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CARACTERISTICS OF THE LOWER DANUBE WATER BODIES BETWEEN PORTILE DE FIER (IRON GATES) AND ISACCEA

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Abstract

The main goal of the Water Framework Directive (2000/60/EC Directive) is the achievement of the "good status" of the water bodies, environmental objective which can be reached through elaboration and implementation of the River Basin Management Plan. According to the legal requirements, at the 22nd of December 2009, Romania has elaborated the first National Management Plan – synthesis of the River Basin Management Plans. This process assumes the types identification and water bodies delineation on the basis of some abiotic and biotic parameters, such: water category, abiotic and biotic typology, physical features, water status, pressures and their impacts, as well as protected areas. Therefore, for the lower Danube sector between Bazias and Isaccea 4 water bodies have been delineated: 2 reservoirs (Portile de Fier/Iron Gates and Ostrov) and 2 river sectors (Ostrov – Chiciu, Chiciu – Isaccea). The procedure for assessment of the environmental objectives risk failing (on the basis of pressures and impacts) has shown that all 4 water bodies have been identified at risk from the point of view of organic substances, nutrients, hazardous substances and hydro-morphological alterations. The Water Framework Directive defines the surface water status through: the ecological status - 5 classes (based on biological, hydro-morphological and physic-chemical elements) and chemical status – 2 classes (based on priority substances). In present, the 4 water bodies identified on the lower Danube sector do not reach the good status, being designated as heavily modified water bodies.
Keywords: typology, water bodies, pressures, impact, risk assessment, heavily modified water bodies, ecological status/potential, chemical status.

1. Recall of the Water Framework Directive requirements

The WFD establishes a framework for the protection of all waters (including inland surface waters, transitional waters, coastal waters and groundwater) which, according to article 1: *prevents further deterioration of, protects and enhances the status of water resources; promotes sustainable water use based on long-term protection of water resources; aims at enhancing protection and improvement of the*

aquatic environment through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances; ensures the progressive reduction of pollution of groundwater and prevents its further pollution; and contributes to mitigating the effects of floods and droughts.

The necessity of analyzing the anthropogenic pressures and their impacts is declared in the Article 5 of the Water Framework Directive (2000/60/EC Directive): "*Each Member State shall ensure an analysis of its characteristics, a review of the impact of human activity on the status of surface waters and on groundwater and an economic analysis of water use for each river basin district or for the portion of an international river basin district falling within its territory*". Also, Member States shall carry out an assessment of the susceptibility of the surface water status of bodies to the identified pressures. The result is an assessment of the likelihood that surface waters bodies within the river basin district will fail to meet the environmental quality objectives set for the bodies under Article 4. For those water bodies identified as being at risk of failing the environmental quality objectives, further characterization shall, where relevant, be carried out to optimize the design of both the monitoring programmes required under Article 8, and the programmes of measures required under Article 11.

The Water Framework Directive requires the achieving the objective of *good water status* (good ecological and chemical status for surface waters) by defining and implementing the necessary measures within integrated programmes of measures, taking into account existing Community requirements. Where good water status already exists, it should be maintained.

The ecological status represents the structure and functioning of aquatic ecosystems, defined according to the provisions of the Annex V of the Water Framework Directive, through biological quality elements, hydro-morphological and physico-chemical general elements as support elements for biological ones, as well as specific pollutants (synthetic and non-synthetic).

Member States may designate a body of surface water as artificial or heavily modified, when:

(a) the changes to the hydro-morphological characteristics of that body which would be necessary for achieving good ecological status would have significant adverse effects on: the wider environment; navigation, including port facilities, or recreation; activities for the purposes of which water is stored, such as drinking-water supply, power generation or irrigation; water regulation, flood protection, land drainage; or other equally important sustainable human development activities;

(b) the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or

disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option.

Such designation and the reasons for it shall be specifically mentioned in the river basin management plans required under Article 13 and reviewed every six years.

The good ecological potential and good chemical status are environmental objectives for artificial or heavily modified water bodies.

2. Typology and water body delineation

The WFD requires that for every surface water category, the surface water bodies shall be differentiated according their types. In Romania, for water courses, the typology has been defined following 3 steps: top down approach - typology based on abiotic descriptive parameters; bottom up approach - typology based on direct measurements of biological communities variability; superposition of the first 2 approaches.

The typology for the Danube River was defined based on: harmonized methodology within the GEF/UNDP Danube Regional Project "Typology and reference conditions for river Danube using national countries contributions"; and national methodologies, considering the abiotic and biotic parameters.

The analysis has led to the definition of 3 water bodies' types for the Danube River : **RO12 – Danube River – Gorges**: ecoregion 12 (Pontic province); Geology: calcareous; catchment area: very large; altitude: 100-200 m; **RO13 – Danube River – Gorges – Calarasi**: ecoregion 12 (Pontic province); Geology: siliceous; catchment area: very large; altitude: 5-70 m; **RO14 - Danube River – Calarasi - Isaccea**: ecoregion 12 (Pontic province); Geology: siliceous; catchment area: very large; altitude: 5 m.

The Water Framework Directive defines a body of surface water as a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water.

In Romania, the following steps have been taken into consideration in the process of surface water delineation: identification of categories limits of surface waters; identification of types limits of surface waters; identification of water bodies limits using physical characterization; identification of limits of water bodies based on other criteria: surface water status, protected areas location, hydro-morphological alterations.

For the Danube River, 4 water bodies (WB) have been delineated (excluding Danube Delta): **WB 1 (Bazias - Iron Gate dam)** - WB length 132 km (km 1075-943); **WB 2 (Iron Gate dam - Ostrov)** - WB length 80 km (km 943-863)**; WB 3**

(Ostrov - Chiciu) - WB length 487,5 km (km 863-375.5); **WB 4 (Chiciu - Issacea)** - WB length 275,5 km (km 375.5-100).

3. Assessment of risk of failing the environmental quality objectives

The main steps for pressures and impact assessment are: identification of driving forces and pressures; identification of significant pressures; impact evaluation; assessment of risk of failing the environmental quality objectives.

For pressures and impact assessment the DPSIR (Driver-Pressure-State-Impact-Response) concept is used. Thus, there is necessary to include information on drivers (anthropogenic activities that may have an environmental effect), pressures (the direct effect of the driver, for example, an effect that causes a change in flow or a change in the water chemistry), state (the condition of the water body resulting from both natural and anthropogenic factors, for example: physical, chemical and biological characteristics), impact (the environmental effect of the pressure, for example: algal growth/eutrophication) and response (the measures taken to improve the state of the water body).

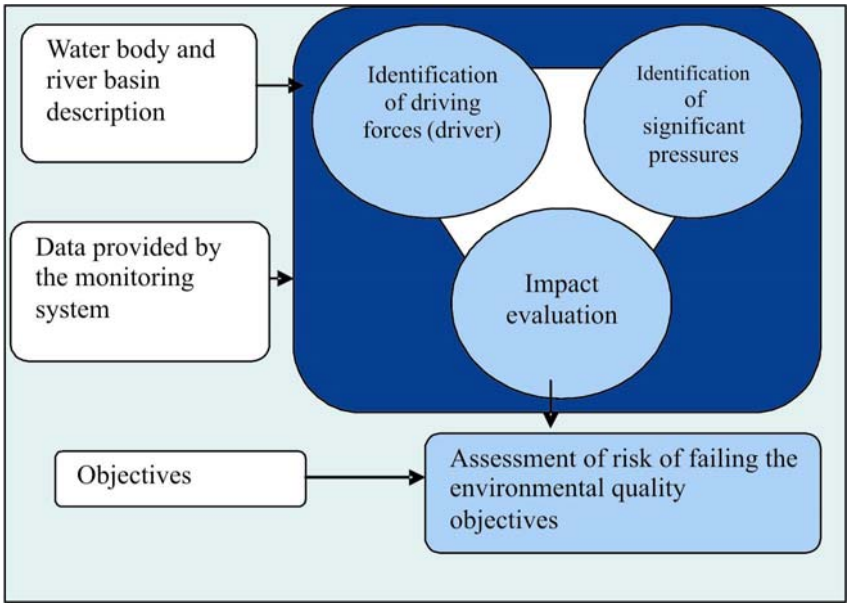

Fig. 1. Pressure and impact assessment

The pressure and impact assessment is used in the processes of water body delineation, water body characterization, water body classification (in 3 categories: natural, heavily modified and artificial water bodies), establishing the

program of measures (especially the supplementary measures), application of cost effectiveness and cost benefit analyses and application of exemptions.

The following significant pressures have been identified for the studied Danube water bodies: **hydro-morphological alterations and pollution: point and diffuse sources**. The Danube River is characterized by numerous hydro-technical structures with the most important uses: hydropower, flood protection, navigation and urbanization.

For the Danube River on the Romanian territory, the social and economical activities have played an important role, which have led to significant morphological and hydrological alterations in the last decades.

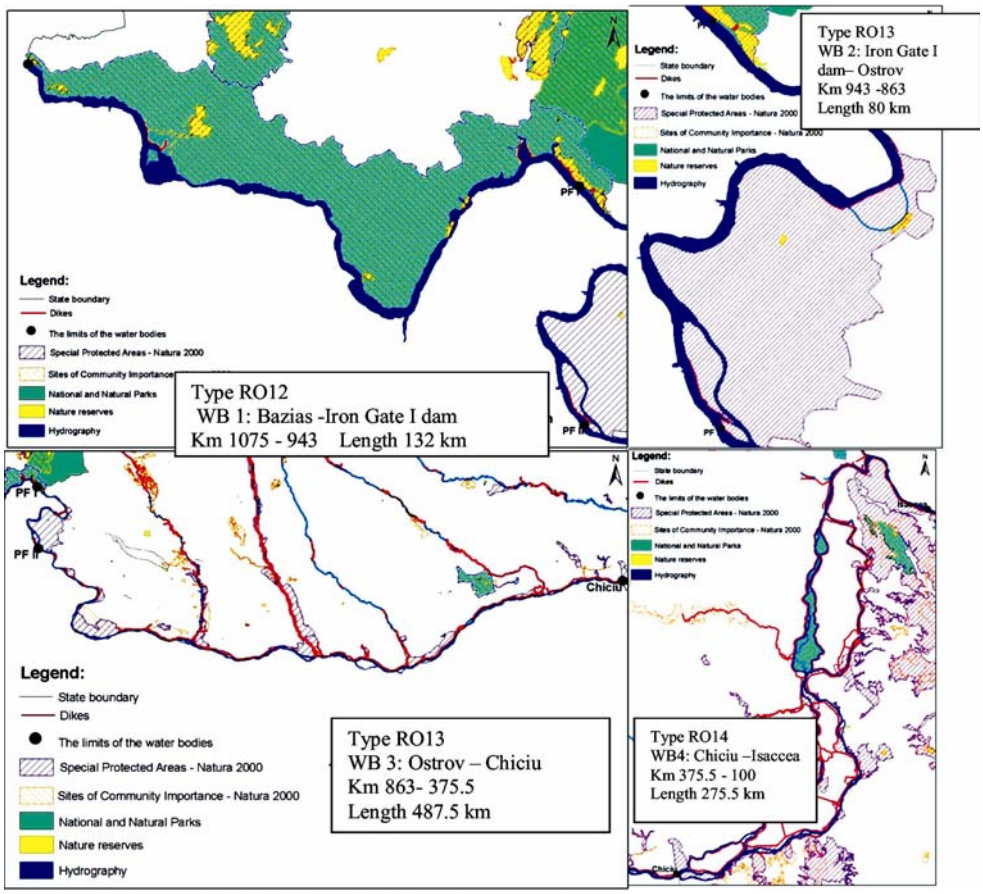

Fig. 2. The Danube River Water Bodies and hydro-morphological alterations

The main **hydro-morphological alterations** located on the above mentioned water bodies and their effects are: **a. transversal barriers (dams)**: WB 1 and 2 (Iron Gates I and Ostrov) with interruption of the longitudinal connectivity, changing the water bodies' category (from river to reservoir) and with multiple effects

on aquatic fauna and flora; **b. extensive embankment**: WB 3 - Ostrov – Chiciu (embankment: 73 %); WB 4 - Chiciu – Isaccea (embankment: 92 %); these embankments have caused the interruption of lateral connectivity, habitats changes, loss of spawning areas and other services ensured by wetlands; **c. navigation**: for all river sectors (WB 1, WB 2, WB 3, WB 4).

For the lower Danube, a significant surface of wetlands and flood plain has been lost (473,556 ha).

The hydrological alterations consist in a slight increase of the flow peaks with about 5%; a big decrease of sediment discharge caused by hydraulic works from the Danube basin (69.4 · 106 t/y – at the beginning of the 20th century; 53 · 106 t/y – at the beginning of the '50s; 30 · 106 t/y – at the late '80s; slight increase in the last period).

The **human agglomerations, the industry and agriculture** contribute significantly through point and diffuse sources to the Danube water bodies pollution with organic substances, nutrients and hazardous substances. At the national level, there have been inventoried a number of 1764 point sources, out of which 947 (436 agglomerations, 325 industrial sources, 181 agricultural sources and 5 other types) are significant taking into consideration criteria of significance. Some of these sources directly discharge in the Danube Water Bodies, but the majority discharge into Danube tributaries. Also, the status of the Danube river on the Romanian territory highly depends on the pollutant inputs (especially nutrients and heavy metals) from upstream countries of the entrance of the Danube river into Romania.

The impact evaluation process is based on comparing water body status with environmental objectives defined for the analyzed water body. In the framework of significant water management issues process, there have been identified 4 categories of major issues: pollution with organic substances, pollution with nutrients, pollution with hazardous substances and hydro-morphological alterations, for which the impact has been evaluated and there have been established specific measures in order to reach the environmental objectives.

The pollution with organic substances produces a significant impact on aquatic ecosystems measures through species composition changes, species biodiversity decreasing, as well as reduction of fish fauna population or fish mortality in the context of a drastic reduction of dissolved oxygen concentration.

The nutrients in high concentration in the water bodies lead to excessive algal growth (eutrophication), especially for stagnant or semi-stagnant water bodies (lakes, reservoirs, shallow rivers running with reduced water velocity), determining species composition changes, species biodiversity decreasing, as well as reduction of water use (drinking water and recreation, etc.).

The hazardous substances produces toxicity, persistence and bioaccumulation in the aquatic environment. In the process of risk assessment with hazardous substance the lack of monitoring data should be mentioned.

The procedure for assessment of the environmental objectives risk failing (on the basis of pressures and impacts) has been shown that all **4 water bodies have been identified at risk from the point of view of organic substances, nutrients, hazardous substances and hydro-morphological alterations**.

4. Heavily modified water bodies designation

Heavily modified water body means a body of surface water which as a result of physical alterations by human activity is substantially changed in character.

The identification and the designation of the Danube water bodies as heavily modified are based on a step-wise approach (steps 1-8) described in the Guidance document no.4 "Identification and Designation of Heavily Modified and Artificial Water Bodies", following the principles of Art. 2 (9) and Art. 4(3) of the Water Framework Directive.

The designation of the Danube River as heavily modified water bodies is the result of a long series and in-depth discussions and analysis, a wide range of universities, institutions and organizations being part of this comprehensive process. The identification of the Danube WBs as heavily modified has been assessed in respect of being physically altered, substantially changed in character with extensive/widespread, profound, and irreversible alterations.

The assessment of failing good ecological status has been considered as the first step (the precondition) in the process on the national and basin-wide final heavily modified designation of the Danube water bodies.

5. Assessment of ecological status/potential and chemical status

The assessment of the ecological status has been based on the Water Framework Directive compliant assessment method developed upon the specific types of the Romanian stretch of the Danube river, which has been derived from: national data - historical data (starting from 1910,1950-1960), reliable empirical data, statistical analyses (recent data from 2001-2007), expert judgment; joint Danube Survey I and Joint Danube Survey II data as a supportive tool in the national assessment process of the Danube River.

Nevertheless, one of the most restrictive issues in the assessment of the Danube River's water bodies was the difficulty to estimate the reference conditions for considered quality elements.

The application of the assessment system for the Danube River based on the improved conceptual and analytic framework considering the Lower Danube river as complex systems / "land-waterscape" (defined by complex and strong

interactions and interdependences among the main river channel and the lentic, lotic and terrestrial – aquatic ecosystems of its floodplain) has led to the conclusion that the 4 analyzed water bodies are not in good ecological status.

The ecological status assessment based on compliant methods, has considered the following quality elements: macro-invertebrates, fish fauna and phytoplankton (based on the "**worst case" approach**), the general physical and chemical conditions, specific pollutants and hydro-morphological conditions. The detailed results of the ecological status/potential and chemical status evaluation for the Danube water bodies are presented in the table 1.

Table 1. Danube water bodies ecological status/potential and chemical status assessment

Water Body	River Type	Biological Quality Elements					Hydro-morphology	General Physical and Chemical Conditions	Specific Pollutants (Good or Failing) for Ecological Status	Overall ecological status	Confidence class for overall ecological status					
		Fish	Benthic invertebrates	Phytobenthos and Macrophytes	Phytoplankton	Overall biological status						Heavily Modified Water Body	Overall Ecological Potential	Confidence Class (overall ecological potential)	Chemical Status	Confidence Class (chemical status)
WB 1	RO12	P	P	Z	G	P	B	G	G	P	Med	Yes	M	L	F	Med
WB 2	RO12	P	P	Z	G	P	B	G	G	P	Med	Yes	M	L	F	Med
WB 3	RO13	M	P	Z	G	P	B	G	G	P	Med	Yes	M	L	F	Med
WB 4	RO14	G	P	Z	G	P	P	G	G	P	Med	Yes	M	L	F	Med

Legend: Ecological status/potential classes: H-high; G-good; M-moderate; P-poor; B-bad; Z-unknown. Chemical status classes (based on priority substances): G-good; F-failing. Confidence classes in status/potential assessment: Med – medium and L – low.

Conclusions

The main goal of the Water Framework Directive is the achievement of the good status of the water bodies, environmental objective which can be reached through elaboration and implementation of the River Basin Management Plan. The River basin Management Plans shall contain a summary of significant pressures and impact of human activity on the status of surface water and groundwater, including: estimation of point source pollution; estimation of diffuse source pollution, including a summary of land use; estimation of pressures on the quantitative status of water including abstractions; analysis of other impacts of human activity on the status of water.

For the Danube River, all 4 water bodies have been identified as heavily modified water bodies because of hydro-morphological alterations and also all water bodies are at risk from the point of view of organic substances, nutrients, hazardous substances.

The water bodies identified on the lower Danube sector do not reach the good status, being necessary measures aiming at reduction of the pollution from human agglomerations, industry and agriculture, both at the national level and in the entire Danube International Hydrographical District, as well as the restoration of the Danube flood plain, having in view the wetlands with specific habitats and biodiversity.

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