18. EXAMPLES OF GOOD MODELLING PRACTICE IN THE DANUBE BASIN

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18.1 Introduction

Examples of modelling projects in the field of water management in which the guidelines and recommendations for Good Modelling Practice (GMP) have been used to the full extent are scarce. In order to gain practical experience with the use of the existing guidelines, the authors have used two existing projects in the Danube river basin that are already finalised. The two Danube projects have been analysed using the guidelines as described in the Dutch GMP Handbook [van Waveren, 1999]. Although this exercise can not illustrate the real influence that the application of modelling guidelines would have had, it can certainly highlight the critical choices and aspects within these projects. One can then judge the effects of the formulated guidelines for the modelling process in these and other projects.

18.2 The Danube River Basin

The Danube River is 2857 km long; the basin covers 817,000 square km in 18 countries in the heart of central Europe. The river water has a high economical, social and environmental value for the 80 millions inhabitants of the basin. The river sustains many important natural areas, including the Danube delta - the second largest wetland area in Europe.

The Danube River Protection Convention, created in the framework of the ECE-Convention for the protection of transboundary waters (Helsinki Convention 1992), became with its entry into force on 22 October 1998 the overall legal instrument for cooperation and transboundary water management in the Danube River Basin. The overall objective of the DRPC is to achieve and maintain the sustainable development and use of water resources in the Danube River Basin. The executing body of the convention is the International Commission for the Protection of the Danube River (ICPDR). In recent years, two numerical water quality models have been developed to support the water quality management under the umbrella of the ICPDR.

18.3 Models for the Danube

Two modelling project that are already finalised, have been chosen for analysis of the existing guidelines for Good Modelling Practice. It concerns a modelling project for accidental spills in the Danube river basin and a modelling project to simulate the actual in-stream loads of nutrients and the resulting water quality in the Danube river.

The Danube Basin Alarm Model (DBAM) was designed to support decision-making in relation to accidental spills with a probable transboundary impact. The February 2000 Baia Mare Spill presents a dramatic example. The model provides forecasts of the travel
time and the expected peak concentrations in the cloud of pollutants during its travel down the river. The DBAM was designed for use in operational conditions, to provide a fast and first order assessment of the effects of a spill. It uses limited and readily available input data. For reasons of computational speed and accuracy, the model uses an analytical technique to solve the governing mathematical advection-diffusion equation. The model is operational in 11 Danube countries. An evaluation of its accuracy has been carried out on the basis of data collected during the Baia Mare Spill. At present, the ICPDR is planning the full-scale calibration of the model.

The Danube Water Quality Model (DWQM) was developed in the frame of the Danube Pollution Reduction Programme (a GEF project) to simulate the actual in-stream loads of the nutrients nitrogen and phosphorus. The model was again based on the advection-diffusion equation. Essential corner stones for its development were: (a) state-of-the-art nutrient emission data, (b) observed concentrations and loads in the river, and (c) empirical relations describing the retention of nutrients in (parts of) the catchment as a function of the hydrology of the catchment. The model has been used to support a so-called Trans-boundary Diagnostic Analysis for the nutrients nitrogen and phosphorus, as well as to assess the effectiveness of the proposed pollution reduction programme. The gaps in knowledge and data identified in this process are now being addressed in the “daNUs” project, in the EU 5th Framework Programme.

18.4 Test-case: Danube Basin Alarm Model (DBAM)

In the first exercise, the modelling study for the Danube Basin Alarm Model for accidental spills has been briefly evaluated against the guidelines as presented in the Good Modelling Practice Handbook [van Waveren et al, 1999; Scholten et al, 2001]. The GMP Handbook divides the modelling process in 7 basic steps, including:

- Step 1: start a journal for the modelling project;
- Step 2: set up the modelling project;
- Step 3: set up the model;
- Step 4: analyse the model;
- Step 5: use the model;
- Step 6: interpret the results;
- Step 7: report and file.

The next overview gives a short evaluation of these steps. Steps that did not result in any specific remark have been omitted from the overview.
### Evaluation of the GMP-guidelines for the modelling process in relation to the project for the Danube Basin Alarm Model (DBAM)

**Step 2: Problem description, objectives and requirements**

The development of the DBAM was started with a "pre-study". This study was financed by the EU in the framework of its support program for the ICPDR. The definition study dealt with the problem description, objectives and requirements, but also with the model definition. Prior experience in the Rhine basin was an important factor in the pre-study. The users were represented by a panel of experts from all Danube countries involved, the so-called AEPWS Expert Group (AEPWS-EG). Since the members of this group had variable levels of experience in this field, and since the members changed a lot during the development trajectory of the DBAM, the EG could not always play its role well enough.

**Step 3: Model definition and implementation**

The model implementation was again financed by the EU, and assigned to an international consortium of partners who were not involved in the pre-study. The implementation proved to be a very cumbersome exercise. A key factor here was the poor performance of one of the partners in the ICT field. The model was finally accepted by AEPWS-EG, but the technical quality of the software was still dubious. A follow-up project, again financed by the EU, tried to remove the main shortcomings, but could only be partly successful given the limited budget.

**Step 4: Calibration and validation**

The original pre-study did not deal effectively with the issue of calibration and validation. An additional definition study for the calibration and validation was commissioned by the EU during the implementation project, again carried out by an independent consultant. This study did not deliver practical results either. At that stage the EU stopped its support programme for the ICPDR, which caused a discontinuity in the funding and an abrupt halt in the activities. At the time this report is written, a new initiative with respect to the calibration and verification of the DBAM is started from within a new Danube GEF project (started in February 2002).

**Step 5: Application and analysis of the results**

The DBAM is installed and formally operational in 11 Danube countries. Nevertheless, the use of the program is problematic, despite the training sessions which have been organised in 1996 and 2000. Reasons are the imperfect quality of the software and the rapid changes in the staffing of the institutes involved. The fact that the model has not yet been calibrated caused doubts as to the accuracy of the model. A quantitative assessment of the accuracy of the model has been made in 2000 after the Baia Mare accident. This analysis showed that the accuracy was satisfactory, but that a calibration exercise would be necessary and useful. Collection and analysis of water quantity related data (discharge, flow velocity) is a major concern.

**Step 6: Dissemination of the results**

So far, the development and the use of the model have been poorly disseminated to the scientific community and to the public.
18.5 **Test-case: Danube Water Quality Model (DWQM)**

In the second exercise, the modelling study for the Danube Water Quality Model for nutrient loads and resulting water quality situation in the Danube river has been briefly evaluated against the guidelines as presented in the Good Modelling Practice Handbook (van Waveren et al, 1999; Scholten et al, 2001). The next overview gives a short evaluation of the 7 basic steps of the modelling process. Steps that did not result in any specific remark have been omitted from the overview.

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18.6 **Analysis, conclusions and recommendations**

The experience described in the previous chapters leads us to formulate the following conclusions and recommendations:

- The GMP procedures, as defined in the Dutch initiative, provide a useful tool to improve the quality of a modelling exercise. If they would have been used as a guiding principle in the development of the DWQM, the implementation would have been much easier and the acceptability less problematic;
- There should be a clearly defined and well-qualified user of the model and/or the modelling results. If this condition is not fulfilled, the modeller may not be able to complete the exercise in a satisfactory way (as demonstrated by the DBAM example);
- There should be continuity in the execution of steps 2 to 5 of the modelling process. If this condition is not fulfilled, the modeller may not be able to complete the exercise in a satisfactory way (as demonstrated by the DBAM example);
- The acceptability of the modelling results is an important point. A model is doomed to be a messenger with an unwelcome message and therefore doomed to be shot, unless all modelling stages get the proper attention. Maybe the current GMP procedures from the Dutch initiative pay too little attention to this aspect.

18.7 **Acknowledgements**

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