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THE ANALYSIS OF THE ANTHROPOGENIC PRESSURES AND THEIR IMPACTS OF THE DANUBE RIVER IN LOWER SECTOR

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Abstract

It is known that the water resources are subject to different anthropogenic pressures as result of human activities such as discharges of untreated or insufficient treated municipal and industrial wastewaters, intensive agriculture and extensive farming, hydromorphological changes and other activities. An assessment of the susceptibility of the lower part of the Danube River surface water bodies to different type of pressures was carried. Based on this, pollution by organic matter, nutrients and priority substances as well as hydromorphological alterations have been identified as significant water management issues. This was an intermediate step in identifying the water bodies at risk of failing the environmental quality objective of surface waters laid down in the Water Framework Directive 2000/60/EC (WFD). The entire analysis will help in designing robust monitoring programmes and establishing appropriate programme of measures with the final goal of reducing or phasing out of pollution with these types of substances and ensuring the WFD environmental objectives.

Keywords: significant pressure, impact, water body, risk assessment

1. INTRODUCTION

The main goal of the WFD is the achievement of the "good status" of the water bodies by 2015. In order to reach the environmental objective of the WFD, the Member States, including Romania had to develop a Management Plan for each of their River Basin District (i.e. Danube RBD for Romania) by 2009. For instance for the Romanian part of the Danube River, each River sub-basin District (i.e. Banat, Jiu, Olt, Arges-Vedea, Buzau-Ialomita and Dobrogea) has its own management plan for ensuring pollution prevention and control of various related to water resources. An important intermediate step in elaboration of the River Basin Management Plan was the assessment of pressures and impacts which leads to the identification of the water bodies which are at risk of failing the WFD environmental quality objectives. According to Article 5 of the WFD, Romania has produced this analysis in 2005 and it has been updated in 2009 in the River Basin Management Plans.

2. METODOLOGY

The methodology applied for the Danube River and used by Romania in both reports (River Basin Analyses and River Basin Management Plans) indicated above is described below. There are four important steps to be followed in order to assess the pressures and their impacts: identification of activities that constitute a pressure, identification of significant anthropogenic pressures, assessment of impacts of those significant pressures and establishment of water bodies at risk of failing to achieve environmental objectives of the WFD. The following intermediate steps have been conducted to complete this analysis:

- description of the water body;
- the monitoring date have been check against anthropogenic activities in order to identify the pressures which may cause the failure of the WFD environmental objectives;
- establishment of environmental objectives for each water body according to Article 4 of the WFD .

The concept of DPSIR (Driver-Pressure-State-Impact-Response) is the basis of type of analysis (see Figure 1). A pressure is considered significant when this generate the failure of the WFD environmental objectives for the water body of concern. It can be possible to judge whether a pressure may cause a certain impact based on the way of functioning of the water body catchment area. This approach correlated with the list of all pressures and characterises of the catchment area is used at the identification of significant pressures.
Another option is to compare the magnitude of the pressure with a certain criterion or limit value (i.e. the emission limit values and the environmental quality standards laid down by EU legislation) for the water body of concern.

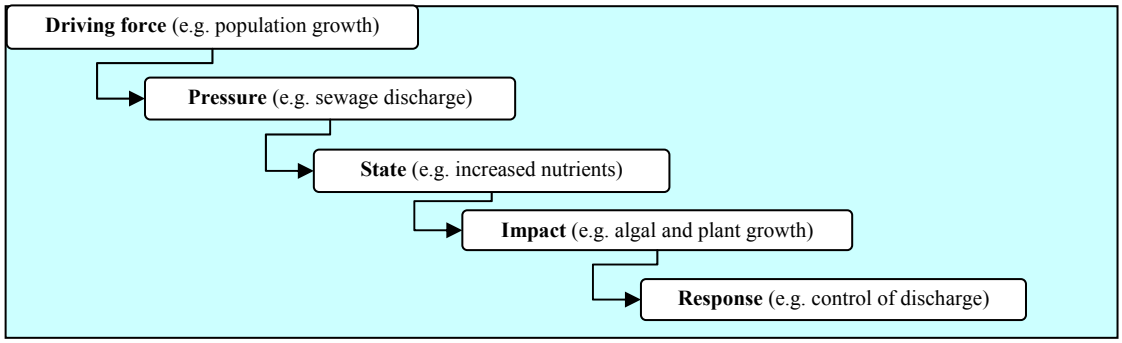

Figure 1. An illustration of the DPSIR analytical framework

For example, in practice, in Romania, the following set of criteria has been applied for the identification of significant point pollution sources:

1. Treated or untreated waters discharged into the water resources from human agglomerations with more than 2000 population equivalent (p.e.), identified according to the requirements of the Urban Waste Water Treatment Directive 91/271/CEE (UWWTD), which have collection systems of waste waters with or without treatment stations. Also, the human agglomeration with less than 2000 p.e. are considered significant point source of pollution if they have centralised sewage systems and those with unitary sewage systems which have the capacity to collect and treat the raw storm sewage during the periods with heavy rains.
2. Treated or untreated waters discharges into the water resources from industry:
    a. Installations reported under the Directive concerning integrated pollution prevention and control 96/61/EC (IPPC Directive), including the installations from the European Pollutant Register (EPER) or the European Pollutant Release and Transfer (E-PRTR) which are relevant for water compartment;
    b. Installations discharging dangerous substances above the limits sets by Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment;
    c. Other installations discharging industrial waste waters into the water resources without complying with the water legislation.
3. Treated or untreated waters discharges into the water resources from agricultural activities:
    a. Stock farms reported under IPPC Directive, including the those from EPER which are relevant for water compartment;
    b. Farms discharging dangerous substances above the limits set by Directive 2006/11/CE;
    c. Other agricultural units with point discharge without complying with the current legislation regarding the water field.

Also, for diffuse pollution sources and hydromorphological alterations, sets of criteria for identification of significant pressures have been developed.

3. RESULTS

As result of applying the criteria mentioned above for the lower part of the Danube River (Romanian part), 38 point sources have been identified as being significant (15 due to urban activities, 15 from industrial and agricultural activities). The characterisation of main categories of point and diffuse sources as well as of those hydromorphological is presented further below.

3.1 Human agglomeration pollution sources

In accordance with the requirements of the UWWTD, waste waters which may contain urban waste waters or a mixture of these waters, industrial and run-off waters are first of all collected in the sewer system, then adequately treated and discharged in the water resources respecting the maximum allowable concentrations. As regards the implementation of this Directive, Romania has obtained a transition period of maximum 12 years from moment of accession to the EU (meaning 31 December 2018). Consequently, there are human agglomerations which are not yet compliant with these requirements not having adequately collection systems and/or treatment stations (at least primary and secondary treatment for human

agglomerations with 2000 – 10000 p.e. plus tertiary treatment for nutrient removal for human agglomerations with more than 10000 p.e.).

Figure 2 shows the human agglomerations with more than 2000 p.e. discharging treated/untreated waste waters into the Danube River and the type of existing treatment stations. The analysis of data from 2007 has underlined the fact that human agglomerations such as Calafat, Calarasi, Zimnicea, Turnu Magurle, Giurgiu and Oltenita have an important contribution with organic matters and nutrients to the Danube River.

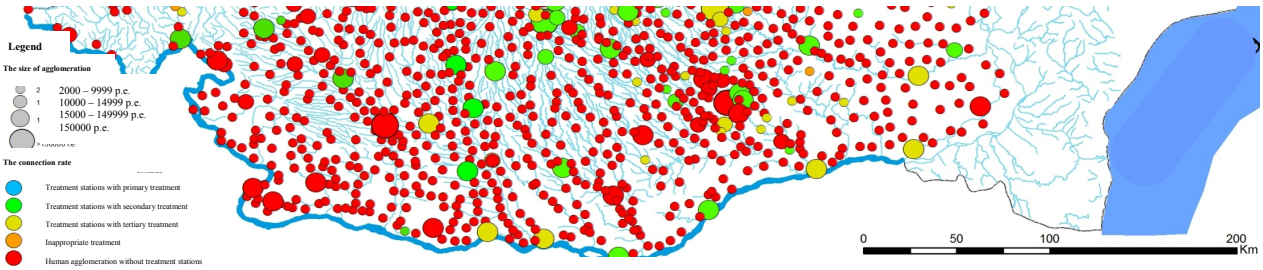

Figure 2. Human agglomeration and treatment station

3.2 Industrial and agriculture sources of pollutions

Industrial and agriculture sources of pollution contribute to the pollution of water resources due to the input of pollutants coming from different type of activities. As regards the discharges of pollutants in the Romanian part of the Danube River, the industrial sources like food, chemical and petrochemical, pulp and paper and fertilizers industry and agriculture sources like livestock farms have a significant contribution with organic matters, nutrients and metals. The significant industrial and agriculture point sources along the Danube River could be observed in Figure 3.

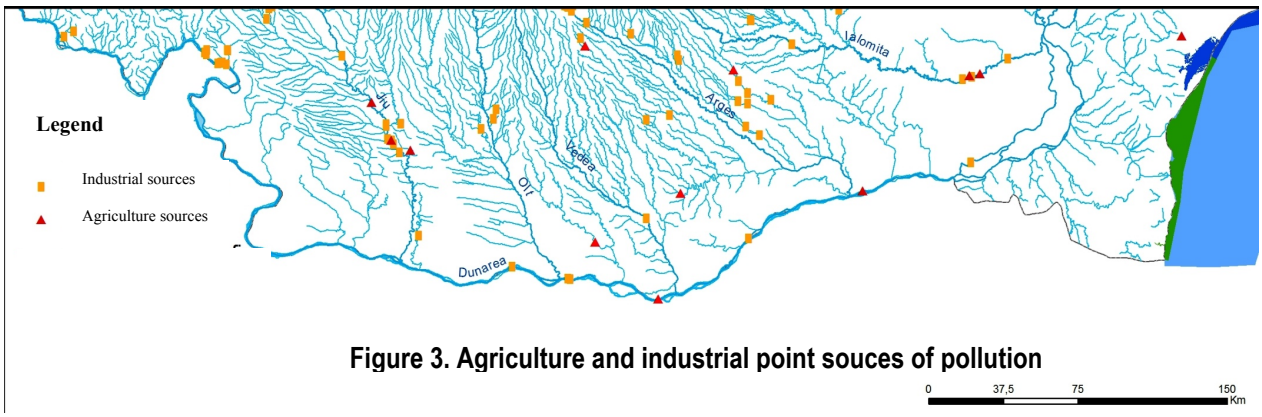

Figure 3. Agriculture and industrial point souces of pollution

3.3 Significant diffuse sources, including the land use

MONERIS model (MOdelling Nutrient Emissions in RIver Systems) was developed and applied for the evaluation of nutrients emissions (nitrogen and phosphorous) in many basins/districts from Europe, including the Danube basin/district. Apart from point sources (from municipal waste water treatment plants and direct industrial discharge), MONERIS model takes into consideration the following pathways responsible for the diffuse pollution: atmospheric deposition, groundwater, tail drainage, urban areas e.g. (paved urban areas, precipitation run-off), soil erosion and overland flow (e.g. surface runoff).

The groundwater run-off represents the main way of diffuse emission for nitrogen and the run-off from impermeable sources has the biggest contribution to the diffuse emission of phosphorous. Furthermore, MONERIS model quantifies the input of various sources of pollution to the total emission of nutrients. For example, the categories responsible for diffuse sources of pollution are agriculture, municipalities, others (i.e. atmospheric deposition of nitrogen oxide) as well as the natural background. It should be stressed that MONERIS model takes into account all type of sources not only the significant ones.

For the Romanian part of the Danube River, the greatest part of the nitrogen emission quantity from diffuse sources is due to the agriculture activities conducting to a specific emission of 2.82 kg N/ha agricultural area. 43 % of total diffuse emission of phosphorous is caused also by agriculture activities contributing with approx 227 t P/y which represents a specific emission of 0,24 kg P/ha agricultural area.

3.4 Sources potentially generation accidental pollution

In general, these types of sources are units which uses, produces, stocks and discharges substances that may end up accidentally in the water resources. The accidental pollution can have local, basin or transboundary impact. The information concerning the accidental pollution with transboundary effect is transmitted using Accidental Emergency Warning System (AEWS) developed at International Commission for the Protection of the Danube River (ICPDR) level.

In 2007, 5 accidental pollutions with petroleum products have been registered in the Romanian part of the Danube River. The sources responsible for these types of accidents are sometimes unknown or are bilge waters. The causes of accidental pollution are: careless of the water users during the technological processes lack of technological processes upgrading for some industrial units, broken of the pipelines used for the transport of petroleum products as result of fuel's stealing or their depreciation. These events registered small and medium amplitude and no sever effects on the water resources or water users.

The ICPDR methodologies establishing the water risk index and identifying contaminated areas with potential elevated risk have been applied for the lower part of the Danube River. As result, none industrial sources have been identified as potential accidental risk spots and only one location (i.e. Turnu Magurele) was determined as having potential relevant risk (100).

3.5 Significant hydromorphological pressures/alterations

It is necessary to make an inventory of the type and magnitude of hydromorphological pressures and to monitor them in each river basin in order to identify and designate the heavily modified water bodies and as well as for the establishment of the restoration or attenuation measures.

Based on the results of the UNDP-GEF Regional Project for the Danube River, Romania has defined its own criteria for the identification of significant hydromorphological pressures which are taking into consideration the types of hydrotechnical works, the magnitude of the pressure and their effects on the ecosystems.

The following hydromorphological pressures affect most parts of the Romanian part of the Danube River:

- *Water flow regulations and embankments*

Water flow regulations and embankments generate changes in the watercourses morphology, alterations of hydraulic characteristics and interruptions of lateral connectivity. The Romanian sector of the Danube River is 80% embanked alternating with few areas with regime of free running. The most affected part of the lower Danube is situated between km 604-182.5. The dikes are located at 200-300m distance from the de watercourse and their main scope is to prevent flooding. The construction of dikes on the Romanian bank of the Danube River started in 16th century. These works have been raised in 19th and 20th centuries, especially at the end of 50th years (Figure 4). Currently, the percentage of embankments for Porțile de Fier II – Calarasi sector is 73%, 92% for Calarasi – Braila sector and 83% for Braila - Ceatal Ismail sector.

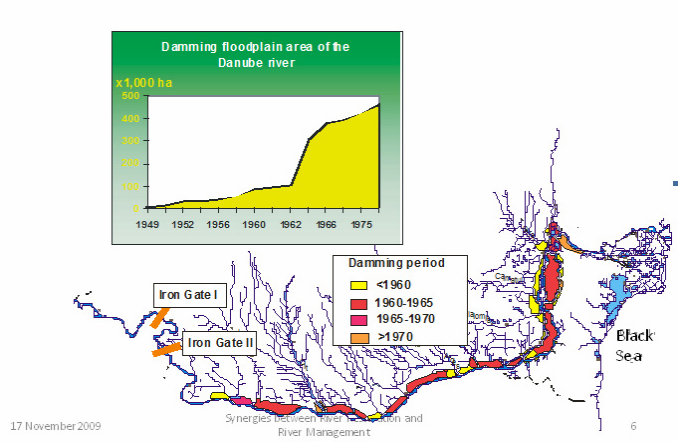

Figure 4. Lateral and longitudinal connectivity affected by specific works

In addition, the flow regulation of Sf. Gheorghe arm took place in 1980 which conducted at shortening of its length and changes in morphology. The hydrotechnical works done after 1983 for agricultural purposes registered great amplitude, the surface embanked rising from 24.000 ha to 103.000 ha.

As regards the Danube Delta, from the total number of 73 (988 km length) only 13 (166 km length) have been classified as being significant.

- *Significant water abstractions/restitutions*

Water abstractions and restitutions (discharges) generate significant hydromorphological alterations consisting in changes of characteristics of watercourses located at the water intake and the water discharges having an important sample flow rate. 4 significant water abstractions have been identified along the lower part of the Danube River.

- *Navigable channels*

Navigation represents a significant pressure for the whole Romanian part of the Danube River due to the changes in river morphology and accidental pollution of waters. Moreover, the hydroenergetic system between Iron Gate I and Iron Gate II exploited though a Romanian-Serbian partnership is a work of transversal barring which has major effects consisting in interruption of longitudinal connectivity and alteration of hydromorphological characteristics.

The Pan European Transport corridor ensures the link between fluvial Danube (from the entrance in Romania to Tulcea), navigable channel Danube – Black Sea and the maritime Danube (from Tulcea to the Danube outlet in the Black Sea), and the good navigation conditions of the Danube being very important strategically. The minimum depth for a navigation in safety conditions in the fluvial Danube is approximately 2.5 m and in the maritime Danube about 7 m. Sulina arm was transform into a maritime navigable channel through complex and expanded hydrotechnical works leading at shorten it with approximately 21 km (from 85 to 64 km) and a relatively constant depth of 7,3 m (initially being 2,5 m).
According to the Romanian Annual Statistics Book, there are 17 ports on the Romanian part of the Danube River. 5 ports out of 17 (Turnu – Severin, Giurgiu, Calarasi, Galati and Tulcea) are considered significant pressures to the Danube River.

The gravel pits constitutes another category of hydromorphological pressures having effects on the changes in the shape of the longitudinal profile, the variability of deposits from the river bad and the degradation process, especially the erosion. Based on the inventory of gravel pits made in 2006, a medium volume of 338913,95 mc was extracted at the level of whole Romanian part of the Danube River.

3.6 Other type of anthropogenic pressures

It was observed that the biological pressures owed to the invasive species or introduction of some flora and fauna species could radically deteriorate the biocenosis structure of those aquatic ecosystems. As regards the fish populations, the first indications of existence in the Danube Delta of some exotic fish species were made at the begging of 1960. Their appearance has generated o couple of pressures on indigene fauna which has finally conducted in some cases to the decline or losses of some sensitive native species. For example, the invasion of crucian crap (*Carassius carassius*) in the entirely Danube basin after 1970 has determined the structure changes of capture species. This species has become dominant due to an effective invasion strategy with impact on native species. In addition, the Chinese species introduced for fish farming after 1960 entering into the natural environment, some of the species (*Hypophthalmichthys molitrix*) reproducing in natural conditions in some favourable years. Other exotic species artificially introduced in the Danube Delta are: *Mugil soiuy, Pseudorasbora parva* (accidentally introduced with the Chinese species) and *Lepomis gibbosus*.

4. CONCLUSION

The impact assessment of anthropogenic pressures consists in comparing the water body status with its environmental objectives if monitoring data are made available. The impact assessment is a crucial step for the characterisation of the water body's status, establishment of the supplementary measures, application of the cost effectiveness and cost benefit analysis as well as for the application of the exemptions from the environmental objectives. The following significant water management issues: pollution with organic substances, pollution with nutrients, pollution with hazardous substances and hydromorphological alterations have been identified at the level of the lower part of the Danube River. *Pollution with organic matter* is due to emissions/discharges of waste waters coming from point and diffuse sources, in particular from human agglomerations, industrial and agriculture sources. The lack or insufficient treatment of waste waters lead to the pollution of water resources consisting in their degradation and oxygen consumption. The pollution with organic matter has a significant impact on the aquatic ecosystems such as changing in species composition, the decrease of species biodiversity as well as the reduction of fish population or even fish mortality as result of sever decrease of oxygen concentration.

Another important problem for water management is *the pollution with nutrients* (nitrogen and phosphorous). The nutrients emissions are also generated on one hand by point sources (insufficient or untreated industrial, agriculture and urban waste waters) and on the other hand by diffuse sources (especially those from agriculture like stock farms, use of fertilisers). The nutrients pollution leads to the water eutrophication (nutrient enrichment and excessive algae bloom), especially for stagnant or semi-stagnant water bodies (lakes and reservoirs, shallow rivers with slow moving water), determining changing in species composition, the decrease of species biodiversity as well as the reduction of water resources use (e.g. drinking water, recreation, etc.).

Pollution with dangerous substances is caused by the discharge of waste waters from point sources or the emissions of non synthetic pollutants (heavy metals) and/or synthetic pollutants (organic micropolutants) from diffuse sources. Dangerous substances are toxic, persistent and bioaccumulative in the aquatic environment. Due to the lack or insufficient monitoring data for dangerous substances, the level of confidence of the risk assessment was low or medium.

Hydromorphological pressures have an influence on the specific hydro-morphologic characteristics of surface waters and trigger an impact on the ecosystem status. The result of hydrotechnical works like transversal barriers (e.g. dams, weirs) is the interruption of river longitudinal connectivity with effect on the hydrological regime, sediment transport and moreover on biota migration. The works along the rivers (e.g. dykes, embankments, flow regulation) lead to the interruption of lateral connectivity of the water bodies with floodplain and the reproduction zones with a final result of status degradation. Water abstractions/restitutions produce effects on hydrological regime and biota status.

The impact of hydromorphological alterations on the water body status consist in obstruction of fish migration, decrease of natural reproduction of fish population, the reduction of biodiversity and species abundances as well as the alteration of population composition. However, there is an insufficient knowledge at EU level regarding the relation between the hydromorphological pressures and their impact, most of the time the different type of pressures acting synergistically making difficult the evaluation of effect related to a certain pressure.

The analysis carried out for the Romanian part of the Danube River has showed that all waters bodies are at risk of not achieving the environmental objectives by 2015 due to the pollution sources coming from Romania but also from upstream countries and tributaries to the Danube River as well as to the hydromorphological alterations.

REFERENCES

Gâştescu,P.,Ţuchiu, Elena, (2012), *The Danube River in the lower sector in two hidrologycal hypostases - high and low waters,* Riscuri şi catastrofe,Casa cărţii de ştiinţă, Cluj-Napoca, an X, vol.10, nr.1

Mihailovici, J., Gabor, O., Şerban, P., Rândaşu, S. (2006), *Soluţii propuse pentru pentru reamenajarea fluviului Dunărea pe* sectorul românesc, Hidrotehnica, vol. 51, nr. 5

Şerban, P., Ţuchiu, E. (2003), *Instrucţiuni metodologice privind identificarea surselor punctiforme şi difuze de poluare şi evaluarea impactului acestora asupra apelor de suprafaţă,* Bucureşti.

Ţuchiu, E. (2010), *Analiza presiunilor antropice şi a impactului acestora asupra corpurilor de apă de suprafaţă-etapă importantă în realizarea planurilor de management*, în Gastescu, P., Bretcan, P. (ed.) (2010), Resursele de apă din România-vulnerabilitate la presiunile antropice, Lucrările primului simpozion naţional al Asociaţiei Române de Limnogeografie, Târgovişte.

***, (2000), *Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*, Official Journal of the European Communities;

***, (2003), *Common Implementation Strategy for the Water Framework Directive (2000/60/EC)– Guidance for the analysis of pressures and impacts in accordance with the Water Framework Directive,* European Commission.

***, (2008), *Elemente metodologice privind identificarea presiunilor semnificative şi evaluarea impactului acestora asupra apelor de suprafaţă – Identificarea corpurilor de apă care prezintă riscul de a nu atinge obiectivele Directivei Cadru Apă,* Administraţia Naţională "Apele Române", Bucureşti;

***, (2010), *Planul Naţional de Management aferent porţiunii naţionale a Bazinului Hidrografic internaţional al Fluviului Dunărea-sinteza planurilor de management la nivel de bazine/spaţii hidrografice*, Administraţia Naţională "Apele Române", Bucureşti.