REPORT ON IMPLEMENTATION OF IWRM PRINCIPLES INTO THE LOCAL AND REGIONAL MANAGEMENT PLANS

Report of the NeWater project, WP 3.3
New Approaches to Adaptive Water Management under Uncertainty
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<td>Authors</td>
<td>Valentina Krysanova, Romana Koskova, Marta Martinkova and Cornelia Hesse</td>
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<td>Status</td>
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December 2008

Prepared under contract from the European Commission

Contract no 511179 (GOCE)

Integrated Project in

PRIORITY 6.3 Global Change and Ecosystems

in the 6th EU framework programme

**Deliverable title:** REPORT ON IMPLEMENTATION OF IWRM INTO LOCAL AND REGIONAL DEVELOPMENT AND MANAGEMENT PLANS

**Due date of report:** 31.12.2008

**Actual submission date:** 20.01.2009

**Start of the project:** 01.01.2005

**Duration:** 4 years
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1 Introduction: major water-related problems in the Elbe basin and objectives of the Report

The Elbe River basin (Fig. 1) covers large parts of two countries - the Czech Republic and Germany. About 2/3 of the drainage basin area (148,268 km²) is located in Germany (96,932 km²), and 1/3 - in the Czech Republic (50,176 km²), and a negligible part of the basin is located in Austria and Poland. The basin covers different geographical regions from middle mountain ranges in the west and south to large flatlands and lowlands in the central, northern and eastern part of the basin. About 25 million inhabitants live in the basin, therein 76% in Germany.

![Fig. 1 The Elbe River basin.](image)

The river basin is used for various purposes. Agriculture areas occupy 56% of the drainage basin, and 25% are covered by forest. The industrial sector withdraws the largest amount of river water (about 70%), followed by the agricultural sector and the water withdrawals for domestic use (both about 15%). Water management in the whole Elbe basin is well developed and has a good potential to introduce IWMR. However, cross-sectoral and transboundary cooperation, as well as participatory approach should be substantially improved.

The Elbe River is experiencing all three major water-related problems: having too much of water from time to time (floods), too little of water often in summer season (droughts), and
water of inadequate quality, especially in some of the tributaries. In the last three years, extreme hydrological situations were observed on the Elbe - a destructive flood in August 2002, and a severe drought and water deficit in 2003. The disastrous flood in August 2002 has strongly shifted general public attention to the flooding problem. Besides, the Elbe is a major contributor of nitrogen and phosphorus loads to the Northern Sea.

According to the Global Water Partnership’s definition, the Integrated Water Resources Management (IWRM) is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM can be characterized as a participatory planning and implementation process based on sound scientific results, which brings water managers, stakeholders and researchers together to determine how to meet long-term needs for water resources while maintaining essential ecological services and economic benefits. The IWRM is emerging as an alternative to the sector-by-sector, top-down traditional management style that has dominated in the past.

The major principal components of the IWRM process are:

1. Managing water resources at the basin or watershed scale. This includes integrating land and water resources, upstream and downstream issues, surface water and groundwater.

2. Optimizing water supply. This includes evaluation of surface and groundwater supplies, analysis of water balances, and evaluating the environmental impacts of different water use options.

3. Managing water demand. This includes adopting cost recovery policies, utilization of efficient water use technologies, and establishing decentralized water management authorities.

4. Providing equitable access to water resources through participatory and transparent governance and management. This may include support for effective water users’ associations, involvement of marginalized groups, and consideration of gender issues.

5. Establishing integrated policy, regulatory, and institutional frameworks. Examples are implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms.

It is very difficult to evaluate all five principal components of the IWRM process encompassing all directions of water resources management in the basin at the international, regional and local levels. Therefore, this Report will be focused only on two principal components: 1) integration and 4) participatory and transparent governance. The Report aims at analyzing these two components not generally in the Elbe basin, but
- in the flood protection strategy, and
- in the implementation of the Water Framework Directive.

Mainly the regional aspect will be considered, with several local examples. Hence, the objectives of this report can be formulated as following:
- to describe existing and planned measures for flood protection and their level of implementation, and **to evaluate the level of integration and public participation** considered in the flood management in the basin,
- to describe the state of WFD implementation in the basin, and **to evaluate the level of integration and public participation** considered in the WFD implementation in the basin.

By that, the status of the IWRM process related to water management in the basin could be, at least partly, evaluated.

**Section 2** is devoted to the implementation of IWRM principles in flood protection. It describes shortly the Action Plan for the flood protection in the Elbe basin, and its implementation in Germany and the Czech Republic, underlying issues of integration and public participation. Subsection 2.4 describes the Simulation game on operational flood management organized by the Elbe team, which contributed to improvement of cooperation between water management authorities, water and climate experts and local stakeholders, and by that promotes the implementation of IWRM principles in flood protection.

**Section 3** aims in evaluation on how IWRM principles are realized in the implementation of Water Framework Directive in the basin. It starts with a general overview on WFD implementation, which is followed by three examples. One example is the modeling study for the Rhin catchment, which was performed by the Elbe CS team on the request of the regional environmental agency in order to support the WFD implementation in the federal state of Brandenburg. Two next examples describe two District Plans of measures as key strategic tools for water management. These two districts incorporate two focus areas of the Elbe case study: the Jizera and the Malse/Rimov catchments. The District Plans include some of the key IWRM principles.

**Section 4** includes the evaluation of the state-of-the-art water resources management and implementation of some IWRM principles based on the Questionnaire results. The Questionnaire survey was conducted by interviewing policy makers and water experts in the Ohre River catchment, one of the large subbasins of the Elbe. This report includes only a part of the results on cooperation, awareness raising and information management issues, which are closely related to the principal components of IWRM.

## 2 Implementation of Integrated Water Resources Management principles in flood protection

Natural extreme events such as floods and droughts are important drivers for adaptation. The Elbe flood in 2002 caused a damage of around 21.1 billion Euros and 37 fatalities. After this catastrophic event the shortcomings of flood disaster management in Germany and Czech Republic became evident. The traditional approach to flood protection in the region was shaped by a safety mentality (Flood risk, 2004), and was dealt in terms of design values such as the 100-year flood, without a detailed analysis of related uncertainties, other probable damage scenarios and whole spectrum of possible protection measures.

Two main elements of flood risk management to be considered in the basin are: 1) reduction of flood risk by means of preventative measures, and 2) coping with floods. Preventative
measures against flooding combine engineering facilities, river basin planning along with financial and social measures. They include:

- Technical flood protection: facilities for water retention such as dams, storage reservoirs, and polders;
- River basin planning: increasing natural water retention in catchment areas;
- Spatial planning: keeping constructional development as far as possible out of floodplains;
- Constructional measures: ensuring appropriate construction methods in areas prone to flooding;
- Risk spreading methods: financial provisions backed by insurance;
- Behavioral or social measures: explaining, preparing for, and practicing ways in which to cope with dangerous flood-related situations; and
- Informational measures: flood alarm and warning systems.

The coping with flood disaster above all means:

- help for flood victims,
- averting disastrous impacts of flooding, and
- help in reconstruction.

In the future climate, higher average temperatures and lower precipitation in summer are projected for the Elbe basin. On the other hand, the intensity of rainfall and, as a result of that, the frequency of floods are expected to increase under climate change (Becker and Grunewald 2003). The need to develop a proper flood management strategy encompassing the whole spectrum of measures is recognized. A clear manifestation of that is The Action Plan for the flood protection in the Elbe basin approved by the International Commission for Protection of the Elbe.

2.1 Action Plan for the flood protection in the Elbe basin

The Action Plan for the flood protection in the Elbe river basin was prepared by the International Commission for Protection of the Elbe (ICPE) and approved on October 21 – 22, 2003 at the 16th ICPE Meeting in Erfurt. It was based on the evaluation of the recent flood events, and mapping of the existing level of flood protection in the Elbe river basin. The Action Plan included a bunch of measures in the drainage basin, on the river itself, and non-structural measures:

1. **measures for increasing water retention capacity in the drainage basin**, including waterbodies and polders;
2. **precaution measures in flood prone areas**: their delineation, declaration and proper utilization;
3. **technical flood protection measures**; and
4. **non-structural flood protection measures**: flood warning, information and education.

The following tasks related to these measures were defined in the Action plan:
- moving the protective levees farther away from the watercourses (2 700 ha), and creating more retention space in 16 localities, in which controlled polders might be built with a capacity of 178 mill. m³;
- development of requirements for the technical facilities handling substances that could endanger water quality in flood prone areas;
- elimination of technical flaws in the protective levees located along the Elbe River watercourse and on the levees holding the returning water on the Elbe tributaries in Germany (548 km of levees, 45% of all existing levees, should be reconstructed by 2015);
- assessment of the impacts of large dam reservoirs (located on the Vltava, the Ohre, and the Saale rivers) on the Elbe River flood development;
- analysis of implementation of technical flood protection measures based on the outflow conditions for the cities in the Czech Republic, which are threatened most in the case of flood events;
- improving the flood information system by establishing a joint international flood forecasting system, and upgrading the technical equipment at the flood warning and forecasting profiles and in the meteorological monitoring networks.

It was decided that the common Czech-German flood forecasting system could be further improved by using the latest upgraded models. The objectives were to lengthen the forecast periods and to improve the accuracy of forecasts. This plan helped to draw conclusions of the August 2002 flood so that they could be transferred into specific management schemes.

2.2 Implementation of the Action plan in Germany

First of all, policies and rules for management in related sectors have to be changes. This cannot be achieved at once, but the process has started. Meanwhile, quite important results for separate measures were achieved in the federal states of Germany located in the Elbe basin since the time when the Action Plan was created. They will be listed below separately for four groups of measures.

Measures for increasing retention capacity in the drainage basin

A number of different measures were implemented in agriculture, forestry and water management for increasing the retention effect and capacity (integration!). The following measures in agriculture belong to this type, e.g.: mulching, ecological cultivation, reduction of soil compaction, maintaining a certain share of grassland (e.g. above 5%) in the total farmland area, and conservative soil practices.

In the forestry an evaluation of potential afforestation for improvement of water retention was done. About 1000 ha of former arable land was converted to forested areas from 1996 until 2004 in the Elbe basin. The Program for protection of wetlands has started in Brandenburg and Schleswig-Holstein aimed in increasing groundwater recharge and reducing water runoff in these areas.
The water retention capacity was increased in the German part of the drainage basin. For example, in Saxony it was increased from 26 Mio. m$^3$ to 148 Mio. m$^3$ after the flood in August 2002 due to reconstruction of dams and barrages (Erster Bericht, 2006). In Saxony-Anhalt green flood retention ponds and polders in flood-prone areas are being arranged. In Brandenburg with its highly regulated river network (about 10000 weirs and barrages) a reconstruction has started aimed in better regulation of the seasonal water discharge: to reduce flood discharge and increase minimum discharge in dry periods. Other measures are related to re-naturation of river network to increase retention capacity and retardation of water in the watersheds.

**Measures related to delineation, declaration and utilization of flood-prone areas**

Important steps have been done in different federal states of Germany to create laws and regulations for utilization of flood-prone areas (Erster Bericht, 2006). Keeping constructional development out of flood plains is very important to reduce risk of damage. There are examples (e.g. in Saxony), when experience of previous floods was ignored, and houses and enterprises were planned and approved in the floodplain of the Elbe River (Flood Risk., 2004). After 2002 flood, the compensation was paid to the residents to inspire them to move and settle in another area. An important instrument used for risk reduction is the set of flood danger maps prepared for Saxony, Saxony-Anhalt and Brandenburg.

In flood-prone areas, where settlements already exist, some preventative building measures can reduce potential damage, such as an artificially elevated configuration, or construction without cellars. Also, permanent or mobile barriers (mobile walls) can be used to keep water out of urban areas. To prevent penetration of water in the buildings, any openings must be raised, or sealing measures using bitumen or plastic must be implemented.

Another necessary measure is the safe and secure storage of oil and other environmentally hazardous substances in flood-prone areas.

The recent flood events motivated population is endangered areas to implement and extend private risk reduction measures (public participation!). Improved information and financial incentives were used to encourage preventative household measures in Saxony, Brandenburg and Saxony-Anhalt.

**Measures related to technical flood protection**

During the Elbe flood in 2002 many stretches of the dikes proved to be insecure. It was estimated that in the German part of the Elbe basin only a small part of the 730 km of dikes along the Elbe and 480 km of reservoir dikes fulfilled the standards of the German industrial norm (Erster Bericht, 2006). In Germany an extensive program of reconstruction of dikes was undertaken in 2003-2005. Altogether, 241.4 km of dikes were reconstructed. According to the reconstruction program in six federal states dikes will be reconstructed at the length of 528,3 km until 2015 (Erster Bericht, 2006).
Improvement of Information systems on flood warning and forecasting

The German Weather Service is developing the numerical weather forecast models, taking into account radar data. The monitoring network of the automatic precipitation stations was expanded to provide better spatial resolution of data.

The early warning of the German Weather service was also improved. Now it is also available via Internet in the graphic form and as tables. Special actions are undertaken to make flood warning gauges flood-proof. To enable a fast and effective flood forecast, four existing regional flood centers were integrated in one State Flood Center for all rivers in Saxony (SMUL, 2003).

The European Flood Forecasting System (EFFS) is under implementation for the Elbe. It is intended to enable a forecast for an impending flood up to 10 days in advance. The flood routing model “ELBA” is to be updated with new stage-discharge relations and supplemented with several new components. In addition, a new flood forecast model “WAVOS” for the Elbe River from the national border to the backwater area of the Geesthacht Weir is under development.

The involvement of NGOs and relevant research projects at the European and national levels definitively contributes to the transparency of plans (public participation!) and to the integration of the current state of knowledge into the new developments.

2.3 Implementation of the Action Plan in the Czech Republic

The Elbe flood in 1997 was important driver for improvement of flood management in the Czech Republic. In 2000 a new legislation on management in a crisis situation, including a new Water Act, was accepted by the government. Though the next flood happened only two years afterwards, the accepted legislation resulted in a more effective management of flood in 2002. Very important and useful are the new regional flood management plans. Some regional authorities have the flood management plans also in a digital form, and they are partly available for the public.

The ICPE Action Plan for the flood protection in the Elbe river basin accepted in 2003 is an important supplementary tool for the national management of flood events in the Czech part of the Elbe basin. This plan helped to draw conclusions of the August 2002 flood, so that they could be transferred into specific national management schemes.

Improvement of water retention effect in the basin

The improvement of the landscape retention effect is one of the objectives of the Main water management plan of the Czech Republic. One of the main tools here is the Program for renaturation of the whole river network, which is considered for a long-term implementation.

Besides, the Water management plans for districts reflect the WFD requirements of a good ecological status in a link with the needed increase of the retention effect in the drainage basin (integration!).
**Flood zones delineation, declaration and exploitation**

For prevention or reduction of damages created by flood events it is important to know the extent of the potentially flooded area. The Water Act requires delineation of the potentially flooded zones. The documentation on potentially flooded zones is now under preparation by the watercourse managers. Ordinance of the Ministry of Environment N. 236/2002 defines the requirements of the documentation. The documentation defining the potentially flooded zones has to be delivered to the water authorities.

Besides, Ordinance N. 236/2002 defines “the active zone of the potentially flooded area” as an urbanized area, the prevailing part of which could be flooded. In the active zone of the potentially flooded area it is forbidden:
- to build any new constructions (exceptions are defined),
- to mine minerals and soils in such a way that the drainage conditions are worsen,
- to store materials and substances that could be washed out, and
- to build fences and permanent camping sites.

Until now, the potentially flooded zones are delimited around the Elbe River in CR and around the lower parts of Vltava (Moldau) and Ohře (Eger).

**Studies of flood hazards and potential damages**

The project “Development of methodology for assessment of flood risk and damage in flood-prone areas, and its verification in the Elbe river basin” considered the flood hazards and damages. The objectives of the project were to evaluate the flood damages and risk potential due to the recurrence interval of 100 years (design flood). The case of failure of flood protection measures was also considered. The project results have been used as a basis for decision making procedures dealing with the variants of territorial and land-use planning, including construction plans within the flood-prone areas.

The project suggested basic rules and methods for providing realistic information to affected public about the flood danger and hazards. This should substantially improve the public awareness on flood issues (public awareness).

**Realization of technical measures for flood protection in the CR**

Technical measures for flood protection are realized in order to protect the important settlements. Mathematical modelling of flood waves provides a basis for technical measures. Recently, the improvement of technical structures was performed in the city of Pardubice (package of measures), city of Hradec Kralove (reconstruction of dikes), and at the dam Nechranice on the Eger (reconstruction). The project results are used for further planning of the reconstruction measures.

**Improvement of monitoring, forecast and information about floods**

Technical equipment of the monitoring systems is continuously modernized in order to make the flood forecast more accurate.
A common international flood forecasting system is under construction in the basin. The following measures for improvement of the flood forecasting system in the area of the CR are implemented:

- specific flood discharge curves were checked for all important gauges and sites;
- time advance of forecast was prolonged to 48 hours;
- the number of river sites for flood forecast was increased from 42 to 70;
- the forecasts for 30 sites are published in the internet (*public awareness*);
- the Czech Flood Forecast Center is linked with the Centers in Dresden and Magdeburg using a FTP server.

Besides, the Czech Republic joined the European Flood Alert System.

The next important issue is an improvement of flood protection measures and individual preventive measures. The land owners in the flood-prone areas are educated on preventive measures at the regular workshops (*public awareness*).

Public information and awareness about flood hazards is improving in the basin. The central water authorities provide information through information system VODA (WATER, http://www.voda.gov.cz/portal/). The administrators of the Water Management Information Portal WATER are the Ministry of Agriculture and the Ministry of Environment together with other central state water authorities of the Czech Republic, i.e. the Ministry of Health, the Ministry of Transport and the Ministry of Defense coordinated by the Ministry of Interior (shared responsibilities). Through the uniform, well-arranged and easily available applications the above-mentioned ministries present authentic information about water resources to the general public (*public awareness*). The portal WATER provides current information about water levels and discharges, precipitations and water quality.

The involvement of the relevant research projects at the national level and non-governmental organizations provides an integration of the state-of-the-art knowledge in water resources management, and makes the procedures more visible and understandable to the public. Up-to-date information is indispensable for a more effective management in the case of extreme events.

### 2.4 Example: Simulation game on operational flood management organized by the Elbe CS

The Elbe CS team organized the Simulation game on operational flood management 12-13 November 2008 in Chomutov, Czech Republic. The Game was requested by the water authorities and intended as a contribution to improved flood management in the Elbe basin.

Floods are caused by meteorological and hydrological conditions, but their consequences and damage created by floods are also influenced by many different socio-economic factors. The Adaptive and Integrated Water Management Regime concept states that the best way to manage water resources is to increase our capacity to learn from experience and adapt to changes taking into account uncertainties. Flood management has to deal with many uncertainties. The uncertainties can be of a physical origin (e.g. related to uncertainties in hydrological modeling), or of a social origin (e.g. relationships among actors during the management process).
Various time scales of decision-making can be encountered within the water management process. The extreme case with the shortest time is the decision-making during operational flood management, especially when the response time of a catchment is very short (e.g. several hours). In this case, a quantitative precipitation forecast is necessary for the flood forecast to have a sufficient lead time. However, the quantitative precipitation forecast is extremely uncertain. Sometimes difficult decisions must be taken within one hour or even less.

During the flood the control room staff communicates with meteorologists and hydrologists, on one side, to get the forecasts of precipitation and discharges as accurate as possible, and, on the other side, with the regional and local authorities who are responsible for the measures taken.

The greatest challenge in a flood situation is to estimate the time of the rainfall end, as most of the difficult decisions depend on it. The management of the system requires a detailed knowledge of the system, experience, skills and good nerves. For developing such skills the active methods are recommended. The efficiency of the active methods of learning (games) is much higher than that of the passive ones (reading, lectures etc.), e.g. 90% compared to 20-50%. Moreover, also the other players in the game, like decision makers from the local and regional administration, can take part and get acquainted with the reservoir management problems and discuss their concerns (about the evacuation etc.) with the control room staff.

In the Czech Republic games on operating a system of reservoirs in a flood situation took place several times in the 80s and the beginning of 90s. The games fulfilled the expectations both from the point of view of learning theories and research. The activity of all participants was high and led to quick understanding of the problems connected to operating water resources systems. Also the laymen (non-professionals) recognized the difficulties of decision making in real time in the situation of lack of information, different degree of operability of individual reservoirs and the necessity of a good preparation of not only the control room staff, but also wide technical and laymen public for extreme situations.

The catastrophic flood damages can be distinctively decreased by good cooperation among relevant stakeholders. Following these assumptions, the simulation game for the flood situation was prepared. The workshop was organized to enhance cooperation and interaction among stakeholders during the flood events. The essential feature is the dialogue between the various groups of stakeholders in the process of decision making. Even with all the modern technology those decisions involve high uncertainties.

**The Simulation game setup**

The water management system considered in the Simulation game consists of four reservoirs: Skalka, Jesenice, Brezova and Stanovice. The operation of these reservoirs is aimed in protecting a well known spa Karlovy Vary (Karlsbad) from the flooding. Four teams were manipulating the dams of four reservoirs to manage the flood. The members of each team included
- representatives of local and regional authorities for crisis management responsible for decision making during flood (warning, evacuations etc.) providing local knowledge, and
- experts for manipulation of dams providing the expert knowledge.

Some participants brought their own laptops to participate in the game in a more effective way (Fig. 2).

**Fig. 2. The team is taking a difficult decision.**

The objectives of the Simulation game were the following:
- to demonstrate clearly the uncertainties connected to using the meteorological forecasts and the difficult decisions which has to be taken by the stakeholders (local decision makers, officers from the ministries, and representatives of enterprises which are in danger in a flood situation);
- to enhance the understanding and cooperation between stakeholders with their various interests and the control room staff.
- to check the possibilities for using the game for the training of students.

Generally, the game is demanding as far as preparation is concerned. The game software should work in larger time steps than what is used in reality, so that the consequences of each decision are evident in a small number of the following steps. The outputs of the software should be similar to the outputs of the real operation software, but has to be simplified so that they could be quickly understood by non-professionals. The information on inputs and outputs of the individual steps should illustrate properly the procedure and the involved uncertainties. The equipment is intended to serve in future for other game-training courses with different types of users (the control room staff, decision-makers and students).

The environment was set in the same way as at a real catastrophic flood situation: the standard equipment of the water administration control room was provided to the playing teams. The standard hardware and software equipment of the water administration control room was provided to the playing teams.
The Simulation game was designed to be played during 8 hours. The tasks for the playing teams were the following:
- to operate the dams in an optimal way,
- to decide about warnings and evacuations,
- to deal with unexpected situations.

The precipitation event was selected and artificially increased for the Simulation game with regard to the possible effect of climate change (Fig. 3).

**Fig. 3.** The precipitation event used in the Simulation game (srážka = precipitation).

The organizers of the game and interested observers (“the simulation control centre”) discussed the Simulation game setup and the results (Fig. 4).

**Fig. 4.** The “simulation control centre” discusses the results
Evaluation of the game

The evaluation of the Simulation game was carried out from two points of view:
- how the individual teams dealt with the catastrophic flood (hydrological or water management point of view)? and
- is the game a powerful tool for enhancement of understanding and interactions among the stakeholders? (social learning point of view).

The results of management decisions of the individual teams are shown on Fig. 5. They could be compared with the optimal solution for this situation (numerical solution).

The evaluation was carried out via a questionnaire mapping the expectations of participants before the Simulation game, and their feedback after. The evaluation of the questionnaire demonstrated that the Simulation game is a very powerful tool for enhancement of understanding, interaction and collaboration among the water management authorities, water experts and local stakeholders.

![Fig. 5. An example of the decisions of four individual teams. The vertical axis shows water level at one of the dams in the basin. “Max. ret.” is the maximum retention of the reservoir. The dashed line is an optimal solution of flood management. The colored lines represent management decisions of the individual teams.](image)

Conclusions

The current flood protection strategy in the Elbe basin shows a certain level of integration between different sectors and issues, which is increasing. The level of public participation is relatively high, and is growing due to awareness raising and in response to dangerous extreme events as drivers for adaptation.
3 Implementation of Water Framework Directive and realization of IWRM principles

3.1 General overview on WFD implementation in the basin

The Directive 2000/60/EC of the European Parliament and Council of October 23, 2000, establishing a framework for Community action in the field of water policy, came into effect on December 22, 2000. It is called the Water Framework Directive. The objective is to achieve good status of water in all the rivers, lakes, transitional waters, and groundwater in the EU member states by 2015. To achieve this, river basin management plans and programmes of measures for each sub-basin must be established by 2009.

The key element of the Water Framework Directive consists in the coordinated effort of the countries in the Elbe River basin. The four countries in the International District of the Elbe River Basin – the Czech Republic, Germany, Austria, and Poland – came to the agreement that during the implementation of the Water Framework Directive they will establish an international coordination and cooperate under the framework of the International Commission for Protection of the Elbe River (ICPER).

One major focus of the ICPER was on establishing the joint monitoring programmes for surface waters and groundwater. This corresponds to one of the main principles of IWRM. The monitoring programmes are based on the joint concept for monitoring the surface waters status and the joint concept for monitoring the groundwater status in the International District of the Elbe River Basin. The programmes were approved in July 2006. The information on the monitoring of the surface waters status and the groundwater status collected in the member states in accordance with the requirements of the WFD was presented in a joint ICPER framework report (2007). The Report is available to the member states in the Elbe River basin.

The Water Framework Directive calls for an intensive involvement of the public in all phases of the Directive’s implementation. This also corresponds to one of the main principal components of IWRM.

One of the instruments of public participation at the international level is publishing of ICPER information sheets. They inform the concerned public on the results and implementation progress of the Water Framework Directive in the International District of the Elbe River Basin. So, the ICPER Information Sheet Nr. 1 of March 2005 summarizes the important results listed in the report on the analysis of the characteristics of the International District of the Elbe River Basin in accordance with Article 5 of the Water Framework Directive. The ICPER Information Sheet Nr. 2 of August 2007 summarizes the important pieces of information listed in the report on the water status monitoring programmes that had been established in the International District of the Elbe River Basin in accordance with Article 8 of the Water Framework Directive.

The implementation of EU Water Framework Directive is affecting everyone involved (directly or indirectly) in water resource management by the new legislation entering into force. General principles of WFD and IWRM implementation should be concretised according to specific conditions in each country and each subbasin. The information has to
be developed with cooperation of a wide range of potential users, especially with those involved in water planning and management at regional and local levels, including land use planners, water supply and treatment companies, and regional and local authorities.

For example, in the Czech Republic the institute of the river basin administration is introduced. It allows a more effective utilisation of the information from operational and measuring water management systems. The involvement of public and water users into the river basin planning process will be a substantial part of the task. An increasing synergy among the river basin administrators, watercourse administrators and water management authorities in the area of flood prevention will help to bring the IWRM principles closer to the practical application in the river basins. Another issue, which will be in the centre of interest is the realisation of the Flood Prevention Programme (maintained by Ministry of Agriculture and approved by the government on 15.11.2006) with regard to new EU Flood Directive.

The realisation of the water management measures in the watersheds that will result from the complex land improvement represents a wide field of IWRM implementation in Germany and the Czech Republic. According to WFD, the evaluation and development of the complex land improvement plans should respect the IWRM principle in the future proposals.

The basic issue for implementation of IWRM is an improvement of the quality of professionals in the water management organisations by dissemination of materials describing the new methods (including IWRM guidelines and handbooks). Improvements should be followed by IWRM dissemination at different educational levels, for example by enhancement of cooperation among the water management organisations in order to use the IWRM principles for optimization of provided services, by extensions of education and applied research using the IWRM approach with respect of specific needs of the countries and federal states.

The following sections describe three examples of the specific focus studies of the Elbe team. One example is the modelling study for the Rhin catchment, which was performed by the Elbe CS team on the request of the regional environmental agency in order to support the WFD implementation in Brandenburg. Two next examples describe two District Plans of measures as key strategic tools for water management. These two districts incorporate two focus areas of the Elbe case study: the Jizera and the Malse/Rimov catchments.

### 3.2 Example: Integrated approach for water quality management in the Rhin subbasin

The Rhin catchment was chosen in the stakeholder participatory process in the Case Study Elbe in view of the Water Framework Directive (WFD) implementation. The aim is to achieve a good ecological status of the river and lakes in the catchment, as well as an optimal water supply for the region and its inhabitants. For the NeWater project it is an example region, for which strategies and measures to implement the WFD will be developed using the results of model runs, trend analysis and scenario computation.

The Rhin is a mesoscale catchment (1716 km²) located in the Elbe drainage area. The Rhin river drains into the Havel river, a tributary of the Elbe river. It can be seen as an area
representative for the lowland part of the total Elbe basin. The catchment is characterized by sandy forested areas in the north with a lot of lakes along the river course, and very flat agricultural areas in the south. The Rhin river network is influenced by more than 300 small dams and weirs. A lot of ditches for irrigation and drainage, pumping stations, water storage/transfer and the barrages influence the hydrological cycle, so that the natural discharge behaviour can hardly be seen.

Regarding water quality, the river network can be clearly distinguished as less polluted in the upper part and higher polluted in the lower part of the catchment. Although water quality on average is not so bad, particularly the ditches draining agricultural areas are heavily loaded with nutrients. Therefore measures to improve water quality and to reach the aims of the WFD (the “good ecological status” and the “good chemical status”) are necessary, especially in the lower part of the basin, which is classified as an endangered water body due to its trophic status and oxygen demand.

Knowing these problems and being interested in finding solutions to get a better ecological status of this lowland river, the Environmental Agency of Brandenburg (LUA) requested a modelling study to support implementation of the WFD in Brandenburg to reach the “good ecological status” until 2015. In general, future water management decisions should be more adaptive, as we are living in a rapidly changing world. It cannot be expected that the former conditions will stay unchanged. Some changes in temperature, precipitation and/or intensity and frequency of extreme events have already been observed in the region, but also changes in land use, technical equipment and population are possible. For this reason, the model scenarios with possible changes of land and water use, management practices and climate conditions as different options for the future should be taken into account by implementing the WFD.

The stakeholders of the LUA were especially interested in answering the following questions:

- What is the potential natural status of the river regarding water quality?
- What are the shares of point and diffuse sources of pollution, and where are the main areas of diffuse pollution located?
- Which consequences could possible changes in management, land use and climate have for the river system in the future?
- What are the most appropriate measures to reach the “good ecological status” as required by the WFD?

The modelling results

The dynamic ecohydrological model SWIM (Soil and Water Integrated Model) was used for modelling water quality and quantity and for scenario runs with changed climate, and changed land use and management. Calibration and validation of the SWIM model in the Rhin catchment was done for water discharge and the nutrients: nitrogen and phosphorus. The analysis of time series and the modelling results have shown that the nitrate nitrogen load is highly influenced by diffuse-source pollution (mainly from agricultural fields), whereas the total load of phosphorus in the Rhin river is affected mainly by emissions from point sources. The fraction of point-borne loading is much higher for phosphorus than for nitrogen.
To investigate the influence of a changing climate on the water quality of the Rhin river, two different approaches were applied. A simple climate sensitivity analysis showed that a reduced precipitation leads to reduced discharge and nutrient load (less diffuse pollution as a result of less washing out), but increased nutrient concentrations as the reduction of discharge is much higher than the reduction of loads. An increase of precipitation has an opposite effect. Lower temperatures cause higher discharge and more leaching (as a consequence of lower evapotranspiration and inhibited denitrification processes) and result in higher nutrient loads and concentrations in the Rhin river. With higher temperatures a decrease in discharge and loads can be observed because of higher evapotranspiration and decreased leaching.

Application of climate scenario obtained by statistical downscaling method STAR revealed similar results. One scenario with 100 realisations was applied, whereas some realisations provided dryer, and some wetter climate in future. In general, the outcomes of the scenario resemble the climate sensitivity analysis with changed precipitations: drier climate causes lower loads but higher nutrient concentrations, whereas wetter climate leads to reduced concentrations mainly due to increased discharge. It appears that the changed precipitation of the scenario runs has much more influence on water and nutrient flows in the region than the changed temperatures.

To find measures for nutrient load reduction in the Rhin river and its tributaries, some model experiments have been applied, which were expected to decrease nutrient loads in the basin (see Table below). The scenarios led to nutrient reduction with different results for nitrate nitrogen and phosphate phosphorus (see Fig. 6 below). Nitrogen seems to be more sensitive against changes in fertilisation regime and crop type composition, whereas phosphorus can be reduced most effectively by decreasing point source emissions. This is due to the relative influence of point and diffuse pollution on the total loads of nitrogen and phosphorus. Noticeable changes in phosphorus concentration via crop type variances and agricultural land use changes could only be achieved by growing crops (or rather no crops) causing higher discharges at the basin outlet (e.g. increase of the amount of set-aside) as a result of dilution processes.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>river bank</td>
<td>conversion of agricultural land with fertilisation within 50 m around rivers and lakes to extensive grassland without fertilisation</td>
</tr>
<tr>
<td>forest</td>
<td>conversion of all forested areas (34% of the whole catchment, thereof 80% evergreen) to deciduous forests</td>
</tr>
<tr>
<td>crop types N</td>
<td>change of the three crop types causing the highest nitrogen concentrations (winter wheat, sugar beet and winter rape) to winter rye</td>
</tr>
<tr>
<td>crop types P</td>
<td>change of the three crop types causing the highest phosphorus concentrations (winter barley, sugar beet and oil flax) to winter rye</td>
</tr>
<tr>
<td>fertilisation</td>
<td>maintaining the reference situation for crop types composition but reducing crop specific N and P fertilisation by 20%</td>
</tr>
<tr>
<td>sewage</td>
<td>reducing the N emissions of all sewage treatment plants within the catchment by 10% and the P emissions by 20%</td>
</tr>
<tr>
<td>combination</td>
<td>combination of the scenarios “river bank”, “fertilisation” and “sewage”</td>
</tr>
</tbody>
</table>
Two tested measures were dealing with possible changes in the landscape composition: the installation of buffer zones without agricultural use around surface water bodies and the conversion of all evergreen and mixed forests to deciduous ones. Both methods resulted in decreasing nutrient concentrations in the Rhin river: the first one due to decreased nutrient loads (caused by a smaller fertilised area in the catchment), and the second one due to a higher discharge at the outlet (caused by reduced plant transpiration of deciduous trees in winter months) and dilution processes. But in general, the effects of a changed land use on nutrient concentrations do not exceed five percent. Changes in fertilisation regime and point source emissions can have a much higher influence on nutrient concentrations.

As no single scenario resulted in a considerable decrease of nutrient loads and concentration for both nitrogen and phosphorus, a combination of some measures was tested. This led to a reduction of the nitrogen as well as the phosphorus loads and concentrations by about 15%, which would allow pushing the system closer to the “good ecological status” as required by the WFD.

![Fig. 6 Changes in water discharge and average nutrient concentrations and loads according to land use/land management scenarios](image)

**Conclusions**

The scenarios for the Rhin catchment allowed to analyze water quality resulting from climate, land use and land management changes as well as changes in wastewater treatment. The Rhin case study was aimed in the nutrient reduction to improve water quality and in finding more optimal solutions for the local government. There are some important conclusions from the study. Agricultural land is the main source of nitrogen load to the river in the studied area. The most effective way to reduce nitrogen concentration in surface water is by changing agricultural practices, like changing crops or reducing fertilizer amounts. Besides, these measures are easier to realize than changes in the landscape composition, as they do not require long periods to grow (like forests). Therefore, application of better
agricultural practices is very important, if reduction of nitrogen pollution is needed. To reduce phosphorous pollution, an improved wastewater treatment should be the first priority measure.

Modelling experiments can help to understand the river system behaviour better. The modelling results can be very useful for identification of the fractions of point and diffuse sources, and the areas of highest diffuse pollution. Knowing these sources and hotspot areas, it is easier to identify appropriate measures for reducing actual nutrient loads in the river network and for achieving the “good ecological status” as required by the WFD. A dynamic catchment model taking into account water dynamics and nutrient cycling processes as a function of vegetation, land use and human impacts, and driven by climate conditions can provide a very functional tool for creating a river basin management plan. This plan can take into account possible changes, which the basin could be confronted with in future.

Using a process-based model for water quality assessment could be beneficial for water managers. However, uncertainty is always included in the water quality modelling results. Therefore, the modelling results should never be interpreted as exact predictions, but within the uncertainty ranges related to uncertain model parameters and input data, as indicators of possible trends, as qualitative differences, etc. The results have to be critically interpreted, and communication with local experts is important. Considering these requirements and constraints, the models have the power to provide insights in water quality processes, to support water management, and to facilitate communication with experts and stakeholders.

Despite all the uncertainties involved in water quality modelling with limited input data, water quality models are very important tools to support water managers and policy makers in implementing Integrated Water Resources Management (IWRM). It would be impossible to evaluate the effectiveness of land management measures, impacts of changes in land use and climate change on water quality without using the modelling tools.

The Rhin study was a pilot project with close cooperation of researchers and representatives of the decision-making government to support implementation of WFD with research results. The stakeholders of the Environmental Agency of Brandenburg can benefit from the model results as well as the researchers benefit from their specific knowledge of the basin and the available data. Such participatory approach allows providing results, which are requested and will be used by water managers and politicians to improve the adaptability of river systems to changing conditions in the future.

### 3.3 Example: Integrated approach for water management in the Jizera subbasin

The Jizera catchment (approx. 2000 km²) is a part of the Upper and Middle Elbe River Basin district (District). The District lies in the north-eastern part of the Czech Republic and occupies an area of 14735 km². A water body is the basic water management unit characterized by an ecological state or potential, chemical and quantitative state. 214 surface water bodies and 46 groundwater bodies are recognized in the District.

The Upper and Middle Elbe River Basin District Plan is a conceptual document prepared by the Elbe River Basin administration (governmental organization, sometimes referred as the
Elbe River Board) in cooperation with regional authorities and central water authorities. The District Plan is a key strategic tool of water management in the area. It includes the WFD requirements regarding water planning and public involvement. The preparation of the District Plan is performed in three phases:
- Phase I: preparatory work (2007),
- Phase II: a draft of the River Basin Management plan (2008),
- Phase III: the finalized draft of the District Plan (2009).

Phase I includes preparation and public consultation on the timetable and work program, evaluation of the effects and impacts on surface water bodies and groundwater bodies, and preparation of the Interim Overview.

The District Plan consists of the following main components:
- the comparison of the current and “targeted“ status of surface water and groundwater,
- the formulation of the main water management issues in the District,
- the objectives of water management, and the design of measures to achieve these objectives.

The Elbe CS team organized a Workshop in October 2005, where major water management issues relevant for the District were chosen. They can be categorized in the following way:

<table>
<thead>
<tr>
<th>Water quality issues</th>
<th>Inadequate sewerage and municipal wastewater treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Erosion as a source of phosphorus and suspended solids</td>
</tr>
<tr>
<td></td>
<td>Eutrophication of water bodies</td>
</tr>
<tr>
<td></td>
<td>Inappropriate use of fertilizers and pesticides</td>
</tr>
<tr>
<td></td>
<td>Contaminated sites</td>
</tr>
<tr>
<td>Protection of aquatic ecosystems</td>
<td>Morphological alteration in watercourses</td>
</tr>
<tr>
<td></td>
<td>Migration barriers</td>
</tr>
<tr>
<td></td>
<td>Unsuitable land use in floodplain</td>
</tr>
<tr>
<td></td>
<td>Unfavourable hydrological regime</td>
</tr>
<tr>
<td>Flood prevention</td>
<td>Insufficient flood protection of urban areas</td>
</tr>
<tr>
<td></td>
<td>Erosion impact of surface run-off</td>
</tr>
<tr>
<td></td>
<td>Impaired water retention in landscape</td>
</tr>
<tr>
<td></td>
<td>Drainage of headwaters, canalization of small watercourses</td>
</tr>
<tr>
<td></td>
<td>Instable river beds increasing flood risk</td>
</tr>
</tbody>
</table>

Besides, the working groups proposed three water management issues relevant to the whole river basin: 1) ensuring condition for safe navigation, 2) implementation of “polluter-pays principle”, and 3) preservation of biodiversity in water courses.
Design and Implementation of Monitoring Programs

The Monitoring Programs has been set up in order to provide a coherent and comprehensive overview of the water status and thus support decision making on measures addressing achievement of good status of water bodies. The monitoring programs are built upon the existing programs of monitoring and integrate obligations corresponding to the existing legislation and the WFD monitoring requirements. The Monitoring programs that have been designed and are in place for 6 years have to be revised and updated annually in the context of revised methodological guidance, updated EU regulation and actual conditions for monitoring financing.

Design of a Program of Measures

A Substantial component of the District Plan is the Program of Measures. The main objective of the Program of Measures is to set a list of measures addressing specific water management issues and ensuring achievement of the objectives specified for water bodies within the District. The impacts of measures on the status of water bodies have to be evaluated. The following measures are relevant and have to be implemented in the District:
- reduction of pollution of waters by industrial waste water and other point sources;
- prevention of nitrogen pollution from agriculture sources;
- reduction of negative influence of pesticide on surface water and groundwater;
- reduction of pollution from atmospheric deposition;
- remediation of alluvium vegetation;
- revitalisation of watercourses;
- security of fish migration (fish ladder);
- reduction of influence of contaminated sites on groundwater.

The District plan will explicitly address the following issues related to the WFD:

- The achievement of good surface water and groundwater status;
- The prevention of water deterioration;
- The promotion of sustainable water use;
- Pollution reduction, especially concerning dangerous substances;
- The mitigation of the effects of floods and droughts.

The Implementation of the District Plan will have significant impact on the quality and quantity of surface water and groundwater, and on water use in the next decades. Good status of surface water and groundwater is a common goal of all individual users and stakeholders, and should be promoted by anybody who is interested in having enough water of sufficient quality.

3.4 Example: Integrated approach for water management in the Malse/Rimov subbasin

The Malse river basin (435 km²) represents a small part of the upper Moldau river basin area (11 059 km²), which is a part of the Elbe River Basin. The water supply is a dominating function in the Malse basin. There is a large drinking water reservoir (Rimov) providing drinking water to the city of Ceske Budejovice in the South Bohemia.
The plans for Integrated Water Resources Management related to Water Framework Directive in the Malse subbasin are directly connected to the preparation of the new District Plan for the Upper Moldau River Basin Area. The legal base for the Plan has been laid by the Water Act No. 254/2001 and its amendment and by the Public Notice No.142/2005 regarding the water management planning. The Moldau River Board is responsible for the development of the Plan in cooperation with the regional authorities. At present time the new Plan is under design. The draft has been released for comments by public to involve the diverse opinions from a wide range of points of view.

The water planning and water management in the Upper Moldau River Basin Area has to be applied for small unified basin areas called water bodies, which are defined by similar hydrologic properties.

**Problems**

The list of the main water management problems in the area has been compiled during the preparation stage. The list of the main problems has been compiled by involvement of stakeholders from different branches and taking into account different legislation rules and documents. Generally, three basic categories of problems in the water management planning have been identified in the Upper Moldau River Basin Area Plan:

- water protection in connection to the nature protection,
- protection against floods and other destructive water effects,
- sustainable use of water resources for fulfilling all water demands, especially for drinking water supply.

One of the main issues in the Malse/Rimov subbasin is water quality management and protection of water quality in the nature preservation areas. The water quality in the drinking water reservoir is continuously influenced by the lack of water infrastructure in several neighbouring settlements. The improvement of water quality in the tributaries of Malse: Stropnice and Svinensky creeks, is necessary for the improvement of water quality in the Rimov reservoir. It was found that the pollution from these tributaries causes eutrophication in the reservoir.

Several vulnerable areas have been identified in the Malse subbasin, where the areal pollution has to be substantially reduced, and where soil erosion has to be better reduced in the future. Several obligatory measures are set in these areas by the Plan. In order to better control the implementation of measures in the vulnerable areas, they have been adjusted according to the cadastral administration units (clear registration of the owners).

The list of dangerous substances included in the EU norms and directives has been used for the evaluation of effects of dangerous substances. The diffuse and point sources of pollution impact groundwater quality in the region. The additional field surveys and a more sophisticated monitoring will be applied for the enhancement of the existing monitoring system. The administration will be involved in the monitoring. The list of the main point sources of pollution has been compiled. An additional information about old sources of pollution, which have not been monitored in the past, is being evaluated now.
The unsuitable modifications of the water courses (mainly barriers for the fish migration and ecologically inappropriate adaptation of streams) made in the past have been detected during the analysis of the problems in the basin. In the scope of necessary ecological protection, the revision of such interventions must be performed to keep the requirements of the WFD.

The Malše river basin has been evaluated as a region with not sufficient warning system for floods. The IWRM enhancement concerning the protection against flash floods has been highly recommended to implement in the region. The localities, where the warning systems will be introduced, are specified taking into account maps of areas with too fast runoff. In several localities the delineation of the potentially flooded areas does not exist. The evaluation of endangered parts of settlements has not been carried out until now.

The revision of safety of the dams in the upper Moldau river basin area has been carried out in the scope of the new Plan preparation. The safety of the Rimov drinking water reservoir has been evaluated as inadequate, and the management rules are being modified according to the new demands at present time. The measures will include the possibilities for adaptation to the climate change.

Measures

Two heavily modified and polluted water bodies were identified in the lower part of the Malše basin. Application of three different types of measures has been suggested to improve water quality status and hydromorphological conditions:
- construction/reconstruction of sewage treatment plants and intensification of sewage water treatment,
- revitalisation of some water courses and elimination of the barriers in the water courses to improve hydromorphological conditions,
- sanation of the past pollution loads in the basin to limit entering of dangerous substances in surface water and groundwater.

The following concrete measures were suggested for water quality improvement in this area:
- reconstruction and enlargement of the sewerage drainage system in Budweis (the main city of the Southern Bohemia) to reduce pollution of the Malše river,
- reduction of pollutant emissions by small polluters in the basin (in three different localities in the Malše basin),
- reduction of nitrogen load from agriculture sources in six localities in the basin,
- elimination of diffuse nitrogen pollution in five localities in the basin,
- reduction of water erosion to eliminate transport of chemical substances in seven localities.

The revitalization and reconstruction of four segments of smaller water courses in the basin was suggested in order to improve flood preparedness:
- system of measures against floods in Budweis,
- system of measures against floods in Benešov nad Černou,
- reparation of the weir in Kaplice,
- reconstruction of the levee at Horní Stropnice.

The revitalisation of tributaries bringing water into the reservoir will be beneficial both for water quantity control (floods), and for water quality improvement.
The evaluation of chemical and ecological status of the water bodies in the Malse basin has been carried out during and after the definition of the Plan priorities. The economical analysis of the measures was used to assess the feasibility of measures implementation.

4 Evaluation of state-of-the-art water resources management and implementation of some IWRM principles based on the Questionnaire results

The evaluation was done using the Questionnaire on “The state-of-the-art of river basin management in dealing with climate-related extreme events” (Huntjens, 2008), which served to provide an overview of the current river basin management in the basin. The research objective was an inventory of factors, which are important for effective water management in view of increased frequency and intensity of climate-related extreme events. The Questionnaire was distributed in other NeWater case Study basins as well. The Questionnaire was subdivided into ten categories:

A) Agency
B) Awareness Raising and Education
C) Cooperation
D) Policy development and implementation
E) Information management and sharing
F) Agriculture
G) Finances and cost recovery
H) Risk management
I) Infrastructure
J) Effectiveness of (international) regulation.

Each question included two possible answers describing the positive and negative status of the management. The respondent had chance to mark, which of these two answers is prevailing, or if the status represents medium situation between the two opposite conditions. The next step was to indicate the importance (or weight) of each indicator. In the last part of the questionnaire inquiry the respondents have been asked to evaluate the indicators for measuring the performance or effectiveness of river basin management.

The Questionnaire survey was conducted in the Ohre River catchment (5870 km²), one of the large subbasins of the Elbe. The Ohre River is located in the North-West Bohemia near German border and partly stretches into Germany (Fig. 7). Eleven respondents: experts from different water management practices and policy makers have been invited to participate in the inquiry. One questionnaire had to be excluded from the evaluation because of errors in the form.

In many cases, the answers of ten respondents differ significantly. Doing the evaluation, we have chosen the prevailing answers with ≥ 70%, and in some cases with ≥ 60%. The diversity of answers could be partly explained by different opinions amongst the respondents, and maybe partly by the complexity of the Questionnaire as a whole, as some respondents maybe felt incompetent to answer all the questions.
This Report includes the results for questions B) Awareness raising and education, C) Cooperation, and E) Information management and sharing, as having direct relation to the principal components of IWRM (see p. 5).

![Map of the Ohre River Basin](image)

**Fig. 7: The location of the Ohre River Basin (in red) as a sub-basin of the Elbe River Basin**

**Evaluation of category B: Awareness raising and education**

The second category was focused on the public awareness raising and education. The main evaluated topics were

- the public awareness programs on water problems,
- water education in schools, and
- water education for water practitioners and professionals.

In general, the level of awareness raising, existence of IWRM programs and programs for public awareness raising and education can be characterised as medium. Most of responders have chosen an option “medium in between”. The IWRM is not fully implemented in school education yet. However, all three indicators were marked as important or very important by all experts.
Evaluation of category C: Governance and cooperation

The governance and cooperation have been evaluated as the third category of the questionnaire. Five basic topics have been discussed in this part:

- type of the governance,
- level of stakeholder participation,
- level of cross-sectoral cooperation,
- level of cooperation between administration levels, and
- cooperation across the administrative boundaries.

Altogether, 14 points had to be answered. The governance could not be uniformly classified. The most frequent respond was that the fact could not be easily characterised by the given description and the situation correspond to the medium state between. A half of respondents indicated top-down governance in the basin as dominant, while another half answered “in between”. The type of governance was evaluated by a majority as important.

Most of responders indicated on existing legal provisions concerning access to information, participation in decision making and access to courts. Regarding stakeholder participation, most of answers were “in between”, which indicates that some stakeholder participation is taking place, but it is not yet sufficient. However, the majority found stakeholder participation important.

The experts evaluated the level of existing cross-sectoral cooperation as being between “medium” and “good”, and found it fairly important or very important. The cooperation between administrative levels was evaluated similarly: between “medium” and “good”, and important. Dealing with conflicts was found at the medium level for both cross-sectoral and administrative levels.

The majority of responders acknowledged that downstream governments are involved in decision-making by upstream governments, and that international transboundary cooperation structures exist. However, they were less certain about dealing with conflicts. This probably indicates that sometimes conflicts are resolved constructively, and sometimes they remain unsolved. Almost all experts found the transboundary and downstream-upstream cooperation very important. The international transboundary cooperation was marked as the most important indicator.

Evaluation of category E: Information management and sharing

The Information management and sharing have been assessed by the fifth category. In this category the following indicators were evaluated:

- joint information production,
- interdisciplinarity,
- elicitation of mental models,
- explicit consideration of uncertainty,
- broad communication,
- utilization of information, and
- decision support system.

In general, the respondents evaluated information management in the basin quite positively. Most of the experts acknowledged that different government bodies are involved in setting the Terms of References (project preparation document) and supervising the search for information, but they were not so sure about the involvement of non-governmental stakeholders in this process (only a half responded positively).

The question about interdisciplinarity (involvement of ecology and social science in the research) was responded rather positively.

The question whether the researchers allow or not their research to be challenged by stakeholders was answered as “in between” by a majority. Most of the responders acknowledged that usually the research results are presented in a facilitative way in order to stimulate reflection by stakeholders.

90% of the responders answered that uncertainties are communicated in reports and orally, and are not glossed over. According to a half of experts, researchers are willing to talk with stakeholders about uncertainties. Another half has chosen the answer “in between”.

The majority agrees that governments exchange information and data with other governments, but they were less sure (50% of positive responses, and 50% “in between”) about the dissemination of governmental information to the public.

The responders agreed that new information is mostly used in public debated and is not distorted, however they were less sure whether new information influences policy or not (40% of positive responses, and 60% “in between”). 70% of experts think that river basin information systems are up to standards.

All indicators in this category were found important by a majority of experts. The lowest importance (60%) was assigned to the involvement of non-governmental stakeholders in the process of information production.

5 Conclusions and policy summary

The conclusions are grouped under sub-headings related to
- flood management in general,
- identified IWRM principles in the current flood protection strategy and WFD implementation practice,
- modeling as a support for management decisions, and
- evaluation of the state-of-the-art river basin management based on the Questionnaire results.
Advances in flood management

Recent catastrophic flood and severe drought in the Elbe basin have shown that the natural extreme events are important drivers for adaptation to climate-related disaster.

The traditional approach to flood protection shaped by a safety mentality and dealt mainly in terms of design values such as 100-year flood has to be updated and changed to adaptive and integrated flood management including the whole spectrum of possible protection measures, with a detailed analysis of related uncertainties.

The policies and rules for flood management in all related sectors have to be changes. This cannot be achieved at once, but the process has started.

The current flood protection strategy in the Elbe basin shows a certain level of integration between different sectors and issues, which is increasing. The level of public participation is relatively high, and is growing due to awareness raising and in response to dangerous extreme events as drivers for adaptation.

Identification of IWRM principles in the flood protection strategy and WFD implementation

The implementation of the Action Plan for the flood protection in the Elbe basin shows that the management is being done at the basin scale, considering measures in the watersheds, on the river network, and non-structural measures, and that specific measures (e.g. for increasing retention capacity in the drainage basin) show a certain level of inter-sectoral integration (principle IWRM component 1).

The Water management plans for districts in the Czech Republic reflect the WFD requirements of a good ecological status in a link with the needed increase of the retention effect in the drainage basin (flood protection) (principle IWRM component 1).

The recent flood events motivated population is endedangered areas to implement and extend private risk reduction measures. An improved information and financial incentives were used to encourage preventative household measures in Germany and the Czech Republic (principle IWRM component 4).

The involvement of NGOs and relevant research projects at the European and national levels, publication of forecasts and information on flood protection measures in Internet, education on preventive measures definitively contribute to the transparency of plans and to the integration of the current state of knowledge into the new developments (principle IWRM component 4).

The evaluation of the Simulation game on operational flood protection by the participants of the Workshop demonstrated that the Simulation game represent a very powerful tool for enhancement of understanding, interaction and collaboration among the water management authorities, water experts and local stakeholders (principle IWRM component 4).
Modelling as a support for management decisions

The dynamic river basin modelling taking into account water and nutrient processes as a function of vegetation, land use and human impacts and driven by climate conditions, can provide a very functional tool for creating a river basin management plan taking into account possible changes, which the basin could be confronted with in future.

Modelling experiments can help to understand the river system behaviour better. For example, the model can be very useful for identifying fractions of point and diffuse sources at the outlet of a river system and the areas of highest diffuse pollution (hotspots). Knowing the fractions and hotspot areas, it is easier to identify useful measures for reducing nutrient loads in the river network and achieving the “good ecological status”.

The future water management decisions should be more adaptive, as we are living in a rapidly changing world. Therefore, model scenarios as different options for a possible future should be taken into account. They can be helpful for finding reasonable measures to achieve better ecological status taking into account possible changes of land and water use, management practices and climate conditions.

Evaluation of the state-of-the-art river basin management

The evaluation of the questionnaire on “River basin management in dealing with climate-related extreme events” for the Ohre basin allowed to summarize the state-of-the-art river basin management for the Czech part of the Elbe.

In general, the level of awareness raising, existence of IWRM programs and programs for public awareness raising and education were characterised as medium. Most of responders have chosen an option “medium in between”. The IWRM is not fully implemented in school education yet. However, all three indicators related to “Awareness raising and education” were marked as important or very important by all experts.

The experts evaluated the level of existing cross-sectoral cooperation as being between “medium” and “good”, and found it fairly important or very important. The cooperation between administrative levels was evaluated similarly.

The respondents evaluated information management in the basin quite positively. The responders agreed that new information is mostly used in public debated and is not distorted, however they were less sure whether new information influences policy or not.

The evaluation of answers also allowed to identify the categories and issues in need of improvement. They are: cross-sectoral cooperation, dealing with transboundary conflicts, implementation of IWRM in education, and enhanced stakeholder participation.
References


