

The qualitative assessment of Crasna River in terms of Water Framework Directive 2000/60/EC and Directive 78/659/EC

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Abstract. It is the central objective of the Water Framework Directive of the EC to achieve "good status" for all bodies of water, both surface and ground waters, but with the exception of heavily modified and artificial bodies. For the latter ones, the central objective is defined as "good environmental potential". In essence, environmental goals by 2015 include: 1) for surface water bodies: achieving good ecological status and good chemical state, or good ecological potential and good chemical status for heavily modified water and artificial bodies; 2) for underground water bodies: achieving good chemical status and good quantitative status; 3) protected areas: environmental objectives under specific legislation; 4) keeping the surface water and ground water away of deterioration status. In this context, our study highlights aspects of water resource management of the Crasna catchment, sub-catchment of Someș Tisa, to ensure compliance with the contents of the EU Framework Directive 2000/60/EC, in the year 2008, and prospects achieving the objectives set, by processing synthetic data created by the Someș Tisa Water Directorate, through monitoring quality and quantity of surface resources. Structural-functional peculiarities of Crasna on the flow velocity, the nature of substrate, flow and water level variations, the influence of the structure and the functioning of plant and animal populations, which in turn determine the physical-chemical properties of water, are analysed. Deteriorating environmental conditions, especially following acute pollution of aquatic organisms, is producing shocks, which are affecting parts of or all trophic structures, so the result is a decrease in aquatic ecosystems' diversity, critical for populational survival.

Key Words: aquatic ecosystem, quality status, ichthyofauna, evaluation.

Résumé. L'objectif central de la Directive Cadre dans le domaine de l'eau est d'obtenir « un état bon » pour tous les corps d'eau, pour ceux de surface ainsi que pour ceux souterrains à l'exception des corps fortement modifiés et artificiels, pour lesquels on définit « le bon potentiel écologique ». Principalement, les objectifs environnementaux jusqu'à 2015 incluent: 1) pour les corps d'eau de surface: atteindre un bon état écologique et un bon état chimique, respectivement un bon potentiel écologique et un bon état chimique pour les corps d'eau fortement modifiés et artificiels; 2) pour les corps d'eau souterrains: atteindre un bon état chimique et un bon état quantitative; 3) pour les zones protégées: atteindre les objectifs environnementaux prévus par la législation spécifique; 4) la non détérioration des eaux de surface et souterrains. Dans ce contexte, notre étude met en relief, pour le bassin hydrographique de Crasna, qui est un sous bassin du Bassin Hydrographique du Someș – Tisa, les aspects concernant la gestion des ressources d'eau conformément au cadre de la Directive UE 2000/60/EC, au niveau de l'année 2008, et les perspectives d'atteindre les objectifs établis par le traitement synthétique de la base de données constituée au niveau de la Direction des Eaux Someș Tisa, suite à un monitoring qualitative et quantitative des ressources de surface. Les particularités structurelles et fonctionnelles de la rivière Crasna, concernant la vitesse d'écoulement, la nature de la nappe, les variations du débit et le niveau des eaux, influencent la structure et le fonctionnement des populations végétales et animales, qui, à leur tour, déterminent les caractéristiques physiques et chimiques de l'eau. La détérioration des conditions d'environnement, surtout comme suite à une forte pollution qui produit des chocs sur les organismes aquatiques et qui affecte partiellement ou totalement les structures trophiques, détermine la diminution de la diversité des écosystèmes aquatiques, point critique dans la survie des populations.

Mots clés: écosystème aquatique, état qualitatif, ichthyofaune, évaluation.

Rezumat. Obiectivul central al Directivei Cadru în domeniul apei este acela de a obține o „stare bună” pentru toate corpurile de apă, atât pentru cele de suprafață cât și pentru cele subterane, cu excepția corpurilor puternic modificate și artificiale, pentru care se definește „potențialul ecologic bun”. În esență, atingerea obiectivelor de mediu până în anul 2015, include: 1) pentru corpurile de apă de suprafață: atingerea stării ecologice bune și a stării chimice bune, respectiv a potențialului ecologic bun și a stării chimice bune pentru corpurile de apă puternic modificate și artificiale; 2) pentru corpurile de apă subterane: atingerea stării chimice bune și a stării cantitative bune; 3) pentru zonele protejate:

atingerea obiectivelor de mediu prevazute de legislația specifică; 4) nedeteriorarea stării apelor de suprafață și subterane. În acest context, prezenta lucrare va reliefa pentru bazinul hidrografic Crasna, subbazin al Bazinului Hidrografic Someș Tisa, aspecte referitoare la asigurarea managementului resursei de apă în conformitate cu conținutul cadru al Directivei UE 2000/60/EC, la nivelul anului 2008, și perspective de atingere a obiectivelor stabilite, prin prelucrarea sintetică a bazei de date constituite la nivelul Direcției Apelor Someș Tisa, în urma monitorizării calitative și cantitative a resursei de suprafață. Particularitățile structural-funcționale ale râului Crasna, referitoare la viteza de curgere, natura substratului, variațiile debitului și nivelul apelor, influențează structura și funcționarea populațiilor vegetale și animale, care la rândul lor determină caracteristicile fizico-chimice ale apei. Deteriorarea condițiilor de mediu, mai ales urmare poluării acute care produce șocuri asupra organismelor acvatice care afectează parțial sau total structurile trofice, determină diminuarea diversității ecosistemelor acvatice, punct critic în supraviețuirea populațiilor.

Cuvinte cheie: ecosistem acvatic, stare calitativă, ihtiofaună, evaluare.

Background. Crasna – order tributary of the Tisa – has its origins in the southern end of the Depression Șimleu, the contact between the mountain ridges and Meseș Plopiș mountains, with the Măgura Priei summit at an altitude of 577 m. Crasna is a well-developed tributary, with a pronounced, but appropriate asymmetry, especially downstream at the junction with Valley Zalău. The genesis and spatial development of the Crasna catchment reflect its position in the extreme north of the Romanian Western Carpathians, but also the mobility of the Transylvania-Pannonia micro-plate, which generated a series of changes in areas of subsidence in the lower Crasna river.

Crasna comprises 54 sub-water streams amounting to a total length of 708 km (0.9% of the total length of current water in the country), an area of 2,100 km², and 9% of the floor area of the Someș-Tisa river basin. Crasna has a length of 134 km from the source to the border with Hungary and a mismatch in favor of the right side of the basin up to Domănești station, where the situation is reversed. The main tributaries of Tisa are the rivers Zalău, Maja and Maria, all with insignificant flows and lengths not exceeding 38 km (Șofronie 2000).

The main component of the water resource consists of the surface water hydrographic network. The Crasna area is considered to be a low water resource, characterized by reduced leakages due to morph-climatic factors (low altitude, low rainfall levels and high temperatures). At Domănești hydrometric station, near the border with Hungary, there is a specific average flow of 3.5 L/s/km². The hydrological regime of the river Crasna in 2008 was as follows: a multiannual average flow of 5.54 cm/s and monthly flows of 80%, 90% and 95% assurance were 0.33 cm/s, 0.21 cm/s and 0.14 cm/s, respectively.

As far as groundwater resources are concerned, 62.3% of these are represented by aquifer groundwater networks and 37.7% by deep underwater sources.

When taking into account the population inhabiting the basin, the specific usable water resource of the Crasna stands at 503 m³/habitant/year and 3426 m³/habitant/year is the specific resource calculated using theoretically available stock (multi-annual average), the latter 90% higher than the specific resource at national level, which is 1650 m³/habitant/year. This situation places the Someș-Tisa area in a favorable position with sufficient reserves of water that may be exploited in the future (see Figure 1).

If the quantity of water resources in the Someș-Tisa river basin can insure a balanced requirements-allocations ratio, the other dimension of water resources, necessary for the absorption of contaminated effluents, is a major issue for the management of water resources. Currently, the capacity to receive pollutants by the water network is exhausted or restricted in many sections of public oversight of water resources (Management Plan of Someș Tisa River Basin 2009).

Qualitative Situation. The Water Framework Directive 2000/60/EC requires that each category of surface water, bodies of water from a basin or river basin district be differentiated by their type (Petrescu-Mag 2008).

The qualitative assessment of the river Crasna has been carried out in accordance with the provisions of the relevant legislation: the Law for waters no 107/1996 with subsequent modifications and Order no 161/2006 of the Ministry for the Environment and Waters regarding surface water quality classification in order to establish the ecological

status of water bodies, using surveillance type or operational monitoring for the controlled sections of water bodies included in the evaluation program, depending on the typology of flowing water bodies.

The typological classification of water courses is the result of combining the descriptive typology based on abiotic parameters, which are in an indirect relationship with biological communities, and that based on direct measurements of variability of biological communities, intended to biologically verify the abiotic typology (Burian 2002; Diaconu 1999; Șerban & Galie 2006; Popa & Coșier 2009).

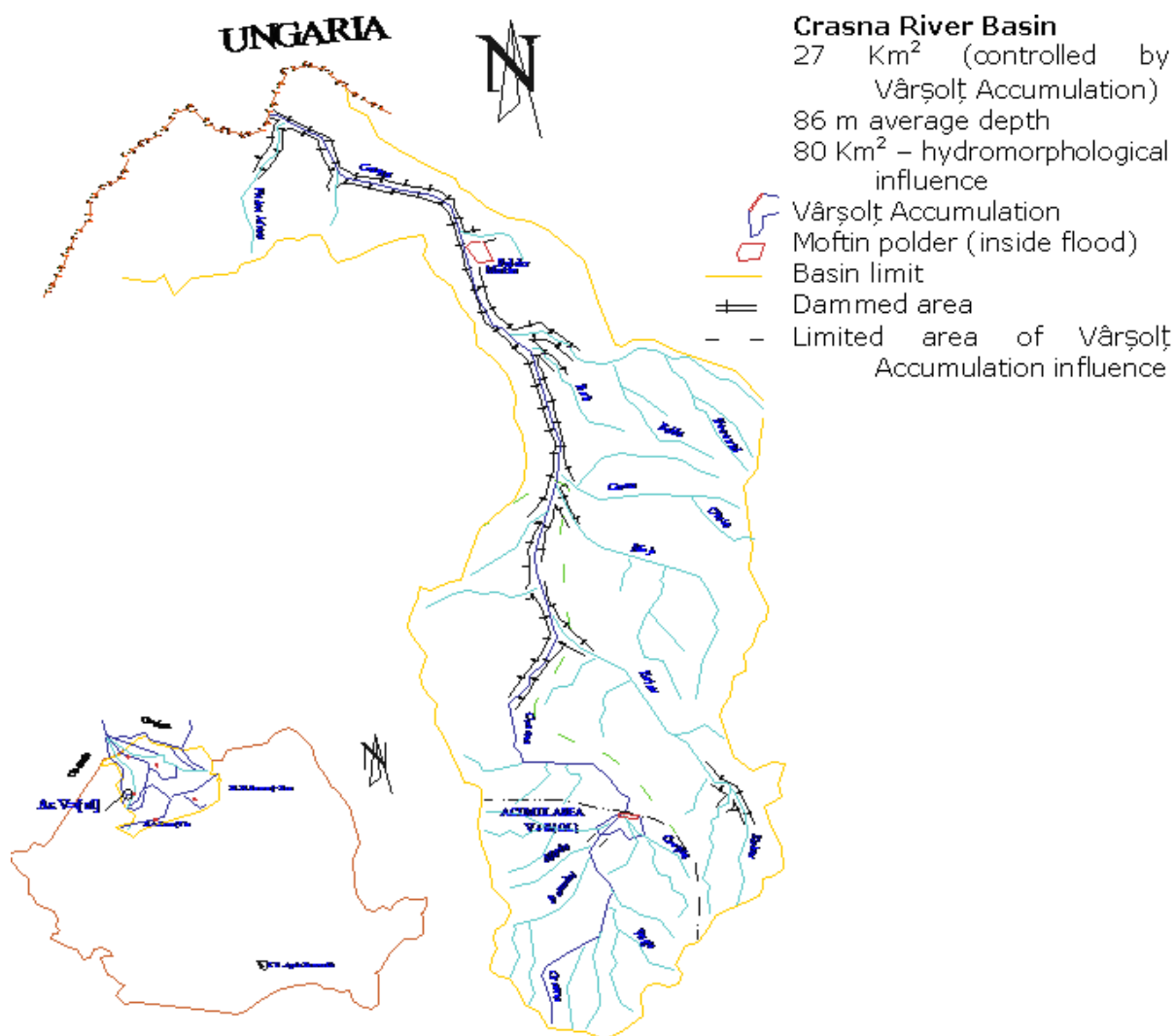


Figure 1. The map of the Crasna river drainage area.

As a result, the description of water quality in the controlled sections may be summarized as follows:

1. Crasna river, upstream from Cizer. This section is representative for the water body "Crasna springs – Vârșolț Accumulation and tributaries", included in the RO04 typology (lowing water in hilly area); in 2008 the quality of this water resource for this section was considered as quality class II due to results recorded for indicators in the "Toxic and particular pollutants of natural origin" group. The chemical and physical-chemical status of the water is good. Biologically, the quality of the river in the referenced section, with an anthropic influence of below 10%, was within the limits of class I quality type according to the Saprobies index of two biological communities:

microphytobenthos and macrozoobenthos ($S = 1.56, 1.74$) (see also similar studies in Stoian et al 2009, or Badea et al 2010). These values indicate that the area corresponds with the oligo-beta-meso-saprobe area and indicates a low contamination level of the water. Therefore, the water has a "very good" ecological status as confirmed by the abundance of oligo-and beta- type bio-indicators.

The ichthyic fauna in this section of the river is primarily represented by the following species of fish: bleak (*Alburnus alburnus* (Linnaeus, 1758)), spined loach (*Cobitis taenia* Linnaeus, 1758), gudgeon (*Gobio gobio* (Linnaeus, 1758)), chub (*Leuciscus cephalus* (Linnaeus, 1758)) and barbel (*Barbus barbus* (Linnaeus, 1758)). The monitoring carried out in accordance with Directive 78/659/EEC, transposed into Romanian legislation by Decision no 202/2002 of the Ministry for the Environment and Waters has revealed that this section of the river flow falls within optimal values of mandatory parameters, i.e. in terms of pH quality indicators, phenols, hydrocarbons, ammonia, chlorine residues and zinc, and within the recommended parameters regarding suspension indicators, i.e. BOD5, total phosphorus, ammonia and ammonium, but not nitrites.

2. Crasna river at Crasna. This section is representative for the "Crasna springs – Vârșolț Accumulation and tributaries" water body and included in the RO04 typology; in 2008 the quality of the water in this section was class III due to the values of the indicators in the "Specific and toxic pollutants of natural origin" group. The chemical and physical-chemical status of this body of water was moderate. Biologically, the river quality was within the limits of class III; according to the Saprobies index levels ($S=2.56$) registered for macro-invertebrate benthic communities for the beta-mezo-alpha- meso-saprobies, indicating a moderate to critical level of water contamination and a "moderate" ecological status due to the abundance of *Limnodrilus hoffmeisteri* Claparede, 1862, *Nais* spp., and *Tubifex tubifex* (Müller, 1774) (Oligochaeta, type alpha-class bio indicators). The quality of the phytoplankton community placed this water section at the upper limit of class II of quality ($S = 2.30$) corresponding with the beta-meso-saprobies area, indicating a moderate level of water contamination and a "good" ecological status.

The ichthyic fauna is represented primarily by the following species of fish: chub (*Leuciscus cephalus*), Prussian carp (*Carassius gibelio* (Bloch, 1782)), bleak (*Alburnus alburnus*), gudgeon (*Gobio gobio*) and roach (*Rutilus rutilus* (Linnaeus, 1758)). The monitoring of water quality, carried out according to the provisions of DC 78/659/EEC, transposed into Romanian legislation by 202/2002 Government Decision, indicated that this section falls within mandatory values of indicators, i.e. pH quality indicators, phenols, hydrocarbons, ammonia, ammonia, chlorine residues and zinc, and falls within the recommended values for BOD5, total phosphorus and copper, but not to suspension, nitrites and ammonium.

3. Crasna river at Moiad. This section is representative for the "Crasna – Vârșolț Accumulation – Hungarian border" water body, with an RO07 typology (lowing water in plains). The quality of the water in 2008 was class III due to the values of indicators grouping the "Specific and toxic pollutants of natural origin" group. The chemical and physical-chemical status of the water was moderate. Biologically, the river quality was within the boundaries of class II, according to Order 161/2006, based on the average of the values of the Saprobe index registered for the phytoplankton community ($S = 2.07$) for the beta-meso-saprobies area, indicating a moderate level of contamination and a "good" ecological status.

The ichthyic fauna is represented primarily by the following species of fish: chub (*Leuciscus cephalus*), Prussian carp (*Carassius gibelio*), bleak (*Alburnus alburnus*), gudgeon (*Gobio gobio*) and roach (*Rutilus rutilus*). The qualitative monitoring has indicated compliance with mandatory values of the following indicators: pH indicators, phenols, hydrocarbons, ammonia, ammonium, chlorine residues and zinc, and revealed that the water falls within the recommended values for BOD5 indicators, but not for suspensions indicators, total phosphorus, nitrates, ammonia and ammonium.

4. Crasna river at Supuru de Jos. This section is representative for the "Crasna – Vârșolț Accumulation – Hungarian border", and has an RO07a typology. The quality of the water in 2008 for this section was class III due to values recorded for indicators in the "Specific and toxic pollutants of natural origin" and "Nutrients" groups. The chemical and physical-chemical status of the water was moderate. Biologically, the river quality was within the boundaries of class III, according to Order 161/2006, based on the average of Saprobies index-based values recorded for phytoplankton communities ($S = 2.45$) for beta-meso-saprobies areas, indicated a moderate level of water contamination and, thus, a "moderate" ecological status.

In terms of the ichthyic fauna, the following species of fish have been found: chub (*Leuciscus cephalus*), bleak (*Alburnus alburnus*), gudgeon (*Gobio gobio*), European perch (*Perca fluviatilis* Linnaeus, 1758), spined loach (*Cobitis taenia*), bitterling (*Rhodeus amarus* (Bloch, 1782)) and topmouth gudgeon (*Pseudorasbora parva* (Temminck & Schlegel, 1846)).

5. Crasna river at Breveni. This section, too, is representative for the "Crasna – Vârșolț Accumulation – Hungarian border" water, with an RO07a typology. This section is of special importance, being situated near the border with Hungary; at the same time, it is in this section that the degree of upstream pollution of the river becomes obvious. The quality of the water in 2008 in this section was class III due to values recorded for the "Specific and toxic pollutants of natural origin" and "Nutrients" indicator groups. The chemical and physical-chemical status of the water for this section is low. Biologically, the river quality was within the boundaries of class IV, according to Order 161/2006, based on the average of Saprobe index-based values recorded for the phytoplankton community ($S = 3.48$) characteristic for the alpha-meso-saprobies area. In addition, high levels of water contamination and a "low" ecological status were obvious.

In terms of the ichthyic fauna in this section, the following species of fish have been identified: chub (*Leuciscus cephalus*), gudgeon (*Gobio gobio*) and bleak (*Alburnus alburnus*).

The map in Figure 2 shows the qualitative status of water bodies in the Crasna river basin from a chemical and biological perspective, respectively, determined in accordance with specific methodology. The latter was developed in close correlation with the application of current legislation pertaining to water resource management and relying on annual campaigns of water and biological samples, which take place for 12 months, and which offer cross-sectional data regarding the level of surface water contamination. Through the interpretation and extrapolation of data, as well as through the positioning of pollution sources and the computation of the impact generated by these sources, those sections of the river flow have been identified which are unlikely to meet the goals set by the 2000/60/EC Water Framework Directive for 2015.

6. Physical-chemical characterization. From a physical-chemical point of view, the discuss sections of the Crasna river may be included in quality class II, but upstream at its confluence with the Tisa river quality, its quality declines to quality class IV. The changes leading to this qualitative shift are the following:

- localized sources of pollution represented by the equivalent of human settlements with over 2000 inhabitants (nitrogen and phosphorus regimes) whose sewage and water cleansing infrastructure is poor, inadequate, coupled with industry (hazardous substances) and animal husbandry (nitrogen and phosphorus regimes, Figs 3-4);
- diffuse sources represented by equivalents of human settlements of under 2000 inhabitants without infrastructure, where pollution is generated by the drainage of nitrates and phosphates originating from fertilizers or pesticides or created by erosion following floods;
- acute or chronic accidental pollution events with negative implications for aquatic ecosystems.

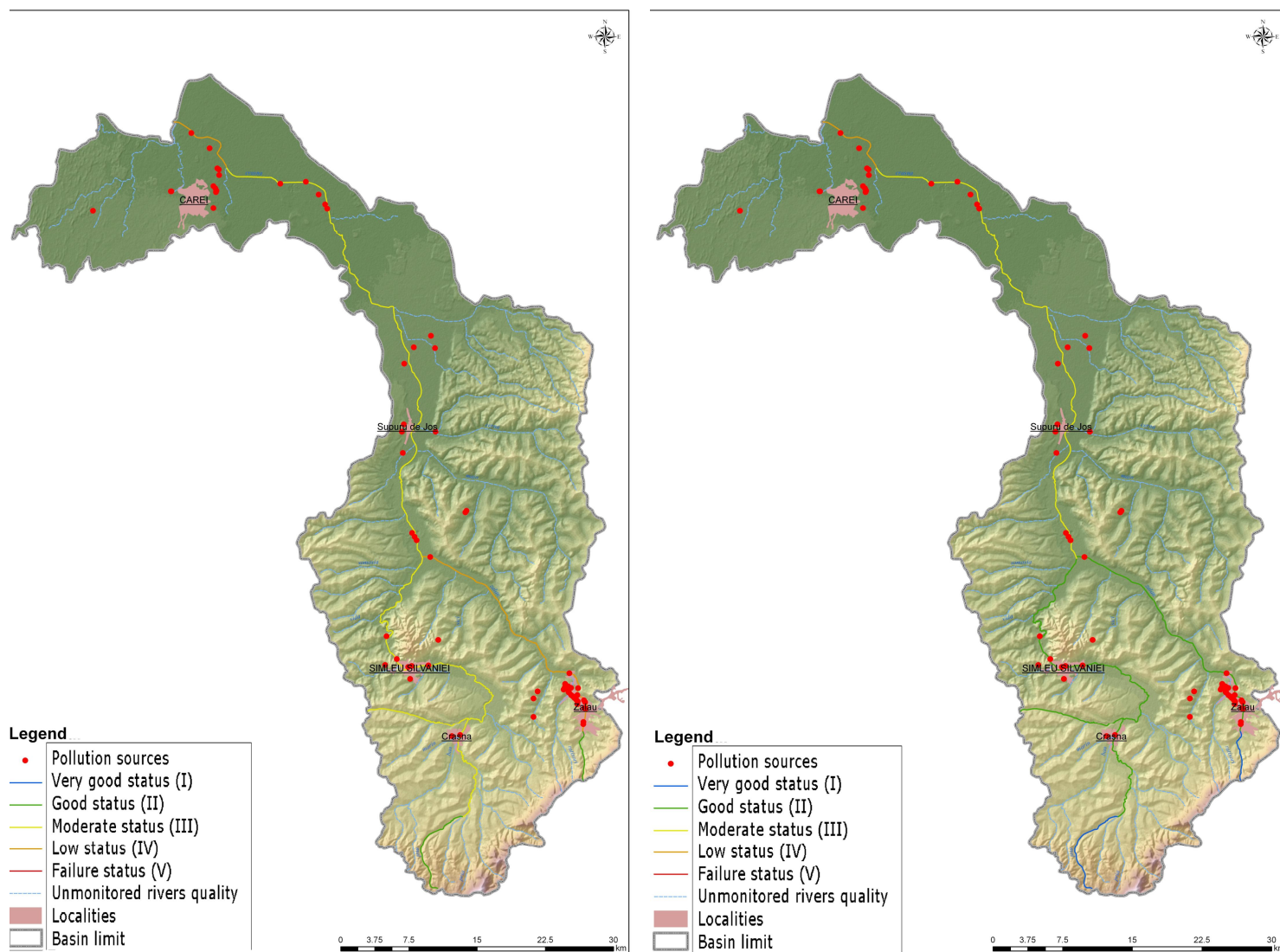


Figure 2. The chemical (left) and biological (right) status of Crasna river, 2008.

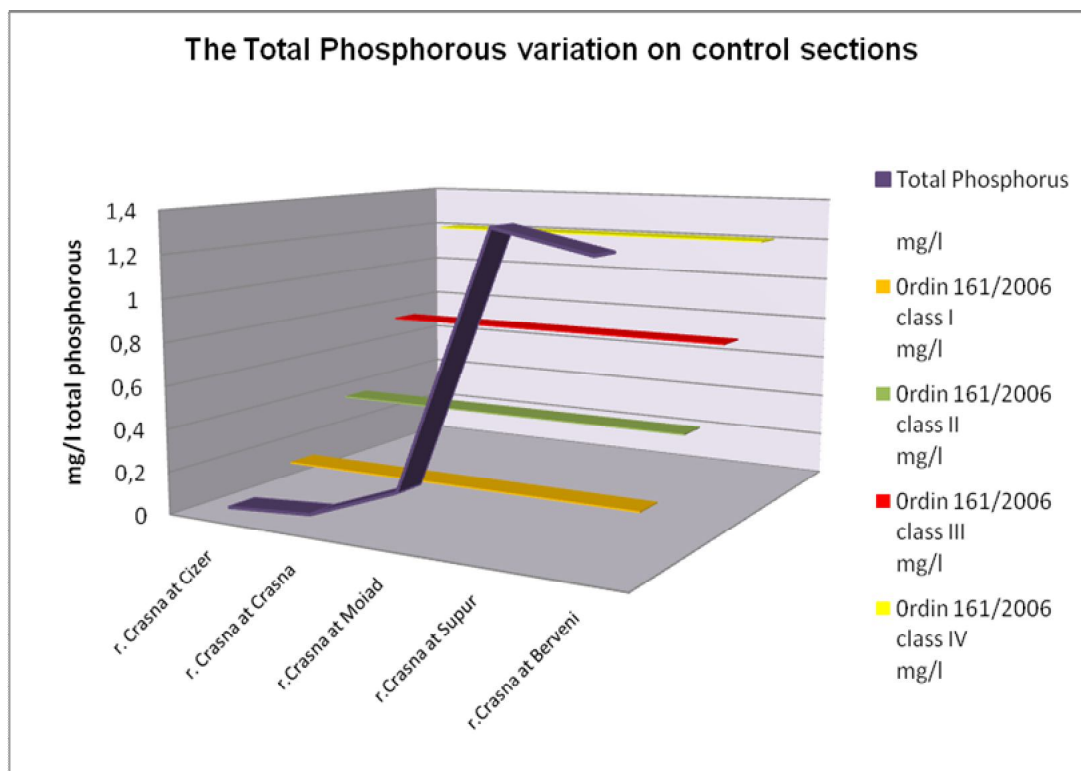


Figure 3. The total phosphorus variation at the sampling sections.

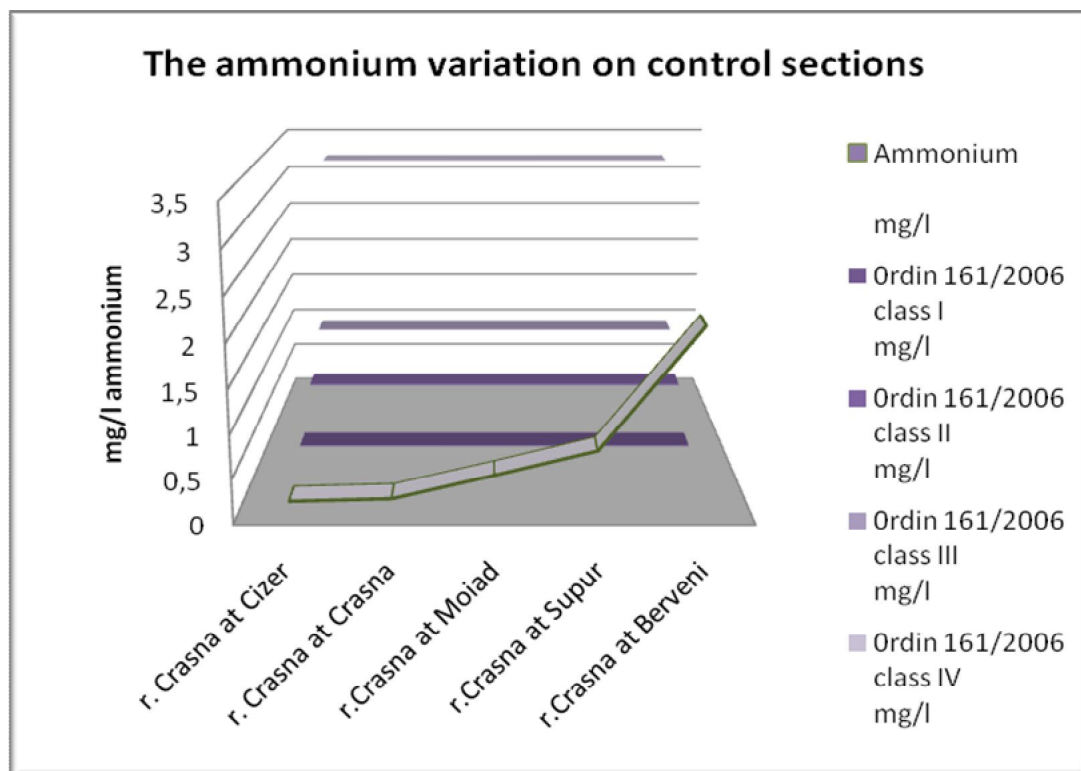


Figure 4. The total ammonium variation at the sampling sections.

The class of dangerous substances as defined in Directive 2006/11/EC and Directive 2008/105/EC, i.e. heavy metals and organic micro-pollutants – mainly generated by industrial activities in urban settlements (metallurgy, refractory, textile, rubber industries) – contribute to qualitative changes of the Crasna's water, but is responsible in particular for triggering bio-accumulation and bio-amplification phenomena among aquatic organisms.

According to the screening carried out on the Crasna RO07 body of water, between the Vârșolț Accumulation and the Hungarian border, on the basis of surveillance and operational monitoring, the identified pollutants were copper, lead and cadmium, at concentrations above the legally imposed limits, which put this body of water at risk of not achieving good ecological status by 2015.

If chemical analysis provides information regarding some characteristics at the moment of sampling, the biological analysis presents information regarding organisms' responses to environmental changes over a longer period, depending on the ecological particularities of the species. This way the degree of the ecosystem's level of intoxication may be established, but without specifying the quantitative and qualitative details concerning pollutants.

The gradient of the particular physical-chemical conditions along the river objectively determines the ecological characteristics that change and differ across the different sections of the river, from its springs to its confluence into the Tisa (Brezeanu & Simion-Gruita 2002).

According to ecological zoning criteria for flowing waters proposed by limnology expert J. Ilies (data not shown), based on longitudinal geomorphologic and biological structures, the Crasna may be included in ecological zone II potamon, the area surrounding the hilly parts and the plains of the river, where the temperatures range between cold / stable and hot / unstable, and the nature of the water varies between oligotrophic and eutrophic.

The ecological area of the rivers is also defined on the basis of the particular ichthyic fauna in concordance with the variables of abiotic (physical-chemical) and biotic (biocenotic) factors (Bănărescu 1964; Brezeanu 1996 cited by Brezeanu & Simion-Gruita 2002).

7. Ecological status. The ecological status represents the structure and functioning of aquatic ecosystems and it is defined in accordance with Annex V of the Water Framework Directive (Mihăiescu & Mihăiescu 2009), through elements of biological quality, physicochemical and hydro-morphological general elements that support biological ones, as well as specific pollutants (synthetic and non-synthetic ones).

In terms of abiotic factors, the quality of the Crasna river in the studied area shows all characteristics of a body of water in "very good" environmental status, with slight contamination levels due to sporadic farming activities, while at the border area the quality of the water deteriorates to "poor". The intake of pollutants from human settlements alongside the water course and its tributaries, the lack of appropriate sewage and wastewater cleansing infrastructure, the many diffuse sources of contamination whose contribution is difficult to quantify, nitrate-vulnerable areas due to farming activities and not least the hydro-morphology of the river featuring low slope drainage and insufficient dilution of pollutants constitute the causes of the Crasna's contamination and change in ecological balance.

Furthermore, anthropogenic actions performed on environmental factors leading to their assault through exposure to stress of the various ecosystems bio-components. The ecosystems responses to stress factors (ecological impact) and the adaptations or recovery of these ecosystems as a result of damage by stress factors indicates the size of impact.

Under these conditions, stress can be exercised continuously, long-term, covering a wide area, or punctual, shock-like, in frequent locations as accidental pollution often is. In the case of the Crasna, the continuous stress source is represented by its nutrients (ammonium and phosphorus), particularly in the section between Supur and Berveni (Ammonium concentrations from 0.42 mg/L to 2.11 mg/L, compared to limit 0.8 mg/L

corresponding quality class II, total phosphorus concentrations from 0.824 mg/L to 1.28 mg/L, compared to limit 0.4 mg/L corresponding quality class II, nitrites concentrations from 0.044 mg/L to 0.136 mg / L, compared to limit 0.03 mg/L corresponding quality class II).

Table 1

The ecological status of the Crasna river in 2008 according to physical-chemical and biological elements

No.	River	Location	Monitoring S	Type of monitoring	Flow (m ³ /s)	Physical-chemical and biological elements								Ecological status
						C1. RTA	C2. RO	C3. NUTR	C4. SAL	C5. PTSON	C6. AICR	A.	D.	
1	R.Crasna	Cizer	S	R, IH*	0.062	I	I	I	I	I	I	I	-	I=Very good
2	R.Crasna	Crasna	O	O (N, HM), IH	1.07	I	I	I	II	III	II	III	-	III=Moderate
3	R.Crasna	Moiad	O	O (N, SO, SPP, HM), IH, CBSD	1.65	I	II	II	II	III	II	III	-	III=Moderate
4	R.Crasna	Supuru de Jos	O	O (N, SO, SPP, HM), IH, CBSD		I	II	III	II	III	II	III	-	III=Moderate
5	R.Crasna	Berverni	O	O (N, SO, SPP, HM), IH, CBSD		I	III	IV	II	III	II	IV	-	IV=Low

RTA - heat treatment and acidification; RO(SO) - oxygen system; NUTR(N) - nutrient regime; SAL - degree of mineralization (salinity); PTSON - specific toxic pollutants of natural origin; SPP – dangerous substances; AICR - other relevant chemical indicators: phenols, detergents, AOX; Chemical state: priority/dangerous; S – Surveillance; O – Operations; R, R* (temporary rivers), CBSD (the best section available) – reference; IH – ichthyic fauna; HM – hydromorphological alteration; C1 – C6 – physical-chemical determination; A – biological determination; D – micro-biological determination;

Table 2

Ecological status of the Crasna river in 2008 according to the nature of the phytoplankton community

No.	River	Location	The value of saprobes index	Saprobe Area	Contamination	Quality class	Ecological status after phytoplankton community
1	R.Crasna	Cizer	1.56	Oligo-beta-meso saprobic	Low	I	Very good
2	R.Crasna	Crasna	2.30	Beta mesosaprobic	Moderate	II	good
3	R.Crasna	Moiad	2.07	Beta mesosaprobic	Moderate	II	good
4	R.Crasna	Supuru de Jos	2.45	Beta mesosaprobic	Moderate	III	moderate
5	R.Crasna	Berverni	2.27	Beta mesosaprobic	Moderate	II	moderate

The evaluation of the Crasna's water quality based on the saprobes' system indicates a mid-level contamination, dominated by oxidation processes, with advanced levels of self-purification and the level of mineralization of organic matter in its final phases, and as a result the amount of oxygen does not fall below 50% of the saturation level.

The entire flow of the Crasna falls within the limits of the beta-mesosaprobes area, although close to the Cizer area the features of the river put it closer to the oligo-saprobe zone, with low levels of impurity dominated by bio- and beta- bio-indicators,

while towards the end of the studied section, in the proximity of Bervenii, contamination becomes more pronounced.

According to the 1964 evaluation of Bănărescu regarding the fish population of the Someș Tisa area, especially the Șimleu section called "Beretău under fortress" (Șimleu river), the following species are to be found: *Leuciscus cephalus cephalus* (Linnaeus), chub and other grouped species. With greater frequency, in the area renowned for chub, the following other species were found: *Rhodeus sericeus amarus*, *Gobio gobio* (gudgeon), *Cobitis taenia taenia* (spined loach), but presently only these species are to be found: *Perca fluviatilis* (perch), *Neogobius gymnotrachelus* (Kessler, 1857) (racer goby) and *Alburnus alburnus* (bleak). Present in but a few rivers in the studied area, the following species were identified: *Esox lucius* Linnaeus, 1758 (pike), *Rutilus rutilus* (roach), *Leuciscus idus* (Linnaeus, 1758) (orfe), *Cyprinus carpio carpio* Linnaeus, 1758 (carp), *Carassius gibelio* (Prussian carp) and *Sabanejewia romanica* (Băcescu, 1943) (romanian loach) (Bănărescu 1964).

The chub is a species of the cyprinid family and its aquatic behavior resembles that of fish predators, a feature that grows stronger as the fish ages. Its prolonged body, well developed with strong fins, provides the chub with the ability to move quickly, collect its food with fish movements and attacking prey (or what it considers to be prey) quickly and vigorously. The chub's favorite habitat is represented by hilly rivers, with clear water and relatively quick flow. The chub is rightly considered to be omnivorous, since its food is equally constituted by animal and vegetal matters, primarily larvae of water insects, worms, drowned insects, the offspring of aquatic plants, small fish and small fruits fallen into the water (Bud et al 2004, 2007ab; Burian & Grama 2005).

On the 8 km section between the Crasna springs and the Vârșolț Accumulation area, the following species of fish have been identified: *Leuciscus cephalus* (chub), *Alburnus alburnus* (bleak), *Cobitis taenia taenia* (spined loach), *Gobio gobio* (gudgeon), while on the 124 km section between Vârșolț Accumulation and the Hungarian border the following species have been found: *Leuciscus cephalus* (chub), *Carassius gibelio* (Prussian carp), *Alburnus alburnus* (bleak), *Gobio gobio* (gudgeon) and *Rutilus rutilus* (roach).

Chub, as an exponent of the omnivorous class, represents the dominant species in the Crasna river, with a density per 100 m² ranging thus: Crasna at Cizer – 19 specimens, Vârșolț Accumulation – 22 specimens, Crasna at Supur – 51 specimens, Crasna at Bervenii – 3 specimens, considering that the river changes three quality classes, from low levels of water contamination to moderate levels of contamination. The chub is resistant to contamination with nutrients, therefore in the Crasna it chooses to develop high densities near the Supur section, a lower water quality class area of the flow, with high phosphorous and ammonium contents. The Supur section appears to be the perfect environment for the chub, since high concentrations of nutrients determine the development of abundant aquatic vegetation, representing shelter and refuge, a direct and indirect food source through periphyton or associations of invertebrates, procreating and raising juveniles in the vicinity of aquatic vegetation. This area has an extended major riverbed, with many areas of water stagnation, frequent sludge as a result of suspension deposits, therefore favorable for the spread of fish species.

The bleak (*Alburnus alburnus*) is to be found throughout the course of the river with a density ranging from 29 specimens per 100 m² in the referenced area to 12 specimens per 100 m² at the confluence with the Tisa.

The Prussian carp, *Carassius gibelio*, in an euriphagous species identified in the Vârșolț Accumulation area with a density of 29 specimens per 100 m² and which only occasionally migrates to downstream sections of the river, though it is a species resistant to adverse environmental conditions. On the same section and the Vârșolț Accumulation area the following two species are also to be found, as well: the gudgeon (*Gobio gobio*) and the spined loach (*Cobitis taenia*). The presence of these species on all sections of the Crasna river, in spite of the level of contamination, can be explained by their tolerance to these environmental conditions and their insensitivity towards contaminated environments.

In addition, however, macrophytes, superior aquatic plants, represent another key factor in explaining the presence of sizable fish populations. The type, distribution and

especially the level of development of these plants are determinants of the aforementioned species' development. Also, their ability to absorb excess nutrients available assists in establishing the quality status of the river. The species of fish found in the Crasna are shy (chub, gudgeon) or sporadic (bleak) consumers of aquatic vegetation.

8. Hydro-morphology. The river's hydro-morphology is influenced by the infrastructural developments carried out, leading to degradation in specially prepared areas, erosions of the side and bottom of the minor riverbed, especially in periods of flooding with increased speeds of the water flow. Furthermore, in the dammed, plains areas, significant clogging of the riverbed may be observed, leading to artificially high groundwater levels and, thus, phenomena of high salt contents in the ground. Infrastructural elements separate the river from the floodable meadows, leading to the withdrawal or even disappearance of wetland sections, thus altering pre-existing ecosystems, initially dependent from their connection to the riverbed. Therefore, due to the impoundment of the Someș River downstream from the confluence with Homorodu Nou (Satu Mare county) over a length of 22 km to the border with Hungary and the execution of drainage and irrigation canals on the Crasna and the tributaries of the Someș and the Crasna, the Eced wetland area has significantly dropped in size, from 285.7 km², to an area bounded by rivers Someș and Crasna.

In the Someș-Crasna basin, infrastructural developments have been carried out for 22.82% of the entire length of the Someș-Crasna hydrographic network and 63% of the Crasna river has been subjected to such developments (Management Plan of Someș Tisa River Basin, 2009).

The environmental consequences of building dams and lakes are multiple. As a result of such works, a flowing water system has been transformed into a relatively stagnant aquatic system, and in the case of lakes with great depths and surfaces, the vertical stratification involves multiple biological consequences, among which the changing structure and functions of the inhabiting populations are probably the most notable.

9. Vârșolț Accumulation. As regards the Crasna basin, the Vârșolț Accumulation plays a crucial role in ensuring the necessary flow and the possible dilution of pollutants, which currently serves as the main source of the water supply for Zalău and Șimleu Silvaniei localities ($Q_{max} = 530 \text{ l / s}$ extended to 750 l / s), after putting the Derivation from the Barcău river to Vârșolț Accumulation into operation. The surface of the receiving basin at Vârșolț Accumulation extends to 354 km² and has a total volume of $40.65 \times 10^6 \text{ m}^3$, initially built as a prevention measure against the flooding of the Crasna. Of the 39.388 million m² of water (the entire capacity of the lake), 16.07 million m² are destined for the drinking water demands of the two towns with a total population of approx. 80,000 inhabitants, of whom 63,300 inhabitants are connected to the centralized water supply system.

Vârșolț Accumulation collects water from Crasna basin, whose receiving basin crosses 22 localities with around 20,000 inhabitants in total, but lacking the infrastructure for collecting and treating wastewater originating from domestic and micro-industrial activities (a frequent problem of north-west Romania; see also Berkesy et al 2008, or Bodoczi 2009). As a result, pollutants are discharged into the river, affecting the physical-chemical, biological and bacteriological properties of the water, with negative outcomes for aquatic biodiversities (Hărșan & Petrescu-Mag 2008). Moreover, soil degradation, surface erosion and erosion at depth, slides and land subsidence phenomena are typical for this area.

From a lithological point of view, clays, sands and gravels formations prevail. For this reason, in areas where slopes are steep and devoid of arboreal vegetation, sediment washing and their entrainment into the water flow is frequent.

The systematic monitoring of flows of all tributaries into the lake is only carried out at the Crasna hydrometric station, located 5 km upstream of the accumulation, and

the station controls an area of 196 km² (60%). The main rivers flowing directly into the reservoir, apart from the Crasna, are the Colitca and Mortauta.

In 2008, Vârșolț Lake was given a "good" ecological status, corresponding to class II of quality for its physical-chemical features. The values of eutrophication parameters observed for each section and campaign: total mineral nitrogen, total phosphorus and phytoplankton biomass, placed the lake in the eutrophic stage given high concentrations of chlorophyll „a”, similar to its status in 2006 and 2007.

Specific indicators of eutrophication, i.e. total phosphorus, total mineral nitrogen, phytoplankton biomass and chlorophyll "a", placed the lake in the first two campaigns of 2008 (February and May) into the mesotrophic category. However, by the summer campaign (August), due to high temperatures and algae proliferation, values for total phosphorus and chlorophyll "a" rose. At the end of the biological cycle, the fall (October campaign) values recorded for the indicators total phosphorus and chlorophyll "a" decreased again.

The analysis of indicators of eutrophication in 2008 on the different sections (Bottom Lake, Middle Lake and Upstream dam-tower sections) and their qualitative classification according to Order no. 161/2006 of the Ministry for the Environment and Waters is presented in the table below.

Table 3

The analysis of indicators of eutrophication in 2008 on the different sections of Vârșolț Lake and their qualitative classification

Section	Point of sampling	Indicators of the degree of eutrophication								Final Framing
		Total Phosphorus μg/l	Framing	Total mineral Nitrogen μg/l	Framing	Phytoplankton biomass mg/l	Framing	Chlorophyll "a" μg/l	Framing	
Bottom lake	1	0.0165	Mezo-trophic	0.331	Oligotrophic	4.39	Mezo-trophic	35.52	Hypertrophic	Eutrophic
Middle Lake	3	0.0150	Mezo-trophic	0.308	Oligotrophic	4.75	Mezo-trophic	43.29	Hypertrophic	Eutrophic
Dam	3	0.0173	Mezo-trophic	0.319	Oligotrophic	5.41	Eutrophic	43.84	Hypertrophic	Eutrophic

The ichthyic fauna in 2008 was well represented by the following species: *Leuciscus cephalus* - 22 specimens/100 m², *Carassius gibelio* - 29 specimens/100 m², *Abramis brama* (Linnaeus, 1758) (freshwater bream) - 20 specimens/100 m², *Lepomis gibbosus* - 2 specimens/100 m², *Perca fluviatilis* - 27 specimens/100 m², *Rutilus rutilus* - 29 specimens/100 m², *Alburnus alburnus* - 4 specimens/100 m², Prussian carp (*Carassius* hybrid complex) - 4 specimens/100 m². The evolution of the ichthyic fauna may suffer interference as a result of watercourse obstructions and, thus, limiting the migration of fish towards breeding grounds, and leading to a decline in the size of fish populations.

The monitoring of water quality carried out to support fish life, according to Directive 78/659/EEC, transposed into Romanian legislation through Resolution 202/2002, have highlighted - from the perspective of mandatory values for quality indicators such as pH, ammonia, total chlorine residues and total zinc, respectively from the perspective of recommended values for indicators of suspension, i.e. BOD₅, total

phosphorus, nitrates, copper, ammonium – a series of nonconformities regarding the values of ammonium concentrations.

The evolution of the lake towards its eutrophic status is due to:

- overload of naturally existing nutrients both in the lake (before 1989 a number of 16 livestock farms operated upstream and whose wastewater led to the gradual accumulation of nutrients in the lake) and the springs of the Crasna, the most sizable contributor in terms of water (Crasna at Cizer: total nitrogen = 4.405 mgN / L, phosphorus from orthophosphates = 0.112 mgP / L)
- lack of infrastructure for collecting and treating wastewater in the villages located on the reception basin of the accumulation;
- the use of nitrogen- and phosphorus-based fertilizers; the flow velocity and consequently water quality are modified in the accumulation area; the resulting change in speed leads to the clogging of the lake because of reduced downstream sediment transport; this, in turn, leads to changes in the composition of the sub-layer as a result of heavy metals' and hydrophobic organic micro-pollutants' adsorption. In fact, the most accentuated clogging phenomenon in the Someș-Tisa river basin area has been observed at Vârșolț Accumulation (long retention time of approx. 120 days), located in an area with frequent soil erosion processes. The degree of clogging in 2002 was 17.6% compared to the total water and volume 23.1% of the usable water volume.

Conclusions. The different sections of the Crasna may be included in different quality classes established through Order no. 161/2006 of the Ministry for the Environment and waters as a result of human activities' impact, which affect the groups indicators relevant for establishing the degree of such impact.

If in the reference area of the Crasna, at Cizer, the determinants for establishing class II of quality were the ones in the "specific and toxic pollutants of natural origin" group, i.e. copper (7.13 mg / L) and lead (11.52 mg / L), in the next section, at Crasna, the same group of indicators, i.e. represented by copper (39.6 mg / L), lead (14.23 g / L), cadmium (1 mg / L) and iron (2.82 mg / L), placed the river in class III of quality status.

In the Supur section, relevant is the class of specific nutrients and pollutants, i.e. nitrites (0.062 mg / L), total phosphorus (1.371 mg / L), lead (11.32 mg / L), cadmium (1 mg / L) and iron (1.09 mg / L). The cumulative effect of these pollutants maintain the river in quality class III, while at Berveni, in the border area, the quality worsens to class IV, the result of the same group of indicators, but with much higher concentrations for ammonium (2.11 mg / L), phosphorus (1.28 mg / L), zinc (325.3 mg / L), lead (33.7 mg / L), cadmium (4 mg / L) and iron (1.17 mg / L).

The constant contamination of the Crasna with nutrients and heavy metals (originating either from natural sources, i.e. the lithological structure of the basin, or from industrial activity) has an acute effect over aquatic ecosystems, decreasing their role in maintaining a clean environment and diversity (Coșier & Petrescu-Mag 2008). The adaptation of aquatic organisms to contaminated environments is reflected in the food chain, the contamination of inferior species resulting in unpredictable outcomes for superior species of plants and animals.

Comparative studies of the ichthyic fauna concerning fish diversity and population density have underlined changes in their structures, but most striking is the level of bioaccumulation of toxic substances in aquatic organisms and in these conditions their responses to environmental changes.

Regarding the Vârșolț Accumulation area, a highly warped eutrophic ecosystem, the intensity of photosynthesis is reduced, the main source of oxygen being the phytoplankton, macrophytes and the phytobenthos, resulting in an even distribution of oxygen concentration throughout the lake. However, given the fact that the lake is situated in a hilly area, with periods of drought and flooding, therefore chances of flooding and variations in oxygen concentrations, photosynthesis also varies with oxygen content, ranging between oversaturation and anoxic states. These processes directly influence aquatic organisms, the ichthyic fauna in particular.

The improvement of waters' quality status, in particular where aquatic ecosystems have adapted to different degrees of contamination, may be achieved by environmental rehabilitation, aiming to "restore the physical, chemical and biological functions that existed before disruption" (Nate. Res. Council USA 1992, cited by Diaconu 1999) or "achieve a status approaching the original features of the ecosystem" (Hamilton 1990, cited by Diaconu 1999).

A restored ecosystem must acquire functional capabilities that permit it to function autonomously, where dominant species may be found, where there is diversity, productivity and a rhythm for the recycling of nutrients, features of an undisturbed ecosystem. The continuous monitoring of the ecosystem to record changes must be ensured through appropriate management that can place into balance the options and final targets of environmental rehabilitation, based on rigorous and integrated assessment of environmental factors. In this context, the implementation of programs for the ecological rehabilitation of the studied water flow is mandatory, so that the central objective of the Water Framework Directive 2000/60/EC, to achieve good environmental status for the resource area in 2015, may be achieved.

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Received: 17 April 2010. Accepted: 14 July 2010. Published online: 16 July 2010.

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How to cite this article:

Popa G., Bud I., 2010 The qualitative assessment of Crasna River in terms of Water Framework Directive 2000/60/EC and Directive 78/659/EC. *AACL Bioflux* **3**(2):103-117.

