Joint Monitoring of a Shared International River Basin - The Danube

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ICPDR

The International Commission for the Protection of the Danube River (ICPDR) is an international organization consisting of 13 cooperating states and the European Union. Since its establishment in 1998, the ICPDR has grown into one of the largest and most active international bodies of river basin management expert in Europe. ICPDR deals not only with the Danube itself, but also with the whole Danube River Basin, which includes also its tributaries and the ground water resources.

The ultimate goal of the ICPDR is to implement the Danube River Protection Convention (DRPC) and make it a living tool. Its ambitious mission is to promote and coordinate sustainable and equitable water management, including conservation, improvement and rational use of waters for the benefit of the Danube River Basin countries and their people. The ICPDR pursues its mission by making recommendations for the improvement of water quality, developing mechanisms for flood and accident control, agreeing standards for emissions and by assuring that these are reflected in the Contracting Parties' national legislations and applied in their policies.

ICPDR monitoring programme

Provisions of the DRPC include the need for cooperation in the field of monitoring and assessment, which is accomplished through the operation of the Trans National Monitoring Network (TNMN) in the Danube River Basin. The TNMN has been in the operation since 1996 but the first steps towards it were taken ten years earlier under the Bucharest Declaration, when a monitoring programme was established containing 11 transboundary cross sections on the Danube River.

The original objective of the TNMN was to strengthen the existing network set up by the Bucharest Declaration, to enable a reliable and consistent trend analysis for concentrations and loads of priority pollutants, to support the assessment of water quality for water use and to assist in the identification of major pollution sources.

In 2000, having the experience of the TNMN operation, the main objective of the TNMN was reformulated: to provide a structured and well balanced overall view of the status and long-term development of quality and loads in terms of relevant constituents in the major rivers of the Danube Basin in an international context.

The TNMN laboratories have a free choice of an analytical method, providing they are able to demonstrate that the method in use meets the required performance criteria. Therefore, the minimum concentrations expected and the tolerance required of actual measurements have been defined for each determinand so that the method compliance can be checked. To ensure the quality of collected data a basin-wide AQC programme is regularly organized by the ICPDR.

During first ten years of its operation TNMN network comprised over 75 water quality monitoring stations and more than 50 chemical, biological and microbiological parameters were investigated. Ten years of TNMN operation provided an excellent overview of the water quality in the Danube River Basin. It gave decision-makers data to make the right policy and investment decisions to improve water quality.

Implementation of the EU Water Framework Directive (WFD) after 2000 necessitated the revision of the TNMN in the Danube River Basin District. In line with the WFD implementation timeline, a revised TNMN has been under operation since 2007.

The major objective of the revised TNMN is to provide an overview of the overall status and long-term changes of surface water and – where necessary – groundwater status in a basin-wide context with a particular attention paid to the transboundary pollution load. In view of the link between the nutrient loads of the Danube and the eutrophication of the Black Sea, it is necessary to monitor the sources and pathways of nutrients in the Danube River Basin District and the effects of measures taken to reduce the nutrient loads into the Black Sea.

To meet the requirements of both EU WFD and the Danube River Protection Convention the revised TNMN for surface waters consists of following elements:

- Surveillance monitoring I: Monitoring of surface water status
- Surveillance monitoring II: Monitoring of specific pressures
- Operational monitoring
- Investigative monitoring

Surveillance monitoring I: Monitoring of surface water status

The design of surveillance monitoring I (SM 1) is based on WFD Annex V, 1.3.1. The monitoring network is based on the national surveillance monitoring networks and the operating conditions are harmonized between the national and basin-wide levels to minimise the efforts and maximise the benefits. The objective of SM 1 is to provide an assessment of the overall surface water status in the Danube River Basin District. More specifically, monitoring will provide information for:

- Supplementing and validating the risk assessment detailed in the Danube Basin Analysis (WFD Roof Report 2004) according to Annex II WFD;
- The efficient and effective design of future monitoring programmes;
- The assessment of long-term changes in natural conditions;
- The assessment of long-term changes resulting from widespread anthropogenic activity.

The selection of monitoring sites is based on the criteria given in WFD with a modification addressing the large scale of the Danube River Basin District. Surveillance monitoring is carried out for each monitoring site for a period of one year during the period covered by a river basin management plan (six years) for:

- parameters indicative of all biological quality elements,
- parameters indicative of all hydromorphological quality elements,

- parameters indicative of all general physico-chemical quality elements,
- priority list pollutants which are discharged into the river basin or sub-basin, and
- other pollutants discharged in significant quantities in the river basin or sub-basin,

unless the previous surveillance monitoring exercise showed that the body concerned reached good status and there is no evidence from the review of impact of human activity that the impacts on the body have changed. In these cases, surveillance monitoring will be carried out once every three river basin management plans.

The results of the surveillance monitoring I are collected from countries in an aggregated form once in six years for preparation of the Danube River Basin Management Plan.

Surveillance Monitoring II: Monitoring of specific pressures

Surveillance Monitoring II (SM 2) is supplementary to SM 1 and aims at long-term monitoring of specific pressures of basin-wide importance. Selected quality elements or specific determinands are monitored at higher frequencies than those in Surveillance Monitoring I. A denser monitoring programme is needed on specific pressures in the Danube River Basin District in order to allow for a reliable long-term trend assessment of specific pollutants and to achieve a sound estimation of pollutant loads being transferred across the Danube riparian countries into the Black Sea. Surveillance Monitoring II is based on the original TNMN and it aims to continue collecting long-term data series for assessing the basin-wide trends of water quality.
The selection of monitoring sites was primarily based on the TNMN sites that were monitored in the past and have already been used for a long-term trend analysis. Following criteria were applied for site selection:

- located just upstream/downstream of an international border,
- located upstream of confluences between Danube and main tributaries or main tributaries and larger sub-tributaries (to enable estimation of mass balances),
- located downstream of the major point sources,
- located to control important water uses.

The major difference between SM 2 and the general principles of the WFD surveillance monitoring is the annual cycle of SM 2 aiming to collect sufficient data for assessment of long term trends in water quality from a basin-wide perspective.

A list of the selected quality elements and monitoring frequencies in SM 2 is as follows:

	Surveillance Monitoring 2	
	Water	**Water**
	concentrations	**load assessment**
Parameter		
Flow	anually / 12 x per year	daily
Temperature	anually / 12 x per year	
Transparency (1)	anually / 12 x per year	
Suspended Solids (5)	anually / 12 x per year	anually / 26 x per year
Dissolved Oxygen	anually / 12 x per year	
pH (5)	anually / 12 x per year	
Conductivity @ 20 °C (5)	anually / 12 x per year	
Alkalinity (5)	anually / 12 x per year	
Ammonium (NH_4^+-N) (5)	anually / 12 x per year	anually / 26 x per year
Nitrite (NO_2^--N)	anually / 12 x per year	anually / 26 x per year
Nitrate (NO_3^--N)	anually / 12 x per year	anually / 26 x per year
Organic Nitrogen	anually / 12 x per year	anually / 26 x per year
Total Nitrogen	anually / 12 x per year	anually / 26 x per year
Ortho-Phosphate (PO_4^{3-}-P) (2)	anually / 12 x per year	anually / 26 x per year
Total Phosphorus	anually / 12 x per year	anually / 26 x per year
Calcium (Ca^{2+}) (3, 4, 5)	anually / 12 x per year	
Magnesium (Mg^{2+}) (4, 5)	anually / 12 x per year	
Chloride (Cl^-)	anually / 12 x per year	
Atrazine	anually / 12 x per year	
Cadmium (6)	anually / 12 x per year	
Lindane (7)	anually / 12 x per year	
Lead (6)	anually / 12 x per year	
Mercury (6)	anually / 12 x per year	
Nickel (6)	anually / 12 x per year	
Arsenic (6)	anually / 12 x per year	
Copper (6)	anually / 12 x per year	
Chromium (6)	anually / 12 x per year	
Zinc (6)	anually / 12 x per year	
p,p´-DDT and its derivatives (7)	see below	
CODCr (5)	anually / 12 x per year	
CODMn (5)	anually / 12 x per year	
Dissolved Silica		anually / 26 x per year
BOD5	anually / 12 x per year	

(1) Only in coastal waters
(2) Soluble reactive phosphorus SRP
(3) Mentioned in the tables of the CIS Guidance document but not in the related mind map
(4) Supporting parameter for hardness-dependent eqs of PS metals
(5) Not for coastal waters
(6) Measured in a dissolved form. Measurement of total concentration is optional
(7) ; In areas with no risk of failure to meet the environmental objectives for DDT and lindane the monitoring frequency is 12 x per a RBMP period; in case of risk the frequency is 12 x year

Operational monitoring of surface water status

Operational monitoring is undertaken in order to establish the status of those bodies identified as being at risk of failing to meet their environmental objectives, and to assess any changes in the status of such bodies resulting from the programmes of measures. Monitoring must also be carried out for all bodies into which priority substances are discharged.
The operational monitoring, however, has certain specificity; it is focused only on relevant parameters (i.e. indicating risk of failure) and it expires once a good status was achieved. On the other hand, new monitoring sites may become necessary when new pressures arise so that water bodies are no longer in the good status. EU Member States can amend their operational monitoring programmes during the duration of a River Basin Management Plan where an impact is found not to be significant or the relevant pressure is removed, and the ecological status is no longer less than good.
The selection of parameters for the operational monitoring is individual for a particular sampling site that represents an affected water body. The parameters have to be selected so that they properly reflect an impact of a relevant pressure. The sampling frequency is not constant as this monitoring is expected to be operational only for a limited time.

Similarly to SM 1 the results of the operational monitoring are collected from countries in an aggregated form once in six years for preparation of the Danube River Basin Management Plan.

The sites of the revised TNMN comprising both surveillance and operational monitoring are indicated in Figure 1.

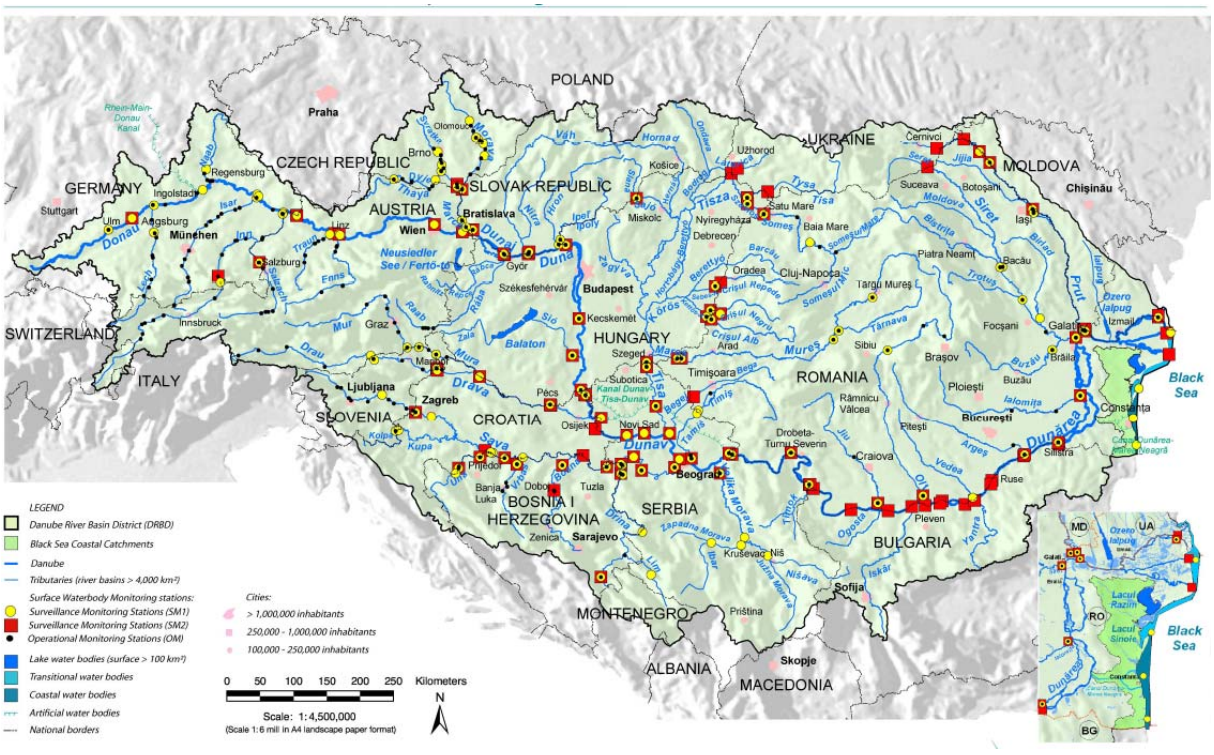

Figure 1: TNMN - surface water monitoring stations

Investigative monitoring

Investigative monitoring is primarily a national task. At the basin-wide level Joint Danube Surveys are used to carry out investigative monitoring as needed, e.g. for testing new methods, checking the impact of “new” chemical substances and so on. Joint Danube Surveys are carried out every 6 years.

The second Joint Danube Survey

To attain a full overview of the water quality needed for EU WFD implementation, the ICPDR organises monitoring surveys on the entire stretch of the river. The results of the first `Joint Danube Survey (JDS1)´ in 2001 were a key information source. During the second `Joint Danube Survey (JDS2)´ in 2007, 96 sites were successfully sampled along the 2600 km stretch of the Danube River, as well as 28 sites on its major tributaries. The survey gathered comprehensive information about riverine hydromorphology, biology and chemistry. The key findings are listed below:

Hydromorphology

The assessment of the hydromorphology of the Danube was a completely new task. Overall, the assessment showed that the Lower Danube is in better condition than the Upper part, and that about 40% of the investigated Danube is in good condition, meaning that there are still many healthy ecological areas – a status that is generally more positive than earlier perceived.

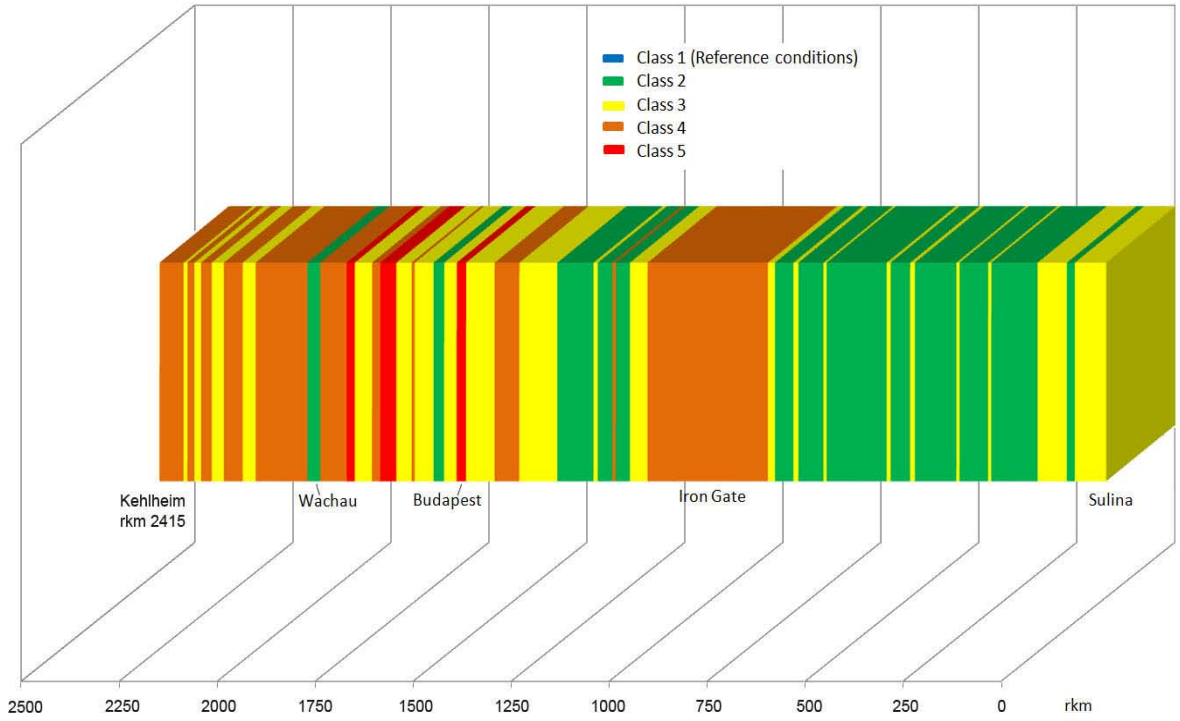

Figure 2: Hydromorphological assessment of the Danube River

Biology

The analysis of macroinvertebrates indicated good biological water quality for almost 80% of the Danube sites. Significant organic pollution affecting living organisms was detected in the tributaries Sio, Jantra, and Rusenski Lom. Due to excessive pollution, the Arges River did not host any macroinvertebrates.

The fish survey, the first ever for the entire length of the Danube, revealed that only about one-third of the investigated sites on the Danube indicated good status. Hydromorphological alterations are the main pressure on fish populations in the Upper Danube, while water quality is a key pressure in the Middle and the Lower Danube. The lack of migratory species in the Danube indicates a loss of river connectivity.

Figure 3: Electrofishing with boom anode

In the regulated, non-impounded stretches of the Danube, macrophytes often meet the conditions for good ecological status. However, the situation is unsatisfactory in the impounded stretches upstream from hydro-electric power plants.

The analysis of phytoplankton found most of the Danube with acceptable conditions. Elevated levels of chlorophyll-a and phytoplankton biomass were found only in the Middle reach.

Phytobenthos, in contrast to aquatic fauna, reacts directly to the nutrient content (mostly phosphorus) in the river, and is considered to be a reliable indicator of long-term eutrophication processes. The indication of ecological status, based on the phytobenthos analysis, suggested an increase of nutrients in the longitudinal profile of the Danube.

One-third of the sites were affected by microbial contamination, while faecal indicators originated mainly from human sewage. Identified hot-spots were the Danube stretch between Budapest and Belgrade and the tributaries Arges and Rusenski Lom.

Chemistry

The chemical analysis revealed a significantly decreasing profile of nitrate concentrations moving downstream the Danube. A comparison with the JDS1 results of 2001 revealed higher concentrations of nitrates and mostly lower concentrations of orthophosphates.

Among the EU's priority substances di-(2-ethylhexyl)phthalate (DEHP) was found in nearly all JDS2 water samples at relatively high concentrations; in 44% of the water samples, the proposed EU WFD environmental quality standard was exceeded. At several sites, an indication of WFD non-compliance was found for polycyclic aromatic hydrocarbons, nonylphenol, tributyltin and trichlorobenzene. The concentrations of metals in water were found above the quality targets at only three sites.

The analytical results obtained for polar compounds in the Danube (including pharmaceuticals, pesticides, perfluorinated acids and phenolic endocrine disrupting compounds) were similar to those in other large European rivers such as the Rhine, Elbe or Po. The most relevant polar compounds identified in the Danube River in terms of frequency of detection, persistency and concentrations were anticorrosives benzotriazoles, pesticide 2,4-D, and antiepileptics pharmaceutical carbamazepine.

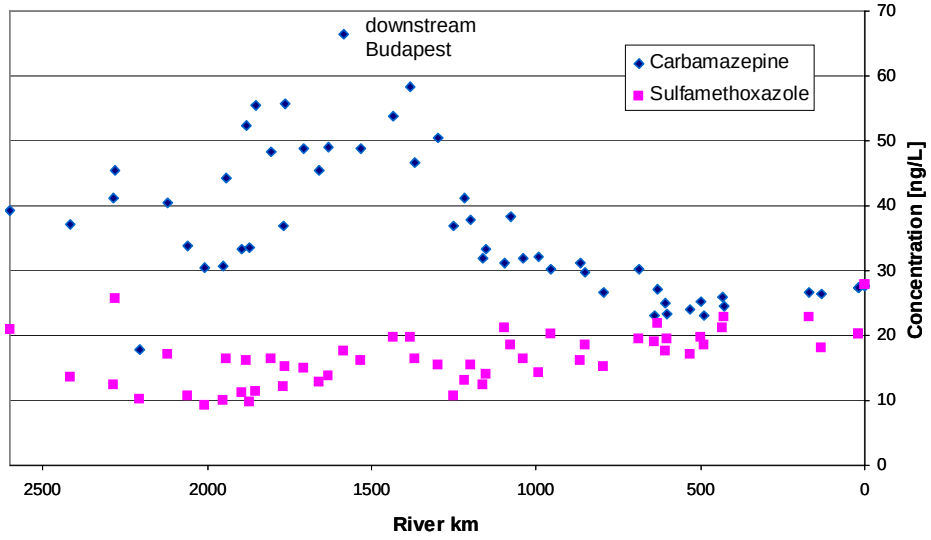

Figure 4: Carbamazepine and sulfamethoxazole in the Danube River

In general, the average concentrations of priority substances detected during the JDS2 tend to be lower than those measured during the JDS1, especially for organic substances.

The results of the ecotoxicological analysis of Danube sediment showed no significant toxic effects.

The regional distribution of ^{137}Cs contamination mainly originated from the Chernobyl accident in May 1986. The JDS2 results demonstrate a clear general decrease by a factor of 10 in the ^{137}Cs activity concentration of Danube sediments between 1988 and 2007. Due to the decreased artificial radioactivity levels in the Danube River, there are therefore no associated health risks. Naturally occurring radionuclides such as ^{226}Ra and ^{228}Ra in the Danube and tributary sediments were found in normal geochemical activity concentration levels. No enhanced anthropogenic input from industrial sources could be detected.

JDS 2 - conclusions

The JDS2 has proved to be an important integral part of the ICPDR Monitoring Strategy. It provided a unique dataset for river basin management planning at the basin-wide level. Joint longitudinal surveys of the Danube and its major tributaries can be considered an important tool for the preparation of the Danube River Basin Management Plan.
The results of the Joint Danube Surveys 1 and 2 create the most comprehensive and homogeneous database on the status of the aquatic ecosystem of the Danube and its major tributaries.
The survey confirmed the earlier TNMN conclusions of a generally improving trend along the main Danube River. However, it also reinforced evidence of specific problems, especially at a number of tributaries and downstream of large cities.
It identified the need for actions to address:

- Hydromorphology (e.g. reconnecting side-arms);
- Continuing the building and expansion of sewage treatment plants;
- Specific industrial pollution problems (e.g. hot spots);
- More intensive investigations and measures on some tributaries.

A common understanding about methods and assessments was generated among Danube scientists and governments. New methods used during the survey proved valuable (e.g. air-lift sampler, benthofluor). The JDS2 results will be made available for future research efforts and dialogue with different stakeholders and users (e.g. concerning problem locations and parameters).

JDS2 was not just a scientific survey but also a tool to raise awareness and understanding about the Danube among the 81 million people who live in the basin. This goal was partially achieved through the events and press conferences held along the Danube during the survey. Follow-up presentations of the results are planned and the ICDPR continues to support people in fulfilling the JDS2 motto: “Watch Your Danube”. Only through the active involvement and interest of people can the goal of a clean and healthy Danube River Basin be achieved.

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