ICPDR methodology for reporting on and assessing diffuse nutrient sources

icpdr iksd
International Commission for the Protection of the Danube River
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Annex 4 of the DRBM Plan

Deutschland //// Österreich //// Česká republika //// Slovensko //// Magyarország //// Slovenija //// Hrvatska //// Bosna i Hercegovina //// Србија //// Crna Gora //// România //// България //// Moldova //// Україна

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1. Background

The methodology used for assessing diffuse sources of pollution and selecting appropriate measures is based on the DPSIR framework (Driving force-Pressure-State-Impact-Response) being the underlying conceptual framework for developing the programme of measures addressing nutrients. The collation of data from Article 5. reports was supplemented by other existing evidence (from the DBS JTWG (Danube-Black Sea Joint Technical Working Group) report on the impact of the Danube on the NW Black Sea; daNUbs (Danube Nutrients Black Sea research project) and the MONERIS (Modelling Nutrient Emissions into River Systems) model etc.). The aim was to identify the scale of the challenge facing Danube countries regarding nutrient pressures to meet EU Water Framework Directive (WFD) objectives (as well as those from other relevant Directives, in particular the Urban Waste Water Treatment Directive (UWWTD) and the Nitrates and Groundwater Directive).

The DPSIR has been extended as a result of the ongoing process regarding scenarios, options, criteria and evaluation as part of the further development of the MONERIS model as a management tool, in order to provide a common structural support for the decision-making processes of the ICPDR. In this context, the nutrient approach can support the Danube countries by introducing a structural system of catchments in which cause-effect chains are formalised and modelled to simulate the expected effects of the proposed courses of action, as the response to nutrient pollution. Scenario calculation considers currently planned and anticipated developments, taking into account different planning decisions (e.g. designation as a *sensitive area*).

2. Basic and supplementary measures

The nutrient loads discharged by the Danube River are an important factor responsible for the deterioration of the Black Sea ecosystem.

The Danube countries have made a commitment to develop nutrient water quality improvement targets to be achieved by 2015. Both the Memorandum of Understanding (ICPBS/ICPDR, 2001) as well as the Danube Declaration (ICPDR, 2005) define the long-term goal: to reduce the nutrient load in the Danube and its tributaries to levels consistent with the achievement of *good ecological status* and to contribute to ensuring the nutrient balance of the Black Sea reaches a sustainable state corresponding to similar conditions observed in the mid 1960s.

These targets are the first examination of the potential for delivering environmental improvements over the first planning cycle of the WFD. The targets will be revised and improved in future years as more information becomes available.

A list of the outstanding *basic measures* and *supplementary measures* related to nutrient pollution in the Danube River Basin (DRB) has been prepared for the Joint Programme of Measures (JPM) of the Danube River Basin District Management Plan (DRBM).

Basic measures (in line with the requirements imposed by the identification of the DRB and its coastal waters as a *sensitive area*) are the implementation of the UWWTD (or for Non EU countries, the appropriate ICPDR Recommendation on wastewater discharges). Measures include the connection of settlements to public sewers and appropriate treatment plants; the upgrading of wastewater treatment plants with respect to nitrogen (N) and phosphorus (P) removal and the implementation of Best Available Techniques (BAT) on agro-industrial units.

Supplementary measures have also been identified. These include the reduction of the volume of wastewater directly discharged from combined sewerage systems into rivers and the introduction of a P-detergent ban.

All river basin district level scenarios should be ones where the competent river basin authority considers they would fit with the requirements of the WFD, transposing regulations and river basin planning guidance. These river basin district (or sub-basin-district) scenarios should relate to the overall approach being taken at the key, upper level of river basin planning, which are currently being made in relation to the Danube River Basin District (DRBD) or the specific sub-basins.

Scenarios with different environmental benefits due to nutrient reduction measures in line with EU policies (*basic/supplementary measures*) and the related timetable of individual countries (respecting agreed transitional periods) are designed and evaluated though MONERIS investigations.

Through the MONERIS model, the nutrient loads within the river network of the DRBD are calculated for the present state and a *baseline scenario* for 2015.

Possible *basic measures*:

1. Implementation of the Nitrates Directive (or for Non EU countries, the appropriate BATs).
2. Implementation of Action Programmes according to the Nitrates Directive - taking vulnerable zones into account in cases where natural freshwater lakes, other freshwater bodies, estuaries, coastal waters or marine waters of the DRBD are found to be eutrophic or may become eutrophic in the near future (or for Non EU countries, the appropriate BATs).
3. Best Environmental Practice (BEP) for farmers linked to the EU Common Agricultural Policy (CAP).
4. Prevention and control of soil erosion.

Possible *supplementary measures*:

1. Instruments and policy measures to support and implement the WFD.
2. Compensation payments for changing land use management etc.
3. Ensuring integration between River Basin Management Plans and Land Use Planning. The achievement of WFD objectives depends fundamentally on the management of land, including the built environment. Factors including pressure from new housing for more water, the management of domestic waste, the impacts of diffuse urban pollution and flood management all affect the water environment and need to be integrated into the deliverable set of measures.
4. Wetland creation and restoration. Pressures on wetlands (e.g. physical modification or pollution) can result in impacts on the ecological status of water bodies. Measures to manage such pressures will need to be considered as part of River Basin Management Plans (RBMP) in order to meet the environmental objectives of the Directive. Further, wetland creation and enhancement should be used within Programmes of Measures to deliver sustainable, cost effective and socially acceptable mechanisms for helping to achieve environmental objectives – e.g. flood management, pollution control, coastal management, groundwater recharge.
5. The Rural Development Regulation (RDR) for the period 2007-2013 is designed to place agriculture within a broader context by covering three major policy objectives. These objectives aim to improve: i) competitiveness of farming and forestry (Axis 1); ii) environment and land management (Axis 2); and iii) quality of life and diversification (Axis 3). Measures under all axes could contribute to reaching WFD objectives as they offer various possibilities to protect and enhance natural water resources. While the measures under Axis 1 and 3 are mainly indirectly linked to water, the measures provided under Axis 2 offer a high potential to support the implementation of the WFD directly. Measures contributing to water protection are mainly contained under Axis 2 of the Rural Development Programmes. In particular, the voluntary agri-environmental measures are used to address diffuse and point sources of agricultural water pollution (nitrates, phosphates, pesticides) as well as soil erosion. Under this second axis, there is also a specific measure allowing farmers to be compensated for income foregone due to WFD implementation (Art. 38).

3. Scenarios for nutrient reduction

Scenarios with different environmental benefits due to nutrient reduction measures and the related timetable of individual countries (respecting agreed transitional periods) are designed and evaluated though MONERIS. Through the model, the nutrient loads within the river network of the DRBD are calculated for the present state and for various different scenarios for 2015.

The requirements and objectives of the WFD are to achieve *good ecological status* by 2015 for all waters. The RBMP will provide the context for setting out a comprehensive programme of measures designed to achieve the objectives set for water bodies.

The measures addressing three of the identified Significant Water Management Issues (SWMI), (namely organic pollution, nutrient pollution and hazardous substances pollution) are strongly interlinked. The selected approach recognises these synergies in the development of the packages of measures in the JPM. For example, the effects of management decisions for urban wastewater development addressing organic pollution have certain positive effects on nutrient reduction in the respective area. These effects - benefits and drawbacks - must be identified and evaluated under different scenarios and based on a wide range of options for development and underlying assumptions that are taken into account and evaluated.

The fundamental assumption made is that there are two types of drivers governing the development of economic, social and environmental conditions in the DRB and which influence scenario building. The first are those drivers that basically operate independently of policy-making i.e. drivers that are not directly influenced by policies, or at least not in the JPM first cycle (up to 2015). These include population growth, environmental conditions and climate change. The second type of drivers involves policies which will have an implementation effect on a 5-10 year horizon.

3.1. Methodological approach

The intention was to use a transparent methodology that consists of four major steps: (i) set out the assumptions for possible developments regarding various sectors, (ii) develop scenarios by combining different sets of assumptions, (iii) map assumptions into load reductions and, in the case of nutrient emissions, into input parameters for MONERIS, and (iv) perform scenario assessments and nutrient scenario calculations with MONERIS using the relevant parameters.

3.2. Setting out assumptions for possible developments regarding various sectors

The assumptions are coherent extrapolations of immediate or medium-term implementation effects of different policy options, such as the implementation of EU or national legislation, changes in agricultural policies etc. For the *baseline scenario* (BLS), which describes developments (considering current, ongoing or planned measures), the assumptions have to be selected accordingly. For example, if we know that a country has to implement the Integrated Pollution Prevention and Control (IPPC) Directive, then they will make investments to ensure compliance with the BAT, and this should be considered as the relevant assumption in the development for industrial wastewater treatment to be used in the BLS. For the non EU Member States (Non EU MS), some future developments appear more likely than others in the EU MS, and therefore the commitment of building a certain number of wastewater treatment plants until 2015 is a parameter of the scenario calculation.

The assumptions have been carefully checked by the Contracting Parties with the view to reduce uncertainties and provide a robust baseline for nutrient reduction analysis as required for developing the JPM.

3.2.1. Example of an assumption related to the use of fertilisers

The European Fertilizer Manufacturers Association (EFMA) assumes an increase in application rates for N fertilizer for the new EU MS of approx. 20% for 2017 (EFMA, 2008). The EFMA forecast also includes values for individual Danube countries: Austria (+9%), Bulgaria (+30%), Germany (-2%), Hungary (+20%), Romania (+24%) and Slovenia (0%). For the projection of fertilizer application in other Danube countries, we used the EFMA average for the new EU MS of a 20% increase.

3.3. Development of scenarios by combining different sets of assumptions

For the preparation of the scenarios, different assumptions were selected and combined. The combination of the various assumptions conceptualises the respective scenarios. The definition of scenarios is a complex procedure that needs assessment and integration of all interlinkages between those policies and assumptions affected by a particular decision or commitment. Building different scenarios on a range of plausible assumptions provides the basis for a discussion about their effects and is a key element in decision support.

In the context of the strategic planning and decision support for the development of the JPM, the scenarios provide a setting to discuss various options and have the value of offering the CPs an opportunity for dialogue about their respective perspectives on plausible future developments for the successful implementation of the measures.

3.4. Mapping assumptions into load reductions and, in the case of nutrient emissions, into input parameters for MONERIS

After having agreed conceptually on the various scenarios, it is necessary to assess quantitatively the influence on the DRB. For point sources, the load reductions can be derived, for example, by means of suitable emission factors. Regarding nutrient fluxes, the ICPDR is using the MONERIS model, which depends on the wide variety of input parameters. To be able to assess the quantitative effect, the results of the assumptions have to be mapped into changes of the input parameters of the model. For example, it is well established that the introduction of P-free detergents will decrease the specific P input per capita by approximately 50% (e.g. in Germany from 4g P/inh.d to approx. 2g P/inh.d). This decreased input will be further used in the scenario calculation.

3.5. Performing scenario assessments and nutrient scenario calculations with MONERIS using relevant parameters

All previous steps are used to define measures and to combine the modelling of different measures or packages of measures. In the case of SWMIs that are mainly caused by point sources, the available regionalised emission information has to be compared to water quality information.

In the case of the nutrient SWMI, which is characterised by a complex emissions situation caused by point and diffuses sources and negatively impacted water bodies (Black Sea coastal areas) situated far away from the sources, such a straightforward analysis isn't possible. In order to facilitate the nutrient pollution analysis, the scenarios are calculated based on modelling - for the DRB countries, the MONERIS model is used. The overall application of MONERIS allows a regionally differentiated quantification of nutrient emissions via different pathways describing point and diffuse sources discharging into river systems.

4. The MONERIS approach

The emission model MONERIS uses spatially and temporally varying input data regarding the natural system and human activities in the Danube River. This comprises among other factors data on: soil characteristics, meteorological factors, land use, population and degree of urbanisation, connection to sewerage systems and degree of wastewater treatment, N surplus on agricultural soils, P accumulation in soils and atmospheric deposition. It uses this information to calculate the emissions of N and P to surface water, by seven different pathways. The results can be shown as tables and maps.

The pathways are:
1. Point sources (waste water treatment plants and industry);
2. Overland flow;
3. Ground water flow;
4. Tile drainage;
5. Erosion;
6. Urban systems;
7. Atmospheric deposition on surface waters.

The MONERIS model was developed to estimate nutrient inputs by point and various diffuse sources into rivers with catchments on a larger scale. The model uses Microsoft Access databases. The average size of basic catchments (analytical units) used in the Danube Basin calculations is 2000 km², but based on data availability and required detail level, can be reduced to approx. 100 km² or even lower.

MONERIS was also conceived as a system for identifying reduction needs to meet applicable water quality standards (target concentrations) by using different scenario options. It is also used to examine a number of scenarios to demonstrate impacts of reducing wastewater loads alone and in combination with measures to reduce diffuse inputs for phosphates e.g. through the use of P-free detergents.

For the use of MONERIS for the Danube, a complete new version of the model was developed. Besides implementation of new scientific approaches regarding retention of nutrients in the river system and erosion, the model now has a user interface (see Figure 1). This allows access to the model at different levels. Modellers can change input data and viewers can select results of the calibrated model for selected years and calculate scenarios. The user interface includes the calibrated model for the DRDB; the scenario manager for certain measures in the field of agricultural, urban and wastewater treatment plants; the possibility to present results for selected years as figures and tables and the export functions to use the model results within further work.

For the MONERIS upgrade of the Danube, a manual was developed that will be published and used by ICPDR experts. This manual includes a detailed description of the methodology and a description of how to use the user interface, as well as maps and data used as input data for the DRBD modelling.

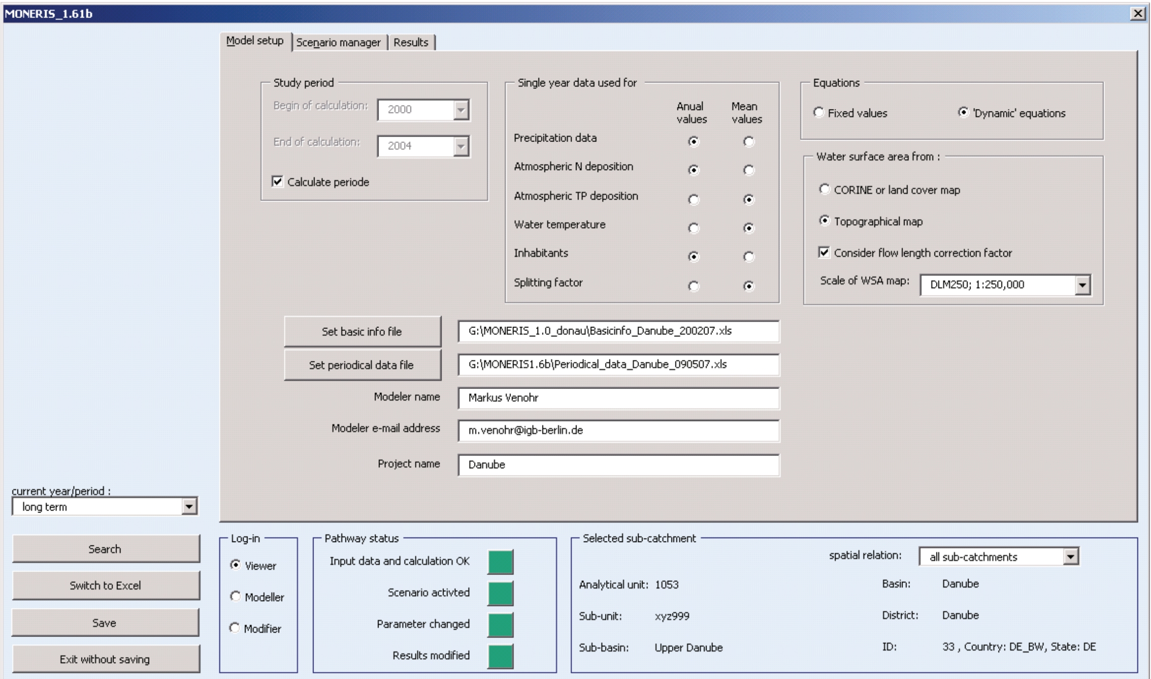

Figure 1: Overview of the user interface of the MONERIS model

The MONERIS model was produced by the Leibniz Institute of Freshwater Ecology and Inland Fisheries in the Forschungsverbund Berlin, Germany.