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WP 3.3 Elbe Basin

Baseline Assessment of the Elbe basin

Elbe river near Dömitz, Germany

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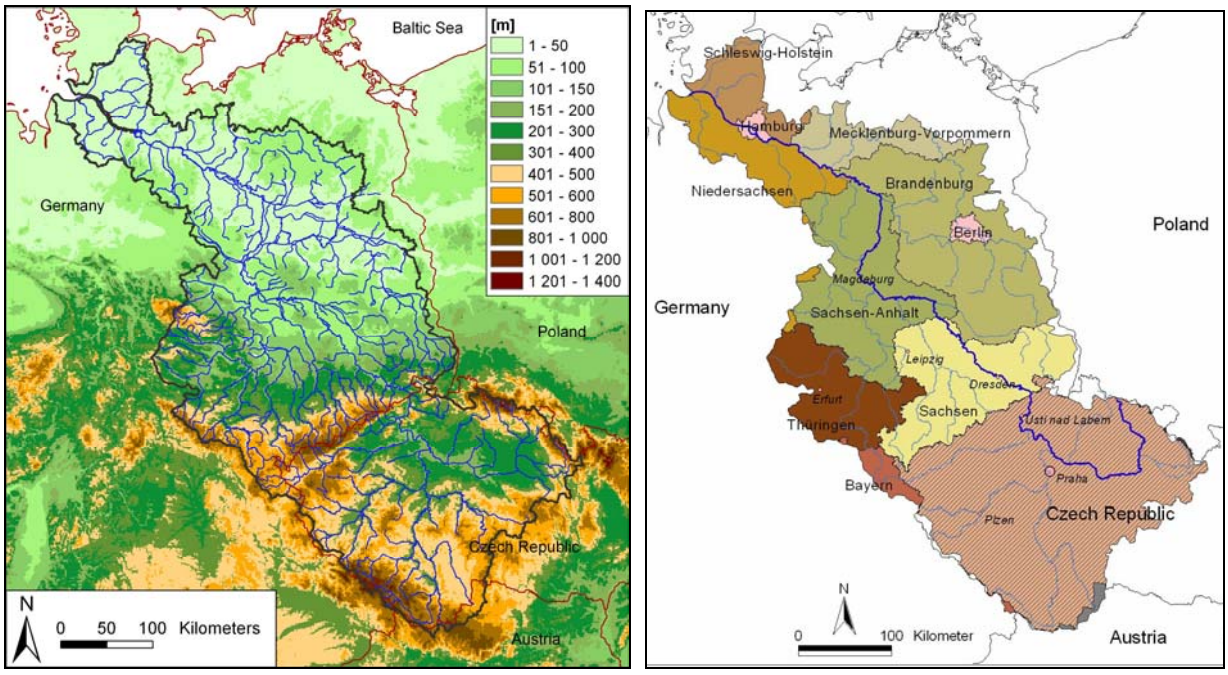

(a) (b)

Fig. 1 The Elbe drainage basin: topography and rivers (a), and administrative borders and cities (b).

River basin. The Elbe River basin 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. The largest cities are Berlin (3.47 million), Hamburg (1.71 million), Prague (1.21 million), Leipzig and Dresden (both ≈ 0.5 million).

The Elbe River. The source of the Elbe River is in the Krkonose mountains (Riesengebirge) in Czech Republic at the elevation of 1383.6 m. Its length is 1094 km, of which 367 km is located in the Czech Republic and 727 in Germany, and the mouth is in the North Sea (considerable tide effects). The principal tributaries of the Elbe are: Vltava (Moldau) with the area of 28,090 km², Havel (24,096 km²), Saale (24,079 km²), Mulde (7400 km²), Eger (5,614 km²) and Schwarze Elster (5541 km²).

Nature. The Elbe basin includes the largest floodplain forest area in Central Europe "Flusslandschaft Elbe", which has been protected as a UNESCO biosphere reserve since 1979 and was enlarged in 1997. Many endangered plant and animal species have survived here (beavers, cranes, black storks, white storks). The population of aquatic species in the central reaches is still considerable, and since 1993 immediate ecological measures for the protection of the habitat structures of the Elbe are undertaken by the International Commission for the Protection of the Elbe (IKSE) established in 1990.

Climate conditions. The Elbe river basin is located in a transition zone between the maritime and the continental climate. The temperature shows considerable inter-annual variability, and this influences the evaporation. Climate characteristics are – to large extent - shaped by the relief and the geographic longitude (weakening maritime climate and more pronounced continental climate towards the East. The spatial distribution of precipitation is very

heterogeneous. The Elbe River basin is the driest drainage basin in Germany (compared to Rhine, Danube, Weser, and Ems) due to low precipitation levels of about 659 mm on average, i.e. nearly 150 mm less than the German average. Precipitation is ranging from below 450 mm in the central part (located in the rain shadow of Thüringia and Czech Republic with their mountainous relief) to over 1600 mm in the mountainous areas.

Hydrological characteristics. The long-term mean annual discharge of the Elbe River is 712 $m^3 s^{-1}$ at the gauge Neu Darchau, the specific discharge is 5.4 $l s^{-1} km^{-2}$, which corresponds to a mean annual runoff of 22.5 x 10^9 m^3, or 26 % of the annual precipitation. The average discharge at the mouth of the river into the North Sea is 850 m^3/s, varying from about 3000 m^3/s after snowmelt in spring to about 150 m^3/s in late summer (Nienhuis, Chojnacki et al. 2000). Specific runoff from the Elbe River basin is low. A large part of the basin is lowland, with high storage capacity of the soil and sub-soil, and poor development of the drainage network. Within Europe, the Elbe River basin has the second lowest water availability per capita. Compared with other areas of Europe, in the Elbe basin water availability per inhabitant (680 m³) is considered as extremely low.

Hydraulic constructions. The Czech part of the Elbe contains many weirs and barrages, whereas the German part is almost free of these constructions. The only German weir can be found at Geesthacht, near Hamburg, which forms the artificial limit of the estuarine, tidal brackish environment. There are a number of storage facilities, with considerable capacity. There are 116 dams with reservoir capacities over 300 thousand m3 in the Czech part of the Elbe drainage basin, and 149 in the German part. Total storage capacity is 3.94 billion m3 (2.53 billion m3 in Czech Republic and 1.41 billion m3 in Germany). The flood storage capacity in winter is 491.8 million m3, while in summer – 403 million m3. These are typically multi-purpose reservoirs, serving flood protection, low water augmentation, energy production, water supply, fishery, and recreation. The original flood retention areas have been dramatically reduced during the last century, from 617,200 ha to 83,654 ha in 1990 (to the level of 13.6%). The lost storage volume is of the order of 1.4 billion m3. Hence, the flood protection strategy is: give rivers their floodplains back.

Navigation. The port of Hamburg is one of the largest ports in Europe (Nienhuis, Chojnacki et al. 2000). The Elbe has been navigable by commercial vessels since 1842 and provides an important trade link between the North Sea and Prague. The river is linked by canals to the German industrial areas and to Berlin. The Elbe-Lübeck Canal links the Elbe to the Baltic Sea (UNEP GRID 2005a).

Human activities. The river basin is used for various purposes. Agriculture areas occupy 56% of the drainage basin, and 25% are covered by original 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 of about 1.8 million people (both about 15%) (Kliot, Shmueli et al. 2001). Principal industries in the basin are chemical, mining, pulp and paper, fine mechanics and electronics, manufacturing and food processing. However after 1990 many factories have been closed or reorganised. Opencast lignite mining in Brandenburg, located in the Eastern part of the Elbe basin, produced up to 200 million t lignite per year in the 1980s. In conjunction, 1200 million m^3 water per year (Arnold and Kuhlmann, 1993) were exported from the mining area into the Brandenburg lowland. After German unification the mining was strongly reduced.

Water-related problems. The Elbe River is experiencing all three major water-related problems: having too much of water (floods), too little of water (droughts), and having water of inadequate quality. In the last three years, extreme hydrological situations were observed on the Elbe - a destructive flood in August 2002, and a severe water deficit only one year afterwards. Besides, the Elbe is a major contributor of nitrogen and phosphorus loads to the Northern Sea.

Floods. The disastrous floods in august 2002 in the Elbe and parts of the Danube basin have strongly shifted general attention to the flooding problem. As a result of the flood in 2002, 38

people died and the economic damage is estimated $9 billion in Germany and $3 billion in the Czech Republic. The rainfall in the Elbe basin in August 2002 exceeded most previously measured rainfall amounts and intensities. Due to climate change the intensity of rainfall and, as a result of that, the frequency of extreme events are expected to increase (Becker and Grunewald 2003). Implications for the Elbe region are still unclear, but the need to take proper flood management measures is strong.

Droughts. Already in the present climate, water is often scarce - precipitation is relatively low over the Elbe River basin and so is runoff coefficient. In the future climate, higher temperatures and lower precipitation are projected for the summer, and this in turn would affect hydrological processes and lead to increased evapotranspiration, and decreased soil moisture, groundwater recharge and river flow. This indicates that the water scarcity problems will grow, with adverse consequences to several sectors, such as agriculture, forestry, water supply, navigation, recreation, nature conservation, and insurance.

Water pollution. In the period between 1960 and 1990 the Elbe was one of the most heavily polluted rivers in Europe (Environmental Policy, 2001, p. 25). Pollution of surface waters and groundwater caused by the high intensity of water use, discharge of insufficiently treated domestic and industrial wastes, and excessive application of fertilizers and pesticides in agriculture, represent a serious problem in the basin. After the German reunification in 1989, water quality improved because most heavy-metal emissions from point sources in eastern Germany were shut down and a beginning was made with effective municipal and industrial waste water treatment (Nienhuis, Chojnacki et al. 2000). The (relative) importance of the pollution problem can be illustrated by the fact that the International Commission for the Protection of the Elbe was established with water quality management as the only purpose. Nutrient pollution (nitrogen and phosphorus) is still one of the most widespread forms of water pollution in the region. Even though emissions from point sources have notably decreased in the basin since the 1990s due to reduction of industrial sources and introduction of new and better sewage treatment facilities, the diffuse sources of pollution represented mainly by agriculture are still not sufficiently controlled.

2. First Characterization of Water Management Regimes in the Elbe Basin

A. Management approach and strategies

A.1. General Issues

Question	Answer	Data Source
What are the major objectives for river basin management regarding water allocation, water quality, flood protection? (possible answers could be maximize economic benefits, guarantee household water supply at any price, security first etc)?	*Objectives of the International Commission for the Protection of the Elbe* In 1990 the Federal Republic of Germany, the Czech Republic and the European Union signed the Convention on the International Commission for the Protection of the Elbe (ICPE) in Magdeburg, Germany. The contracting parties agreed to cooperate in the ICPE to prevent the pollution of the Elbe and its drainage area (IKSE 2005). The prevailing importance of the water pollution problem can be illustrated by the fact that the ICPE was established with water quality management as the only objective. Recently the Commission has also established a working group on flood management. With regard to the latest activities also the *joint* development of the river basin management plan is considered of major importance (Bundesministerium für Umwelt 2005). *National objectives* On German national level, water policy takes international agreements and guidelines such as the successful implementation of the WFD and the objectives of the UN-Millennium on water and sanitation into consideration. Improvement of water quality as well as improvement of preventive flood protection gain here major attention (Bundesministerium für Umwelt 2005) The most prominent strategic target in Czech water management is the improvement of water management infrastructure (drinking water and sanitation), and the successful implementation of the WDF along with the flood protection measures. Protection against floods is considered as very important especially after the damaging floods in 1997 and 2002. There were and are several projects on government level and many research activities supported by national funds. Also the new implementation of flood forecasting system used by Czech Hydrometeorological Institute for the Czech part of Elbe is in progress. Interestingly, the Czech water management policy conception includes among the strategic targets also aspects of improvement of the water management institutions themselves, including an improvement of the cooperation between the different ministries.	IKSE 2005 Bundesministerium für Umwelt 2005 Bundesministerium für Umwelt 2005 Ministry of Agriculture of the Czech Republic 2003 ; Ministry of Agriculture of the Czech Republic 2004 Ministry of the Environment of the Czech Republic; Czech Hydro-meteorological Institute; Academy of sciences of the Czech Republic; Grant agency of Czech Republic
To which extent is the current management paradigm characterized by a belief in prediction and control?	no information yet, a special investigation is needed	
What are the current strategies for risk management? What it the attitude towards – risk	*Both countries.* In flood management risks are being reduced by a broad range of measures (see Chap. 4.3 of Raadgever & Mostert). The attitude for risk management is rather risk averse. *Czech Republic:* The risk issue is not yet fully considered in	Raadgever & Mostert, Chap 4.3 Ing. Nesmerak

averse, risk seeking?	water management. It is considered in the area of water providing from reservoirs (dams) – here it is based on the national technical standard, which prescribes acceptable risks of not providing water supply when operating based on handling procedures (dispatch charts). Something like that does not exist in the area of water quality.	
If and how are uncertainties (e.g. about effectiveness of measures, future developments of water demand) addressed and included in strategic and operational management?	In the ICPE Flood Action Programme a broad package of measures is determined, which reflects (or is reflected in) national flood policy. One of these measures is the establishment of a joint flood warning system (and increasing the prediction timeframe). This measure will decrease *uncertainty* about discharges and water levels during periods of (extreme) high water. Other measures are aimed in retaining precipitation within the area it falls, creating more room for the river and raising awareness and improving preparedness. These measures increase the capacity of the natural and social system to deal with the decreasing predictability of extreme meteorological events. In projects like GLOWA-Elbe, climate change and resulting socio-economic problems in the Elbe basin are considered and strategies to deal with future change and *uncertainty* are developed.	Raadgever & Mostert, Chap 2.5
To which extent does water management rely on hard versus soft approaches (technology versus "societal" measures such as pricing or awareness rising)?	Water managers rely on both hard and soft approaches. For example, gradual improvement of wastewater treatment technologies along with reformation of charges for water supply and sewerage (to meet costs of water abstraction and sewage water treatment costs), and awareness rising (information exchange between water managers, stakeholders and citizens) are taking place in the water management. (It should be also mentioned that partly higher charges were introduced as cover up for former technology "solutions" like over-sized STPs.) In the Czech Republic water management is based first of all on hard approaches that are amended by price measures (fees for water consumption, contaminated discharge, fines, etc.), and in some cases by voluntary approaches of water consumers and voluntary agreements between the industrial unions and state administration. In the HarmoniCOP case study regional water managers expressed their hope that information provision and involving the public is prerequisite for successful implementation of measures (Borowski 2004).	Borowski Ing. Nesmerak
What are performance criteria for success or failure for water management?	On international level, the progress of the action plans of the ICPE are reported every two years and further necessary measures are identified (IKSE 2003). Water managers from all levels expressed that the pressure from the EU to successfully and completely implement the WFD is rather strong (Borowski, 2004) which brings its objectives and deadlines to be a important performance criteria..	IKSE 2003 Borowski, 2004
What are the consequences for success or failure?	The implementation of ICPE policies is evaluated on regular basis. It is not (clearly) determined if and how policy can be changed based on these evaluations. The probable consequences are: if success – strategy is continued, if failure – strategy is changed.	Raadgever & Mostert, Chap. 4.3

A.2 Planning approach

Question	Answer	Data Source
Does water management rely on integrated management plans	In Germany the various decision-making bodies form a close network, in which technical departments, scientific associations and interest groups are *integrated*. With regard to the latest activities also the *joint*	Raadgever & Mostert, Chap. 2.5 Bundesministerium für Umwelt 2005

at basin scale?	development of the river basin management plan is considered of major importance (Bundesministerium für Umwelt 2005). In the Czech Republic the Ministry of Agriculture has practically concentrated the whole administration of watercourses in its responsibility. It controls the privatized water management facilities for providing the household drinking water supply, sewerage systems and wastewater treatment where it executes (by virtue of the National Property Fund), even the regulation function because it represents a stock-holder with special rights in the so-called combined water companies. The Ministry of Agriculture took up the leading role in submitting the new water management legislation. Management groups and plans are i*ntegrated* to a certain extent. However *the integrated management plans for the total Elbe basin do not exist yet*. The ICPE does have a comprehensive general Action Programme Elbe (including water quantity and water quality management), but this cannot be called an integrated management plan. There are also policy documents for specific issues, like the Flood Action Programme.	Ministry of agriculture of the Czech republic, General Information about water management in the Czech Republic, article 29 published on 27.4.2005
Are stakeholder groups included in the development and implementation of the management plans?	*Germany:* The technical departments, scientific associations and interest groups are integrated within a close network forming the various decision-making bodies. The complex decision-making structure and the diversity of non-governmental interests have triggered the development of comprehensive formal arrangements for public participation. The 'obligatory and widespread hearing of experts and interested parties of all relevant groups and in the democratic and constitutional consideration of various interests and viewpoints' is one of the strengths of the German policy process (Rudolph and Block 2001) p.15). Although these formalised processes often take a lot of time, they usually result in better solutions and faster implementation (Rudolph and Block 2001). Organized stakeholders are invited to working group meetings of the IKSE with observer status since recently (before - separate meetings of stakeholders once a year). This involvement requires a lot of resources from the stakeholders. Therefore they are relatively reluctant to participate. On German national level public participation is delegated to the Länder level as the Länder ministries are the competent authority for the implementation of the WFD while the federal ministry has got only frame giving competences. As there are 10 different Länder (federal states) involved in the Elbe basin, the range of stakeholder involvement varies from no to very intensive and active involvement from the very beginning. The mutual interaction between different *stakeholders* groups is often limited. An emerging problem is that participants are used to being informed by the water authorities, which to a large extent limits information exchange – even in multiparty meetings - to a bilateral exchange between the water authority and one specific stakeholder group. The challenge is to present ideas objectively and to facilitate open discussion (Borowski 2004). *Czech Republic:* In Czech Republic, since 1970 the governance structure	Raadgever & Mostert, Chap. 2.5 Rudolph and Block 2001 Borowski 2004 Raadgever & Mostert, Chap. 2.5

	has been more and more decentralised. In new legislation more responsibilities have been given to municipalities and citizen participation has been included in the policy cycle. However, in the Czech republic the water authorities are still too busy to adapt to the different changes, which came with the EU membership, so that in practice there are not yet sufficient resources for public participation. Discussions about some events (floods), measures, impacts on environment take place at many scientific conferences, where state authorities often attend; also in media (professional and also amateur opinions); persons responsible for decisions often migrate among governmental, scientific and stakeholder positions, so to some extent cooperation exists, but probably not on an organized level.	
Is scenario planning used in developing and/or revising management plans – are a diversity of solutions compared for different possible future developments?	Experimentation on a transboundary level mainly takes place in the form of computer simulation (*scenarios*). This way the effects of different physical flood management measures are determined. The ELLA project aims at realisation of pilot projects. In these pilot projects the integration of interests regarding flood management (e.g. risk reduction, spatial planning, and housing) is elaborated in detail for selected regional plans. This is also a form of (policy) experimentation. The GLOWA Elbe is an example of a project that explicitly considers (and communicates to stakeholders) *scenarios of future development* in water sector and agriculture for the German part of the basin, and related uncertainty. However this project is not formally linked to the policy process yet. The NEWATER project (CS Elbe team) in cooperation with the GLOWA Elbe can provide *scenarios of future development* in water sector and agriculture for the total Elbe basin.	Raadgever & Mostert, Chap. 4.3
Is any revision of management plans foreseen? If yes how often?	There are no formal requirements for change of laws or policies that would be established by the ICPE. On national level, periodical changes in water law, regulation and policy are in some cases possible and in other cases even obligatory. In both Germany and the Czech Republic, the laws and regulations can be changed by the legislative authorities. It seems that radical changes can be more easily realised in the Czech Republic. In Germany state legislation has to be adapted to federal legislation. The WFD will introduce new legal requirements for evaluation and adaptation of (some of the) water management plans. These plans will be valid for a period of 6 years.	Raadgever & Mostert, Chap. 4.2
What type of measures prevails in management practice (e.g. voluntary agreements, legal regulations, economic incentives).	Due to the administrational diversity in the Elbe basin, the measures in management vary from voluntary agreements on local level to financial programs on international (European level). The dominant measures are legal regulations and economic incentives. Whereas in general the user pays and polluter pays principles are agreed upon, e.g. in the agricultural sector also financial incentives are in place or planned to reduce the farmers impact (EU 2003). Also technology based solutions like the improvement and the construction of STP are highly favoured (IKSE 2003). Also in flood management: the measures that are considered in the Elbe basin cover a wide range of small and large scale, structural and non-structural measures. In the *Czech Republic* the water management is based on legislative measures (for instance the set of emission and	EU 2003 IKSE 2003 Tom Raadgever Ing. Nesmerak

	immission standards, the obligation to build wastewater treatment plants, etc.) that are amended by economic tools (fees and fines) and voluntary agreements.	
To which extent are emerging problems such as climate change and possible shifts in extreme weather events are taken into consideration?	The emerging problems are taken into consideration. *Example 1*. The devastating floods of 1990s and 2002 triggered political and general attention to flood management and to transboundary cooperation in flood management. So, recently the ICPE Commission has established a working group on flood management. Furthermore, the Czech Hydrometeorological Institute, the T.G. Masaryk Water Research Institute and the Institute of Atmospheric Physics use a broad arsenal of models to describe and predict the processes that can cause floods. *Example 2*. In the GLOWA-Elbe project: strategies that are developed have to deal with climate change and socio-economic changes. *Example 3.* During past years the national climate program of the Czech Republic (CHMI) prepared several studies about discussed climate change projections (different scenarios) and the assessment of its possible impact on agriculture, forestry, hydrology and water resources in the Czech Republic. The part of these studies suggested measures needed to adaptations to climate change. The research was funded by Ministry of Environment of the Czech Republic.	Raadgever & Mostert, Chap 1.2, 2.5, 3.2
Would you describe the water management practitioners as conservative or innovative?	Due to the fragmentation of the competence in water management in the main Elbe basin countries, the Czech Republic and Germany, the process is strongly formalized and seems therefore to have a quite strong conservative character. On the other hand, especially some of the German water managers do have a strong interest to further develop the situation and ensure a political and technical successful implementation of the WFD. They look for new ways which fit into the old traditions and might be called in the regard innovative (Borowski 2004). The operative management in the Czech Republic is defined by handling procedures that so far do not allow for free decision making (and for being innovative).	Borowski 2004 Ing. Nesmerak

A.3 Degree of fragmentation

Question	Answer	Data Source
To which extent are the management of water quantity in terms of allocation of a scarce resource to different users and quality aspects and flood protect-tions integrated in the current manage-ment regime?	Water scarcity is only a temporarily problem in hot summers. However, (1) water quality management according to the WFD and (2) flood protection are in general dealt with in different (sub-)working groups, but the interaction between both aspects is acknowledged and considered (Bundesministerium für Umwelt 2005). The situation is similar for the Czech part of the Elbe Basin.	MK Elbe März 05 Bundesministerium für Umwelt 2005
Is there any successful formal or informal cooperation between water management and agriculture?	The representative from the agricultural chambers in Germany has participated in the work of the ICPE for several years. Also, on lower level the chambers are involved in advisory boards and also in daily, bi-lateral management. With the non-governmental agriculture organizations, cooperation has taken place so far on regional/ local level e.g. in joint projects. In the Czech Republic, the water management is assigned mostly to the Ministry of Agriculture, which already shows a	Borowski 2004 Ing. Nesmerak

	strong cooperation potential (Borowski 2004). Formal cooperation exists, because the river basin plans are currently being processed by the water basin administration subordinated to the Minister of Agriculture. The problem is in the cooperation between the Ministry of Agriculture and the Ministry of the Environment that is responsible for monitoring and protection of water as a component of the environment.	
Is there any successful formal or informal cooperation between water management and regional planning?	On regional scale in Thuringia water managers and regional planners have started discussing cooperation (Borowski, 2004). In terms of flood protection, spatial planning is integrated into water management on German federal level as the main legal regulations cross-refer to each other. This is already implemented also on lower (regional/ local) level (Bundestag 2003). In the German ELLA project national, regional and local governments cooperate in producing information about the links between spatial planning and housing and flood risk management and how to deal with these links in formulating policies. Thus, in this project those who have to implement policy conduct joint research.	Borowski 2004 Raadgever & Mostert, Chap. 3.2 Bundestag 2003

A.4 Technological infrastructure – size, life-time, costs.

Question	Answer	Data Source
Have more recently big investments been made in large-scale infrastructure (reservoir, dams)? If yes please specify?	Big investments in STP construction and renovation have been made in Eastern Germany during the last 15 years. In the year of disaster flood 1997 the construction of Slezka Harta dam was finished. The volume is 218.7 mil. m3. It supplies drinking water for the city Ostrava region. The dam significantly reduced the discharges during first flood days, because the reservoir was empty. The pumped storage power plant Dlouhe Strane was finished in 1996. The power station capacity is 650 MW and the volume of the upper reservoir is 2.58 mil. m3. After the disaster floods in 1997 and 2002 there were high investments made to recover destroyed river courses. There are investments planned for the construction of two large weirs for sailing conditions enhancement at the Elbe River.	IKSE 2003
Is there any sign for a “paradigm shift” that people take into consideration more small scale infrastructure and integrated planning?	Yes. The measures that are considered and implemented in flood management in the Elbe basin cover a wide range of small and large scale, structural and non-structural measures. Small-scale measures are elaborated in the lower levels policies in Germany and the Czech Republic. In the Czech Republic the tendency toward construction of the “small” water management infrastructure exists. In cities and municipalities it is necessary to reconstruct and finish constructing potable water production facilities and wastewater treatment plants based on the requirements of national and Community legislation. The need for integrated planning has not penetrated public awareness yet, while the need for planning has been long absorbed.	Raadgever & Mostert, Chap. 4.3 Ing. Nesmerak

B. Governance Structure

B.1 General Issues

Question	Answer	Data Source
What are the most relevant national water legislation and	The overlying framework is anchored in the European Union legislation, including the Water Framework directive, which is the most influential directive for water management.	Raadgever & Mostert, Chap. 2.1

regulations.	*Germany* The Federal Water Management Act (*Wasserhaushaltgesetz*) is the most comprehensive German water law, providing framework legislation for both water quantity and quality management. Federal waterways are owned by the Federal Republic and other water bodies are owned by the respective State (*Land)* or municipality or (riparian) landowners, depending on the *State* water law (*Landwassergesetz)*. The federal Waste Water Charges Act (*Abwasserabgaben-gesetz*) establishes a water pollution charge for emissions into the aquatic environment. In 2005 the Federal Act on the Improvement of Flood Prevention has been passed, based on the five points of the flood action plan program that was developed after the flood of 2002. *Czech Republic* In the Czech Republic, the new Water Act of 2001 integrated several formerly separated acts, which represented the typical centralized system of the socialistic government. The Act complies with the requirements of all European Union legislation and introduced modern financing mechanism that follow the 'polluter pays' and 'user pays' principle. Simultaneously with the new Water Act, the Act on Water Supply and Sewerage has been adopted. This Act establishes legal agreement with the privatisation processes that occurred in the water supply sector from 1993 to 1995. *Comparison* Both Germany and Czech have a legal system that is directed by the 'user pays' and 'polluter pays' principles. Besides by these charges, the use of water is regulated by a system of permits and (emission) limits. Germany, as a federal republic, has more levels of legislation than the Czech Republic. In addition, the German legislative framework had more time to evolve and therefore is more comprehensive.	Winnegge and Maurer 2002 Puncochar 2005
What government actors are responsible for which issues (quality and quantity, surface water/groundwater) in water management?	*International level:* There exists the International Commission for the Protection of the Elbe (ICPE). ICPE goals: - Reducing polluting discharges by communities, industries and diffuse sources; - Ecological recovery of floodplains and improvement of biotope structures; - Improvement of the Elbe water quality; - Flood protection in the Elbe basin; and - Implementation of the EU WFD in the Elbe basin. *Germany:* The three primary levels of competence in German water management are the Federal Government, the Federal States (*Länder*) and the municipalities (*Kommunen*). There is no strict hierarchy between the levels, but each level has its own specific responsibilities. The federal government is responsible for defining national tasks of water management. In line with Germany's constitution, the Federal Government has the framework responsibility for flood defence policy. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is responsible for water resources management as a part of environmental policy, and for the protection of water bodies. The Federal Ministry for Transport, Building and Housing,	Rudolph and Block, 2001 Borowski, 20904 Raadgever & Mostert, Chap. 2.2, 2.3 Borowski 2004 Puncochar 2005b Obrusnik 2005

	which is responsible for the administration of federal waterways, navigation and sea pollution. The Federal Ministry of Economics and Technology oversees water supply systems. The Federal Ministry of Education and Research is in charge of developing new technologies. The Federal Ministry for Health ensures the quality of drinking water. The ministries have advisory authorities: the Federal Environmental Agency and the Federal Institute of Hydrology. The state (Land) governments elaborate legislative details and formulate policy. They are responsible for the regulation of water supply and wastewater disposal in their states, within the framework of the federal laws. In general the states' environmental ministries are responsible for water management. They cooperate in the Elbe basins mainly in two instituitions: Arbeitsgemeinschaft für die Reinhaltung der Elbe *(ARGE Elbe)* and the Flussgebietsgemeinschaft Elbe *(FGE Elbe).* In accordance with state water laws, the organization and implementation of water supply and wastewater disposal belong to the duties of the municipalities. The municipalities use various forms of enterprises for implementation of water supply and waste water disposal, ranging from municipal agencies to private companies (Winnegge and Maurer 2002). *Czech Republic:* In the Czech Republic traditionally three levels of administration are responsible for water related decisions: central authorities (ministries), 14 regional offices and 76 district offices. At state level, the Ministry of Agriculture is responsible for the management of water bodies, artificial canals and irrigation systems, public water supplies and sewerage (water quantity aspect). The Ministry of the Environment is in charge of the protection of water resources and the related ecosystems (water quality aspect). Both Ministries are jointly responsible for the development and implementation of water management policy (Puncochar 2005b). Besides, the Ministry of Health is responsible for the quality of drinking water. Long-term flood management is organised via the River Basin Authorities and lead by the Ministry of Agriculture. The Ministry of Agriculture started the important 'Program of Prevention against Floods', focused on the increase of protection in the most endangered regions of the Czech Republic. The basin water boards and the Agricultural Water Management Authority are responsible for the realisation of the program, the first phase of which was scheduled for 2002 - 2005. The flood early warning is organized by the Ministry of Environment in cooperation with the Ministry of Agriculture. Flood warning systems are operated by the Czech Hydro-meteorological Institute, in cooperation with River Basin Authorities and regional and local administrations. Besides these three administrative layers, five *Povodi*'s (Water boards) were established in 1966. Since then they gradually evolved to 'River Basin Authorities', state enterprises responsible for control, monitoring and evaluation of water flow of the main river basins (among which the Labe, Vltava and Ohre, which are part of the Elbe basin) (Puncochar 2005b) The water supply and sewerage sector has been privatised from 1993 to 1995. The new owners are municipalities, unions	

	of municipalities or joint stock companies, whose main shareholders are municipalities (Puncochar 2005b).	
Characterize briefly the main governmental actors/authorities by: their interest, goals, strategies, technical capability and/or power.	In addition to the above outlined competences, the German federal government is obliged to meet the European legal requirements as well as the Czech government as the member states would have to pay the fines for insufficient implementation. Also, both environmental ministries have got the competence for international water affairs whereas the (operational) implementation of the WFD lies with the federal states (Länder) in Germany or the Ministry of Agriculture and the Povodi (Water boards) in the Czech Republic. Therefore, the interest for a smooth implementation of the WFD is in the national environmental ministries stronger then in the other authorities (Borowski, 2004). On the other hand, the competent authorities for the national and regional water management (Ministry of Agriculture and federal states' ministries) have a strong interest to promote their competence and keep their responsibilities. Their interest is in general to act as independent from the international level as possible, while at the same time financial issues are strongly related to the European level (CAP programs). Especially on the lower levels, water managers are also directly confronted with conflicting interests (e.g. higher farming standards without financial compensation). This may lead to some tension as the financial situation in water management is in general tight (Borowski, 2004). In Germany, international agreements are sometimes used by the Ministry of Environment to re-introduce or strengthen federal interests on national level as the Länder ministries are also bound to them and do also participate in international negotiations (Borowski, 2004).	Borowski, 2004 Raadgever & Mostert, Chap. 2.3
If changes in the institutional make up of water management and the prevailing water management strategy have occurred, which factors explain them (is this always a matter of extreme weather events, or are there other drivers as well) and what factors seem to inhibit these changes (ie training of water managers)? Are the changes necessarily slow and reactive or are they sometimes quick and anticipating?	Shortly after the political barrier between the Eastern and Western European countries was broken, in 1990 the ICPE was established to combat the pollution in an international context. The devastating floods of 1990s and 2002 triggered political and general attention to flood management and to transboundary cooperation in flood management between Germany and the Czech Republic. Finally, the accession of the Czech Republic to the European Union in 2004 resulted in the legal obligation to cooperate with Germany for the implementation of the WFD. The implementation of the WFD requires both countries to cooperate on the basin scale and requires national institutional changes. The German *Länder* and the Federal Government have established cooperation in the *Flussgebietsgemeinschaft* Elbe in 2004 to support the implementation of the WFD. Thus, history has created the awareness that Germany and the Czech Republic are mutually dependent in water management of the Elbe, for example in pollution prevention or the exchange of real time data for flood early warning. ⇒ So, *the factors explaining* are not only external driving factors (like flood events), or emerging problems (like poor water quality) but also political and socio-economic changes (unification of Germany, EU legislation, accession of the Czech Republic to EU). The changes are rather quick. Changes in the Czech administrative structure occur quite regularly, and can be called anticipating. Already in 1966 water boards were established that match the (sub) basin areas of the main Czech rivers, which developed to river basin authorities, which	Raadgever & Mostert, Chap. 2.5, 2.6

	are required for the implementation of the WFD.	

B.2 Stakeholder/citizen participation

Question	Answer	Data Source
What are the most relevant stakeholder groups (organized and unorganized water users, citizens, etc.) and how are they organized?	***Drinking water supply and wastewater treatment*** In both Germany and the Czech Republic municipalities play a leading role in water supply. In the Czech Republic the drinking water sector consists of private enterprises, owned by municipalities, whereas in Germany the drinking water sector is only partly privatised. The *Deutscher Vereinigung des Gas- und Wasserfaches (DVGW),* which supports technological development, and the *Bundesverband der Deutschen Gas- und Wasserwirtschaft (BGW)*, which represents 80% of the German water suppliers, are the German organizations representing water supply and wastewater treatment at the federal level. In the Czech Republic the Association of Water Supply and Sewerage Services (SOVAK) was established as a voluntary, non-governmental and non-profit organisation that supports the sector (Puncochar 2005b). ***Agriculture*** In Germany the farmers are represented by the agricultural chambers, governmental authorities on state level with a lot of technical knowledge and a strong interest in agricultural issue, and by farmers associations, which cooperate on local, state and federal level. The federal *Verband der Landwirtschaftskammern* (VLK) coordinates the technical collaboration between all federal chambers and the agricultural administrations in federal states without chambers. The farmers association are represented at the federal level by the German *Bauernverband* (DBV), which represents over 90 percent of the ca. 400,000 German agricultural enterprises. Both the public chambers and the private associations aim at sustaining agricultural land use. The chambers act trough the governmental structure, whereas the associations are more active in public (Borowski 2004). In the Czech Republic, the Czech Agrarian Chamber, the Agricultural Association of the Czech Republic and the Association of private Farming represent the interests of the agricultural sector (COPA 2005). ***Industry and power generation*** In Germany the main part of water abstractions is used for cooling of power station. The second largest water user is the industrial sector. The 81 German chambers for industry and trade operate according to legal requirements. The chambers joined forces in the *Deutsche Industrie- und Handelskanmertag* (DIHK), an umbrella organisation which represents over three million entrepreneurs. The German-Czech Industrial and Trade Chamber (GTIHK) mediates and facilitates interactions between Czech and German companies. In the Czech Republic the Association of Chemical Industry of the Czech Republic was founded in 1990 as a voluntary association of manufacturing, commercial, designing, research and advisory organisations with relations to chemical, pharmaceutical, petrochemical, and rubber and plastics industries. The Association embraces over hundred member companies, which represent over 60% employees working in this sector (Association of Chemical Industry of the Czech Republic 2005).	Raadgever & Mostert, Chap. 2.4 Borowski 2004 COPA 2005 Puncochar 2005b Borowski 2004 Winnegge and Maurer 2002

	Navigation There are several national and international non-governmental organisations that represent the interests of navigation. The *Verein zur Förderung des Elbstromgebietes* is an association aimed at the development of the waterways and ports in the Elbe basin, including the navigable tributaries and canals. The association focuses on the development of the Elbe downstream of Magdeburg to an important European shipping route. The activities include assessing, recommending and organizing meetings (Verein zur Förderung des Elbstromgebietes 2005). On sub-basin scale organisations like the *Verein zur Hebung der Saaleschifffahrt* are active. In Germany, inland navigation is promoted by the *Bundesverband der deutschen Binnenschiffahrt* (BDB), which is a member of the European Barge Union (EBU). In 2004 the Czech union of ship owners AVP-CZ entered the EBU as first organisation of the new EU Member States. The interests of navigation are also represented by governmental actors. The German Waters- & Shipping Administration (East) (WSD-OST) supervises the administration of most of the waterways in the Elbe basin. The main goal of the administration is to maintain and expand the traffic capacities of the federal waterways in order to promote economical growth. The administration is a strong stakeholder as it represents strong federal competences and shipping interests (Borowski 2004). ***Fishing*** There is no (or very limited) professional fishing on the Elbe. Recreational fishing, however, has a long tradition in the both countries. In Germany the *Verband Deutscher Sportfischer* (VDSF) represents 24 *Landesverbänden*, which include about 7000 associations and 700 000 individual fishers. The Czech Fishers' Union deals not only with sports fishing, but also with the protection of fish and their living environment, the education of members, and breeding and stocking of fish. ***Nature protection*** There are numerous environmental organisations active in the Elbe basin. In Germany, among others, the *Bund für Umwelt und Naturschutz Deutschland (BUND),* the WWF *(*incl. the *Auen institute)* and *The Naturschutzbund Deutschland* (NABU) are active. Most organisations are well connected through different inter-organisational working groups on water at federal and state level, through cooperation in the Deutscher Naturschutz Ring and through coordination by the Grüne Liga (Borowski 2004). Also in the Czech Republic there are several environmental organisations. The largest is the Czech Union for Nature Conservation. Very active are Arnika and the Czech part of Greenpeace. The *Deutsche Umwelthilfe* is an independent association for protection of nature and environment, which supports the River Network project 'Living Elbe'. The project aims for the Elbe basin to be acknowledged as cultural world heritage by UNESCO (Borowski 2004). ***Citizens' organizations*** The German *Bundesverband Bürgerinitiativen Umweltschutz* (BBU) is an umbrella organization of citizens' action committees that are committed to environmental protection. One of these action committee's is the *Arbeitskreis Wasser*, which has been trying to connect small and midsize Environmental Protection Organizations and Civil Engagement Groups in the realm of aquatic environmental protection since 1981. The Arbeitskreis provides these organizations and other	Ing. Nesmerak

	interested people with an elaborate 'water archive' and a newsletter (AK Wasser 2005). However, they are not really active in the Elbe basin (Borowski). Citizens' organisations are acting in the Elbe basin in general on more local level. In Brandenburg, the high prices for wastewater led to considerable activities. Also, there are different local environmental groups which act on local problems and are sometimes also linked to Local Agenda activities (Kampa, Kranz et al. 2003). In the Czech Republic the Union of Towns and Municipalities is focused on protecting the water use interests of municipalities.	
Has water management been a main concern for the political system and general population or not? Is much attention paid to water issues in the media?	*Germany.* There are many formal and informal ways in which stakeholder and the public as well as the scientific community are involved in water management. The following major issues are of a main concern for general public attention: flood issues, drought problems, water quality, reduction of mining activities and effects, nature protection in the Spreewald nature reserve, effects of industrial breakdown, conditions in the Black Triangle in Krusne Hory Mountains, and the building of weirs in the Elbe River (Czech Republic). In the media - yes. *Czech Republic.* Water management is not the foremost interest of politicians and the political establishment. The media (especially state operated media) sometimes do cover these issues. However after the recent disastrous floods in the Czech Republic much attention is paid to this topic in daily news; there is a web portal of Ministry of Agriculture with daily information on precipitation and possible flood occurrence. During the daily weather forecasting on TV the CHMI issues warning of flood danger if high precipitation is predicted in parts of the Czech Republic. *On international level* in the Elbe basin since 2003 non-governmental organisations are involved as observers in the work of working groups of the ICPE. This involvement, however, requires significant resources from the NGOs and until autumn 2004 only environmental NGOs considered the offer (Borowski 2004).	Raadgever & Mostert, Chap. 2.5, 4.1 Borowski 2004 Ing. Nesmerak

B.3 Information management and sharing

Question	Answer	Data Source
Which parties collect/produce, and which parties interpret/analyse what kind of information? Is there any joint/participative information production (experts/ public)?	The ICPE working groups monitors and collect all kinds of information about discharges, pollution, fish etc. The flood working group has collected an extensive set of information about the 2002 flood (IKSE 2005). Non-governmental organisations participate in the production of information by the working groups of the ICPE. The dissemination of information by the ICPE to stakeholders and the public is limited. (New) data and information are mainly exchanged between the involved public parties (Borowski, 2004). *Germany* has a comprehensive network of formal and informal actors, which produce information about water management in many settings. Most research institutes are gathered in the Helmholtz Gemeinschaft deutscher Forschungszentren, the Max Planck Gesellschaft, the Fraunhofer Gesellschaft and the Wissenschafts-gemeinschaft Gottfried Wilhelm Leibnitz. There also various private Research and Development companies active in the field (Courbet 2004). Examples of prominent institutes are the public Bundesanstalt für Gewässerkunde (BfG) and the private Institute for International and European	Raadgever & Mostert, Chap. 2.5, 3.2, 4.4

	Environmental Policy: Ecologic. In the German GLOWA-Elbe project 19 institutions cooperate to develop integrated river basin management strategies for the Elbe basin. The strategies that are developed have to deal with climate change and resulting socio-economic changes and therefore the project analyses uncertainty and change. In the *Czech Republic* production, collection, analysing and interpretation of information is very scattered. Water management data (the data about the amount and quality of used water and discharged waste water) are produced by industrial companies and municipalities (or operating organizations working for these municipalities); the quality of surface water – by Water boards (Povodi); the quality of released waste water – by controlling bodies (regulatory agencies and The Czech Environmental Inspectorate). The basic data (annual averages) about the amount and quality of used water and released wastewater are collected by the Water boards. On the state level the data is analyzed and interpreted by the Water Research Institute and the Czech Hydrometeorological Institute. The data on the quality of surface and groundwater are produced by the Czech Hydrometeorological Institute (by water management laboratories chosen in a public tender) and by the Water boards. This data is analyzed and interpreted at the Czech Hydrometeorological Institute and to some extent in the Water Research Institute. The academic and research community of the *Czech Republic* is also involved in the production of information about floods and water management. The Czech Hydrometeorological Institute, the T.G. Masaryk Water Research Institute, the Institute of Hydrodynamics and the Institute of Atmospheric Physics use a broad arsenal of models to describe water quality and predict the processes that can cause floods. The state supports research programs to deal with flood risk reduction, the development of innovative tools etc. (Obrusnik 2005).	Ing. Nesmerak Obrusnik 2005
How is this information used in decision-making? (Is it used?)	The ICPE working groups develop recommendations, which can be adopted by the (yearly assembled) official delegations of Germany, the Czech Republic and the European Union. Many of the recommendations are via this way adopted in national policies. In several case studies concerning the implementation of the WFD, participation improved the communication between authorities and stakeholders. (An example in Thuringia: see Chap. 3.4 in Raadgever & Mostert) At international level the ICPE working group on the WFD decided, after a workshop in March 2004, to improve information supply to the general public by providing a regular newsletter and organizing an information event and to involve stakeholders in a special forum. An international advisory board of stakeholders is also considered (Borowski 2004). In the Czech Republic the information produced is used in the decision-making process, the ways of use vary according to the user needs and the level of the decision-making process. Quite often the necessary information for decision-making is missing.	Raadgever & Mostert, Chap. 3.4 Borowski 2004 Ing. Nesmerak
What is the role of the scientific community and expert advice in the process of water	The scientific community in the Elbe area cooperates on numerous levels in water management. The European Commission finances many research projects on the different aspects of integrated river basin management, like HarmoniCOP, Mantra-East, NeWater, FloodSITE etc.	Raadgever & Mostert, Chap 2.5 and 3 JRC 2005 Obrusnik 2005

management?	Furthermore, the European Commission organises research by institutions like the European Environment Agency (EEA) and the Joint Research Centre (JRC), which provides independent, customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies (JRC 2005). In *Germany* several universities and research institutes are active in the field of water management. In the Czech Republic the academic and research community is, among others, involved in special research programs, supported by the state, to deal with flood risk reduction, the development of innovative tools etc. (Obrusnik 2005). In the GLOWA-Elbe project funded by Federal Ministry for Education and Science 19 project partners, including private companies, government bodies and scientific partners, cooperate to develop integrated river basin management strategies for the Elbe basin. The main goal is to develop strategies that deal with decreasing water availability and water use conflicts due to climate change and resulting socio-economic problems in the Elbe basin. In the *Czech Republic* the findings and recommendations of research organizations and experts are widely used for the purposes of water management, but even greater involvement of these organizations is needed.	Ing. Nesmerak
Do specifically designed monitoring programmes exist with the goal to revise management strategies (monitoring present at all, for control and/or for change in strategies)?	Those programs are currently in development. Earlier, the ecological aspects of the Elbe river have been supervised in order to monitor the impact of the action plans (IKSE; 2003). *Czech Republic.* So far there is a general monitoring program used mostly for controlling purposes and as a basis for the decision-making process. In the future, monitoring will be more specialized, however a monitoring solely for the purposes of making strategy changes is not planned.	IKSE 2003 Ing. Nesmerak

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3. Baseline Rapid Assessment of Vulnerability for Adaptation (BRAVA)

Introduction to BRAVA

The baseline rapid assessment of vulnerability for Adaptation (BRAVA) is designed to identify who is exposed to which threats and stresses. It is not confined to climate change or climatic hazards. In many cases, the threat of pollution events, regulation and financial constraints are more pressing than coping with droughts or floods.

A matrix of the sensitivity of exposure units to hazards will help the case study team structure further assessment activities. The issues given high priority in 1.6 (below) should include an indication of their relevance to the most vulnerable groups. For example, in semi-arid basins, groundwater use by larger landowners may be competing with water availability for smaller farmers. A high priority research issue might be related to the allocation of water between these two groups, along with ways to improve governance of groundwater use. r, the link between climate change and increased flood hazard may be identified as high-priority threats. The case study team might want to focus on the differential impact of floods (for example, households with or without insurance, home owners vs renters) and the balance between ecological uses of the flood plain and flood mitigation (two different exposure units).

The output from BRAVA includes:

- Identification of the different exposure units. The exposure units, or the elements of the 'water management system', are the basis for subsequent analysis.
- A list of major threats.
- An impact matrix with subjective score relating the exposure units to the major threats.
- A concise summary of current vulnerability. Mostly in qualitative terms, the answers to the key questions will help define priorities for further assessment.
- A subjective profile of vulnerability along common dimensions for use in comparing the case studies (and to help identify priorities for further work)
- A checklist of initial plans for more formal assessment of indicators and future vulnerability. These will be further explored in the General Assembly and throughout the NeWater project.

Table 1. Inventory of historical and present threats

Basin: Elbe Location: Central Europe

Historical risk	Year/month	Water system effects	Significance
Droughts	1947 1976 1992 2003	Low water level, low crop yield, endangered water supply for large cities	moderate
Floods	April 1988 1997 August 2002 January 2003	Indirect negative effects on water quality (destroying oil tanks and factories with toxic substances, flushing of contaminated sediments	High High
Change in seasonal distribution of precipitation: more precipitation in winter, and less in summer	Last decade	Higher risk of floods during winter and early spring, and higher risk of summer drought	
High temperature events	Summer 1992 Summer 2003	Low water level, low crop yield, endangered water supply for large cities	
Windstorm: Tornado Michelin in Saxony-Anhalt	23 June 2004	-	
Regulatory changes: Higher charges on drinking water and sewage disposal for citizens	1990ies	Decrease in water use	
Regulatory changes: regulation of river flow: construction of weirs, locks, reservoirs, dikes etc.	*since 19th century*	Destroy of floodplain areas, stress for river and lake ecosystems and fish species	
Environmental pollution event during disastrous flood	August 2002	Indirect negative effects on water quality (destroying oil tanks and factories with toxic substances, flushing of contaminated sediments	high
Environmental pollution events: acid rains in mountainous areas	Long-term, until now	Negative effects on forest (deforestation), and indirect effects on water cycle as decrease in water retention leading to higher risk of floods	high
Long-term pollution in subareas: mining area Lausatia, where mining activities are strongly reduced and open-cast mining areas are filled with water	Since 1998	Pollution of lakes in the area, reduction in water discharge in the Spree river, possible shortage of water supply for the metropolitan area of Berlin	high
Long-term pollution in subareas: uranium mining area in the Czech Republic	Long-term: 1960-1985	Groundwater pollution	
Long-term pollution in subareas: coal mining area in North Bohemia	1950 - 1990	Changes in hydrological cycle	high
Long-term pollution in subareas: groundwater pollution in agriculture areas	Long-term	Pollution by nitrates	
Long-term pollution in subareas: Eutrophication of lakes	Long-term	Low attraction for tourists, danger for fish	

Table 2. Frequency and trends in threats

Basin: Elbe Location: Central Europe

Threat	Likelihood	Trend in likelihood	Trend in magnitude	Trend in location	Comments
flood		no trend	no trend	no trend	There have been a number of recent efforts to identify trends in flood records in the region (e.g. Mudelsee et al., 2003, Fig. below), which found no upward tendency in summer flooding and existence of downward tendency in winter flooding (see *)
drought		no trend	no trend	no trend	
wind storm		no trend	no trend	no trend	
High temperature events		no trend	no trend	no trend	
pollution events		need investigation	need investigation	need investigation	
pollution in subareas		need investigation	need investigation	need investigation	

*

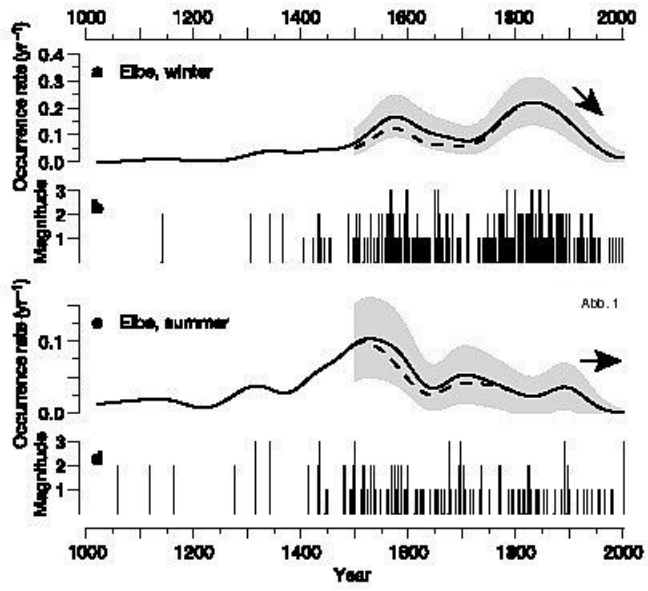

Fig. 2. Frequency and intensity of the Elbe floods in winter (up) and summer (down). Source: *Mudelsee, M. u. a.: NATURE, Vol. 425, 11. September 2003, S. 166-168.* The lines show the flood occurrence rate 1/year. The vertical columns reflect the magnitude of flood (1 – small/insignificant, 2 – strong, 3 – very strong. The authors' conclusion is that during the last 200 years the frequency of Elbe floods in winter became lower, and in summer practically did not change (see arrows). Historically the winter floods were normally connected with snowmelt. This conclusion agree with that of climate scientists about lower probability of very cold winters in the basin during the last 200 years.

Table 3. Impacts of threats

Basin: Elbe Location: Central Europe

	Impacts					
Historical risk	**Lives lost**	**Popula-tion affected**	**Gender, age, social vulnerability**	**Economic impacts**	**Environmental effects**	**Notes**
Drought 1992	0			2080 ha of forest was destroyed by fire		
Drought 2003	0		Stress for old people	**Germany:** Crop yield lost in comparison with the average values: 32-40%; **Czech:** Effects on inland navigation in the Elbe river (stopped); Effects on forestry	Floodplain forest under stress;	
Flood 1997	Several				Damage of river banks, water pollution	
Flood 2002	38	About 100.000 people were evacuated	Psychological stress	The economic damage is estimated as $9 billion in Germany and $3 billion in the Czech Republic. **In Germany:** 25.300 houses were damaged; many streets in Dresden; about 10.000 companies were affected; 700 km train railways were locked, 130 km railways were damaged, 94 bridges were damaged; 115 memorial buildings were affected (Semperoper, Dresdner Zwinger), 18 churches, 7 mills; **Effects on agriculture, Germany:** Flood affected areas: 100.000 ha grassland, 83.500 ha cropland, total lost of yield: 25.600 ha	Water pollution (oil spills, urban pollution); damage of river banks	
Flood 2003	0					
Tornado 23.6.2004	0	Several people were hurt; two villages in Saxony-Anhalt were affected		275 houses were destroyed;		
Higher charges on drinking water and sewage	0		Low income group was affected		Reduction in water use	

disposal for citizens						
Regulation of river flow: construction of weirs, locks, reservoirs, dikes etc.	0				Loss of floodplain ecosystems; affects fish popolation	
Pollution event during disastrous flood 2002	0			See above	Water pollution (oil spills, urban pollution)	
Pollution events: acid rains in mountainous areas	0				Forest death; higher flood risk in the area; higher erosion risk; soil acidity	
Long-term pollution in subareas: mining area Lausatia	0				Pollution of lakes in the area	
Long-term pollution in subareas: uranium mining area in the Czech Republic	0				Contamination of groundwater	
Long-term pollution in subareas: coal mining area in North Bohemia	0				Pollution of rivers	
Long-term pollution in subareas: groundwater pollution in agriculture areas	0				Consequent pollution of surface waters	
Long-term pollution in subareas: eutrophication of lakes	0				Ecosystems affected, fish may be affected	

Table 4 Exposure units

Basin: Elbe Location: Europe

Exposure unit	Type of exposure	Location/ scale	Water use (amount)	Water use type	Source of water use	Other notes
Water users with a low income	Indirect exposure due to increased water prices	Whole basin				
Population living in floodplains	Exposure to floods	floodplains				
Population in Spreewald (National reserve)	Exposure to droughts	Spreewald				
Population in the former mining areas	Exposure to env. pollution	Lausatia, NN				
Urban population in large cities (Berlin, Prague, Hamburg)	Exposure to droughts: water supply	Berlin, Prague, Hamburg				
Old people	Exposure to high temperature, warm spells	Whole basin				
Agriculture sector in upland areas	Exposure to droughts	Upland areas				
Agriculture sector in floodplain areas	Exposure to floods and droughts	Floodplain areas				
Agriculture sector in Saxony Anhalt (loess soils, high concentration of agriculture)	Exposure to droughts	Saxony-Anhalt				
Water supply sector in Berlin	Exposure to droughts and water pollution	Berlin				
Tourist sector in Spreewald	Exposure to droughts, Exposure to env. pollution	Spreewald				
Tourist sector in the lake subregions (Havel, NN)	Exposure to env. pollution	Havel, NN				
Navigation in the Elbe	Exposure to droughts, exposure to floods	Elbe				
Floodplain forest	Exposure to droughts and hydraulic construction	Floodplain areas				
Groundwater	Exposure to droughts	Lowland part of				

recharge in the lowland part		the basin				
Mountain areas in CR	Exposure to acid rains, deforestation	Mountain areas in CR				
Lake ecosystems	Exposure to water pollution and droughts	Havel basin, NN				
Endangered species (beaver, white stork, etc.)	Exposure to water pollution, droughts, urbanization	???				
Bridges	Exposure to floods	NN				
Roads	Exposure to floods	NN				
Reservoirs	Exposure to droughts	NN				

Table 5. Exposure matrix

	Threats and stresses							
Exposure units (vulnerable groups)	**drought**	**flood**	**Warm spell**	**windstorm**	**water pollution**	**higher waterpric e**	**River training**	**Acid rains**
Water users with a low income	3	3	2	3	3	**5**	2	1
Population living in floodplains	2	**5**	2	2	3	3	2	1
Population in Spreewald (National reserve)	**5**	2	2	2	4	3	2	1
Population in the former mining areas	3	3	2	2	**5**	3	2	1
Urban population in large cities (Berlin, Prague, Hamburg)	**5**	3	2	3	**5**	3	2	1
Old people in the whole basin	4	3	**5**	3	2	3	2	1
Agriculture sector in upland areas	**5**	1	2	2	2	**5**	2	1
Agriculture sector in floodplain areas	4	**5**	2	2	2	**5**	2	1
Agriculture sector in Saxony Anhalt (loess soils, high concentration of agriculture)	**5**	1	2	2	2	**5**	2	1
Water supply sector in Berlin	**5**	2	1	1	**5**	4	1	1
Tourist sector in Spreewald	**5**	4	3	3	**5**	1	1	1
Tourist sector in the lake subregions (Havel, NN)	3	3	2	2	**5**	1	1	1
Navigation in the Elbe	**5**	4	1	3	1	1	2	1
Floodplain forest	**5**	1	3	3	1	1	**5**	1
Groundwater recharge in the lowland part	**5**	1	3	1	1	1	1	1
Mountain areas in CR	2	1	2	3	1	1	1	**5**
Lake ecosystems	**5**				**5**			
Endangered species (beaver, white stork, fish species, etc.)	**5**	2	3	1	**5**	1	**5**	1
Bridges	1	**5**	1	2	1	1	1	1
Roads	1	**5**	1	2	1	1	1	1
Reservoirs	**5**	2	2	1	**5**	1	1	1

Table 6. Relative scoring of common attributes of vulnerability

Attribute	Low	1	2	3	4	5	High	Notes
	Few people affected; few economic impacts						Large population affected; economic impacts cause hardship to many people	
Water usage	High water usage		X				Low water usage	
Water usage	Willingness to save water during crises			X			Inability to reduce use during times of scarcity	
Access	Piped and metered water use for almost all	X					Large portion of population without piped access	
Infrastructure	Well developed and integrated water infrastructure	X					Little regulation of water supply	
Technology	High technological base, strong investment	X G	X CR				Traditional or out-of-date technology	G – Germany, CR – Czech Republic
Actors and institutions	Few actors, well integrated management regimes			X			Many actors, fragmented authorities, conflicts over management of resources	
Information and skills	High information base and access, sufficient skill base for wide range of stresses and threats		X				Poor information collection, restricted access, shortage in key skills	
Political willingness	High priority for water management, effective political decision making		X G	X CR			Low awareness and priority, ineffective or restricive decision making	
Gender	Equitable distribution of resources, effective means to promote participation by women	X					Inequitable impacts of hazards, discrimination against women in decision making	
Poverty and income	Almost all water users have sufficient income to secure their water needs	X					Large population affected by poverty, inequitable water charges	