THE MONITORING OF SURFACE WATER BODIES (RIVERS) FROM TISA CATCHMENT AREA - MARAMUREŞ COUNTY IN 2014

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ABSTRACT. – The Monitoring of Surface Water Bodies (Rivers) from Tisa Catchment Area - Maramureş County in 2014. This study is focused on the monitoring and evaluation of river's water bodies from Maramureş County, using the methodology associated with the EU Water Framework Directive 60/2000. Thus, in the first part are defined the theoretical terms of monitoring activities related to the water bodies' quality and the specific features of those we can find in the studied area. There are presented the water bodies' features, quality indicators and the monitoring frequencies for the rivers situated in the Tisa catchment area. The results have shown the actual ecological and chemical state of those water bodies, in relation with the standard values mentioned through the Water Framework Directive.

Keywords: monitoring, surveillance, water bodies, quality

1. WATER BODIES MONITORING - INTRODUCTION

In Romania, the monitoring programs of water bodies became operational since 2006, according to the Water Framework Directive 2000/60/EU. Thus, the National System of Water Integrated Monitoring comprises the following six sub-systems: rivers, lakes, transitional waters, coastal waters, groundwater, wastewater (control monitoring of wastewater discharged into natural receivers).

A body of surface water means a discrete and significant element of surface waters: river, lake, canal, river sector, sector channel, transitional waters, or part of coastal waters (www.rowater.ro). The monitoring programs of surface waters in the county of Maramureş includes three features: surveillance program, the operational program and investigation program. Alongside these monitoring program, for the body of Tisa River, there is a joint monitoring Romania-Ukraine, according with international conventions and in accordance with EIONET-Water (European Environment Information and Observation Network).

The surveillance monitoring activities are oriented for assessing the status of all waters within each river basin or sub-basin, providing information on: the validation procedure for impact assessment, efficient design of future monitoring programs, evaluation of long-term changes on the impacts of human activities on watercourses (Mihăiescu R., 2014).

The operational monitoring is carried out on the bodies of water that are not likely to achieve the environmental objectives and also on assessing any changes in the status of these water bodies.

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2. THE MONITORED WATER BODIES FROM TISA CATCHMENT AREA, MARAMUREŞ COUNTY

In Maramureş County, the rivers of Tisa basin are divided into eight water bodies, totaling about 828 km, with 16 monitoring sections (Table 1), at which monitoring activities are carried out on the surveillance program – MS and operational monitoring program – MO.

Table 1. ***Water bodies of Tisa catchment area, in Maramureş County***

No.	Water body name / monitoring program	Length (km)	Monitoring sections
1	Tisa / MO	61	Valea Vişeului – country entrance point Teceu - country exit point
2	Vişeu-spring- Vaser confluence/ MO	234	Vişeu at Poiana Borşa, Vişeu at Moisei Vaser – upstream Vişeu confluence
3	Vişeu- Vaser confluence-Tisa confluence/ MO	41	Vişeu at Bistra Bocicoiel upstream of Bocicoiel village
4	Cisla and tributaries/ MO	26	Cisla upstream of Baia Borşa, Cisla downstreamof Baia Borşa water supply source for SUP Borşa on Balasîna water supply source for SUP Borşa on Cislioara
5	Ruscova and tributaries / MS	137	Ruscova upstream Vişeu confluence Valea Bilei, water supply source Ruscova
6	Iza- spring- Valea Morii confluence and tributaries / MS	174	Iza at Săcel
7	Iza- Valea Morii confluence-Tisa confluence/ MS	29	Iza at Vadu Izei
8	Mara and tributaries / MS	126	Mara-Vadu Izei
9	**Total**	**828**	**16 monitoring sections**

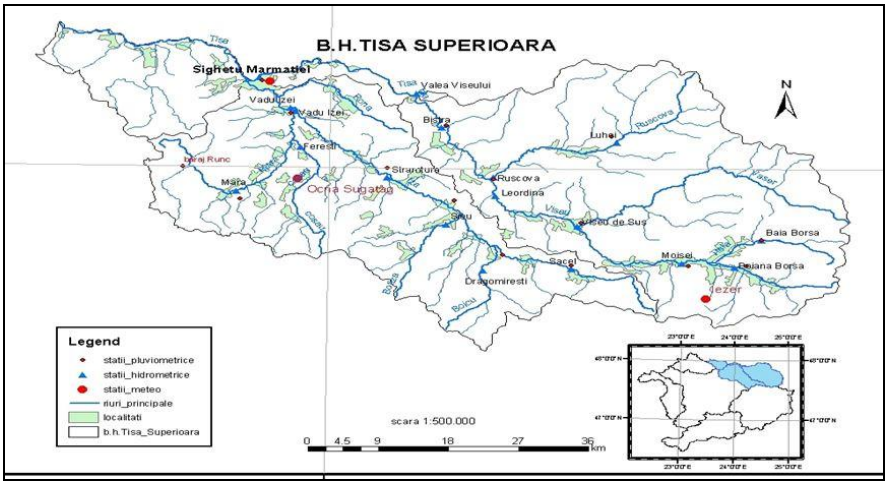

Fig. 1. ***Tisa catchment area in the Maramureş County (Nacu S., 2009)***

3. EVALUATION METHODOLOGY FOR SURFACE WATER BODIES QUALITY

Quality assessment of surface water bodies in Maramureş was carried out under the Water Law no.107 / 1996, as amended and supplemented, and using classification systems and methodology for comprehensive assessment of the surface waters status on the biological, chemical and hydro-meteorological basis developed by INCDPM Bucharest.

Table 2. ***Elements, indicators and monitoring frequencies for water bodies***

Quality elements		Indicators	Frequency	
			SP	OP
Biological elements	Phytoplankton	Taxonomic composition	2/yr	3/yr
	Micro-phytobenthos	Taxonomic composition	2/yr	3/yr
	Macrophytes	Taxonomic composition	1/3 yr	1/3 yr
	Zoo-benthos	Taxonomic composition	2/yr	3/yr
	Fish fauna	Taxonomic composition	1/3 yr	1/3 yr
Physico-chemical elements	Transparency	Materials in suspension, turbidity, color	6/yr	6/12/yr
	Thermic conditions	Temperature	6/yr	6/12/yr
	Oxygenation conditions	Dissolved oxygen, COD_{-Mn}, COD_{-Cr}, BOD_5, TOC, OD	6/yr	6/12/yr
	Salinity	Conductivity/ TDS	6/yr	6/12/yr
	Acidification status	pH, alkalinity	6/yr	6/12/yr
	Nutrients	Nitrites, nitrates, ammonium, Total Azote, Orthophosphate, Total Phosphorus, Chlorophyll „A”	6/yr	6/12/yr
	Nutrients (materials is suspension)	Total Azote, Total Phosphorus	6/yr	6/yr
	Water priority substances	Annex 10 WFD	12/yr	12/yr
	Priority substances (materials in suspension)	Heavy metals: Cd, Ni, Pb, Hg	6/yr	6/yr
	Priority substances (sediments)	Heavy metals and organic micro-pollutants relevant for sediments	1/yr	1/yr
	Priority substances (biota)	Heavy metals and organic micro-pollutants relevant for biota		1/yr
	Specific non-priority pollutants	Annex 8 and 9 WFD	6/yr	6/yr
	Specific non-priority pollutants (materials in suspension)	Other heavy metals list II	6/yr	6/yr
	Specific non-priority pollutants (sediments)	List I and II substances relevant for sediments	1/yr	1/yr
	Specific non-priority pollutants (biota)	List I and II substances relevant for biota		1/yr
	Other pollutants	Substances not included in Appendix 8.9 and 10	6/yr	6/yr
Microbiolo-gical elements	Bacteriological parameters	Total coliforms, faecal coliforms, faecal streptococci, Salmonella	4-12/yr	4-12/yr

SP – Surveillance program, OP – Operational program

The assessment of ecological status/ecological potential of surface water bodies is achieved by integrating quality elements (biological, chemical-physical

support, specific pollutants). Ecological status/ecological potential take into account the principle of "one out all out" and the worst situation recorded. The quality elements monitored, parameters and monitoring frequencies applied in the monitoring programs used on Tisa catchment area, in Maramureş County are presented in Table 2.

4. RESULTS AND DISSCUSIONS

Water sampling and analysis was performed by SGA Laboratory Maramureş in Baia Mare and by the Water Basin Administration Laboratory Someş-Tisa in Cluj-Napoca. The results obtained for the water bodies included in the operational monitoring program on the quality elements, that defines the ecological and chemical status are listed in Table 3.

Table 3. ***Water bodies assessment on the quality elements basis - I***

Quality elements	Tisa water body	Vişeu-spring-Vaser confluence water body	Vişeu- Vaser confluence- Tisa confluence water body	Cisla and tributaries water body
Microphytobenthos	v. good	v. good	v. good	v. good
Zoobenthos	v. good	good	v. good	v. good
Fish Fauna	v. good	-	-	-
Thermic conditions	v. good	v. good	v. good	v. good
Oxygenation conditions	good	moderate	moderate	moderate
Salinity	good	good	good	good
Acidification status	v. good	v. good	v. good	v. good
Nutrients	good	moderate	good	good
Specific pollutants	good	good	good	-
Organic substances	good	-	good	good
Metals	good	good	good	bad

On ***Tisa water body***, ichthyofauna inventory in both sections, led to a very good status (MI = 0.8). Zoobenthos monitoring status, indicated the presence of a biocoenosis well-structured, diversified, where the predominating species, prefer well-oxygenated waters. Over 70% of species found were reofile, which indicates a very good state of the water body. Oligochaetes species, that usually tolerates waters with organic load, where absent on the monitoring evaluation. Biocoenosis structure in terms of phyto-benthos, was well structured, with the diversity indices falling within very good condition (ID = 2.64-very good).

All phyto-benthos parameters features were framed within very good condition. General physico-chemical parameters monitored during 2014 indicates a very good condition considering the specific indicators groups: thermal conditions, acidification status and a good standing defined by the following indicators: oxygenation conditions, nutrients and salinity conditions.

The water body assessing state, after the general physico-chemical elements, indicates a classification associated with good condition. Evaluating the ecological state elements, by taking into account the biological and physico-chemical elements, lead to its inclusion, in general good ecological status. Assessing chemical status, in

terms of hazardous substances, both in terms of synthetic (organic) and non-synthetic (metals) were classified in good chemical status.

For the ***Vişeu-spring – Vaser-confluence and tributaries water body***, biological elements status assessment was based on the analysis of phyto-benthos and zoo-benthos. Zoo-benthos condition was good (MI = 0.71) while the phyto-benthos condition was very good (MI = 0.84), which led to a good state for biological elements. General physico-chemical state assessment indicated: a very good value for thermic conditions and acidification status; a good state for salinity; a moderate state for oxygenation conditions (dissolved oxygen = 7.44 mg/l) and nutrients (NH^{4+} = 0.336 mg/l), which led to a moderate level state for the analyzed water body. The monitored chemical indicators associated with specific pollutants and metals were classified in good condition, resulting in a good chemical status of the water body.

Regarding the ***Vişeu-Vaser confluence – Tisa-confluence water body***, zoo-benthos condition was defined as very good (MI = 0.75). Also, a very good condition for phyto-benthos (MI = 0.91), led to the classification of biological elements into a good condition state. General physico-chemical state assessment have shown: a very good state for the thermic conditions and acidification status indicators; a good state for salinity and nutrients; a moderate state for oxygenation conditions (dissolved oxygen = 7.06 mg/l), which led the water body condition as moderate. The ecological status is good, being given by the status of biological elements, decisive for the final classification of the water body. The monitored chemical indicators associated with specific pollutants, metals and organic substances were classified in good condition, resulting in a good chemical status of the water body.

The results obtained for ***Cisla water body*** revealed that the biocoenosis of this body of water are affected by discharges of mine waters, which ussualy are untreated or insufficiently treated by Borşa Mining Company. The monitoring section located upstream of Baia Borşa is affected by the mining history of the area, limiting the installation of a specific mountain area biocoenosis. It was observed the presence of a poorly diversified communities, dominated by reobionte bodies and those of taxonomic groups. The status of the zoo-benthos, in the upstream section of Baia Borşa was very good (MI = 0.85). For the downstream section of Baia Borşa, in the month of May, the evaluation has defined that the biocoenosis was poorly represented, with 10 organisms/m^2, while in August was obtained the maximum density of 54 organisms/m^2. The status of the phyto-benthos for Cisla and tributaries water body was very good, which led to a similar general level for the status of biological elements.

General physico-chemical state assessment indicated a very good status for thermic conditions and acidification indicators; a good state for salinity and nutrients indicators; a moderate state for oxygenation conditions (dissolved oxygen = 7.2 mg/l), which led to a moderate condition for this water body. The ecological status was good, being given by the status of biological elements, decisive for the final classification of the water body. The monitored chemical indicators associated with specific pollutants and organic substances were classified in poor chemical status for this water body. This is the result of a high value for Cadmium (5.596 mg/l).

The results for the water bodies included in the surveillance monitoring program, on the quality elements that are defining the ecological and chemical status are listed in Table. 4.

Table 4. ***Water bodies assessment on the quality elements basis - II***

Quality elements	Ruscova water body	Iza-spring –Valea Morii confluence water body	Iza-Valea Morii confluence – Tisa-confluence water body	Mara and tributaries water body
Microphytobenthos	v. good	v. good	v. good	v. good
Zoobenthos	v. good	v. good	good	good
Fish Fauna	-	v. good	good	-
Thermic conditions	v. good	v. good	v. good	v. good
Oxygenation conditions	moderate	moderate	moderate	moderate
Salinity	good	good	good	good
Acidification status	v. good	v. good	v. good	v. good
Nutrients	good	moderate	moderate	moderate
Specific pollutants	-	good	-	-
Organic substances	-	-	-	-
Metals	good	good	good	good

Thus, for ***Ruscova and tributaries water body***, zoo-benthos condition was very good (MI = 0.76), benthic community was well represented, being made up of reophile species, specific to the mountain area and sensitive to human impact. Phyto-benthos was composed entirely of diatoms species, which led to a very good condition (MI = 0.86), by biological elements to this water body. General physico-chemical state assessment indicated a very good status for thermic conditions and acidification indicators; a good state for salinity and nutrients indicators; a moderate state for oxygenation conditions (dissolved oxygen = 7.659 mg/l), which led the water body condition as moderate. Ecological status is good, being given by the status of biological elements, decisive for the final classification of the water body. The monitored chemical indicators associated with specific pollutants, metals and organic substances were classified in good condition, resulting in a good chemical status of the water body.

The results obtained for ***Iza-spring – Valea Morii-confluence water body*** define favorable values for zoo-benthos status, which was very good (MI = 0.82); benthic community was well represented, being made up of clean water-loving species, well-oxygenated, specific to the mountain area. Phyto-benthos was composed entirely of species of diatoms, which led to a very good condition (MI = 0.83). Ichthyofauna inventory led to the identification of salmonid species characteristic of the area, very sensitive to the environmental conditions like: indigenous trout (Salmo trutta fario), European bullhead (Cottus gobio), minnow (Phoxinus phoxinus) “cicar” (Uudontomyzon Danford) - migratory species, loach (Barbatula barbatula).

According to the evaluation methodology, ichthyofauna condition was very good (MI = 0.82), which led to a very good condition after the biological elements for this water body. General physico-chemical state assessment indicated a very good status for thermic conditions and acidification indicators; a good salinity

indicator; a moderate state for oxygenation conditions (dissolved oxygen = 7.642 mg/l) and nutrients (NH^{4+} = 0.323 mg/l), which led the water body condition as moderate. Ecological status is good, being given by the status of biological elements, decisive for the final classification of the water body. The monitored chemical indicators associated with specific pollutants and metals were classified in good condition, resulting in a good chemical status of the water body.

Regarding the ***Iza-Valea Morii confluence – Tisa-confluence water body***, zoo-benthos condition was good (MI = 0.66); benthic community was made up mainly of oligo-beta saprophobe bodies, while the oligochaetes species were absent in both monitoring campaigns. Phyto-benthos was composed entirely of species of diatoms, which led to a very good condition (MI = 0.87).

Ichthyofauna inventory had led to the identification of several species, characteristic for the intermountain region as: "moioagă" (Barbus petenyi), barbel (Barbus barbus) – migratory species, chub (Leuciscus cephalus), skipjack chub (Leuciscus souffle), "beldiţă" (Alburnoides bipunctatus), "dunăriţă" (Sabanejewia aurata) loach (barbatula barbatula), "boarţă" (Rhodeus siriceus), bleak (Alburnus Alburnus) and common gudgeon (Gobio gobio).

According to the evaluation methodology, ichthyofauna condition was good (IN = 0.71), which led to a very good condition after biological elements for this water body. General physico-chemical state assessment indicated a very good status for thermic conditions and acidification indicators; a good salinity indicator; a moderate state for oxygenation conditions (dissolved oxygen = 6.965 mg/l) and nutrients (ammonium NH^{4+} = 0.323 mg/l, nitrites NO^{2-} = 0.0235 mg/l) which lead to a moderate condition of the water body. Ecological status is good, being given by the status of biological elements, decisive for the final classification of the water body.

On ***Mara River and tributaries water body***, zoo-benthos condition was good (MI = 0.69), being represented by well-oxygenated water loving species like *Ephemeroptera, Caddisflies, Plecoptera*. The maximum value of the index was reached in August: 67.85% - a good state, while for the reophile species a value of 86.58% -a very good state. Phyto-benthos was composed entirely of species of diatoms, which led to a good condition (MI = 0.83). General physico-chemical state assessment indicated a very good status for thermic conditions and acidification indicators; a good salinity indicator; a moderate state for oxygenation conditions (dissolved oxygen = 6.917 mg/l) and nutrients (ammonium NH^{4+} = 0.434 mg/l) which lead to a moderate condition for the water body.

CONCLUSIONS

The water bodies from Tisa catchment area in Maramureş County, are generally characterized by favorable values regarding the biological, environmental and chemical state. A summary of these considerations is presented briefly below.

- Tisa water body has a very good biological state, a good ecological and chemical state;

- Vişeu-spring – Vaser-confluence and tributaries water body has a good biological state and a good ecological and chemical state;
- Vişeu-Vaser confluence – Tisa-confluence water body has a very good biological state, a good ecological and chemical state;
- Cisla and tributaries water body has a good biological and ecological state and a bad chemical state due to a high value for Cadmium (maximum value 5.59 µg/l). Cisla water body starts to recover from ecologically point of view because the mining activity in the area is currently stopping.
- Iza-spring-Valea Morii confluence and tributaries water body has a very good biological state, a good ecological and chemical state;
- Iza-Valea Morii-confluence – Tisa-confluence water body has a good biological, ecological and chemical state;
- Mara and tributaries water body has a good biological, ecological and chemical state;
- Ruscova and tributaries water body has a very good biological state, a good ecological and chemical state;

In the near future, limiting the elements that induce harm to aquatic environment, may lead to a generalization of the status of water bodies at levels of maximum favorable assessment, according to the terms of the Water Framework Directive.

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