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WATER QUALITY CHARACTERIZATION OF THE PRUT RIVER

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Abstract

The catchment of Prut River is located in an area with many natural and anthropogenic pressures. The various uses of water, as well as the fact that the river corresponds to the border with Moldova Republic makes the monitoring of water quality a necessity for the authorities. The monitoring of the water quality of Prut River in 2008 was carried out as a complex and necessary process in order to establish the qualitative state of the waters corp. Four sections of the river were monitored considering ecological and chemical indicators. In accordance with these results, it was adopted an efficient strategy for the protection of the water quality.

Key words: monitoring system, river, water quality

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1. Introduction

Prut River springs from the Carpathian Mountains, from the territory of Ukraine and enters Romania territory north of the Oroftiana locality after 251 km in the neighboring country. Prut River is a typical lowland river, with a wide valley, sinuous, well-fed by its mountain tributaries, with high flows

The Prut River quality monitoring system includes observation points at Oroftiana, Darabani, Radau-Prut, Stefanesti, Ungheni Prisecani, Drânceni, Bravicea, Oancea and Şivița, two observation points in weekly fast flow at Prisecani and Darabani and a daily fast flow monitored section at Ungheni Tutora (where is place the drinking water intake for Iasi).

Due to the economical development between 1960 and 1989, the water quality has decreased very much comparative with the reference state from the 50's. After 1989, the state of water quality improved due to the decline of socio - economic activities and of the appliance of economical mechanism in water field, including the "the polluters-pays" principle.

The national monitoring system includes two types of monitoring, according to the Law 310 (2004) for modifying and completing the Water Law (Law 107, 1996) Within the Water Framework Directive (EC Directive, 2000) and other EU Directives (Petraru and Gavrilescu, 2010). Hereby, a supervision monitoring is runed in order to evaluate the state of all water corps from the hydrographic basin and an operational monitoring (incorporated to the monitoring system) of all the water that present a risk of not achieving the water protection objectives (Crăciun et al., 2009; Ene and Teodosiu, 2009).

For the representative water corps were proposed monitoring sections, investigation environments and monitoring programs in order to know the state and the trends of water corp's evolution and the moment of achieving the environmental objectives (Ungureanu et al., 2010).

According to the qualitative functions of the water corps, a series of different monitoring programs were made for each section: the Monitoring Program (S), the Operational Program (P), the Investigation Program (I), the Reference Program (R), the Best Available Section Program (CBSD), the Intercalibration System (IC), the Monitoring of the Vulnerable Areas Program (ZV), the Ichthyofauna Monitoring Program, the Habitats and Species Protection Program (HS), the International Convention Program (CI) and the CAPM Program (Crăciun et al., 2009).

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The aim of this paper is to analyze the water quality status of the Prut River located in an area with many natural and anthropogenic pressures. Monitoring water quality is a priority as water is used for ensuring various uses, but also because it is a river marking the border with Moldova Republic. Another utility is represented by knowing how the pollutants evolve and interact in the river's aquatic ecosystem. Based on the knowledge of these elements it can be imagined the most appropriate solution in terms of technical and environmental goals can be produced long-term strategies and may be established effective monitoring and control techniques.

2. Investigation

According to the Romanian laws, in accordance with European Directives related to the water's field, it is compulsory to adopt measures to eliminate the waters pollution of with certain dangerous substances included in the Lists I and II of the EC Directive (1976). In Romania, this Directive was adopted as Governmental Decision 351 (GD 351, 2005). Thus, taking into consideration the risks for the aquatic ecosystem and for the human health, it asserts the monitoring of dangerous and priorities the dangerous substances in all subsystems and investigation environments (Giurma, 2000).

According to the Water Law (Law 107, 1996), modified and completed with the Law 310 (2004), the Water Framework Directive (EU Directive, 2000) and other EU Directives, for the surface running waters, the next types of investigation environments are monitored: water, biota and suspended particles. The quality of the surface waters is stated through five indicators: oxygen regime (OR), nutrients, salinity, mineralization organic and inorganic toxic substances. There are also monitored dangerous and certain dangerous substances: heavy metals (dissolved fraction and total density) and organic micropollutants.

According to this programme, samples are taken annually with a sampling frequency ranging from 6 to 12 annual samples. The variables measured include determination of basic variables (e.g. pH, conductivity, water temperature etc.), organic pollution indicators (eg. dissolved oxygen, BOD, etc.), nutrients and suspended solids. The programme also includes determination of specific ions (e.g. chloride, sulphate, calcium etc.) and heavy metals. Additionally, determination of more specific contaminants (such as organic micropollutants and radionuclide) is included in this monitoring programme.

To establish the quality state of the water (one of the five classes), the evaluation took into consideration both aspects: chemical and ecological. The categorization of the control sections on different quality classes has been done according to the MO 161 (2006) which approves the *"Normative for the classification of surface water quality in order to establish the ecological status of water corps"*. Into this grouping of the water quality, the references objectives correspond with values of the second quality class representing the national and regional levels to be accomplished during a long term strategy (Gavrilescu, 2009a, b).

In the year 2008, the monitoring of the Prut River water quality was made by following the monitoring Program (annual and monthly campaigns) and the rapid flow (daily and weekly campaigns) of the physical-chemical, biological, bacteriological indicators (Teodosiu et al., 2009).

For the follow up of the pollution indicators in the monitoring frame, there were taken specimen samples for 11 control sections. In rapid flow the monitoring of the water quality was made at one monitoring section level with daily frequency (Prut-Ungheni, daily flow) and at a section with weekly frequency: Prut-Darabani.

The study of the border River Prut was made with a bilateral collaboration with the Moldavian Republic and Ukraine in eight monitoring sections with monthly/quarterly frequency. The best available sections are: Prut-Darabani, Prut-Ungheni and Prut-Şiviţa. The analyzed environments of the investigation in 2008 were: water, suspended particles and biota. For the monitoring procedures of the Ichthyofauna it was used a reversible capture device with a continuous harmless current. Depending on the width and the depth of the river there were used two different gathering methods of the fish specimens:

- in the small rivers the specimens were fished in ford;
- in big rivers the specimens were gathered near the shores.

In the year 2008, due to the lack of special devices needed for reversible fishing, no stock-taking of the ichtyofauna has been made.

The global quality of water registered in the monitoring sections

In 2008 the evaluation of the ecological and chemical status of the water of the river Prut was done according to the MO 161 (2006) – "Normative for the classification of surface water quality in order to establish the ecological status of water corps, correlated with the results of the chemical and biological evaluation".

The ecological status is the qualitative state in terms of structure and functionality of the aquatic ecosystems of the surface waters and it's represented by common parameters obtained as a result of monitoring the physical-chemical elements and biological and hydromorfological elements, features of all the monitoring programs (Gavrilescu, 2009a).

The general framing of the ecological status was made for all the 5 groups of indicators - the oxygen regime, nutrients, salinity, mineralization, specific toxic pollutants of natural origin and other chemical important indicators with the use of weighted average for all the indicators. The global characterization of the quality, at section level, is the result of evaluating the group with most

disadvantageous state, not taking into account the conditions in which the natural background significantly exceeded the admitted limits, appreciated on analytical basis in the "control" sections. The evaluation of the chemical status of the water was established related to the concentrations of dangerous and priority dangerous substances: dissolved fraction of heavy metals and organic micro-pollutants according to the unique value established for the "quality objective" (Gavrilescu, 2009a).

The chemical state was partially/totally determined at the level of all monitoring sections after the following substances:

- metals and composites: Zinc, Copper, Lead, Chrome, Arsenic, Nickel, Silver, Barium, Boron, Cobalt, Hydrogen, Molybdenum, Selenium, Stibium, Tin, Tantalum, Titanium, Vanadium, Uranium
- organic micro-pollutants (36 parameters): solvents and organic chlorate solvents: 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene; Organochlorate pesticide: aldrin, isodrin, endrin, alaclor, lindane, p'p-DDT; PAHs: naphthalene, antracen, fenantren, fluoranten, crisen, benza antracen, Benzo (b) fluoranten, Benzo (k) fluoranten, Benzo (a) piren, Indeno (1,2,3) piren, Benzo (g,h,i) perilen; Triazinic pesticides: trifluralin, simazin, atrazin; BTEX: benzen, toluen, o-xilen, m and p xylen. SP-MO type species may be considered relevant for a section if the observed concentration value in that section is 80% of the value of the objective/standard of quality, according to GD 351 (2005), as well as the class II of quality according to the MO 161 (2006) for the other substances.

3. Results and discussion

3.1. Water and biota

The Prut River springs from the Carpathian Mountains in Ukraine and emerges on Romanian territory through a Northern locality - Oroftiana. 251 km of the total length lie within Ukrainian territory. The Prut River is a typically depression river, with a large and sinuous valley, well supplied by its mountain confluents, with high level debits.

3.2. Control sections of the Prut River

In 2008 the Prut River has been monitored with 11 monitoring sections (Fig. 1 and Fig. 2): Oroftiana, Darabani, Rădăuţi-Prut, Ştefăneşti downstream, Ungheni, Prisăcani, Drânceni, Bumbăta, Oancea, Şiviţa and Giurgiuleşti.

A section of weekly high flow supervision was Darabani and a section of daily high flow monitoring was Ungheni-Tuţora (here is the drinkable water supply for the Iasi municipality) (NARW Prut, 2008a, b, c). Below are the results of the monitoring on five sections on the Prut River in 2008: Darabani, Ştefăneşti downstream, Ungheni, Prisăcani and Drânceni.

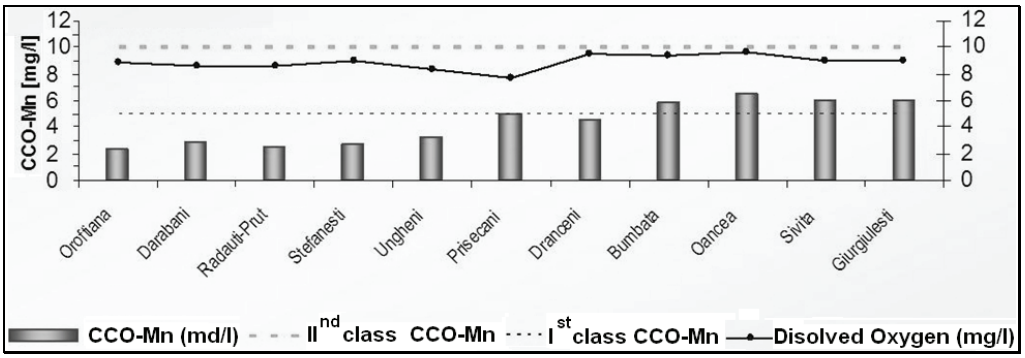

Fig. 1. Variation of the Dissolved Oxygen and CCO indicators (the Prut River - 2008)

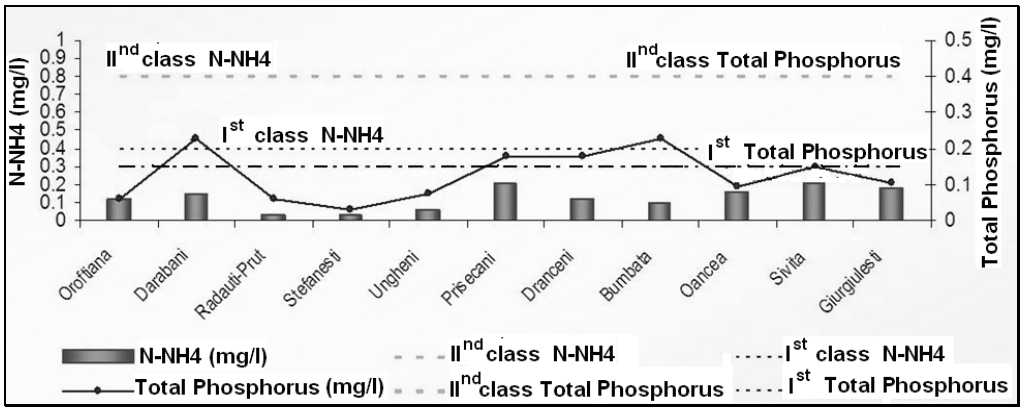

Fig. 2. Variation of the Ammonium and Phosphorus indicators (the Prut River - 2008)

3.2.1. Darabani section

The numbers of physico-chemical and biological assays depends on each type of assessments between January – December 2008 as shown in the Table 1.

Table 1. Inventory of analysis types for Prut River monitoring in Darabani section

Type of assays		*Number of assays per year*
• physico-chemical		6 or 12
• biological	- phytoplankton	3
	- zoobentos	3

For the Darabani section biological analysis has been made with a quarterly frequency both for the phytoplankton indicator and the macrozoobentos indicator.

The shores structure was made of inorganic soft material, with a variable back fall, the sediment was made of gravel, the water flow was average and the turbidity was high. The adjacent grounds were made of shrubbery.

The benthic biocenosis includes species such as: Trichoptera - *Psychomia pusilla*, *Hydropsyche angustipenis, Beraea pullata*, Odonata - *Lestes viridis, Coenagrion pulchellum, Gomphus vulgatissimus*, Heteroptera - *Ilyocoris cimicoides, Corixa punctata*, Gastropoda - *Gyraulus albus, Bithynia leachi*, Ephemeroptera - *Heptagenia sulphurea, Ecdyonurus venosus, Caenis rivulorum*, Bivalvia - *Unio pictorum* and Amphipoda - *Gammarus kischineffensis, Orchestia cavimana*. The average density of the organisms was 502 organisms/m^2, and the saprobe indicator had an average value of 2.07, therefore the Darabani section belonged to the II quality class.

The phytoplankton taxonomy was dominated by the diatom (*Synedra acus, Surirella ovata, Pinnularia viridis, Diatoma vulgare, Cymbella ventricosa, Achnanthes minutissima, Amphipleura pellucida*). The average numeric density was of 447.389 organisms/l, the saprobe indicator had an average value of 2.00 - quality class II. Globally, according to the biological evaluation, the Prut-Darabani section belonged to the quality class II.

In this monitoring area, the water of the Prut River is clean and belongs to the qualitative class II due to the oxygen regime and the nutrients.

The remaining physical and chemical indicators (Table 2) enlist the River's water in quality class I.

Table 2. Values of the average water quality indicators for Darabani section

Water quality indicator	*Value*
CBO_5 (mg/L)	3.88
CCO - Cr (mg/L)	14.13
Entire Phosphor (mg/L)	0.2299
N-NH4 (mg/L)	0.153
Rfix (mg/L)	339.4
Copper (µg/L)	18.85

The evaluation of the chemical state was realized according to the MO 161 (2006) on the established value of the qualitative standard for the description of the chemical state. Table 3 includes the exceeding indicators of weighted average (µg/L) for the Darabani section for metals and composites (dissolved fraction) and organic micropollutants. The improper chemical state of this section is due to the following indicators: Copper and Lead.

3.2.2. Ştefăneşti Downstream Section

The numbers of assays depending on each type of assessments abouth the physico-chemical and biological indicators for Ştefăneşti Downstream Section between January – December 2008 are shown in the Table 4. For the Ştefăneşti section, for the biological element the samples were taken with a quarterly frequency, in order to establish the phytoplankton and biannual in order to establish the macrozoobentos indicator.

This section is placed downstream of the Stânca-Costeşti storage lake. The structure of the shores was made of inorganic soft material, with a large back fall, the sediment was made of inorganic soft material, the water flow was high and the turbidity level was low. The adjacent grounds were made of shrubbery.

Table 3. Average values for metals and composites (dissolved fraction) and organic micropollutants for the Darabani section

Qualitative elements	*Monitoring indicators*	*Exceed indicators / weighted average (µg/L)*
Metals and composites (dissolved fraction)	Zinc, Copper, Lead, Chrome, Nickel	Lead = 3.81 Copper = 14..44
Organic micro-pollutants	lindan, endrin, aldrin, dieldrin, isodrin, alaclor, p,p' DDT, trifluralin, simazin, atrazin, antracen, naphthalene, antracen, fenantren, fluoranten, crisen, benza antracen, Benzo benz(k)fluoranten, benz(a)piren, benz(g,h,i)perilen, indeno(1,2,3)piren, 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene, benzen, pentaclorbenzen, o-xylen, (m+p) xylen	-

Table 4. Inventory of analysis types for Prut River monitoring in Ştefăneşti section

Type of assays		*Number of assays per year*
• physico-chemical		4
• biological	- phytoplankton	4
	- macrozoobentos	2

The benthic biocenosis includes species such as: Heteroptera - *Ilyocoris cimicoides, Aphelocheirus aestivalis*, Ephemeroptera - *Ecdyonurus venosus, Cloeon dipterum*, Odonata - *Aeschna grandis, Lestes sponsa*, Trichoptera - *Hydropsyche angustipennis, Psychomia pusilla*, Amphipoda - *Dikerogammarus haemobaphes*, and *Orchestia cavimana*. The density ranged between 385 organisms/m^2 and 688 organisms/m^2, the saprobe indicator had an average value of 1.95, heberby the section belonged to the quality class II.

After the biological analysis was observed that the average phytoplankton density was 398-958 organisms/l. The phytoplankton was dominated by diatom *Nitzschia acicularis, Achnanthes minutissima, Nitzschia palea, Navicula cryptocephala*. The average value of the phytoplankton saprobe indicator was of 1.89, therefore the water belongs to the IInd quality class. Globally, according to the biological evaluation, the Ştefăneşti section belonged to the quality class II. For the qualitative physical and chemical elements in this area of monitoring, the water of the Prut River is clean and belongs to the qualitative class I as a result of the majority of physical - chemical indicators.

It has to be mentioned that the qualitative determination the "phenol" indicators has been excluded because its average value exceeded the limit laboratory that was much higher than the class I limit of the quality class II (5 µg/L) due to the detection limit of the device offered by S.G.A. Botosani according to the MO 161 (2006) (1 µg/L). The values of the weighted average for Ştefăneşti Downstream Section are show in the Table 5. The evaluation of the chemical status was done according to the MO 161 (2006) on the established value of the qualitative standard for the description of the chemical state. The monitored qualitative elements of the Prut River at the Ştefăneşti Downstream Section are presented in the Table 6.

It can be seen that the improper chemical state of this section is due the exceeding indicators for Cooper of 20.15 µg/L.

Table 5. Values of the average values of water quality indicators for Ştefăneşti section

Water quality indicator	*Value*
CBO_5 (mg/L)	2.75
CCO - Mn (mg/L)	2.8
CCO - Cr (mg/L)	11.42
Entire Phosphor (mg/L)	0.0299
N-NH4 (mg/L)	0.029
Rfix (mg/L)	284.8
Chlorite (mg/L)	22.9
Sulphate (mg/L)	55.2
Cu (µg/L)	23.2
Phenol (µg/L)	8.25

3.2.3. Ungheni Section

For Ungheni Section the numbers of assays depending by the physico-chemical and biological indicators between January – December 2008 are show in the Table 7, while the majority of physical - chemical indicators in Table 8. This is the best available section and its importance is very high because it represents the checking point for the quality of raw water extracted for the use as drinking water and for industrial users from Iasi Municipality.

In order to assess the ecological state for the Ungheni section, the samples of the phytoplankton indicator were taken with a monthly frequency, while the macrozoobentos indicator with quarterly frequency. The structure of the shores is made of inorganic soft material, with a large back fall, the sediment is made of sand, the water flow was average and the turbidity level was high. The adjacent grounds lacked vegetation.

For the macrozoobentos indicator the density presented values among 139 organisms/m^2 and 348 organisms/m^2, the average density was 245 organisms/m^2. The benthic biocenosis included species such: crustacean - *Corophium curvispinum, Dikerogammarus haemobaphes*, diptera - *Orthocladius saxicola, Simulium sp., Orthocladius rivulorum*, molluscs - *Dreissena polymorpha, Theodoxus fluviatilis*. The saprobe indicator had an average value of 2.01 – the II quality class. In 2008 the phytoplankton had an average density of 216-385 organisms/L with a maximum value of 500-625 organisms/L.

Table 6. Average values for metals and composites (dissolved fraction) and organic micropollutants for the Ştefăneşti section

Qualitative elements	*Monitoring indicators*	*Exceed indicators / weighted average (µg/L)*
Metals and composites (dissolved fraction)	Chrome, Copper, Nickel, Lead, Zinc	Copper = 20.15
Organic micro-pollutants	lindan, endrin, aldrin, dieldrin, isodrin, alaclor, p, p' DDT, trifluralin, simazin, atrazin, antracen, naphthalene, fluoranten, fenantren, crisen, benz(a)antracen, benz(b)fluoranten, benz(k)fluoranten, benz(a)piren, benz(g,h,i)perilen, indeno(1,2,3)piren, 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene, benzen, pentaclorbenzen, o-xilen, (m+p) xilen	-

Table 7. Inventory of analysis types for Prut River monitoring in Ungheni section

Type of assays		*Number of assays per year*
• physico-chemical		12
• biological	- phytoplankton	12
	- macrozoobentos	3

Table 8. Values of the average values of water quality indicators for Ungheni section

Water quality indicator	*Value*
CBO_5 (mg/L)	3.56
CCO - Mn (mg/L)	3.29
CCO - Cr (mg/L)	15.34
Entire Phosphor (mg/L)	0.0758
N-NH4 (mg/L)	0.06
Rfix (mg/L)	325.1
Copper (µg/L)	10.29
Phenol (µg/L)	5.1

The predominating species belonged to the bacillariophyta - *Cyclotella meneghiniana, Synedra acus, Fragilaria crotonensis* together with the chlorophyta - *Scenedesmus opoliensis, Scenedesmus quadricauda, Monoraphidium contortum*, cyanobacteria - *Oscillatoria limosa* and euglenophyta - *Euglena pisciformes, Trachelomonas planctonica*. The phytoplankton saprobe indicator had an average value of 2.08 – being in the II quality class. lobally, according to the biological evaluation, the Ungheni section belonged to the II quality class. Abouth the physical and chemical elements in the Ungheni Section, the water of the Prut River is clean and belongs to the IInd quality class due to the oxygen regime and phenol indicators. The Table 8 shows the values of the weighted average for physical and chemical indicators.

The chemical status for Ungheni Section according to the MO 161 (2006) on the established values of the qualitative standard shows that the improper chemical state of this section is due to the overshooting of Copper concentration.

3.2.4. Prisăcani Section

The numbers of assays between January and December 2008 depending by the physic-chemical and biological indicators are show on the Table 10.

This section is monthly monitored within the "Partnership Program of Romania with the Moldavian Republic". Its importance is crucial because this section is a genuine "barometer" of the water quality from the Prut River after the confluence with Jijia River - that is from a qualitative perspective, a "spoiled" river on its middle and inferior course.

Abouth the biological indicators for the Prisăcani section biological analysis were made with a monthly frequency for the phytoplankton indicator and with a quarterly frequency for macrozoobentos indicator. The structure of the shores was made of inorganic soft material, with a large back fall, the sediment was made of sand, the water flow was average and the turbidity level was high. The adjacent grounds lacked vegetation. The benthic biocenosis included species such: crustacean - *Dikerogammarus haemobaphes, Corophium curvispinum* together with molluscs - *Dreissena polymorpha*. The average density for the zoobentos indicator was of 183 organisms /m^2 and the saprobe indicator had an average value of 2, therefore the Prisecani section belonged to the second II quality class.

The phytoplankton was determined with a monthly frequency and had an average density between of 126-1000 organisms/L and 472-500 organisms/L with an average value of 290-979 orgs/L. The main identified species were: bacillariophyta - *Cyclotella meneghiniana, Synedra acus, Nitzschia acicularis*, chlorophyta - *Monoraphidium contortum, Cryptomonas erosa, Scenedesmus quadricauda*, cyanobacteria - *Oscillatoria limosa*. The average value of the phytoplankton saprobe indicator was of 2.24 – the II quality class.

Globally, according to the biological evaluation, the Prisecani section belonged to the quality class II. In this area of monitoring, the water of the Prut River is clean and belongs to the qualitative class II due to the oxygen regime, nutrients and the main relevant chemical indicator - phenol.

The remaining physical and chemical indicators enlist the River's water in quality class I. The values of the weighted average indicators for the Prisăcani Section are shown on the Table 11.

Table 9. Average values for metals and composites (dissolved fraction) and organic micropollutants for Ungheni section

Qualitative elements	*Monitoring indicators*	*Exceed indicators / weighted average (µg/L)*
Metals and composites (dissolved fraction)	Chrome, Copper, Nickel, Lead, Zinc	Copper = 20.15
Organic micro-pollutants	lindan, endrin, aldrin, dieldrin, isodrin, alaclor, p,p' DDT, trifluralin, simazin, atrazin, antracen, naphthalene, fluoranten, fenantren, crisen, benz(a)antracen, benz(b)fluoranten, benz(k)fluoranten, benz(a)piren, benz(g,h,i)perilen, indeno(1,2,3)piren, 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene, benzen, pentaclorbenzen, o-xilen, (m+p) xilen	-

Table 10. Inventory of analysis types for Prut River monitoring in Prisăcani section

Type of assays		*Number of assays/ year*
• physico-chemical		12
• biological	- phytoplankton	12
	- macrozoobentos	3

Table 11. Values of the average values of water quality indicator for Prisăcani section

Water quality indicator	*Value*
CBO_5 (mg/L)	5.14
CCO - Mn (mg/L)	4.97
CCO - Cr (mg/L)	22.41
Entire Phosphor (mg/L)	0.1792
N-NH4 (mg/L)	0.205
Rfix (mg/L)	381.7
Chlorites (mg/L)	27
Sulphates (mg/L)	83.1
Copper (µg/L)	8.84
Phenol (µg/L)	7.83

The chemical state is evaluated according to the MO 161 (2006) on the established value of the qualitative standard. Data from Table 12 show the improper chemical state for Prisăcani Section due to the Copper and Nickel indicators.

3.2.5. Drânceni Section

For the Drânceni Section the numbers of assays depending by the physic-chemical and biological assays between January and December 2008 are shown in Table 13. Regarding the biological indicators for the Drânceni section biological analysis was made with a quarterly frequency for the phytoplankton indicator and the macrozoobentos indicator. The structure of the shores is made of inorganic soft material, with a large back fall, the sediment is made of sand, the water flow was average and the turbidity level was high. The adjacent grounds were made of shrubbery.

From the taxonomic perspective, the benthic biocenosis was predominated by crustacean - *Dikerogammarus haemobaphes, Corophium curvispinum, Gammarus fossarum*, followed by the gastropoda - *Planorbis carinatus, Anisus vortex*, efemeroptere - *Heptagenia sulphurea*. The density ranged between 49 organisms/m^2 and 102 organisms/m^2, the average saprobe indicator was 1.99 – being placed in the IInd quality class.

The average phytoplankton density was of 354,167 organisms/L with a maximum value of 622,500 organisms/l. The phytoplankton was predominated by diatom: *Cyclotella meneghiniana, Melosira granulata, Navicula gracilis, Cymbella ehrenbergii* together with chlorophyceae *Closterium venus Chlamydomonas simplex* and euglenophyta *Euglena variabilis, Euglena acus*.

The average value of the phytoplankton saprobe indicator was 2.07 – the IInd quality class, corresponding to the β-mezosaprobe area. Globally, according to the biological evaluation the Prisecani section belonged to the IInd qualitative class.

About the majority physical and chemical elements in this monitoring area, the water of the Prut River is clean and belongs to the qualitative class I as shown in Table 14.

Table 13. Inventory of analysis types for Prut River monitoring in Drânceni section

Type of assays		*Number of assays per year*
• physico-chemical		6 or 12
• biological	- phytoplankton	3
	- macrozoobentos	3

Table 14. Values of the average values of water quality indicators for Drânceni section

Water quality indicator	*Value*
Dissolved Oxygen (mg/L)	9.55
CBO_5 (mg/L)	2.34
CCO - Mn (mg/L)	4.63
CCO - Cr (mg/L)	12.24
N-NH4 (mg/L)	0.122
Rfix (mg/L)	367.8
Chlorites (mg/L)	25.7
Sulphates (mg/L)	70
Cleanser (µg/L)	31.4
Phenol (µg/L)	1.44

The chemical status for Drânceni Section according to the MO 161 (2006) can be evaluated based on the data from the Table 15, which show the improper chemical state of this section due by the Copper and Lead indicator.

Table 12. Average values for metals and composites (dissolved fraction) and organic micropollutants for Prisăcani section

Qualitative elements	*Monitoring indicators*	*Exceed indicators / weighted average (µg/L)*
Metals and composites (dissolved fraction)	Zinc, Copper, Lead, Chrome and Nickel	Copper = 6.26 Nickel = 2.37
Organic micropollutants	lindan, endrin, aldrin, dieldrin, isodrin, alaclor, p,p' DDT, trifluralin, simazin, atrazin, antracen, naphthalene, fluoranten, fenantren, crisen, benz(a)antracen, benz(b)fluoranten, benz(k)fluoranten, benz(a)piren, benz(g,h,i)perilen, indeno(1,2,3)piren, 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene, benzen, pentaclorbenzen, o-xilen, (m+p) xylen	-

Table 15. Average values for metals and composites (dissolved fraction) and organic micropollutants for Drânceni section

Qualitative elements	*Monitoring indicators*	*Exceed indicators / weighted average (µg/L)*
Metals and composites (dissolved fraction)	Chrome. Copper, Nickel, Lead, Zinc	Copper = 5.2; Lead = 1.88
Organic micro-pollutants	lindan, endrin, aldrin, dieldrin, isodrin, alaclor, p,p' DDT, trifluralin, simazin, atrazin, antracen, naphthalene, fluoranten, fenantren, crisen, benz(a)antracen, benz(b)fluoranten, benz(k)fluoranten, benz(a)piren, benz(g,h,i)perilen, indeno(1,2,3)piren, 1,2,4 Trichlorobenzene, 1,2,3 Trichlorobenzene, Pentachlorobenzene, Hexachlorobenzene, benzen, pentaclorbenzen, o-xylen, (m+p) xylen	-

Table 16. Classification of control sections according to quality classes for the Prut River in 2008 (Ecological state)

Section	*Type of the monitoring program*	*OS*	*Nutrients*	*Salinity*	*STPNO **	*Other indicators*	*General class - Physico-chemical indicators*	*Physico-chemical indicators that determine the quality*	*General class - The saprobe indicator*
Darabani	O,IH,CBSD, EIONET, CAPM	I	I	I	I	-	I	-	II
Ungheni	O, IH,CBSD,CI,CAPM	II	I	I	I	II	II	CBO_5, CCOCr	II
Prisecani	O,IH,HS,CI	II	II	I	I	II	II	CBO_5, CCOCr, NO_2, NO_3, P	II
Drânceni	O,IH,EIONET	I	I	I	I	I	I	-	II

Table 17. Classifying control sections in quality classes for the Prut River in 2008 (Chemical state)

Section	*Monitoring section*	*Type of the monitoring Program*	*Dangerous substances (Metals and composites - dissolved fraction, organic micro-pollutants)*	
Darabani	S	O,IH,CBSD, EIONET, CAPM	I (MG: Pb, Cu)	Bad
Ungheni	S	O, IH,CBSD,CI,CAPM	I (MG: Ni, Cu, Cr)	Bad
Prisecani	S	O,IH,HS,CI	I (MG: Ni, Cu)	Bad
Drânceni	S	O,IH,EIONET	I (MG: Pb, Cu)	Bad

Abbreviations: Ecological state: OS - oxygen system; STPNO - specific toxic pollutants of natural origin; OM - organic micro-pollutants; Chemical state: G - Good chemical state; I - other chemical state than the good one (inadequate)

*Note: * The classification was made using the total concentration of metals. The higher values (quality class III or IV) of the Iron and Manganese indicators were omitted.*

The Prut River is characterized by a natural basis with a higher level in non-synthetic substances (i.e. metals): Copper, Chromium, Nickel, and Lead. The quality of water was also influenced by the flash floods water from April 2008 to August 2008 that determined water loading with substances (Tables 16-17).

4. Conclusions

The catchment of Prut River is located in an area with many natural and anthropogenic pressures. The many uses of water and the fact that the river represents the border with Republic of Moldova require careful monitoring of water quality.

The monitoring of the water quality of Prut River in 2008 was carried out as a complex and necessary process in order to establish the qualitative state of the water's corp. In accordance with these results, it was adopted an efficient strategy for the protection of the water quality.

For a better understanding of the Prut River water quality in 2008, from its entrance on the Romanian territory to the confluence with the Danube River, the results of the monitoring process in 11 sections were considered. Five of them were described in the paper.

After a systematic analysis of water quality of the Prut River in the monitoring sections according to their place, a classification was set up:

- Section Oroftiana - the confluence with the Başeu River located between Oroftiana and Stânca - Costeşti, having a 203 km length corresponds to the global first quality class, according to the results recorded in the monitoring sections Prut - Oroftiana, Prut - Rădăuţi Prut, Prut - Darabani, Prut - Stânca.

- Section between the confluences of Prut River with the Başeu River and Moşna River,

respectively, having 237 km, corresponds to the IInd quality class, being influenced by the Başeu River and diffuse sources of pollution.

- Section between confluence with the Moşna River – Bumbăta and the confluence with the Pruteţ River, of 83 km goes through a self-purification process; the Prut River's water corresponds to the Ist quality class - according to the monitoring section Prut - Drânceni.

- Section Bumbăta, ranging between the confluence with the Pruteţ River and the confluence with the Danube River (of 219 km) corresponds to the IInd quality class, which can be found down to the confluence with the Danube River, according to the analysis of the sections from the lower water course confluences with the following rivers: Bumbăta, Oancea, Şivița and Giurgiuleşti.

The Prut River is characterized by a natural basis with a higher level in non-synthetic substances (i.e. heavy metal ions), being also influenced by the flash flood waters from April 2008 to August 2008.

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