The Danube River Basin: A need for a cohesive international work in the region – Joint Danube Survey (#306)

Abstract

There has been a long history of cooperation in Danube region stretching from the 17th century, but the first institutional framework for the joint measures for protecting the water environment was established under the Bucharest Declaration in the 1980s. An important milestone was the signing of the Convention on Protection and Sustainable Use of the Danube River (Danube River Protection Convention, DRPC) in June 1994 in Sofia. The DRPC was created with an intention of intensifying cooperation in the field of water protection and water use between countries in the Danube basin. Under auspices of this convention, the Joint Danube Survey (JDS) was launched. The JDS includes a series of scientific expeditions designed to explore a wide spectrum of multiple types of pollution in the whole reach of the Danube. The foremost goal of this survey is to make a thorough analysis of water, sediments, river flora and fauna, as well as to check for as many polluting substances as possible. Collecting such a homogenous data set produced by the best laboratories in the Danube River Basin is helping to identify and confirm specific pollution sources and their pathways. Joint participation of all countries sharing the Danube River on this research exercise is also providing an excellent opportunity to exchange experiences and to harmonise the different monitoring procedures in use. From August to September 2001, two ships equipped with accommodation and research facilities sailed from Regensburg, Germany, down to the Danube Delta carrying scientists from different countries who collected and analysed samples of water, sediment and suspended solids in order to obtain homogeneous data on the chemical and biological status of the Danube and its main tributaries.

The Survey was made possible by the generous financial support of the German government and a large contribution from the Austrian government. In-kind contributions came from other Danube Basin countries and all riparian states contributed their scientific, logistical, managerial and other necessary expertise to make JDS a truly joint enterprise.

Key words: Danube Convention, Joint Danube Survey, Water Framework Directive

1. Background and Problems

With the coming into force of the DRPC, the International Commission for the Protection of the Danube River (ICPDR) was legally established as the main decision making body under the DRPC, acting as common platform for Integrated River Basin Management. The present work and activities of the ICPDR are focused on fulfilling all commitments towards sustainable ecological development in the Danube region and they are strongly influenced by the current water legislation of the EU. The new EU Water Framework Directive (WFD) has become an effective tool to safeguard well balanced life conditions for all communities sharing the Danube River. As an expert and operational body, ICPDR has created a number of expert groups, amongst which is the Monitoring and Assessment Expert Group that governs the Transnational Monitoring Network (TNMN), the National Reference Laboratory and Regional Laboratories Network, as well as a network of National Data Centres. To enable the satisfactory protection of the environment against polluting substances we need to have detailed information on their occurrence in the ecosystem. That is why the ICPDR approaches water authorities from individual countries and organises regular monitoring works for assessment of water quality within the framework of Transnational Monitoring Network. Each year the results of the survey are evaluated and published. However, the regular monitoring process only includes a restricted range of parameters and the results are being collected from different laboratories in all ICPDR countries. Nevertheless, the harmonisation of sampling and analytical methods and also the improvement of comparability of the produced results is a continuous process. Although major progress had been achieved in this respect (on-going laboratory intercomparison schemes within the Danube basin, standard operational procedures available at the basin level), much more effort was necessary in order to achieve data comparability of a high degree, amongst various laboratories and institutions and among respective riparian countries. Another critical aspect that imposed further expertise in the Danube monitoring approach consisted in improvement of knowledge on the contamination not perceivable within the framework of TNMN (persistent organic and inorganic micropollutants in sediment, biota and suspended solids).

2. Decisions and actions taken

Given the reasons mentioned above, the ICPDR decided to organize a broader scientific expedition exploring the multiple type of pollution in the whole reach of the Danube – the Joint Danube Survey. The survey had the following major objectives:

- To produce a homogenous data set for the Danube River based on a single laboratory analysis of selected parameters;
- To identify and confirm specific pollution sources;
- To screen the pollutants as specified in the proposed EU Water Framework Directive;
- To provide a forum for riparian/river basin country participation for sampling and intercomparison exercises;
- To facilitate specific training needs and improve in-country experience;
- To promote public awareness.

2.1. Survey Plan

The list of JDS sampling sites included 74 sampling locations on the main river and 24 locations on major tributaries and arms of the Danube. Sampling at each of the 98 locations included five different sample types (water, sediment, suspended solids, mussels and biota) each with its relevant parameter list and to be taken at different sampling points (left, middle, right) was performed.

The investigations followed the EU Water Framework Directive, which does not apply only to chemical water quality but also and especially to the ecological status. Therefore, all biological elements mentioned in the Directive for the assessment of the ecological status were investigated during JDS except fish because it would have required a different sampling method. For the determination of the chemical status the priority substances listed in the Water Framework Directive as well as a large number of further parameters were analysed. Some of them were monitored for the first time in the Danube River Basin.

Two ships – *Argus* from Germany and Szechenyi from Hungary were selected as the expedition vessels. Argus – a laboratory ship from Hessen was the centre of all scientific activities. A large laboratory facility enabled on-board processing of collected samples and immediate analyses of those samples, which might be deteriorated by storage (e.g., for microbiological analysis). A big grab mounted on the front deck of Argus was used for collecting of boulders for examination of fauna attached on it. *Szechenyi* – a prime Hungarian icebreaker – served as a support vessel for accommodation, storage and other logistics.

The survey covered 2581 km along the Danube River and 6 weeks journey towards the Black Sea. The survey was performed by an international Core Team comprising ten experts in hydrobiology, microbiology and chemistry from Danube countries (see Figure 1). The Core team along with the other ICPDR experts put a lot of effort into the preparation of the survey. Each small scientific detail was thoroughly discussed in advance because during the expedition no delay was possible. Similar strict and systematic preparation was necessary for the logistical support. Any item missing on-board in a right time would harm the success of the teamwork. Moreover, the helpful support from all kinds of local authorities was a necessary prerequisite for the uninterrupted journey. These were the tasks for the management of the whole project that was done by the ICPDR Secretariat in Vienna. In each riparian country the scientific Core Team was accompanied by local experts. This enabled the exchange of experience between countries and contributed to very careful examination of the river.

2.2. Danube Reaches

In order to have a better assessment of chemical and ecological data obtained during the JDS, the Danube has been divided into three major reaches:

(1) **the Upper Danube** reach from the source to the Gabcikovo dam (1816 river km) nearly 1000 km, which is characterised with frequent damming and very limited free-flow sections,
(2) **the Middle Danube** reach from the Gabcikovo dam to the Iron Gates dam (943 river km) a completely free-flow section, and
(3) **the Lower Danube** reach from the Iron Gates dam to the Danube Delta being again a free-flow section.

Each of these three major Danube reach can be further subdivided into three sub-reaches, altogether nine so called geo-morphological reaches, characterised by the specific geo-morphological landscape features within the Danube Basin and the anthropogenic impacts. These geo-morphological reaches are as follows

Reach 1*: Neu Ulm - Confluence with River Inn (river km 2581-2255)*
Alpine (rhithron) river character, anthropogenic impact by hydroelectric power plants.

Reach 2*: River Inn - Confluence with River Morava (river km 2225-1880)*

Alpine (rhithron) river character, anthropogenic impact by hydroelectric power plants.

Reach 3: *River Morava – Gabcikovo dam (river km 1880-1816)*
Anthropogenic impact by dam construction Gabcikovo.

Reach 4*: Gabcikovo dam – Budapest (upstream, river km 1816-1659)*
Starting development from alpine to lowland river, Danube passes Hungarian highlands.

Reach 5: *Budapest (upstream) – confluence with River Sava (river km 1659-1202)*
Lowland river, Danube passes Hungarian lowlands, anthropogenic impact by significant emissions of untreated wastewater in Budapest.

Reach 6*: River Sava/Belgrade – Iron Gate dam (river km 1202-943)*
Lowland River, Danube breaks through Carpatian and Balkan mountains, anthropogenic impact by damming effects of Iron Gate hydroelectric power plant and significant emission input of untreated wastewaters in Belgrade.

Reach 7*: Iron Gate dam – Confluence with River Jantra (river km 943-537)*
Lowland river, Danube flows through Walachian lowlands (Aeolian sediments and loess), steep sediment walls (up t 150 m) characterise Bulgarian river bank.

Reach 8*: River Jantra – Reni (river km 537-132)*
Lowland river, alluvian islands between two Danube arms.

Reach 9*: Reni – Black Sea / Danube Delta arms (river km 132 – 12)*
Danube splits into three Delta arms, characteristic wetland and estuary ecosystem, slopes decrease to 0.01 ‰.

2.3. Public awareness

During the JDS press conferences were organised in Germany (Regensburg), Austria (Vienna), Slovakia (Bratislava), Hungary (Budapest), Croatia (Osijek), Serbia (Belgrade), Bulgaria (Ruse and Silistra), Romania (Orsova and Tulcea), Ukraine (Ismail). The survey also attracted a lot of attention: it was followed by journalists and TV crews in all countries and usually made it into the headlines of major newspapers, radio and TV news.

2.4. Finances

The JDS was financed by Germany and Austria (560,000 Euro). Each participant country provided in-kind contribution by establishing a National team of Experts who worked along with the international Core Team on their national Danube stretch.

3. Outcomes

During the planning for the survey it was agreed that the survey should be conducted during low water period. As it was revealed from the actual flow-rates the survey satisfied this requirement almost all along the Danube. This made it possible that the concentration of the chemical pollutants represented the "worst-case" scenario as far as possible.

3.1. Technical findings

The JDS provided a reliable and consolidated picture containing the results for characterization of the biological and chemical quality of the Danube River and confluence of its major tributaries. Issues of concern are the stretches with identified hot spots of pollutants listed in the EC-Water Framework Directive as priority substances, the nutrient concentrations in the whole Danube with special attention to the middle part, and overall pollution by bacteria and heavy metals. The results in more details were the following:

- **Biodiversity**

The collected data show the Danube to have a high degree of biodiversity since more than 1,000 aquatic species and higher-level organisms were identified during the survey, and specifically:

- 268 macrozoobenthos taxa (small animals living on the bottom sediment)
- 340 phytobenthos taxa (algae living on the bottom sediment)
- 49 macrophyte species (water plants and mosses)
- 261 phytoplankton taxa (algae drifting in the water)
- 120 zooplankton taxa (small animals drifting in the water).

The number and type of species depends on both natural conditions and anthropogenic pollution or changes in hydromorphological structures. Although at sampling time (late summer) many aquatic insects had already emerged, the number of found species was high and in general more influenced by hydromorphology and substrate than by pollution. A large number of rare species, especially for zooplankton was detected. However, some degraded sites were still identified.

- **Organic Pollution**

The organic pollution (classified by saprobity) of the Danube varied between water quality class II (according to the Austrian classification scheme this means moderately polluted) and II/III (critically polluted). Many side arms and tributaries were found to be more polluted than the main stream and some of them even reached water quality class III (strongly polluted, e.g. the Sió River in Hungary). In some tributaries (e.g. the Iskar in Bulgaria, the Olt and the Arges in Romania) no macro-invertebrates at all were found - a clear indication of an even higher level of organic pollution or even toxic effects. This situation might be partially caused by low water conditions.

- **Eutrophication**

Particularly high concentrations of algal biomass/chlorophyll-a were found in the Hungarian stretch of the Danube downstream of Budapest, which indicates elevated nutrient concentrations in this reach of the Danube River. The overproduction of algal biomass can lead to a variety of problems ranging from anoxic waters in deeper regions (through decomposition) and toxic algal blooms to a decrease in biodiversity and habitat destruction. The algal blooming observed during the survey increased both the pH values and the daily dissolved oxygen concentration in the Middle Danube reach.

- **Microbiological Pollution**

Microbiological (bacterial) indicators are widely applied for the assessment of anthropogenic impacts such as faecal pollution caused by untreated or insufficiently treated sewage as well as diffuse impacts from farm land and pasture (manure). Faecal bacteria also indicate the potential presence of pathogenic bacteria, viruses and parasites endangering human health. The highest values in microbiological pollution were observed in the tributaries (the Rusenski Lom in Bulgaria and the Arges in Romania in particular) and the side arms (the Moson Arm, the upper part of Soroksár Arm in Hungary).

- **Heavy Metals**

Specific heavy metal pollution hot-spots were detected. The biggest excesses in terms of heavy metal concentrations in water were observed in the Rusenski Lom, the Iskar and the Timok tributaries in Bulgaria. An analysis of sediments revealed exceeding of the German quality targets for cadmium, lead and zinc in the Iskar River and of arsenic and copper in the Timok River, which makes the two tributaries serious contamination sources.

- **Pollution from Navigation**

Navigation along the Danube is the main source of oil pollution observed during the survey. The highest values of petroleum hydrocarbons in sediments and suspended solids were found in the Middle Danube reach.

- **Pesticides**

From 23 pesticides under investigation only Atrazine and Desethylatrazine could be found along the Danube. The elevated concentrations of Atrazine were mainly occurring in tributaries - the maximum value was found in the river Sava and it affected the Danube River downstream the Sava confluence.

- **Other chemical pollutants**

Significant concentrations of harmful chemical pollutants (4-iso-nonylphenol and di[2-ethyl-hexyl] phthalate) featuring on the EU Water Framework Directive List of Priority Pollutants, were found in bottom sediments as well as in suspended solids. Most of the elevated concentrations of nonylphenol were found in the Serbian section of the Danube. This may be caused by the use of alkylphenol-containing detergents in this region. These compounds were monitored in the Danube River for the first time during the JDS.

3.2. Increased knowledge and practical expertise

The survey provided an excellent framework for harmonizing sampling, sample preparation and analytical methods used in different Danube countries. The jointly collected samples analyzed on board and in the national laboratories provided a unique opportunity for scientists to compare their results and improve the quality of their analytical work and the monitoring results. Last but not least, the close contact that JDS researchers established during the survey with country representatives, the media, local experts and the public, created a forum for raising public awareness about pollution reduction policies and activities in the Danube River Basin.

4. Lessons learned and followed-up activities

The survey provided a framework for harmonising sampling, sample preparation and to certain extent also of analytical methodologies used among the different Danube countries through the cohesive team-work of the JDS scientists and the effective collaboration with the national scientific teams. Also interlaboratory exercises performed during the survey helped strengthening the analytical quality control of Danube laboratories.

All TNMN, data as well as other special data sources, serves multiple plans of measures like the Joint Danube Action Programme (JAP) created in accordance with DRPC and Integrated River Basin Management Plans that have been elaborated within the WFD implementation process. The JAP has remained the framework for action but JDS contributed to a more specific identification of pollution sources. Moreover, the outcomes of the survey served as one of the most important basis for preparation of the Water Framework Directive Roof Report according to requirements of the WFD.

Relevance to other projects
Lessons learned from the Joint Danube Survey served as a basis for other related research or monitoring projects aimed at the protection of the Danube River. Among them the most relevant to be mentioned are:

- *Aquaterra Danube Survey* (ADS) – as part of AQUATERRA Project within the 6^{th} Framework Programme (August – September 2004)
- *Iron Gates Sediment Evaluation* – a UNDP-GEF Project, mainly addressing the information gaps related to the pollution burden of the sediments from the Iron Gates reservoir area (September 2006);
- *Joint Danube Survey 2:* the next international similar survey along the whole stretch of the Danube River, as part of the Survey Monitoring activity as requested by the WFD (August – September 2007).

Importance of the case:
Results of JDS acted as a view to identifying follow up activities at both the international and national levels, as well as a framework in establishing the priorities for coordinated measures to be taken by the regulatory bodies and enforcement agencies. In particular, the following activities are to be considered:

- taking measures to decrease nutrient input from agriculture and building of waste water treatment plants with nitrogen and phosphorus removal;
- introducing phosphate-free detergents where they are not yet on the market;
- taking measures to decrease heavy metal pollution from the mining and metallurgy areas in the middle and lower Danube reach, however also a natural geomorphological influence may be present which needs further study;
- preparing additional ICPDR recommendations on measures addressing priority substances as a basis for establishing coordinated programmes of measures in line with the EC Water Framework Directive;
- supplementing the list of Danube priority substances by e.g. arsenic, copper, zinc and chromium;
- intensifying the cooperation with the Danube (Navigation) Commission on reducing oil pollution from shipping;
- establishing quality targets for sediment and suspended solids;
- registering the variety of animal population in the Danube Delta as a genetic pool for the re-colonization of upstream river reaches;
- improving the Danube Trans-National Monitoring Network (TNMN) by including the newly identified transboundary hot-spots and the relevant pollutants and by revising the biological monitoring system;
- redefining and harmonizing methodologies for the characterization of the ecological status, as required by the EU-WFD;
- organizing regular surveys to obtain further consistent and comparable data sets to monitor the development of the water status.

5. Contacts, references, organizations and people

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References:

Overall results of the JDS could be found at:

- Joint Danube Survey – Technical Report of the International Commission for the Protection of the Danube River, September 2002;
- JDS Database from www.icpdr.org ;

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