmental Integrated Analysis and Assessment, to determine the ecological status of surface waters and sediments in nine points from Danube Delta Biosphere Reserve, according with water quality index (WQI) for water and ecological risk index (RI) for sediments.

Phytoplankton is the first link in food chain being able to set inorganic substances in organic matter. This process is called photosynthesis and is the most important process for life support in aquatic ecosystems and in terrestrial system at plants level.

Zooplankton is important indicators of ecological state. Based upon the taxonomical composition one will be able to deduce whether the sample was taken from a nutrient poor or a nutrient rich system, from acid or alkaline water, even whether the sample was taken from a lotic or lenitic waterbody. The changes in the zooplankton appear to cascade to the phytoplankton. We used the zooplankton:phytoplankton biomass ratio (zoo:chl a biomass ratio) as an indicator of the cascading effects on phytoplankton.

Macroinvertebrates - play an important role in helping provide a comprehensive ecological assessment alongside other Water Framework Directive biological elements. They form an important intermediary link between primary producers and fish, which is key to a functioning ecosystem, thereby providing a reflection of ecosystem health useful in assessment. The response of macroinvertebrate to eutrophication may be complex especially in littoral zones.

Benthic invertebrates form an important link between primary producers, detrital deposits and higher trophic levels in aquatic food webs. Hence, any environmental changes in lakes, for example in nutrient concentrations, would be reflected by changes in the structure of the benthic invertebrate community. This means that benthic invertebrates may potentially indicate eutrophication, as planktonic communities, but in addition several other modes of lake degradation.

Attempts to classify lakes based in invertebrates and across nutrient gradients have revealed the difficulty of disentangling highly multivariate data (Kansanen et al., 1984, Brodersen et al., 1998, Hämäläinen et al., 2003).

Work on individual taxa groups has shown trends with nutrient enrichment but these are often associated with high variance and, hence, low predictive power, which limits their use in relating a pressure to impact (Håkanson, 2001). Specific indicator species and/or taxa ratios may not be universally reliable because of e.g. the nature of sediments, trophic gradient, extent of eutrophication, physical structure and biogeography (Dobrowoloski, 1987).

Macrophytes contribute to maintaining key functions and related biodiversity in freshwater ecosystems, and to provide the needs of human societies. Moderate disturbances (by floods or drawdowns) decrease biotic interactions in aquatic plant communities and as a consequence favor biodiversity and decrease succesional rate. Free-floating and tall species with floating leaves are the most competitive for light, and usually dominate macrophyte communities when nutrient levels in the water are sufficiently high.

Fish ecological diversity study is very important in modern ecology, but also very complex, with several issues. Regarding *α* diversity, in addition to species richness, heterogeneity, etc. more other is equitability. The main index used in the analysis of biodiversity is Shannon-Wiener index. In correlation between Shannon-Wiener/equitability indices with relative abundance/biomass in CPUE we want to observe the status of fish fauna from selected lakes.

Research initiatives 4

4. Type of correlation analysis

4.1. Physical-chemical indicators

Pollution indexes are powerful tools for establishment of the ecological status. It is necessary to find an appropriate method for correlating the concentrations of all indicators to give a classification of surface waters quality and sediments quality.

For the Danube Delta lakes, branches and channels, water quality index (WQI) and for sediments (lakes) ecological risk index (RI) have been developed to integrate water and sediments quality variables summarizes large amounts of quality data into simple terms (high, good, moderate, poor, bad) for reporting to managers and public in a consistent manner, according with the Water Framework Directive 2000/60/EC "Establishing a framework for Community action in the field of water policy".

The classification of water quality status is established by the Romanian Order 161/2006, Classification of surface water quality to determine the ecological status of water bodies. Elements and biological, chemical and physical and chemical quality standards that setting ecological status of surface waters, Appendix C, Elements, chemical and physical - chemical quality standards according with Water Framework Directive.

Water Quality Index (WQI), a very useful and efficient method for assessing the suitability of water quality, a dimensionless number that combines multiple water-quality factors (all chemical indicators) into a single number by normalizing values to subjective rating curves: general physical-chemical quality elements (water temperature, Secchi disk transparency, water depth, pH, chloride, sulphates, calcium and magnesium, sodium, filterable residue dried at 105^0C, anionic detergent active, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand), nutrients (nitrite, nitrate, ammonium, dissolved phosphorus, total phosphorus, total nitrogen, chlorophyll ,,a"), metals (total chromium, copper, zinc, arsenic, lead, cadmium, total iron, mercury, total magnesium, nickel).

Each advantage has a corresponding disadvantage in analysis of WQI (**Table 4.1.1).** In view of these advantages and disadvantages, a water quality index appears to meet the requirements as a tool designed to advise decision makers and the public of the water quality levels but does not show the specific pollution problem of a water body. In other words, an index will provide a general indication of water quality but will not indicate which pollution related parameters exceed the required criteria, which uses are impaired, and why a particular poor (or good) condition exists (Biggs, 1977).

Table 4.1.1 Advantages and disadvantages of a Water Quality Index (Biggs, 1977)

Advantages	Disadvantages
Measures general water quality	Does not measure water pollution
Single number for overall water quality	Insensitive to individual problem parameters
Good for communicating with the layman	Poor for addressing particular technical problems
Standardized so that different geographic areas can be directly compared	Does not take into account local natural background water quality effects
Many water experts' opinions taken into account when formulating WQI	Somewhat arbitrary and lack of a firm scientific basis

For sediments, integrated indices are indicators used to calculate more than one metal contamination. Potential ecological risk index (RI) is a degree of contamination with heavy metals (arsenic, cadmium, chromium, lead, nickel, iron, mercury, manganese, zinc, copper).

4.1.1. Water Quality Index Method

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables (Chowdhury et al. 2012, Lumb et al. 2011, Tyagi et al 2013).

The calculation of WQI was made by using the following equation (4.1.1.1) (Brown et al. 1972):

$$\mathbf{WQI = (\sum Q_{i*} W_i)/ \sum W_i}, \qquad 4.1.1.1$$

Where

W i = Unit weight for each water quality parameter

Q_i = Quality rating scale for each water quality parameter

The quality rating scale (Qi) for each parameter is calculated by using this expression (4.1.1.2):

$$\mathbf{Q_i = 100 * [(V_i - V_o)/(S_i - V_o)]} \qquad 4.1.1.2$$

Where,

V_i = Estimated concentration of ith parameter in the analysed water

V_o = Ideal value of this parameter in pure water The quality rating scale (zero for all indicators, except pH=7.0 and oxygen demand (D.O.)= 14.6 mgO_2/L)

S_i = Standard value of i-th parameter, for the second quality class, according with Romanian Order 161/2006

The unit weight (W_i) for each water quality parameter is calculated by using the following formula (4.1.1.3):

$$W_i = K / S_i, \quad (4.1.1.3)$$

Where,

K = Proportionality constant
S_i = Standard value of i-th parameter, for the second quality class, according with Romanian Order 161/2006

The proportionality constant, K, can be calculated by using the following equation (4.1.1.4):

$$K = 1 / \sum(1/ S_i) \quad (4.1.1.4)$$

Where,

S_i = Standard value of i-th parameter, for the second quality class, according with Romanian Order 161/2006

Water Quality Index method ranks 5 water quality classes. (**Table 4.1.1.1**)

Table 4.1.1.1 Surface waters quality classes according with Water Quality Index Tyagi et al. (2013)

Water quality class	Very good	Good	Moderate	Bad	Very bad
Water Quality Index (WQI)	WQI<25	25≤WQI<50	50≤WQI<75	75≤WQI<100	WQI≥100

Calculating Water Quality Index, taking into accounts 28 chemical indicators, analyzed in 2009-2013 (mean yearly concentrations), in 9 sampling points, it was found that all surface waters in Danube delta and its arms have **very bad quality (Tables 4.1.1.3 - 4.1.1.11).**

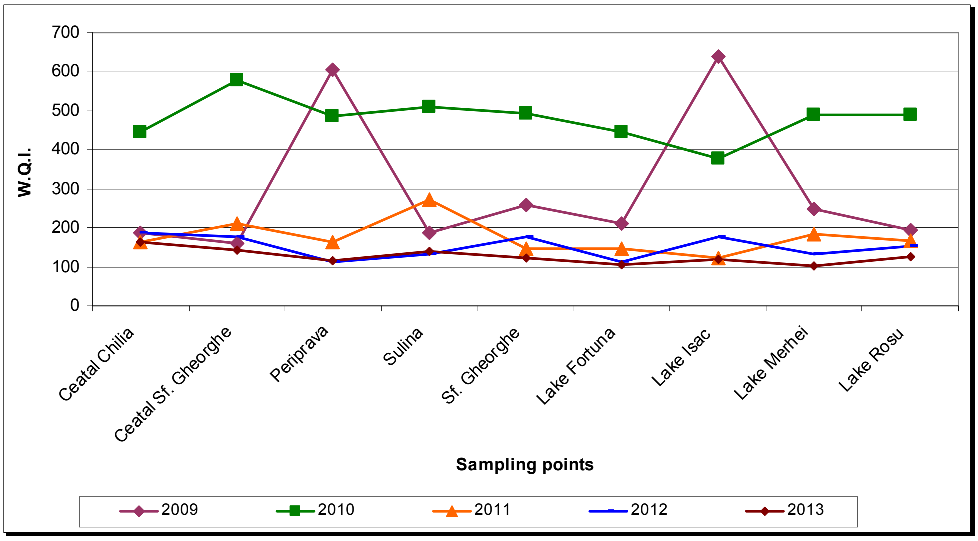

Figure 4.1.1. Water Quality Index values between 2009-2013

The maximum WQI values were obtained in 2010, except Periprava and Lake Isac (maximum in 2009) and the minimum values in 2013; this general trend was observed, also, by analyzing the general trend of each chemical indicator (maximum in 2010 and minimum in 2013) (**Figure 4.1.1**).

Comparing the mean values of Water Quality Index of five Danube sampling points, Chilia branch at Periprava village section is most polluted (296.299), while from four analized lakes, Isac Lake has the maximum mean value of Water Quality Index (287.049) (**Figure 4.1.1**).

The decrease rank order of Water Quality Index mean values (2009-2013) for river sampling points is:

$WQI_{Periprava} > WQI_{Ceatal\ Sf.\ Gheorghe} >> WQI_{Sulina} > WQI_{Sf.\ Gheorghe} > WQI_{Ceatal\ Chilia}$

For lakes sampling points, the decrease rank order of Water Quality Index mean values (2009-2013) is:

$WQI_{Isac} > WQI_{Merhei} >> WQI_{Rosu} > WQI_{Fortuna}$

However, it is not observed any decreasing trends from upstream, at the peak of the delta, towards discharge into Black Sea as it was hypothesised due to auto cleaning of Danube River waters in the delta buffer zones ecosystems. This could be due to local point pollution of riverine towns on Danube River and branches, but no reason for the lakes.

Cadmium has a very important role in Water Quality Index Method, due to high concentrations in surface water for one side, and very low value of maximum concentration allowed (for the second quality class) 0.001 mg/L, by the other side.

Water Quality Index values computed without cadmium concentrations, by integrating the 27 indicators concentrations, all 9 surface waters have a **very good quality** (**Table 4.1.1.2**).

Table 4.1.1.2 Water Quality Index Method ***without cadmium*** concentrations

Years	Sampling points								
	Ceatal Chilia	Ceatal Sf. Gheorghe	Periprava	Sulina	Sf. Gheorghe	Lake Fortuna	Lake Isac	Lake Merhei	Lake Rosu
	WQI								
2009	**14.165**	**9.869**	**22.448**	**21.686**	**21.117**	**17.528**	**14.697**	**10.803**	**8.102**
2010	**14.122**	**16.515**	**11.642**	**13.326**	**18.376**	**14.428**	**11.289**	**16.942**	**14.255**
2011	**13.717**	**15.677**	**11.848**	**13.901**	**15.446**	**15.498**	**14.520**	**10.294**	**14.197**
2012	**3.267**	**5.551**	**5.325**	**4.079**	**4.587**	**5.298**	**4.340**	**4.690**	**2.430**
2013	**11.999**	**14.000**	**8.638**	**9.814**	**13.519**	**19.764**	**12.097**	**15.499**	**16.851**
Limits values for WQI									
Very good	**WQI<25**								
Good	**25≤WQI<50**								
Moderate	**50≤WQI<75**								
Bad	**75≤WQI<100**								
Very bad	**WQI≥100**								

Table 4.1.1.3 Water Quality Index calculation for Danube river section at Ceatal Chilia splitting point

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
	pH	pH unit	8.5000	7.000	0.000		73.778		30.333		57.000		67.778		69.333	
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		76.272		50.822		33.020		74.912		67.654	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		63.847		31.160		226.960		46.987		37.740	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		7.537		14.490		6.114		6.857		19.135	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		13.792		31.938		50.313		3.167		8.125	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		56.667		75.000		58.333		84.444		58.889	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		238.822		46.900		24.483		10.800		44.644	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1766.400		906.000		661.600		788.867		773.533	
	Phosphate ($P\text{-}PO_{4\text{-}}$)	mg/L	0.2000	0.000	0.001		46.500		23.250		5.250		8.167		22.667	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		42.500		21.250		18.000		17.417		29.917	
	Chlorophyll “a”	mg/L	50.0000	0.000	0.000		0.000		0.000		0.000		0.000		0.000	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		51.733		32.053		27.644	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		54.365		63.821		78.003		56.921		76.349	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		29.019		34.244		44.209		30.870		25.583	
Ceatal Chilia	Calcium (Ca^2+)	mg/L	100.0000	0.000	0.000	0.000215	50.234	186.479	36.072	444.907	46.894	164.492	41.446	186.351	50.501	162.774
	Magnesium (Mg^2+)	mg/L	50.0000	0.000	0.000		23.671		35.000		32.102		25.617		21.402	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		44.130		29.182		46.177		47.459		57.808	
	Total chromium (Cr^3+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		24.000		168.000		93.000		24.000		72.000	
	Copper Cu^2+)[5]	mg/L	0.0300	0.000	0.007		90.000		53.333		81.667		220.000		80.000	
	Zinc (Zn^2+)	mg/L	0.2000	0.000	0.001		17.500		33.000		35.250		50.500		93.500	
	Arsenic (As^3+)	mg/L	0.0200	0.000	0.011		105.000		260.000		52.500		0.000		65.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		70.000		100.000		90.000		0.000		130.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		800.000		2000.000		700.000		850.000		700.000	
	Total iron (Fe^2+ + Fe^3+)	mg/L	0.5000	0.000	0.000		73.600		49.400		83.800		137.200		158.000	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		11.000		5.667		11.333		0.000		7.667	
	Total manganese (Mn^2+ + Mn^7+)	mg/L	0.1000	0.000	0.002		4.600		438.000		181.000		32.000		145.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		224.000		256.000		116.000		65.600		112.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		18.750		31.500		20.250	

Table 4.1.1.4 Water Quality Index calculation for Sf. Gheorghe branch section at Ceatal Sf. Gheorghe splitting point

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
Ceatal Sf. Gheorghe	pH	pH unit	8.5000	7.000	0.000		72.444		44.333		40.667		69.111		70.000	
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		86.601		32.428		55.974		76.732		66.149	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		78.440		87.620		120.200		28.527		61.460	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		14.719		15.104		5.278		6.169		12.147	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		20.333		27.063		43.375		7.458		7.125	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		53.333		78.333		70.000		37.778		61.111	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		205.356		53.333		30.217		12.589		42.289	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1096.667		879.950		271.700		967.967		554.633	
	Phosphate ($P\text{-}PO_{4\text{-}}$)	mg/L	0.2000	0.000	0.001		23.833		27.500		11.750		19.167		25.167	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		19.583		26.125		23.125		14.667		36.917	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		0.000		0.000		0.000		0.000		0.000	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		35.733		29.689		25.067	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		39.761		60.275		74.457		54.625		73.749	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		33.016		61.418		37.452		27.769		30.074	
	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000	0.000215	48.698	160.644	30.461	576.536	37.676	209.531	39.278	177.865	51.302	143.236
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		22.047		38.425		52.531		25.293		26.590	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		42.772		29.790		33.366		45.709		64.114	
	Total chromium (Cr^{3}+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		64.000		344.000		68.000		24.000		90.800	
	Copper Cu^{2}+)[5]	mg/L	0.0300	0.000	0.007		50.000		73.333		26.667		186.667		96.667	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		28.000		26.000		35.000		47.500		44.500	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		80.000		260.000		45.000		100.000		90.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		90.000		140.000		70.000		60.000		130.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		700.000		2600.000		900.000		800.000		600.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		297.600		292.000		101.600		242.200		172.200	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		5.667		3.000		15.667		0.000		9.667	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		19.000		186.000		65.000		141.000		177.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		172.000		600.000		128.000		84.000		124.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		17.750		35.250		14.500	

Table 4.1.1.5 Water Quality Index calculation for Chilia branch section at Periprava vilage

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
Periprava	pH	pH unit	8.5000	7.000	0.000	0.000215	85.778	604.009	50.333	485.506	50.444	162.623	66.444	113.021	66.000	116.335
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		63.000		50.750		65.728		65.965		61.612	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		0.000		46.580		130.367		64.433		25.450	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		0.000		11.042		9.063		13.673		10.418	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		25.083		53.000		25.958		6.625		11.625	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		111.111		76.667		94.444		45.556		55.000	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		210.333		38.017		30.222		12.522		59.700	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		966.400		1120.250		473.800		1273.900		2082.150	
	Phosphate ($P\text{-}PO_{4\text{-}}$)	mg/L	0.2000	0.000	0.001		31.000		30.750		16.500		16.833		25.500	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		29.167		29.750		20.250		16.083		25.500	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		0.000		0.000		0.063		0.000		0.000	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		49.067		28.444		32.000	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		40.124		63.821		75.639		57.380		64.530	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		41.764		32.408		49.187		26.602		29.121	
	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000		45.103		51.703		48.630		34.482		54.910	
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		32.421		33.561		41.182		26.590		25.101	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		41.671		43.252		43.235		38.597		27.389	
	Total chromium (Cr^{3}+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		40.000		176.000		68.000		88.000		68.000	
	Copper Cu^{2}+)[5]	mg/L	0.0300	0.000	0.007		203.333		46.667		63.333		73.333		80.000	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		18.000		38.000		17.000		45.500		51.500	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		100.000		270.000		70.000		130.000		75.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		560.000		120.000		90.000		70.000		74.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		2700.000		2200.000		700.000		500.000		500.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		292.400		41.800		134.600		182.600		94.000	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		8.000		3.000		8.667		0.000		4.333	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		8.000		23.000		123.000		77.000		147.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		80.000		224.000		116.000		64.000		108.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		15.500		26.000		16.500	

Table 4.1.1.6 Water Quality Index calculation for Sulina branch section at Sulina town

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
	pH	pH unit	8.5000	7.000	0.000		90.667		41.000		34.667		68.444		68.222	
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		73.250		54.230		74.539		68.610		67.228	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		0.000		82.690		85.673		47.820		67.200	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		0.000		16.090		5.511		6.560		7.580	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		16.417		31.250		38.708		8.542		17.208	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		61.111		68.333		95.556		50.000		63.333	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		180.000		43.650		31.800		16.889		43.367	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1513.633		1058.850		719.700		907.667		855.700	
	Phosphate ($P\text{-}PO_{4-)}$)	mg/L	0.2000	0.000	0.001		27.000		14.500		14.167		12.167		11.833	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		19.750		32.125		18.417		13.250		30.417	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		0.000		0.000		0.000		0.000		0.000	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		42.133		31.600		30.933	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		56.730		67.366		125.277		61.970		71.149	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		29.227		42.361		35.016		19.718		25.624	
Sulina	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000	0.000215	48.470	185.384	51.704	508.729	43.287	272.372	33.935	133.314	48.363	139.050
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		28.859		35.021		45.073		28.211		30.157	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		40.405		37.338		70.141		42.725		59.343	
	Total chromium (Cr^{3}+ + $Cr^{6+)}$)	mg/L	0.0500	0.000	0.004		102.000		116.000		48.000		24.000		70.000	
	Copper Cu^{2}+)[5]	mg/L	0.0300	0.000	0.007		96.667		86.667		40.000		133.333		86.667	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		42.000		40.000		34.500		52.000		43.000	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		55.000		270.000		75.000		45.000		80.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		140.000		100.000		80.000		50.000		90.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		760.000		2300.000		1200.000		600.000		600.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		112.400		118.800		174.200		182.200		82.200	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		18.667		4.333		12.333		0.000		5.667	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		81.000		158.000		111.000		64.000		128.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		284.000		328.000		88.000		68.000		112.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		22.500		12.500		14.750	

Table 4.1.1.7 Water Quality Index Method calculation for Sf. Gheorghe branch at Sf. Gheorghe village

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
Sf. Gheorghe	pH	pH unit	8.5000	7.000	0.000	0.000215	86.444	258.049	29.333	492.240	37.111	144.681	64.000	176.901	69.111	121.216
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		74.351		38.000		65.864		71.851		70.978	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		0.000		95.620		93.280		35.747		65.587	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		0.000		15.104		6.844		10.935		11.181	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		24.708		33.438		24.583		8.208		8.708	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		293.333		93.333		103.333		45.556		64.444	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		150.000		43.433		31.433		29.689		43.622	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1092.300		533.575		384.733		521.833		530.733	
	Phosphate ($P\text{-}PO_{4-}$)	mg/L	0.2000	0.000	0.001		44.167		21.250		17.333		21.000		17.833	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		34.167		26.375		24.667		26.250		31.833	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		0.000		0.000		0.000		0.000		0.000	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		30.400		22.400		25.244	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		49.639		67.366		73.275		61.901		75.876	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		30.680		30.925		34.456		21.568		27.326	
	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000		44.088		33.267		39.546		24.571		50.233	
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		31.454		19.942		45.073		37.126		25.293	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		41.797		34.133		37.520		30.251		56.556	
	Total chromium (Cr^{3}+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		48.000		400.000		96.000		24.000		76.000	
	Copper Cu^{2}+)[5]	mg/L	0.0300	0.000	0.007		63.333		260.000		76.667		96.667		76.667	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		15.000		33.000		80.500		49.500		49.500	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		90.000		250.000		50.000		105.000		70.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		50.000		120.000		100.000		40.000		90.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		1100.000		2200.000		600.000		800.000		500.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		76.800		90.200		179.600		197.600		119.000	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		20.000		5.333		12.333		0.000		10.667	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		41.000		100.000		169.000		168.000		156.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		172.000		528.000		176.000		92.000		140.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		15.333		16.000		16.000	

Table 4.1.1.8 Water Quality Index calculation for Lake Fortuna

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
Lake Fortuna	pH	pH unit	8.5000	7.000	0.000		94.000		44.667		68.000		89.556		66.444	
	Dissolved oxygen	mgO$_2$/L	7.0000	14.600	0.000		49.390		37.480		40.759		81.430		57.610	
	Biochemical oxygen demand (5 days)	mgO$_2$/L	5.0000	0.000	0.000		92.293		100.400		139.147		44.627		42.333	
	Chemical Oxygen Demand (I $_{KMnO4}$)	mgO$_2$/L	25.0000	0.000	0.000		14.800		15.778		14.163		22.565		90.627	
	Ammonium (N-NH$_4$+)	mg/L	0.8000	0.000	0.000		49.375		39.250		37.375		7.917		13.542	
	Nitrite (N-NO$_2$)	mg/L	0.0300	0.000	0.007		38.889		35.000		32.222		10.000		26.667	
	Nitrate (N-NO$_3$)	mg/L	3.0000	0.000	0.000		114.822		10.333		9.489		4.433		21.356	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1368.167		542.150		642.400		1372.967		625.500	
	Phosphate (P-PO$_{4-}$)	mg/L	0.2000	0.000	0.001		20.667		10.500		10.833		25.333		17.833	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		17.083		9.875		21.750		23.417		15.417	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		59.484		28.416		229.696		135.763		77.355	
	Filterable residue dried at 105^{0}C	mg/L	750.0000	0.000	0.000		3.940		1.894		43.022		31.600		42.133	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		65.449		61.098		82.731		71.610		66.657	
	Sulphate (SO$_4^{2}$+)	mg/L	120.0000	0.000	0.000		39.946		42.752		29.742		24.026		22.188	
	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000	0.000215	15.727	211.381	17.484	445.214	42.485	144.734	38.210	112.994	41.416	105.921
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		44.172		40.816		35.993		26.914		32.427	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		0.026		0.204		47.627		53.996		41.683	
	Total chromium (Cr^{3}+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		54.000		204.000		102.000		44.000		214.000	
	Copper Cu^{2}+)^5	mg/L	0.0300	0.000	0.007		90.000		100.000		63.333		166.667		318.889	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		49.500		61.000		62.000		45.000		88.067	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		80.000		250.000		65.000		90.000		37.633	
	Lead (Pb)^6	mg/L	0.0100	0.000	0.022		70.000		120.000		70.000		50.000		121.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		900.000		2000.000		600.000		500.000		400.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		109.600		772.600		140.600		240.800		469.733	
	Mercury (Hg)^5	mg/L	0.0003	0.000	0.718		11.333		5.667		13.667		0.000		13.556	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		78.000		158.000		139.000		34.000		375.667	
	Nickel (Ni)^5	mg/L	0.0250	0.000	0.009		608.000		272.000		200.000		140.000		269.333	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		18.000		14.500		14.500	

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Table 4.1.1.9 Water Quality Index calculation for Lake Isac

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
	pH	pH unit	8.5000	7.000	0.000		76.667		66.000		68.000		68.222		74.444	
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		45.763		15.401		10.425		60.338		62.417	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		71.887		112.200		210.673		92.000		68.960	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		26.944		26.128		18.965		18.080		72.787	
	Ammonium ($N\text{-}NH_4+$)	mg/L	0.8000	0.000	0.000		13.167		23.188		28.833		4.188		7.500	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		52.222		23.333		50.000		17.778		25.556	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		154.933		11.167		6.878		3.500		28.478	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		1002.767		927.900		291.200		545.833		685.300	
	Phosphate ($P\text{-}PO_{4-}$)	mg/L	0.2000	0.000	0.001		4.000		23.500		26.000		9.667		10.833	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		17.333		29.125		29.000		22.750		12.083	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		152.259		549.376		310.563		156.287		139.712	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		33.773		30.400		24.000	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		54.366		63.821		82.731		88.594		67.130	
	Sulphate ($SO_4^{2}+$)	mg/L	120.0000	0.000	0.000		22.233		21.598		29.083		24.630		21.293	
Lake Isac	Calcium ($Ca^{2}+$)	mg/L	100.0000	0.000	0.000	0.000215	35.270	639.336	44.088	377.457	30.995	122.216	31.530	176.654	47.829	119.793
	Magnesium ($Mg^{2}+$)	mg/L	50.0000	0.000	0.000		35.021		29.767		35.993		25.941		22.374	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		39.765		34.869		46.928		47.744		48.539	
	Total chromium ($Cr^{3}+ + Cr^{6+}$)	mg/L	0.0500	0.000	0.004		40.000		116.000		100.000		26.000		330.667	
	Copper $Cu^{2}+$)[5]	mg/L	0.0300	0.000	0.007		76.667		40.000		40.000		163.333		263.889	
	Zinc ($Zn^{2}+$)	mg/L	0.2000	0.000	0.001		56.000		22.000		18.000		34.500		25.583	
	Arsenic ($As^{3}+$)	mg/L	0.0200	0.000	0.011		65.000		240.000		85.000		0.000		56.000	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		100.000		120.000		70.000		70.000		80.333	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		2900.000		1700.000		500.000		800.000		500.000	
	Total iron ($Fe^{2}+ + Fe^{3}+$)	mg/L	0.5000	0.000	0.000		96.800		926.800		58.200		102.600		258.867	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		12.333		3.000		12.667		0.000		5.889	
	Total manganese ($Mn^{2}+ + Mn^{7}+$)	mg/L	0.1000	0.000	0.002		121.000		154.000		165.000		27.000		149.667	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		148.000		232.000		160.000		128.000		160.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		17.500		25.000		13.333	

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Table 4.1.1.10 Water Quality Index calculation for Lake Merhei

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
	pH	pH unit	8.5000	7.000	0.000		68.000		61.667		48.000		67.111		82.444	
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		29.474		4.447		73.289		47.193		11.952	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		171.200		169.490		111.000		91.480		73.233	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		42.212		21.996		20.292		22.768		244.601	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		24.625		25.813		51.250		5.875		12.667	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		16.667		116.667		16.667		11.667		17.778	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		1.467		3.833		7.867		4.589		10.967	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		123.800		917.250		619.600		1228.433		1138.000	
	Phosphate ($P\text{-}PO_{4-}$)	mg/L	0.2000	0.000	0.001		14.500		32.750		5.500		28.167		7.000	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		28.000		27.375		19.250		25.083		8.000	
	Chlorophyll “a”	mg/L	50.0000	0.000	0.000		4.720		309.024		51.200		42.624		255.744	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		71.467		0.000		28.800	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		56.720		70.912		92.186		89.512		64.767	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		44.747		29.798		37.512		21.409		24.014	
Lake Merhei	Calcium (Ca^{2}+)	mg/L	100.0000	0.000	0.000	0.000215	41.683	247.735	52.505	490.805	48.096	182.609	37.141	133.925	46.493	101.656
	Magnesium (Mg^{2}+)	mg/L	50.0000	0.000	0.000		34.048		37.938		39.884		26.589		26.265	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		49.304		46.423		40.618		50.007		46.033	
	Total chromium (Cr^{3}+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		24.000		264.000		98.000		24.000		54.667	
	Copper Cu^{2}+)[5]	mg/L	0.0300	0.000	0.007		106.667		113.333		53.333		76.667		90.000	
	Zinc (Zn^{2}+)	mg/L	0.2000	0.000	0.001		82.000		41.000		19.000		54.500		44.333	
	Arsenic (As^{3}+)	mg/L	0.0200	0.000	0.011		65.000		270.000		80.000		110.000		39.667	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		30.000		100.000		90.000		70.000		93.333	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		1100.000		2200.000		800.000		600.000		400.000	
	Total iron (Fe^{2}+ + Fe^{3}+)	mg/L	0.5000	0.000	0.000		124.000		729.000		97.800		205.400		146.467	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		7.667		5.667		7.000		0.000		13.111	
	Total manganese (Mn^{2}+ + Mn^{7}+)	mg/L	0.1000	0.000	0.002		59.000		154.000		148.000		59.000		143.667	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		304.000		472.000		112.000		76.000		224.000	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		22.000		11.000		16.833	

Table 4.1.1.11 Water Quality Index calculation for Lake Rosu

Sampling point	Parameter	Unit	Standard values		Calculated values		2009		2010		2011		2012		2013	
			Si	Vo	Wi	K	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI	Qi	WQI
Lake Rosu	pH	pH unit	8.5000	7.000	0.000	0.000215	83.111	193.340	58.000	488.119	78.444	164.972	62.667	153.205	72.667	124.547
	Dissolved oxygen	mgO_2/L	7.0000	14.600	0.000		56.965		20.158		45.544		53.579		61.921	
	Biochemical oxygen demand (5 days)	mgO_2/L	5.0000	0.000	0.000		147.427		79.730		156.207		97.713		74.293	
	Chemical Oxygen Demand (I_{KMnO4})	mgO_2/L	25.0000	0.000	0.000		22.525		18.356		15.812		25.707		147.109	
	Ammonium ($N\text{-}NH_4$+)	mg/L	0.8000	0.000	0.000		23.458		30.813		35.667		6.042		3.000	
	Nitrite ($N\text{-}NO_2$)	mg/L	0.0300	0.000	0.007		26.667		10.000		14.444		38.333		17.778	
	Nitrate ($N\text{-}NO_3$)	mg/L	3.0000	0.000	0.000		31.344		5.900		6.878		1.800		9.722	
	Total nitrogen (P)	mg/L	1.0000	0.000	0.000		472.500		1199.750		503.333		286.500		829.800	
	Phosphate ($P\text{-}PO_{4\text{-}}$)	mg/L	0.2000	0.000	0.001		5.333		3.250		3.667		6.000		4.500	
	Total phosphorus (P)	mg/L	0.4000	0.000	0.001		13.750		9.000		13.250		14.500		12.583	
	Chlorophyll "a"	mg/L	50.0000	0.000	0.000		46.309		126.688		209.173		228.117		28.133	
	Filterable residue dried at 105^0C	mg/L	750.0000	0.000	0.000		0.000		0.000		0.000		31.289		31.644	
	Chloride (Cl-)	mg/L	50.0000	0.000	0.000		56.725		62.048		89.822		85.837		78.949	
	Sulphate (SO_4^{2}+)	mg/L	120.0000	0.000	0.000		33.443		33.809		35.258		20.121		20.316	
	Calcium (Ca^2+)	mg/L	100.0000	0.000	0.000		41.309		54.509		40.080		32.652		47.294	
	Magnesium (Mg^2+)	mg/L	50.0000	0.000	0.000		29.833		30.643		43.128		30.416		26.589	
	Sodium (Na+)	mg/L	50.0000	0.000	0.000		53.851		36.877		46.929		60.471		68.394	
	Total chromium (Cr^3+ + Cr^{6+})	mg/L	0.0500	0.000	0.004		14.000		140.000		92.000		16.000		124.000	
	Copper Cu^2+)[5]	mg/L	0.0300	0.000	0.007		73.333		120.000		50.000		73.333		98.889	
	Zinc (Zn^2+)	mg/L	0.2000	0.000	0.001		47.000		48.000		25.500		42.500		31.500	
	Arsenic (As^3+)	mg/L	0.0200	0.000	0.011		75.000		250.000		60.000		0.000		68.333	
	Lead (Pb)[6]	mg/L	0.0100	0.000	0.022		88.000		100.000		80.000		60.000		91.000	
	Cadmium (Cd)	mg/L	0.0010	0.000	0.215		860.000		2200.000		700.000		700.000		500.000	
	Total iron (Fe^2+ + Fe^3+)	mg/L	0.5000	0.000	0.000		54.200		884.800		133.000		107.000		328.867	
	Mercury (Hg)[5]	mg/L	0.0003	0.000	0.718		4.333		5.667		13.333		0.000		14.667	
	Total manganese (Mn^2+ + Mn^7+)	mg/L	0.1000	0.000	0.002		12.000		154.000		63.000		29.000		132.000	
	Nickel (Ni)[5]	mg/L	0.0250	0.000	0.009		148.000		320.000		120.000		0.000		182.667	
	Anionic detergent active	mg/L	0.2000	0.000	0.001		0.000		0.000		0.000		24.000		16.500	

4.1.2. Potential Ecological Risk for sediments

The most used pollution indices by heavy metals sediments pollution, are the **single index** and the **integrated index**.

The single indices are used to calculate only one metal effect (pollution).

A single index is the **contamination factor**, used to describe the contamination of a single heavy metal in lake sediment, and is defined as a ratio between the concentration of heavy metal and the heavy metal quality standard in sediment (4.1.2.1) (Hảkanson 1980).

$$C_f^{Me} = C^{Me} / C_{SCM}^{Me} \qquad 4.1.2.1$$

Where

C^{Me}	=	Heavy metal concentration determined in sediment sample;
C_{SCM}^{Me}	=	Standard value of each heavy metal according with Romanian Order 161/2006, Table 8 Elements and quality standards to establish the chemical status of surface water, Annex B, Elements and chemical quality standards for sediments;

Ecological Risk Factor, E_r^{Me}, is also a single index, used to quantitatively express the potential ecological risk of heavy metals (Hảkanson 1980, Gong 2008). It is also a useful tool for assessing the quality of sediments in environment by heavy metals. It can be calculated using the formula (4.1.2.2):

$$E_r^{Me} = T_r^{Me} * C_f^{Me} \qquad 4.1.2.2$$

Where

T_r^{Me}	=	Toxic response factor for a single heavy metals;
C_f^{Me}	=	Contamination factor;

Hảkanson (1980) proposed the values of toxic response for different pollution metals (**Table 4.1.2.1).**

Table 4.1.2.1 Values of Toxic response factor Hảkanson (1980)

T_r^{As}	T_r^{Cd}	T_r^{Cr}	T_r^{Cu}	T_r^{Pb}	T_r^{Zn}
10.000	**30.000**	**2.000**	**5.000**	**5.000**	**1.000**

For a single heavy metal, it was defined five sediments quality classes (Table 4.1.2.2)

Table 4.1.2.2 Ecological risk classes for a single heavy metal Gong (2008)

$E_r^{Me} < 40$	Low potential ecological risk
$40 \le E_r^{Me} < 80$	Moderate potential ecological risk
$80 \le E_r^{Me} < 160$	Considerable potential ecological risk
$160 \le E_r^{Me} < 320$	High potential ecological risk
$E_r^{Me} \ge 320$	Very high ecological risk

The **potential ecological risk index (RI)** in an integrated index, used to calculate more than one heavy metal contamination (Gong 2008).

The **potential ecological risk index (RI)** is defined as a sum of the heavy metals risk factors (**E_r^{Me}**) (4.1.2.3) (Hẳkanson 1980).

$$RI = \sum E_r^{Me} \qquad 4.1.2.3$$

Where E_r^{Me} is the single index of ecological risk factor.

According with Hẳkanson (1980), for sediments, where established four ecological risk classes, taking into accounts the heavy metals potential ecological risk index values (Table 4.1.2.3).

Table 4.1.2.3 Ecological risk classes according with potential ecological risk index Hẳkanson (1980)

RI < 150	Low ecological risk
150 ≤ RI < 300	Moderate ecological risk
300 ≤ RI < 600	Considerable ecological risk
RI ≥ 600	Very high ecological risk

Between 2009 – 2013, zinc, copper, lead, arsenic, chromium present a low ecological risk for Isac, Rosu, Fortuna, Merhei lakes sediments (Table 4.1.2.4).

Cadmium presented a low ecological risk in 2011 and 2013 in all lakes sediments and in 2012 only for Isac, Fortuna and Merhei lakes.

Cadmium presented a moderate ecological risk in 2009 (Isac Lake sediment), 2010 (Isac, Rosu, Merhei lakes sediments) and 2012 in Rosu Lake sediment.

Table 4.1.2.4 Ecological risk values – single index

Sampling year	**Sampling points (lake sediment)**	E_r^{Zn}	E_r^{Cu}	E_r^{Cd}	E_r^{Pb}	E_r^{As}	E_r^{Cr}
2009	Isac	0.339	3.756	57.788	0.453	3.985	0.570
	Rosu	0.156	1.418	85.088	0.756	2.869	0.242
	Fortuna	0.790	7.576	137.738	0.324	6.016	0.900
	Merhei	0.000	0.000	0.000	0.000	0.000	0.000
2010	Isac	0.265	2.196	63.225	0.500	0.848	0.271
	Rosu	0.166	0.650	59.288	0.049	0.753	0.128
	Fortuna	0.634	3.911	87.000	1.268	5.059	0.608

	Merhei	0.148	1.212	62.250	0.339	4.520	0.220
2011	Isac	0.103	1.282	9.750	0.284	1.403	0.220
	Rosu	0.265	2.689	11.700	0.632	2.107	0.843
	Fortuna	0.295	2.761	14.850	0.649	2.144	0.491
	Merhei	0.107	1.128	8.775	0.287	1.978	0.276
2012	Isac	0.354	2.314	31.779	0.256	0.557	0.182
	Rosu	0.228	1.710	41.315	0.558	0.369	0.174
	Fortuna	1.287	1.139	18.844	0.555	0.585	0.239
	Merhei	0.628	1.753	27.195	0.516	0.736	0.285
2013	Isac	0.287	3.130	17.831	0.931	2.682	0.593
	Rosu	0.221	3.049	10.491	1.003	3.031	0.488
	Fortuna	0.243	2.586	17.337	0.862	1.999	0.410
	Merhei	0.136	1.656	8.657	0.543	2.278	0.273
Low potential ecological risk	**$E_r^{Me} < 40$**						
Moderate potential ecological risk	**$40 \le E_r^{Me} < 80$**						
Considerable potential ecological risk	**$80 \le E_r^{Me} < 160$**						
High potential ecological risk	**$160 \le E_r^{Me} < 320$**						
Very high ecological risk	**$E_r^{Me} \ge 320$**						

The integrated index RI was computed for sediments in 4 selected lakes between 2009-2013 year period (**Table 4.1.2.5**).
All lakes sediments presented low ecological risk, except Fortuna in 2009 (moderate ecological risk).

Table 4.1.2.5 Ecological risk values – integrated index

Sampling year	**Sampling points (lake sediment)**			
	Isac	**Rosu**	**Fortuna**	**Merhei**
	RI	**RI**	**RI**	**RI**
2009	66.890	90.530	153.343	-
2010	67.305	61.033	98.479	68.689
2011	13.044	18.236	21.189	12.551
2012	35.443	44.354	22.649	31.113
2013	25.454	18.282	23.437	13.542
Low ecological risk	**RI < 150**			
Moderate ecological risk	**150 ≤ RI < 300**			
Considerable ecological risk	**300 ≤ RI < 600**			
Very high ecological risk	**RI ≥ 600**			

4.2 Phytoplankton

Eutrophication represents water enrichment with organic and inorganic nutrients. Naturally this is a beneficial process of aquatic productivity growth, but a quick growth of nutrients caused by artificial processes result a burst of planktonic algae with serious changes in aquatic environment.

Phytoplankton is identified as Biological Quality Element under the European Water Framework Directive (2000/60/EC), suitable to be monitored to determine anthropogenic influences on aquatic ecosystems (Török, 2012).
Phytoplankton investigated in Danube River does not have a significant variation which can conclude in a good development status.

In present, in Romania, the biological method for river phytoplankton analysis is the method Pantle – Buck (1955), in which is made a classification of impurity of waters with bio degradabile organic matter after saprobic system.

After estimate this index the results show a quality class II for five stations representing good ecological status, and one station in third class representing moderate ecological status for Danube arms (**Table 4.2.1**).

Table 4.2.1 Saprobic index for studied aquatic ecosystem

Station	Ceatal Chilia	Aval Izmail	Periprava	Ceatal Sf. Ghe.	Sulina	Sf. Gheorghe
Saprobic Index	2.23	2.34	2.42	2.23	2.27	2.25
Quality Class	II	II	III	II	II	II

4.3 Zooplankton

The Saprobity index of Pantel and Buck (1955) and the Diversity indices of Shanon and Weaver (1948) were applied in the assessment of the level of pollution in nine stations in the aquatic system investigated. The results obtained indicate that the delta branches is β- mesosaprobic to eutrophic and the Danube Delta shallow lakes is mainly β-mesosaprobic.

An analysis of data from Danube Delta lakes has shown clear changes in zooplankton community structure and richness along eutrophication gradient.
The results denoted low species richness in river-branches, whereas in shallow permanent lakes, a high number of species were reported (**Table 4.3.1**).

Diversity was evaluated using Shannon-Weiner index. A positive relation had been found between trophic state of shallow lakes and diversity of zooplankters. The values for the Shannon-Weiner index varied from 1.44 - 3.16 among the lakes.

Saprobic index analysis was performed to establish the role and significance of the activity of zooplankton in creating a biocenotic balance. Eutrophication has a considerable impact on zooplankton species composition and abundance.

Table 4.3.1 Geographical location, surface, maximum depth, number of species and diversity index (mean 2009-2013)

No	Name	Kind of site	Geographical location	Surface open water (km2)	Depth (m)	Number of species	Shannon-Weaver (H')	Pantle & Buck	Degree of pollution
1	Isac	shallow lake	45^0 08' N - 29^0 17'E	10.20	2.40	116	1.79	2.05	good
2	Merhei	shallow lake	45^0 19' N - 29^0 26'E	13.68	1.71	53	1.48	2.09	good
3	Rosu	shallow lake	45^0 03' N - 29^0 35'E	13.65	3.78	76	2.32	1.97	good
4	Furtuna	shallow lake	45^0 12' N - 29^0 07'E	7.79	2.42	39	1.79	1.83	good
5	Ceatal Sf. Gheorghe	river branch	45^0 11' N - 28^0 52'E		26	17	2.64	3.74	bad
6	Sf. Gheorghe	river branch	44^0 52' N - 29^0 45'E		26	19	2.90	3.28	poor
7	Ceatal Chilia	river branch	45^0 13' N - 28^0 44'E		39	25	3.027	1.97	good
8	Sulina	river branch	45^0 09' N - 29^0 36'E		3	39	3.16	2.15	good
9	Periprava	chanel	45^0 24' N - 29^0 32'E		3	9	1.44	2.37	moderat

Zooplankton species, especially rotifers, has an apparent indicator value for lakes (Gannon and Stemberger 1978). Rotifers have the highest intrinsec rates of natural increase among the major zooplankton groups.

Zooplankton: phytoplankton ratio is an indicator of zooplankton grazing (**Figure 4.3.1**). During 2009-2013, when was found very low ratio, perhaps the suspended sediment particles who reduce the reaction distance for visual planktivorous fishes regulates this status.

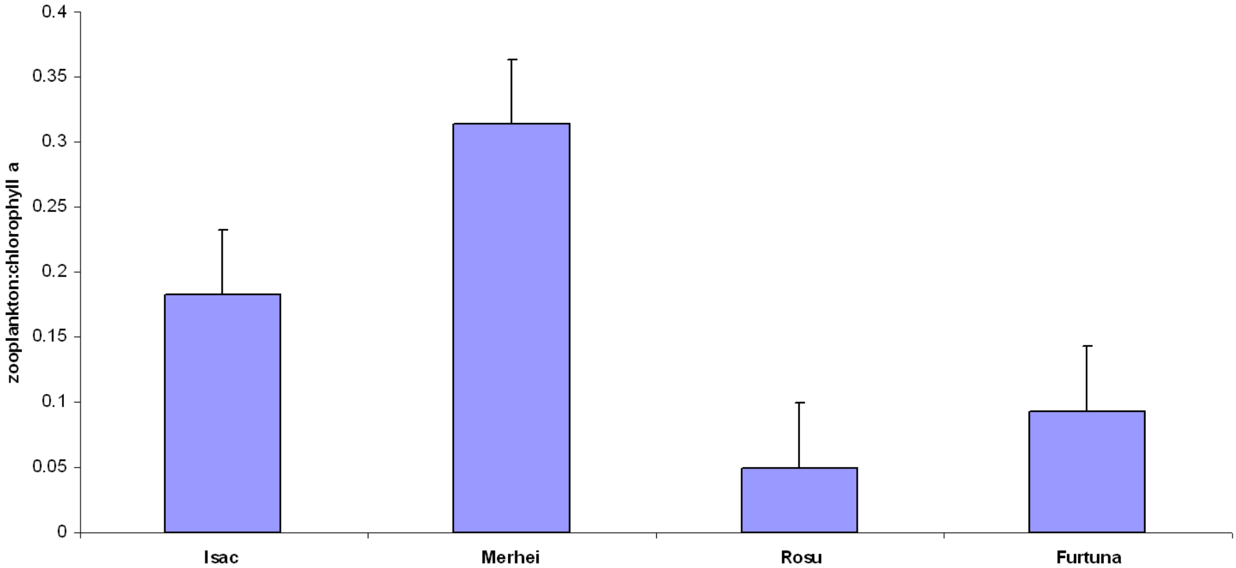

Figure 4.3.1 Ratio of zooplankton to phytoplankton biomass (Zpk:Chl *a*) in the four shallow Delta lakes

The changes in the zooplankton community structure and biomass appeared to cascade down the phytoplankton.

4.4 Macroinvertebrates

Directive 2000/60/EC, commonly known as the Water Framework Directive (WFD) has initiated a change in both the concept of water quality and its assessment throughout Europe.

Annex V of the (WFD) lists three main parameters of the macroinvertebrate community to be focused on for ecological assessment: diversity, taxonomic composition and abundance. Restoration from moderate to at least good status is required when these parameters differ from type specific reference conditions to an extent coincident with the absence of major taxonomic groups. These parameters are not exclusive and others may be included to achieve the overall aim of an ecological status designation of the WFD as an “expression of the quality of the structure and functioning of aquatic ecosystems” (WFD, Article 2).

Despite their key role in aquatic ecosystems, macroinvertebrates are a neglected element in the development of an assessment system in lakes. Factors that may be largely responsible for this include their complex biotic structure, high temporal variability and the high substrate heterogeneity found in lakes. A solution needs to be found to understand natural variability so that anthropogenic impact may be identified and extracted from other sources of variation.

Nutrient enrichment is the most widespread pressure affecting European lakes. It is a significant challenge for the implementation of the WFD, for understanding of natural distribution patterns of littoral invertebrates, which needs reliable determination of reference conditions and response to increased nutrients for littoral invertebrates. The limited investigations of littoral macroinvertebrate distribution and response to anthropogenic pressures (e.g. Tolonen et al. 2001, Brodersen et al. 1998, Willén et al. 1997, White and Irvine 2003) in lakes is in marked contrast to their extensive use as indicators of water quality for rivers.

One of the biological indicators of water quality is saprobic index. This system is based on the observation that there are different degrees of water pollution with organic substances and also in the cleaned waters plant and animal species that inhabit these one are different. Their presence is conditioned by the quality and the quantity of food, by some physical-chemical properties of water, especially the amount of oxygen dissolved in water and the quantity produced by the decomposition of organic matter. The presence of certain species in very polluted areas is explained by their tolerance to these environmental conditions and the presence of others only in areas with clean water is explained by their sensitivity. **Table 4.4.1** shows the values of the saprobic index, for 5 quality classes or for the ecological status determined by the quality classes in Romanian legislation.

Table 4.4.1 Saprobic index values for the 5 quality classes, respectively ecological status determined by the quality classes (Order 161/2006)

Saprobic index	WFD class	Ecological status (Colour codes)
1 - <1.8	I	Very Good (Blue)
1.8 - <2.3	II	Good (Green)
2.3 - <2.7	III	Moderate (Yellow)
2.7 – 3.2	IV	Poor (Orange)
>3.2	V	Bad (Red)

There is a tendency of improvement of water quality in Danube delta. In the last 2 years only one lake is in moderate condition others being classified as good ecological status. (**Table 4.4.2**).

Table 4.4.2 Saprobic index values (Pantle Buck) during 2009-2013 in analyzed lakes

	2009	2010	2011	2012	2013
Fortuna	2.5	2.5	2.3	2.2	2.2
Isac	2.6	2.3	2.3	2.4	2.4
Rosu	2.3	2.2	2.3	2.0	2.1
Merhei	2.0	2.3	2.3	2.1	2.0

Only in 2011 all lakes fall in the same category – moderate. The ecological status has improved in all but one lake (Isac) which remains in moderate class for all 5 years investigated.

Another parameter used in assessing water quality is Shannon diversity index. There are no threshold limits between quality classes using this indicator for Romanian water bodies. It calculates the average degree of uncertainty in predicting which species an individual would be if that individual were picked at random from the community. This uncertainty increases as the number of species in a community increases and as the individuals in a community are distributed more evenly among the species in a community (i.e. as each species in a community comes closer to having the same number of individuals). The Shannon index varies from values of 0 for communities with one species, to various other values for other species mixes **(Table 4.4.3**).

There is no correlation between saprobic index values (quality classes) and diversity. As it can be observed, the highest values of the diversity was obtained in Fortuna lake in 2011 but in that year the lake was classified to moderate state by saprobic index. In the same lake we recorded the same value of the diversity index (2.92) in 2013 and 2010 respectively. If we are looking at the saprobic index values we can observe that the lake is assessed as good in 2013 and moderate in 2010.

Table 4.4.3 Diversity index (Shannon) during 2009-2013 in analyzed lakes

Lake/Year	2009	2010	2011	2012	2013
Fortuna	2.81	2.92	3.11	2.39	2.92
Isac	2.77	2.78	2.83	2.84	2.91
Rosu	2.30	2.58	2.70	1.74	2.04
Merhei	2.47	2.98	2.36	2.38	2.50

4.5 Macrophytes

According to the Water Framework Directive (WFD; European Union 2000) the member states of the European Union are obliged to assess and report on the ecological status of all water bodies. This status shall be determined by the biological quality elements such as macrophytes. This group species can be recorded relatively easily in the field, and their determination is normally not time consuming or expensive (Schaumburg et al., 2004). The taxonomic composition and abundance of the taxa have to be determined, and five classes of ecological status (high, good, moderate, poor, bad) have to be defined following normative definitions in the WFD. In order to assess the ecological status of the studied water bodies, based on macrophytes and in accordance with Water Framework Directive it was initiated an overview of the relationship between the trophic macrophyte Schaumburg (2004) and the abundance indices Kohler (1978).

The trophic index (RI) is an expression of the abundance of type-specific sensitive taxa compared to the abundance of tolerant taxa, and is therefore a tool for estimating the deviation of observed macrophyte communities from reference communities, as follows:

$$RI = \frac{\sum_{i=1}^{n_A} Q_{Ai} - \sum_{i=1}^{n_C} Q_{ci}}{\sum_{i=1}^{n_g} Q_{gi}} \times 100$$

where: RI = reference index; Q_{Ai} = quantity of the *i*-th taxon from species group A; Q_{Ci} = quantity of the *i*-th taxon from species group C; Q_{gi} = quantity of the *i*-th taxon of all groups (A, B, C); n_A = total species number of taxa from species group A; n_C = total species number of taxa from species group C; n_g = total species number of taxa from all groups (A, B, C).

For macrophyte data, relationship between the five degrees of estimation and the actual quantity of the submerged macrophytes can be described best by a function $y = x^3$ (Melzer 1988, Kohler and Janauer 1997). Therefore the ordinal values of the five-point Kohler-scale were x^3-transformed into quantitative values (Schaumburg et al., 2004) (**Table 4.5.1**).

Table 4.5.1 Five scale trophic macrophyte index, WFD classes and ecological status

Trophic macrophyte index		Kohler scale*		WFD class	Ecological status Colour codes)
A	C	A	C		
100 to 75	-1 to -15	5	1	I	Very Good (Blue)
75 to 50	-15 to -25	4	2	II	Good (Green)
50 to 25	-25 to -50	3	3	III	Moderate (Yellow)
25 to 15	-50 to -75	2	4	IV	Poor (Orange)
15 to 1	-75 to -100	1	5	V	Bad (Red)

* Kohler scale A (1=<1-15%;2=15-25%;3=25=50%;4=50-75%;5=75-100%)

For the 2009 – 2013 period were calculated the mean values of macrophyte trophic index and species abundance (quantitative index) in order to classify the lake by the biological quality element, macrophyte species. The resulting index values range from + 100 (only species group A taxa) to – 100 (only species group C taxa) (**Table 4.5.2**).

Table 4.5.2 Lake classification based on of macrophyte trophic index (Schaumburg) values during 2009-2013

Lake name	2009	2010	2011	2012	2013
Furtuna	-62.34	-57.14	-55.84	-43.33	-53.25
Isac	-12.70	-9.79	-13.23	-11.90	-11.11
Merhei	-25.93	-25.10	-23.46	-25.93	-23.87
Rosu	-27.27	-30.30	-50.00	-25.76	-27.27

For the 2009 – 2013 period was calculated the mean values of macrophyte trophic index and transparency in order to test relationship between the two variables. We assumed a non-linear relationship between macrophyte trophic index (RI) and water transparency (measured as Secchi depth). On the basis of available data the model that most appropriately describes the relation between RI and transparency is represented by a second order polynomial regression (~36% of the variability of RI is explained by the model) (**Figure 4.4.1**).

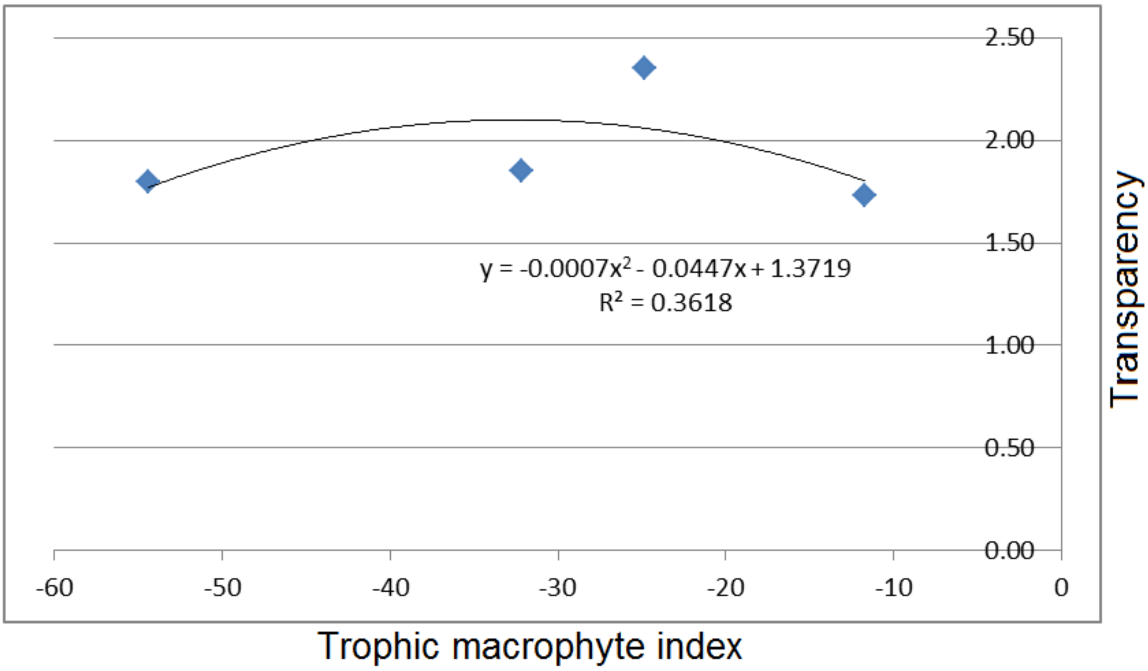

Figure 4.4.1 Relationship of mean trophic macrophyte index and mean transparency of the lakes

According to Candfield *et al*. (1985) different species of aquatic macrophytes have various light requirements, therefore the canopy of *Ceratophyllum demersum* it will develop in less light compensation point than *Potamogeton trichoides* canopy, for example. The relation tends to overestimate the macrophyte development primarily by light – water transparency and can be used only for predictive models along with other chemical parameters. Furtuna and Roșu Lakes have the highest abundance of C taxa and no presence of A taxa. Merhei Lake has moderate C taxa abundance and low A taxa presence. As for the Isac Lake the A taxa is frequently found and C taxa are scarce.

In general, the macrophytes biomass increased with increasing water transparency and decreasing with lake depth. Macrophyte response to lakes disturbance allows them to be used as indicators. In order to assess of the quality elements, transparency and trophic index are laid down specifically for each studied lake.

The species group A and C taxa in investigated lakes show a moderate degree of natural variability. Therefore, no significant change in taxonomic composition and transparency is evident with increasing degradation of lake sites during 2009 - 2013.

In contrast, the species group C taxa indicate a poor quality ecological status, in all years. Aquatic plant communities respond to degradation with changes in taxonomic composition, as well as an increase or decrease of plant abundance (Kohler 1975). The transparency plays an important role in macrophyte canopy development. These features make them very suitable indicators for the purposes of the WFD ecological status classification.

The group species (A , and C) in some cases (Furtuna, Isac and Roșu lakes in 2011 and 2012) show a moderate degree of natural variability. The difference between the Furtuna Lake and the other studied ones can be explained by the strong siltation process that occurs in the lake and has the tendency to separate the water body. The water circulation is done mainly by crossing the middle of the lake and according to macrophyte trophic index (mean -54.38) the lake Fortuna have a poor ecological status with very high C taxa abundance. *Myriophylletum spicati* and *Ceratophylletum demersi* are the association found in the lakes. They usually occur in lakes with low water transparency, which limits growth and eliminates their competitive pressure. The relationship between Secchi-disc transparency and colonization of macrophytes has not been quantified for a large number of lakes. The maximum depth, to which aquatic macrophytes can colonize, however, is determined to a large degree by water transparency.

Scarcity of macrophytes (A taxa) can occur as a result of anthropogenic influences, but can also be due to turbidity or other natural processes (Strand and Weisner 1996). Therefore, the absence or scarcity of sensitive macrophytes in the lakes cannot be interpreted as degradation if the tolerant species (C taxa) remain constant. An indication of the ecological status by macrophytes requires certain minimum species richness. The trophic index for macrophytes can describe the deviation of the observed macrophyte composition from reference conditions and can indicate a certain hydro-morphologic pressure (Hanganu and Doroftei, 2008).

4.6 Fish

Ecological lake classification matrix using WFD 5 classes versus 2 parameters (abundance - CPUE and Biomass – BPUE, expressed as Catch per Unit Effort – number or biomass of fish on 100m gillnets-night) and 2 diversity indexes (Shannon-Wiener and Equitability) (**Table 4.6.1**).

Actually, there is no yet developed threshold limits between for those 5 WFD quality classes using these indicators. The Shannon-Wiener index varies from values of 0 for communities with one species, to various other values for more species mixes. The Equitability index ranges between 0 and 1. Class limits was proposed by author based on field experience and expert judgment, thresholds were not validate.

Table 4.6.1 Ecological matrix class based on fish parameters/indicators

Statuts	Class	CPUE	BPUE	H	E
Bad	**I**	**<25**	**<500**	**<1**	**<0.3**
Poor	**II**	**25-100**	**500-2000**	**1 - 1.4**	**0.3-0.5**
Moderate	**III**	**100-200**	**2000-5000**	**1.4 - 1.8**	**0.5-0.6**
Good	**IV**	**200-600**	**5000-10000**	**1.8 - 2.2**	**0.6-0.8**
Very Good	**V**	**>600**	**>10000**	**>2.2**	**>0.8**

Consolidate classification for several years was made after principle the lowest class indicator gives the class quality of lake (on out all out – WFD principle).

Study lake were ranked between Good and Poor classes with moderate in between (**Table 4.6.2**).

Table 4.6.2 Lake ecological classification matrix using fish data indicators (WFD classes: high=blue, good=green, moderate=yellow, poor=orange, bad=red; white=no data)

	An	2010	2011	2012	2013
Furtuna	CPUE	40			282
	BPUE	829			4571
	H	1.23			1.799
	E	0.51			0.62
Isac	CPUE	295			92
	BPUE	6713			5242
	H	1.76			1.83
	E	0.59			0.74
Merhei	CPUE		294		45
	BPUE		6745		2994
	H		1.94		2.02
	E		0.60		0.77
Rosu	CPUE		437	116	
	BPUE		10732	6188	
	H		2.018	1.842	
	E		0.635	0.680	

	2010	2011	2012	2013

Furtuna	CPUE=40			BPUE=4571
Isac	H=1.76			CPUE=92
Merhei		CPUE=294		CPUE=45
Rosu		CPUE=437	CPUE=115	

Ecological quality differs between lakes and years for same lake, difficult to be explained, since samplings were in June, August, September and October when water level and temperature differ.

Even, it was published several studies of fish biomass relationship and status of trophic lake using Total Phosphorous and/or Chlorophil a in Nordic lakes (Jepesen *et al*. 2000) that ranks from oligotrophic to eutrophic, this relationship was not proved in Danube delta lakes, which are all eutrophic waters. Other studied relationship was between Fish Yield Potential and Phytoplankton Primary Production, which relate with Total Phosphorous in German lakes (Brämik and Lemcke 2003), relationship which changes from exponential to logarithmic function.

PCA analysis described a trophic gradient of Danube delta lakes using comprehensive data sets on hydrology, chemistry, vegetation, phytoplankton and fish (Oösterberg *et. al* 2000).

Although, the impact of nutrient pressure on biological quality is relatively well understood for lake in qualitative terms, there has been very limited development of quantitative dose-response relationship between physic-chemical measures of eutrophication and associate biological responses (Carvalho *et al*. 2006). This can be split into two types of relationships: 1) primary responses (phytoplancton, phytobentos and macrophytes) to nutrient state, and 2) secondary responses to primary production or production-related decrease in transparency and oxygen.

Fish biomass is sensitive to nutrient-related primary production, but limited data is available. Fish species richness, biodiversity and trophic structure are linked to a trophic gradient of Total Phosphorous on Nordic lakes (TP) (Jepesen *et al*. 2000).

Conclusions

Water Quality Index (WQI) is a very useful and efficient method for assessing the suitability of water quality, a dimensionless number that combines multiple water-quality factors (28 chemical indicators) into a single term (very good, good, moderate, bad, very bad), by normalizing values to subjective rating curves: general physical-chemical quality elements, nutrients metals.

Cadmium concentrations have an essential role in determining the quality class, according to Water Quality Index. All nine water bodies (2009-2013) have very bad quality (with cadmium concentrations) and very good quality (without cadmium concentrations).

For sediments, single indices are used to calculate only one metal contamination, and integrated indices are indicators used to calculate more than one metal contamination. Potential ecological risk index (RI) is a degree of contamination with heavy metals (arsenic, cadmium, chromium, lead, nickel, mercury, manganese, zinc, copper).

In general, zinc, copper, lead, arsenic, chromium, cadmium present a low ecological risk for sediments sampled between 2009-2013 in Isac, Fortuna, Merhei, Rosu lakes (except cadmium in different points).

Taking into account potential ecological risk values, between 2009 – 2013, all lakes sediments have low ecological risk, except Fortuna in 2009 (moderate ecological risk).

Plankton indicates that studied lakes have features typical of shallow lakes with good status correlation between saprobic index (Pantle&Buck) values and diversity.
Shannon diversity Index values for zooplankton ranging from 1.44 to 3.02, confirm that aquatic system investigated is good to moderate ecological status for all the analyzed period.

The analysis of saprobic index values for **macroinvertebrates** concludes towards a tendency of improvement of water quality;
Lake Isac is the only site remaining moderate (as water quality status) for all the analyzed period. Other lakes show an improvement in the last two years;
There in no correlation between saprobic index values and Shannon diversity index values for macroinvertebrate data.

The trophic macrophyte index is a tool for describing the deviation of the observed macrophyte community from reference conditions by means of the quantitative index Kohler. This index should be used in ecological classification of waters. Therefore, the hydro-morphological pressures that affect the taxonomic composition and abundance of macrophytes (A of C taxa) need to be identified. More relationships of macrophyte and physic-chemical parameters should be tested.

Delta studied lakes are ranked using fish parameters from good to poor WFD classes, with moderate in between, based on exercises, but no methods were accepted and/or validated yet.

In relationship study for ecological water quality estimation, the availability of indicators and classification metrics is not only restricted by data, but also the limited research efforts to develop regional-wide inter-calibrate bio-indicators for all ecological quality elements required to be assessed.

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