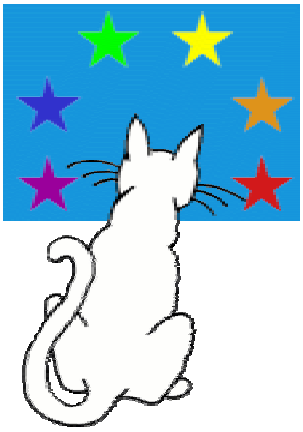

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CONSORTIUM

THE ELBE CATCHMENT AND RELATED COASTAL AREA: GERMAN BIGHT AND WADDEN SEA

Part A:

CATCHMENT PROFILE

Version:
May 2002

Part A:

Work Package n. 4: Past, present and future changes in catchment fluxes
Contractor n. 2: FVB-IGB (Institute of Freshwater Ecology and Inland Fisheries)
Horst Behrendt & Jürgen Hofmann

Institut für Gewässerökologie und Binnenfischerei
im Forschungsverbund Berlin e.V.

General description of the Elbe catchment
1 Area delineation

The Elbe basin comprises a total catchment area of 148,270 km^2 with a total length of 1091km (Fig. 1). The spring of the Elbe is located in the Czech Republic in the southern slope of the Riesengebirge/Krkonose with its peak Schneekoppe/Snézka (1.602 m a.s.l., Fig. 2). After having passed the basin of Northeast Bohemia the Elbe merges with the Moldau (Vltava), being its greatest tributary with a catchment area of 28,090 km^2. Upstream of Pirna the Elbe reaches the border between Germany and the Czech Republic and passes the Elbsandsteingebirge. Downstream of the wide valley of the Dresdner Kessel the Upper Elbe flows through the lowland of northern Germany. From there up to the weir of Geesthacht the middle Elbe is a typical lowland river. The territorial distribution of the river basin is shown in Tab. 1. About two third of the catchment area belongs to Germany and one third to the Czech Republic. Austria and Poland have nearly the same small shares in the catchment (see table 1). The "riparian states" are those countries which are reliant in some capacity on the Elbe. The Elbe catchment covers 27.2% of Germany and 63.6% of the Czech Republic. Seven are the German regions (Bundesländer) through which the Elbe flows (Saxony, Saxony-Anhalt, Brandenburg, Mecklenburg-Vorpommern, Hamburg, Schleswig-Holstein and Lower Saxony, while part of Thüringen, part of Bayern and whole Berlin are included in the catchment.

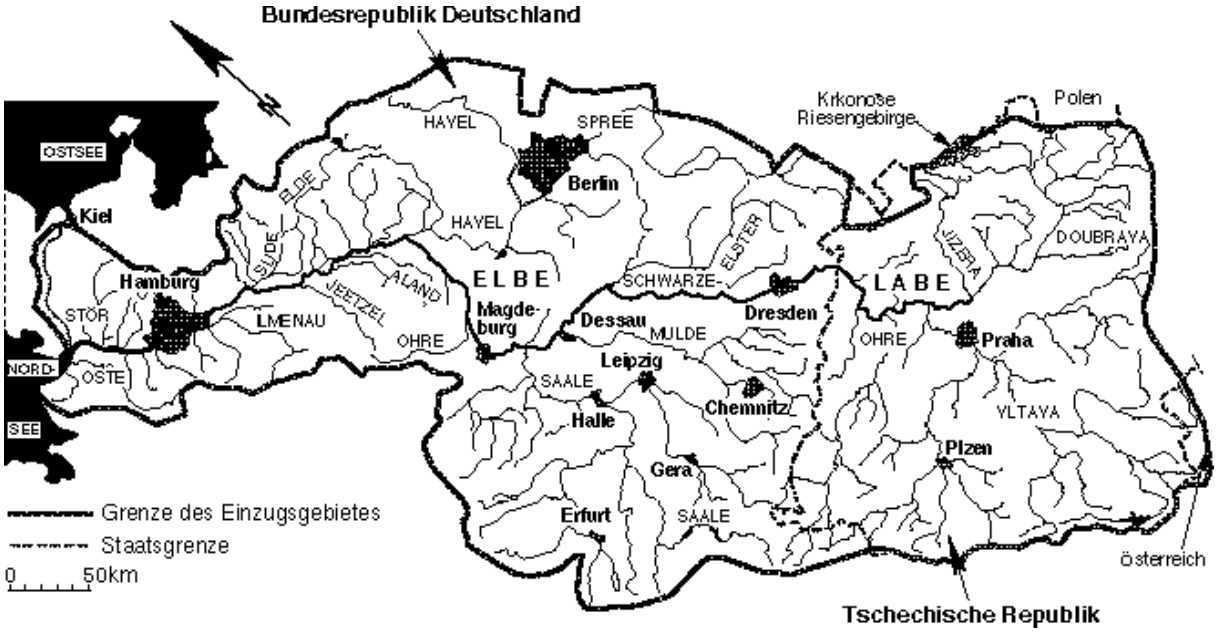

Fig. 1: Elbe river basin (after IKSE 2001)

COUNTRY	AREA [KM^2]	AREA [%]
Germany	96,932	65,38
Czech Republic	50,176	33,84
Austria	920	0,62
Poland	240	0,16
TOTAL	**148,268**	**100,00**

Tab. 1: Areas of the Elbe basin shared by different states

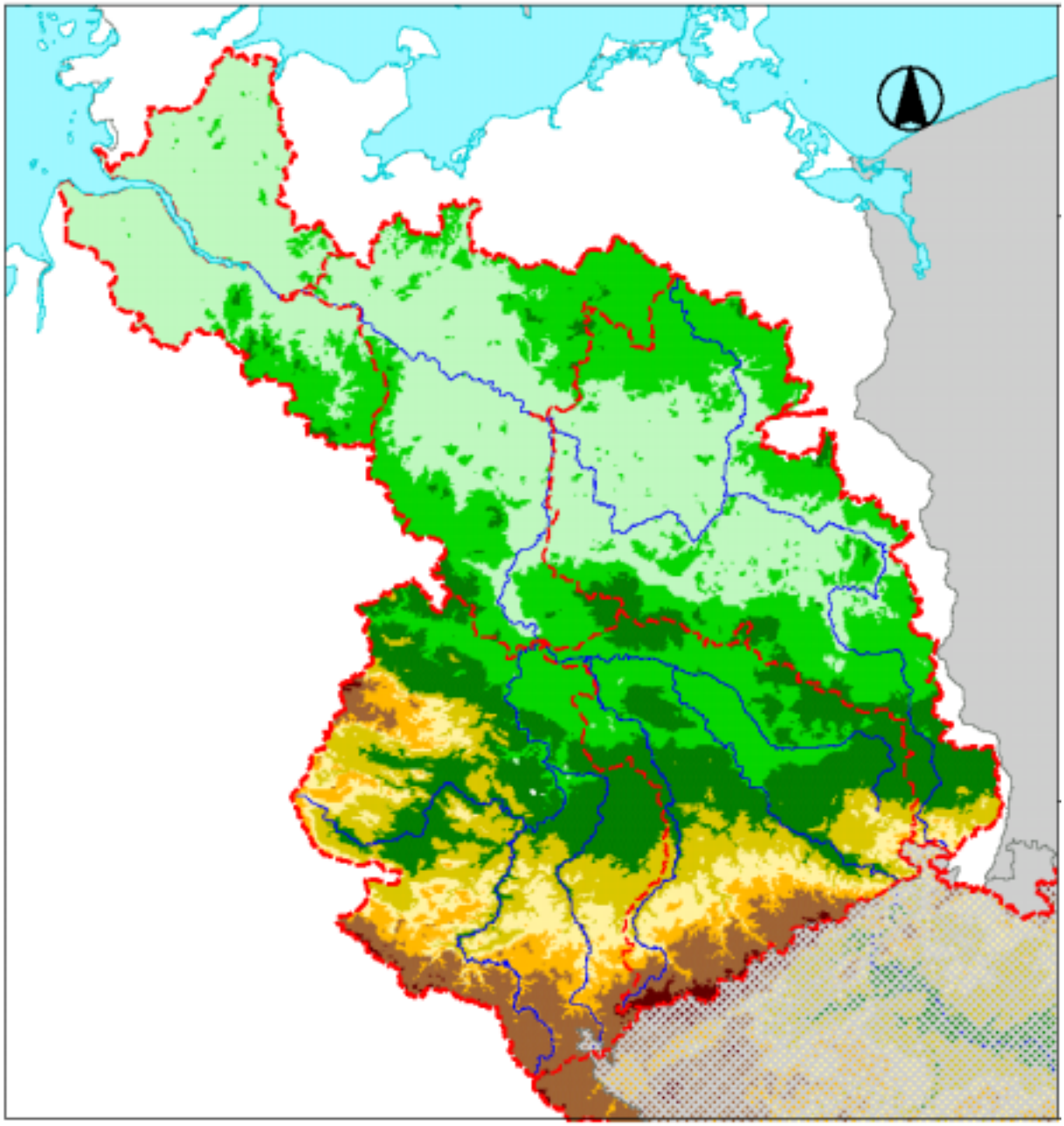

Fig. 2: Relief of the Elbe catchment (german part) GTOPO30 of USGS. Dotted red lines indicate the boundaries as shown in Fig,4. (after PAGENKOPF & REINCKE 2001, map 2.2)

2 Physical area characterization

On the way from the spring in Krkonose to the estuary in the North Sea the Elbe passes nine important landscapes as indicated in Fig. 3 with numbers:

- No. 1: National Park Riesengebirge
- No. 2: Middle Bohemia
- No. 3: Elbe valley in the highlands of Bohemia
- No. 4: Böhmische and Sächsische Schweiz (Elbsandsteingebirge)
- No. 5: Elbe valley in Saxony from Pirna to Torgau
- No. 6: Biosphere reservation Middle Elbe
- No. 7: Elbe valley in Saxony-Anhalt from Magdeburg to the mouth of river Havel
- No. 8: Elbe valley from the river mouth of Havel to Lauenburg
- No. 9: Elbe estuary from Hamburg to Cuxhaven, North sea

Conventionally the Elbe is divided into: upper Elbe (from the spring to the Elbe-km 96 - Schloss Hirschstein), middle Elbe (from Elbe-km 96 to Elbe-km 585.9 – weir Geesthacht) and lower Elbe (from Elbe-km 585.9 to the North Sea, Elbe-km 727.7 -Cuxhaven-Kugelbake).
After having left the spring region with max. elevations of 1600 m a.s.l. the **upper Elbe** river leaves the mountainous area of Riesengebirge downstream of Vrchlabi. The first dam is located near the city of Dvur Kralove. From this point to the river mouth of the Ohre (Eger) the Elbe flows on a length of 225 km through the wide plain of the Bohemian Cretaceous (No. 2) basin, being the warmest and driest area of Bohemia (annual mean temperature: 9°C, annual mean precipitation: 550 mm). Agriculture is an important issue of landuse in the upper reaches of the Elbe. The character of the upper Elbe river in the Czech Republic is characterized by many regulation measures taken between 1904 to 1976. For a distance of 170 km (from Pardubice to Usti nad Labem) the Elbe is a canalized river with 24 weirs and sluices. On this part the Elbe is a dammed river and the flow velocity is altered from a slow flowing river to nearly standing water conditions. The Elbe passes on a length of 46 km the Bohemian mountain massif (No. 3) forming valleys about 300 m incised in the bedrock. For reasons of nature protection this part was declared as special protection area (Böhmisches Mittelgebirge) with an area of 1063 km^2.

Fig. 3: The Elbe catchment (http://www.rivernet.org)

Here the leisure activitites play a dominant role. The Elbe river passes the tectonically lifted and faulted rocks of the Bohemian highlands and forms a deeply incised valley. Near Usti nad Labem (No. 3) the river is dammed by the biggest weir (storage volume 18.8 Millions m^3) on the whole river course which was built in 1930. From this weir downstream to the weir of

Geesthacht the Elbe is a free flowing river. In the cretaceous sandstones of the Sächsische Schweiz (Elbsandsteingebirge) the river has formed an impressive erosion landscape during the Quaternary. The Elbe valley is characterized by steep valley flanks reaching 200 to 300 m relative height. Since 1912 there are protection measures. Nowadays the protected areas (Landschaftsschutzgebiet "Sächsische Schweiz") cover on both riversides of the Elbe a total area of 668 km^2 for a length of 43 km.

Near Riesa the Elbe enters the lowland of Northgermany and is then called the **middle Elbe** reaching downstream to the weir of Geesthacht. In the middle reaches the Elbe river has a low gradient of 17 cm/km and tends to form meanders. Therefore the river is controlled with groynes (Buhnen) and dykes. Remnants of riparian forests are protected as **"UNESCO Biosphärenreservat Teilgebiet "Mittlere Elbe"** on a length of 129 km.

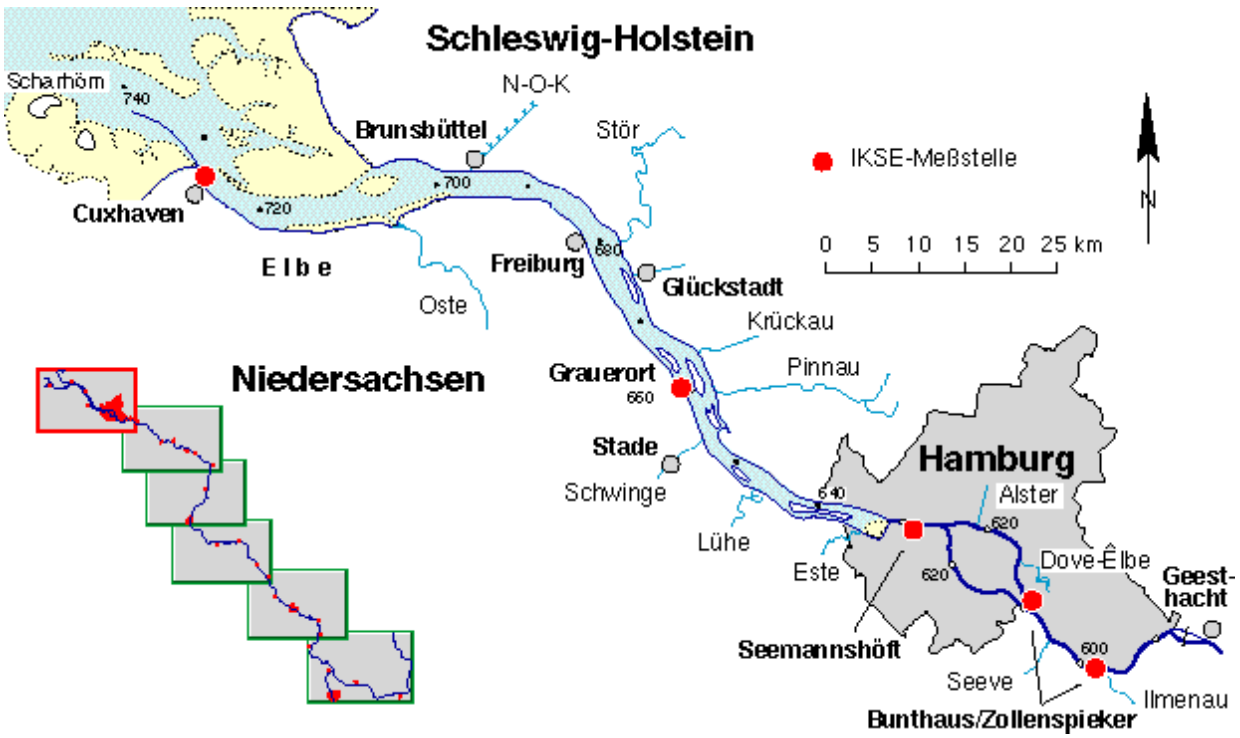

Fig. 4: The Elbe estuary and the Tide-Elbe (lower Elbe) between Geesthacht and Cuxhaven. (IKSE-MKOL 2001)

The weir of Geesthacht (4 m a.s.l.) is the only weir in the german Elbe catchment and is an artificial border for tidal influences. Downstream of Geesthacht the river is influenced by tidal action. Therefore it is called **Tide-Elbe** or **lower Elbe**. The total length of the lower Elbe to the North Sea at Cuxhaven/Kugelbake is 142 km. Near the city of Hamburg the river is divided in two branches: the Norderelbe and Süderelbe encompassing the harbour. From this point the river forms an estuary with a width of 1,5 km downstream of Hamburg and 18 km near Cuxhaven. Because of lacking gradient and tidal influence the direction of water drift changes every six hours. For this reason a given water body has to pass the same river section several times unless it reaches the open waters of the North Sea. Speaking in numbers it means that for the last section of the middle Elbe from Schnackenburg to Geesthacht (110 km length) a water body needs 1 to 2.5 days, while from Geesthacht to Cuxhaven it needs 4 to 70 days! Therefore the residence time of polluted water is much greater in the Tide-Elbe than in the upper reaches. Between Glückstadt and Cuxhaven the estuary becomes a mixing zone of fresh water and salt water.

2.1 Water discharge

The long time average discharge at the German-Czech border is 315 m^3/s (9.9 * 10^9 m^3/a), while at the inflow in the north sea it is 877 m^3/s (27.7 * 10^9 m^3/a). Having the river a rain-snow water regime, high water events occur mainly in winter and early spring.
The most significant tributaries are the Moldau (28 090 km^2), the Havel (24 096 km^2), the Saale (24 079 km^2), the Mulde (7 400 km^2), the Schwarze Elster (5 541 km^2) and the Eger (5 164 km^2).
The river Elbe has a length of 1091 km and it flows for a length of 286.8 km in the Czech Republic. The German kilometre numbering starts at the Czech/German border at the left bank of the river, and ends at Cuxhaven, with Elbe-km 727.7.
The water engineering works along the Elbe have mainly the function of flood protection or that of ensuring navigability. About 80% of the river bank length is dammed in order to offer protection against high water events. In order to make navigation possible the Elbe has been shortened 115 km, thus increasing its slope and also causing the presently observed soil erosion. In the Czech Republic along the canalised Elbe from Chvaletice harbour to Střěkov weir (Ústí nad Labem) numerous weirs ensure river navigability in spite of the average river-depth of about 2 m. After Střêkov the next weir is to be found in Geesthacht, 600.2 km downstream. The river flows from Geesthacht to the North Sea (141.8 km) is strongly influenced by the tides, such that in medium discharge conditions the time needed for riverine water to reach the North Sea is about 26 days. In order to preserve the Elbe from further engineering measures, in 1996 a declaration was signed, planning the use of the existing Elbe-side canal for navigation from Hamburg to the Czech republic.
The runoff regime of the Elbe in the mountainous regions is characterized by a large difference between low flow and high flow.

PARAMETER	**ELBE**	
Altitude gradient (mean)	1,27 m/km	
Highest point	1384 m (Schneekoppe)	
Length	1091,47 km 726,95 km (D) 364,52 km (CR)	
CAT total [km^2]	148268	
CAT [km^2] and [%]	Darchau	131950 (89%)
CAT [km^2] and [%]	Dresden	53096 (36%)
MQ [m^3/s]	Darchau	702
	Dresden	325
HHQ [m^3/s]	Darchau	3840
	Dresden	4350
NQ [m^3/s]	Darchau	128
	Dresden	23
Variability HHQ/NNQ	Darchau	30,0
	Dresden	57,0
Water runoff (l/s km^2]	Darchau	5,32
	Dresden	6,12

Tab. 2: Catchment and runoff parameters for the Elbe basin.
(Data from MARCINEK, J. & K.-H. SCHMIDT 1995: 142)
MQ = mean discharge HHQ = extreme flood discharge (maximum)
NQ = minimum flood discharge. CAT = Catchment of the Elbe. Period: 45 years

2.2 Monitoring system, water quality and its development

The International Commission for the Protection of the Elbe (IKSE-MKOL) maintains a network of international monitoring stations (Fig. 5). The names of the international stations are mentioned in Tab. 4. The data can be viewed and downloaded on the homepage of ICPR (www.ikse-mkol.org).

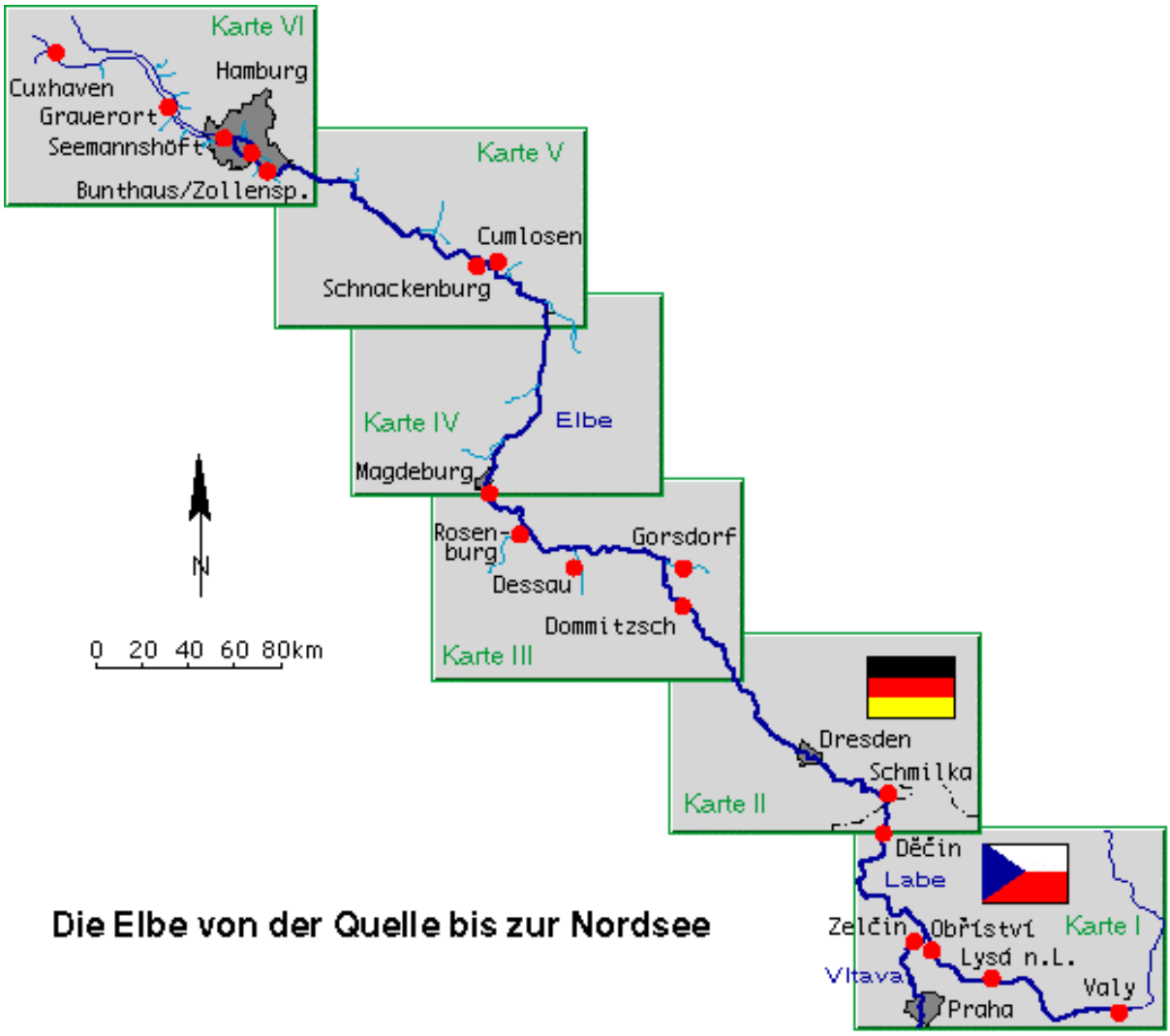

Fig.5 :Monitoring stations in the Elbe catchment (IKSE-MKOL 2001)

Together with the monitoring stations of the german research programme there exists a sufficient database to cover the water quality issues.
Nutrient pollution of the Elbe by phosphorous and nitrogen, particularly of municipal and agricultural origin, is a key factor for eutrophication. The method of MONERIS (Behrendt et al. 1999) could help to identify the pathways of these substances, to estimate the inputs and to define targeted measures.
During 1985 to 1996, the total phosphorous inputs of anthropogenic origin was reduced by 54 %, from 30.000 t P/a to about 14,000 t P/a almost exclusively by addressing point source inputs. In the same period, nitrogen inputs of anthropogenic origin could only be reduced by 28 %. The targeted 50 % reduction by 1995 was failed by far. The reduction is almost totally due to a reduction of point source inputs by implementing measures in industry and improving denitrification in sewage treatment plants. Diffuse nitrogen inputs from leaching and drainage via groundwater remained almost unchanged (reduction only 14 %) so that the overall reduction target has not yet been delivered. Reduction measures in agriculture are rather designed to become effective on the long term. Apart from that, the effect of the time lag due to the soil passage is that reduction effects due to changes in agricultural practice will only show and be detectable in decades. For the Elbe basin estimations for the residence time of nutrients in groundwater are in the range of 30 years. Thus, a basic and final assessment is not yet possible.

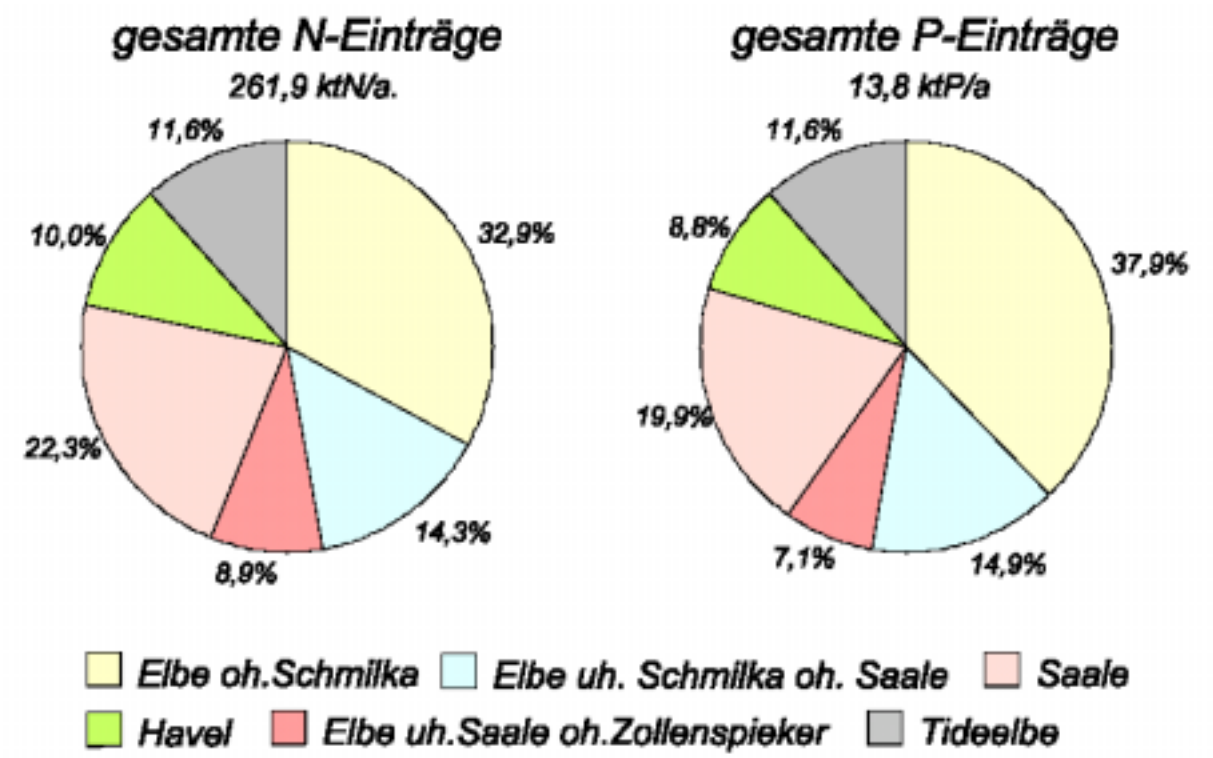

Fig. 6: Percentages of nitrogen and phosphorus inputs for different Elbe subbasins during the time period 1993-1997. (Pagenkopf & Reincke 2001: 78)

3 Institutional area characterization

3.1 Governance, relevant treaties and environmental policy targets

The Water Framework Directive (WFD 2000/60/EC, entry into force on 22 December 2000) is the most important reference legislation concerning the water quality policy targets also in the german part of the Elbe catchment. For the implementaion of the WFD five working areas were created as shown in Fig. 7.

Thus co-operation along the Elbe and in its catchment area so far are bundled, intensified and extended to the entire Elbe catchment within the IKSE-MKOL. The Czech Republic will support the concern of Germany (EU member state) within the possibilities of its national water protection law.
The new **longterm action program Elbe** (Langfristiges Aktionsprogramm Elbe) was decided in Prague in 1995 and covers the time period 1996–2010. The conversion will be executed in two steps with following targets:
time horizon 2000:

- riverbank filtrate must be such that the production of drinking water is possible only using simple near-nature treatment procedures
- water quality standards should be sufficient to establish fisheries
- Fish caught in the Elbe must be apt for human consumption
- use of the Elbe river water for irrigation of agricultural areas

time horizon 2010:

- fine-grained flood and riverine sediments must be such that the reuse in agricultural areas is possible
- aquatic biotic communities are in accordance with a near-natural biodiversity

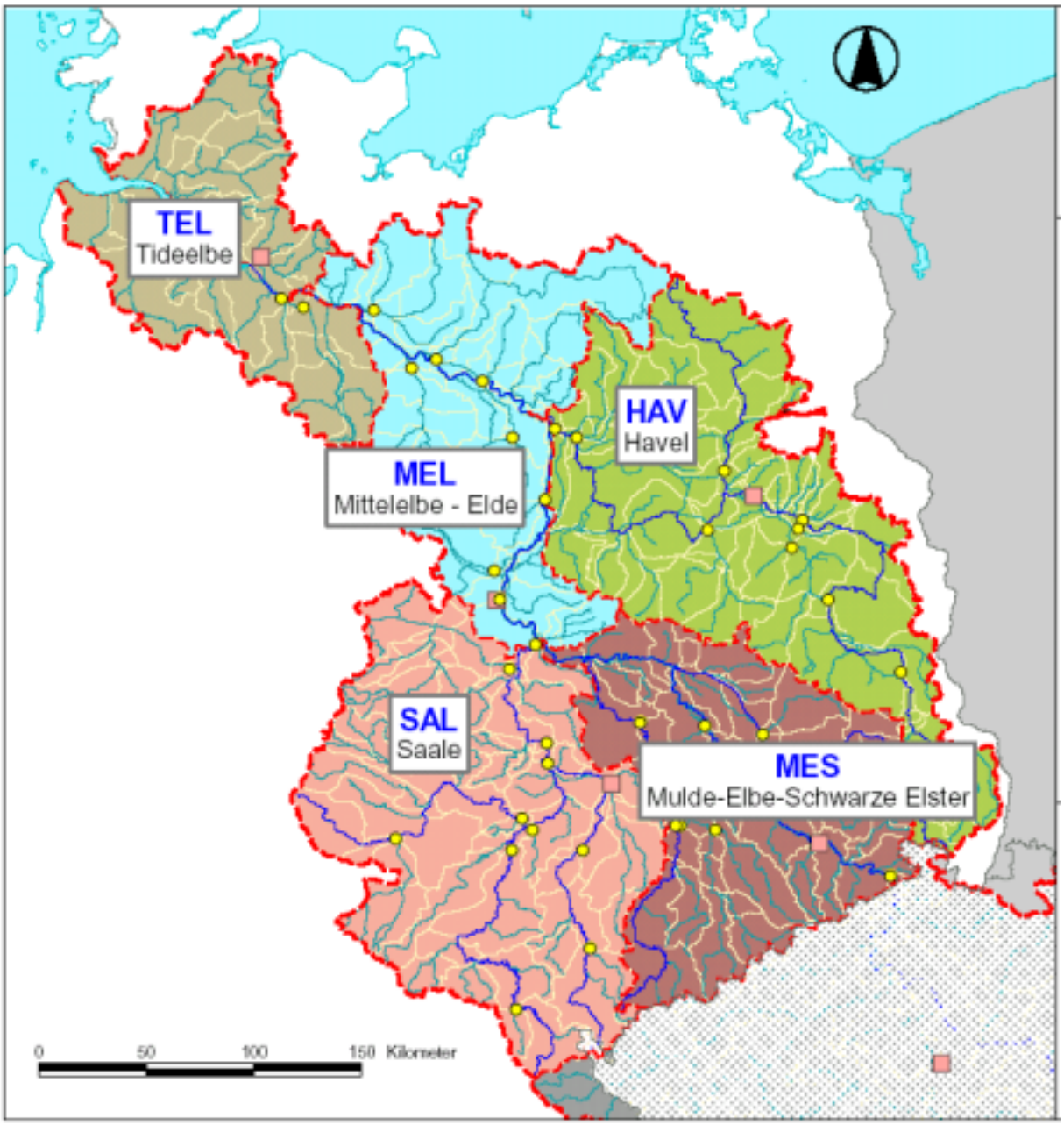

Fig. 7: German catchment part of the Elbe river with the five coordination areas for the implementation of the EC-water framework directive (WFD). The yellow circles indicate the location of monitoring stations used for calculations with MONERIS. The fine light-yellow lines are catchment delineations. (after PAGENKOPF, W.G. & REINCKE, H. 2001, map 2.1)

The **concrete policy targets** for the improvement of water quality are:

- Permanent compliance with the target values of all substances relevant for the Elbe in water, suspended matter, sediments and organisms
- Cease or phase out discharges, emissions and losses of priority hazardous substances listed in the water framework directive
- Progressive reduction of discharges, emissions and losses of priority substances listed in the water framework directive

- Further reduction of discharges, emissions and losses of priority OSPAR substances in order to achieve concentrations in the marine environment near the background values for naturally occurring substances and close to zero for industrially produced synthetic substances as fixed by the OSPAR Commission and set out in the Sintra Declaration
- Water quality is supposed to be such that using simple, near-nature treatment is sufficient for the production of drinking water.
- Substances contained in Elbe water must neither individually nor in combination have adverse effects on the biocoenosis of plants, animals and micro-organisms
- Concentrations of dangerous substances in plants, animals and micro-organisms must be further reduced
- No excessive production of biomass
- It must be ensured that the disposal of dredged material does not have any adverse impact on the environment ARGE Elbe 1996: Umgang mit belastetem Baggergutan der Elbe – Zustand und Empfehlungen BfG 1997: Handlungsanweisung für den Umgang mit Baggergut im Binnenland (HABAB)
- Further depollution of the North Sea

The approach and measures to be taken are as follows:

(1) Continued reduction of discharges, emissions and losses of substances relevant for the Elbe by applying the state of the art and best environmental practice

(2) Implement the relevant decisions taken by the IKSE

(3) Update the list of substances relevant for the Elbe and the targets according to the developing state of knowledge, integrating the quality objectives the water framework directive sets for priority substances and priority hazardous substances as well as the OSPAR priority substances

(4) Implement further measures targeted at reaching the aims set for the priority substances and the priority hazardous substances

(5) Applying the EU directives concerning water quality in the german part of the Elbe catchment : water framework directive (2000/60/EC), IPPC (96/61/EC), urban waste water (91/271/EEC), Nitrates (91/676/EEC), Plant protective agents (91/414/EEC), Biocides (98/8/EC) and others contributes to improving water quality.

(6) Further develop waste water discharge monitoring systems of authorities and industrial plants integrating auto-surveillance; develop and incorporate uniform ecotoxicological assessment methods (see the relevant work done in OSPAR, the overall assessment of waste water discharge is of importance)

(7) Further develop the Elbe warning and alarm system

(8) Promote ecological management of substances in industry and trade, i.e. the development of products representing a lower risk for the environment; close material cycling, integrate environmental protection according to the state of the art into production (prevention: environmentally acceptable products, clean technologies, measures integrated into production, environmentally acceptable raw materials and process materials, eco-friendly management, use of material and maintenance; recycling: close material cycling within and outside the production process; recycling eventually after processing or waste water treatment)

(9) Develop an assessment method for individual measures with a view to possible effects on other fields of action including a comprehensive assessment by experts

(10) Promote environmentally acceptable land management, biological farming, measures aimed at extensified land use and entrust farmers with landscape care.

Natural preserves are also of great importance since the UNESCO certified in 1995 the establishement of the biosphere reserve (Biosphärenreservat "Flußlandschaft Elbe") ranging from the border of Saxony and Saxony-Anhalt to Lauenburg in Schleswig-Holstein. With an area of 3,750 km^2 and a river length of 400 km it is one of the largest biosphere reserves in Central Europe.

Further targets of IKSE-MKOL are the establishments of :

- Minimum requirements for waste water discharge for 10 selected industrial branches (e.g. chemical and pharmaceutical plants, energy production etc.)

- Analysis of 186 municipal sewage dischargers (with more than 20,000 inhabitants connectes) and of 58 industrial sewage dischargers from seven different branches according to a list 27 priority substances

- Estimations of nitrogen and phosphorus losses from diffuse sources in agricultural areas. Recommendations for reductions are derived from different research programmes (see Annex:). Also historical burdens from former waste disposal sites etc. contribute to effluents.

3.2 International and national organizations in the Elbe river basin

The International Commission for the Protection of the Elbe river was founded in 1990 with an agreement between Germany, the Czech Republic and the European Commission. Besides that there exists also a national organization in Germany the ARGE-ELBE. Because of the significance of pollutions in the Elbe river basin this commission was established in 1977 and have been active for some time already. Before 1989 one important issue was the arrangement of contacts with the former GDR to discuss protection measures. Especially the high nutrient and mercury loads were a point of concern. A Survey on the present commissions and the scopes of their work is given in table 3. A common issue is the quality of waters as well as defining standards and requirements for the monitoring programs. The distribution of tasks and responsibilities among the institutional bodies is also addressed.

Table 3: International organizations in the Elbe river basin

NAME Homepage	TASK	ACTIVITY
ICPE / IKSE International Commission for the Protection of the Elbe Founded 1990 Committee: Germany, Czech Republic, EC http://www.ikse-mkol.de/	Investigations on sources, transport and sinks of pollutants Recommendations for the governments of the Elbe basin countries Drafting contracts for the protection of the Elbe Realization of governmental agreements Plan of action related to floods	Investigations on pollutants in the water, flora and fauna of the Rhine Biological and chemical monitoring Research on ecomorphology Investigation on point and non-point sources of pollutants Alarm modelling Surveillance of emissions
ARGE Elbe Arbeitsgemeinschaft zur Reinhaltung der Elbe (Working group for the Protection of the Elbe) Founded 1977 Members are the seven Bundesländer Brandenburg, Hamburg, Mecklenburg-Vorpommern, Lower Saxony, Saxony, Saxony-Anhalt and Schleswig-Holstein http://www.arge-elbe.de	Investigations on pollution in the german part of the river Elbe Recommendations for the governments of the riparian countries Realization of governmental agreements and conferences (Elbe-Ministerkonferenz, EMK) Cooperation with IKSE-MKOL	- committee for action programmes (Aktionsprogramme, AP) - committee for analysis and monitoring programmes (Mess- und Untersuchungsprogramme (M) mit Arbeitskreis Analytik) - committee for protection and formation of river and riverside structures (Schutz und Gestaltung der Gewässerstrukturen und der Uferrandregionen, O) - committee for accident related river loads (Unfallbedingte Gewässerbelastungen, H) - committee for flood protection (Hochwasserschutz, HWS) Research on ecosystems Planning of measures against pollutant inputs Standardization of measuring systems Inventrory of main pollutants and their reduction Alarm modeling
Wassergütestelle Elbe (WGE)	Administrative office of ARGE-Elbe; Monitoring of water quality Standardization of water analysis concerning drinking water supply Improvement of water quality	Technical consulting of the ARGE-Elbe members

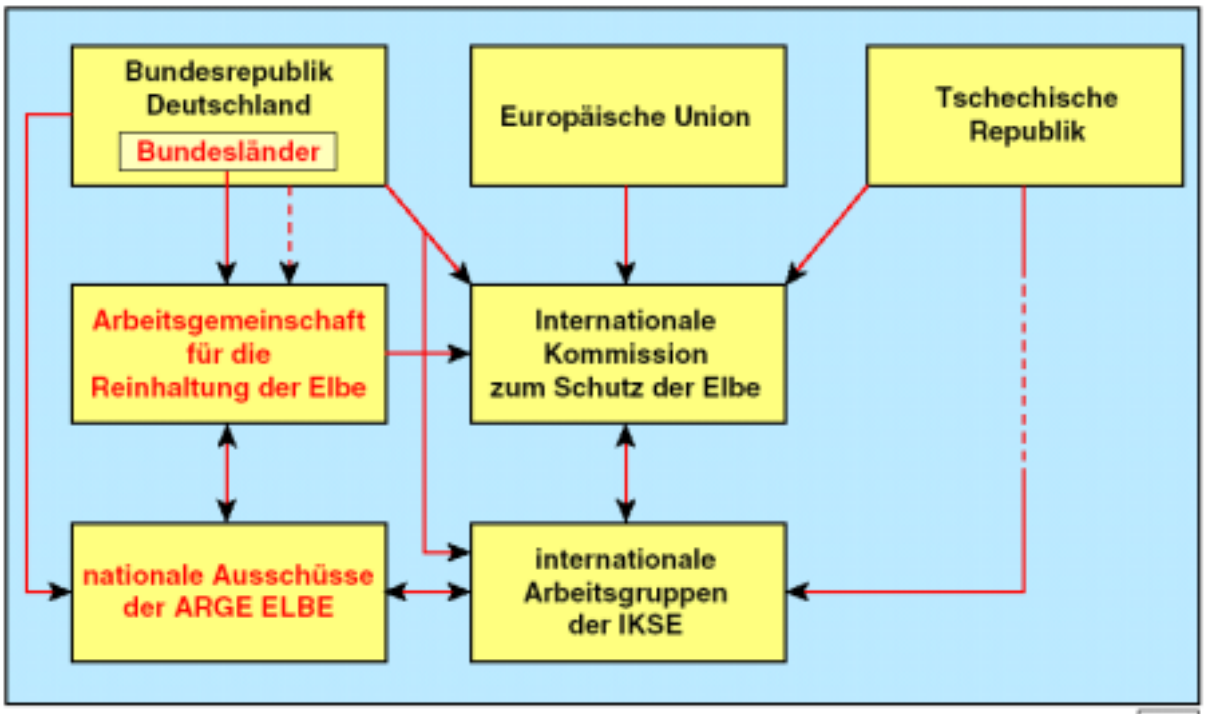

Abb. 1 Nationale und internationale Zusammenarbeit an der Elbe

Fig. 8: National and international cooperation in the Elbe river basin (ARGE-ELBE 2001)

Abb. 2 Organisationsstruktur der ARGE ELBE

Fig. 9 :Organization structure of the ARGE-ELBE (ARGE-Elbe 2001)

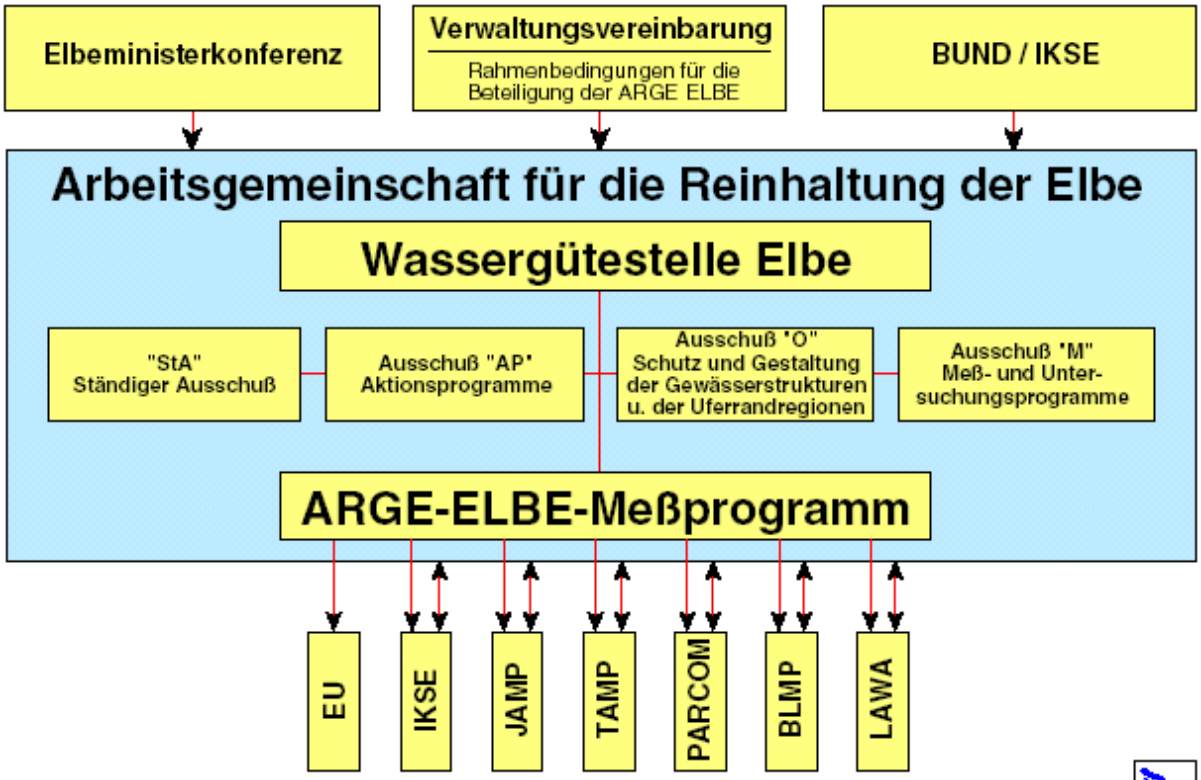

Abb. 3 Einbindung der ARGE ELBE in nationale und internationale Belange

Fig. 10: Links of ARGE-Elbe with national and international organizations

3.3 Available environmental programmes and reports

A list of national/international institutions that are carrying researches, public relations and and environmental monitoring programs in the area is presented here. The list is certainly incomplete and is reported only with the purpose of giving an idea of the huge research effort that is exerted on this area.

Links:

- ARGE ELBE (www.arge-elbe.de)
- BLMP (Meeresumweltschutz) -Bund/Länder-Messprogramm für die Meeresumwelt von Nord- und Ostsee) (www.bsh.de)
- **Bundesanstalt für Gewässerkunde** (www.bafg.de)
- **Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit** (www.bmu.de)
- Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (www.bmbf.de)
- **Cesky hydrometeorologicky ustav (Tschechisches Hydrometeorologisches Institut)** (www.chmi.cz)
- ELBIS (www.elbis.de)
- ELISE (elise.bafg.server.de)
- ELWIS (www.elwis.de)

- **Europäische Union** (www.europa.eu.int)
- **European Environment Agency (EEA)** (www.eea.eu.int)
- **European Rivers Network** (www.rivernet.org)
- **GKSS-Forschungszentrum** (www.gkss.de)
- IGB-Leibniz Institute für Gewässerökologie und Binnenfischerei (www.igb-berlin.de)
- IKSE / MKOL (International Commission for Protection of the Elbe) (www.ikse.de)
- LAWA - Länderarbeitsgemeinschaft Wasser (lawa.de)
- **Ministerstvo zemedelství CR (Ministerium für Landwirtschaft der Tschechischen Republik)** (www.mze.cz)
- **Ministerstvo zivotniho prostredi CR (Ministerium für Umwelt der Tschechischen Republik)** (www.env.cz)
- **Oslo and Paris Commission** (www.ospar.org)
- Research Centre Karlsruhe (www.fzk.de)
- Statistisches Bundesamt (www.statistik-bund.de)
- **Umweltbundesamt** (www.umweltbundesamt.de)
- **Umweltforschungszentrum Leipzig-Halle GmbH** (www.ufz.de)
- **Vyzkumny ustav vodohospodarsky TGM (Forschungsinstitut für Wasserwirtschaft TGM)** (www.vuv.cz)
- **Wassergütestelle Elbe der ARGE ELBE** (www.arge-elbe.de)

All these institutions participate to national and international research programs and produce reports and data on the Elbe catchment and the North Sea area.
Among them the most important one is the homepage of ARGE-Elbe. Programs and records can be downloaded from their homepage :
http://www.arge-elbe.de/wge/Download/DBerichte.html
A list of some of the dataset available is provided in the table below.
Annual reports of the ARGE Elbe (water quality data Elbe 1977-1999)
Finally many international agencies and research projects are providing pertinent datasets. The following list is not complete and has to be considered only representative.
Important International programmes are :

- PARCOM (Program for the determining of substance inputs to the North Sea (Paris Convention) and
- TMAP (Trilateral monitoring and assessment programme)

Monitoring programs (Selection)

Program, Research Institution	Time period	Spatial Coverage	Dataset/Project description
IKSE-MKOL	1990-2001	Elbe catchment	Data measured every week in 16 international monitoring stations (5 in Czech Republic and 11 in Germany) covering all the catchment area. Discharge in the river, physico-chemical and water quality parameters including P, N, Si, BOD, COD, O_2, EBI, Coli-forms, metals and microorganic pollutants. For detailed Info see: http://www.ikse-mkol.de/html/ikse/ikse/deutsch/index_themen.htm
ARGE – Elbe Wassergütestelle Elbe	1977-2001 (data av. since 1950)	German part of Elbe catchment	Water quality (physicochemical data), macrozoobenhos, plankton, fish fauna Since 1980 CKW Network of 100 measuring points and 18 stations in the german part covers the 30 important Elbe tributaries strating from the Czech/German boder to the North Sea, daily and weekly measurements
Vyzkumny ustav vodohospodarsky TGM (Forschungsinstitut für Wasserwirtschaft TGM)	? - 2001	Czech part of Elbe basin	Water quality data (completeness of data set difficult to estimate due to legal problems)

Environmental reports from IKSE-MKOL (1998-2000)

PUBLIKATIONSVERZEICHNIS DER IKSE

Allgemein		Schutzgebühr	
1	Arbeitsplan der IKSE bis zum Jahre 2000, beschlossen am 21.09.1992	10,00 DM	vergriffen
2	Tätigkeitsbericht 1990		vergriffen
3	Tätigkeitsbericht 1991 herausgegeben im Juni 1993	10,00 DM	vergriffen
4	Die Elbe und ihr Einzugsgebiet herausgegeben am 08.10.1995	10,00 DM	vergriffen
5	Symposium 5 Jahre IKSE - Prag, den 19.10.1995 herausgegeben im Mai 1996		
6	Ergebnisse der Elbeforschung 1991 - 1995, herausgegeben im Februar 1997		vergriffen
7	Anthropogene und geogene Schwermetallbelastungen von Sedimenten im Elbe-Einzugsgebiet (Poster) herausgegeben 1998		
Aktionsprogramme und Bestandsaufnahmen		Schutzgebühr	
8	Erstes Aktionsprogramm (Sofortprogramm) zur Reduzierung der Schadstofffrachten in der Elbe und ihrem Einzugsgebiet herausgegeben am 09.12.1991	10,00 DM	vergriffen
9	Bericht über den Stand der Durchführung der im "Ersten Aktionsprogramm (Sofortprogramm) zur Reduzierung der Schadstofffrachten in der Elbe und ihrem Einzugsgebiet" enthaltenen	10,00 DM	vergriffen

	Maßnahmen. Stand: Juni 1993, herausgegeben am 02.11.1993		
10	Inventar wichtiger Abwassereinleiter im Einzugsgebiet der Elbe im Jahre 1989 herausgegeben am 04.02.1992	10,00 DM	vergriffen
11	Aktionsprogramm Elbe herausgegeben am 15.11.1995	10,00 DM	
	Nachdruck 1996		
12	Bestandsaufnahme von bedeutenden punktuellen kommunalen und industriellen Einleitungen von prioritären Stoffen im Einzugsgebiet der Elbe 1995, herausgegeben am 10.11.1995	10,00 DM	vergriffen
13	Abschlußbericht über den Stand der Durchführung der im "Ersten Aktionsprogramm (Sofortprogramm) zur Reduzierung der Schadstofffrachten in der Elbe und ihrem Einzugsgebiet" enthaltenen Maßnahmen, herausgegeben im Oktober 1996	15,00 DM	
14	Erster Bericht über die Erfüllung des "Aktionsprogramms Elbe" herausgegeben im Oktober 1998	20,00 DM	
Unfallbedingte Gewässerbelastung		Schutzgebühr	
15	Internationaler Warn- und Alarmplan Elbe, herausgegeben im Juli 1992 und ständig aktualisiert; Stand Oktober 1995	10,00 DM	vergriffen
16	Maßnahmenkatalog zur Vermeidung unfallbedingter Gewässerbelastungen im Einzugsgebiet der Elbe, herausgegeben 1995	10,00 DM	vergriffen
17	Verzeichnis potentiell der gefährlichen Anlagen im Einzugsgebiet der Elbe herausgegeben im Oktober 1998	10,00 DM	
Ökologie		Schutzgebühr	
18	Ökologische Sofortmaßnahmen zum Schutz und zur Verbesserung der Biotopstrukturen der Elbe herausgegeben am 24.08.1993	10,00 DM	vergriffen
19	Ökologische Sofortmaßnahmen zum Schutz und zur Verbesserung der Biotopstrukturen der Elbe, Karte		vergriffen
20	Ökologische Studie zum Schutz und zur Gestaltung der Gewässerstrukturen und der Uferrandregionen der Elbe herausgegeben am 01.12.1994	35,00 DM	vergriffen
21	Die Elbe - erhaltenswertes Kleinod in Europa, herausgegeben 1995		vergriffen
22	Die Fischfauna der Elbe herausgegeben im Oktober 1996	15,00 DM	
23	Schutzgebiete an der Elbe, Poster herausgegeben im Oktober 1997		
24	Bericht über den Stand der Umsetzung der "Ökologischen Sofortmaßnahmen zum Schutz und zur Verbesserung der Biotopstrukturen der Elbe" herausgegeben im Dezember 1997	20,00 DM	vergriffen
Hochwasserschutz		Schutzgebühr	
25	Strategie zum Hochwasserschutz im Einzugsgebiet der Elbe herausgegeben 1998	10,00 DM	
Meßprogramme		Schutzgebühr	
26	Informationsnetz Elbe-Sanierung (INES), herausgegeben 1995	15,00 DM	
27	Wassergütemeßstationen des Internationalen Meßprogramms der IKSE, herausgegeben 1995	20,00 DM	
28	Gewässergütebericht Elbe 1989, herausgegeben im September 1991	10,00 DM	vergriffen
29	Gewässergütebericht Elbe 1990/1991, herausgegeben im Dezember 1992	10,00 DM	vergriffen
30	Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogrammes der IKSE 1992, herausgegeben im August 1993	10,00 DM	vergriffen
31	Gewässergütebericht Elbe 1993 mit Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogrammes der IKSE, herausgegeben im November 1994	20,00 DM	
32	Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogramms der IKSE 1994, herausgegeben im September 1996	15,00 DM	
33	Gewässergütebericht Elbe 1995 mit Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogramms der IKSE, herausgegeben im September 1997	20,00 DM	
34	Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogramms der IKSE 1996, herausgegeben im Dezember 1997	15,00 DM	
35	Gewässergütebericht Elbe 1997 mit Zahlentafeln der physikalischen, chemischen und biologischen Parameter des Internationalen Meßprogramms der IKSE, herausgegeben im Februar 1999	20,00 DM	

4 Socioeconomic profile

4.1 Population, landuse and pollution sources

About 24,74 million of inhabitants (data from 1994) live in the catchment, 75.7 % of which in Germany and the remaining 24.1% in the Czech Republic, this means about 22.9% of the German and 57.8% of the Czech population. The most significant cities are Berlin (3.47 millions of inhabitants), Hamburg (1.71 millions), Prague (1.21 millions), Leipzig (0.48 millions), Dresden (0.477), Halle (0.290), Chemniz (0,278 millions) and Magdeburg (0.256 millions).

COUNTRY	INHABITANTS	
	[MILLION]	[%]
Germany	18,72	75,6 %
Czech Republic	5,97	24,2 %
Austria	0,05	0,2 %

Tab. 4: Population among the Elbe countries (IKSE 2001)

Known point sources of pollutants are waste water treatment plants and industrial discharges, a high potential pollution is also associated with dismissed industrial sites as well as with waste disposals.
In the time span between 1990 and 1999 in the catchment a total of 181 water treatment plants (hi.eq.>20000) were constructed or improved, thus causing a significant water quality improvement. Nevertheless one of the main still unsolved problems is the direct discharge of untreated rainwater into the rivers, and the mixed canalisation of rainwater and waste water.
In 1998 the IKSE identified the most significant industrial emissions in the Elbe basin as being originated from: chemical, pharmacological, cellulose and paper, metallurgic, electrical, leather, fur, glass, ceramic and textile industries, as well as from mining (table 1).
In 1999 in the Elbe basin 33 dismissed industrial sites and 15 waste disposals were indicated as potentially dangerous, the sites associated with major risk of pollution are Bitterfeld-Wolfen, Magdeburg-Rotensee, BUNA and LEUNA.
Among diffuse sources of pollutants are those connected with agriculture and farming. About 55,7% of the catchment (148 268 km^2) is used for agriculture, 55 160 km^2 (56,9% of the German basin) in Germany and 26 810 km^2 (53,4% of the Czech basin) in the Czech Republic. The N emissions for the Elbe basin in the period between 1993 and 1997 are a significant example of the weight that diffuse sources can have: in this span of time nitrogen emission of point sources represented about 27% of the total emissions, while the remaining 93% was due to diffuse sources.

		AE_o	Bevölkg.	urbane Fläche	landw. Fläche	Acker-land	Grün-land	Wald	Wasser
		[1000 km²]	[1000 EW]	[%]	[%]	[%]	[%]	[%]	[%]
Elbe bis Schmilka		51,5	6065	4,4	59,3	55,9	3,4	31,4	0,8
Elbe uh Schmilka oh Saale	MES	18,0	3484	7,0	58,6	55,5	3,1	27,0	0,7
Elbe uh Saale oh Zollensp.	MEL	17,1	1692	4,1	69,6	58,3	11,2	24,6	2,6
Saale	SAL	24,1	4524	6,7	68,2	66,2	2,1	23,0	0,4
Havel	HAV	23,6	5491	7,7	48,5	40,5	8,0	37,3	2,5
Tideelbe	TEL	12,9	3627	12,0	64,7	38,9	25,9	20,1	0,8
Elbe bis Saale		69,5	9548	5,1	59,1	55,8	3,3	30,2	0,8
Elbe bis Zollenspieker		134,9	21256	5,7	60,2	55,3	4,9	29,5	1,2
Elbe gesamt		147,2	24650	6,3	60,7	53,7	6,9	28,6	1,2

Tab. 5: Population and landuse in different Elbe subbasins. (from left to right: name of subcatchment, inhabitants per 1000 km^2, inhabitants, percentages of urban area, agricultural area, arable farmland, grassland, forest and water surface. Pagenkopf & Reincke 2001: 37)

River	Type of Industry	Major industrial sites
Elbe (from its spring to the confluence with the Moldau)	Chemical	Sintesia Pardubice
	Textile, leather, glass and ceramic, metal.	Spolana neratovice
Iser	metal	Škoda Mladá Boleslav
Moldau	Chemical, cellulose and paper	Paper factory Větřní, Kaučuk Kralupy n. Vlt
	Metal	Aktivita Kaznějov, Metal industry in Plzeň, Příbram, Králův Dvůr and Rockycany
	Glass and ceramic	Glass Bohemia in Světlá
Eger	Metal, leather and fur	Sokolov
	Coal	Sokolov, Chomutov, Vřesová
Bílina	Chemical	Chemopetrol Litvínov, Spolchemie Ústí nad Labem
	Coal	Minings in Most and Litvínov, Ústí nad Labem
Elbe (from the confluence with the Moldau to the German/Czech border)	Chemical	Lovochemie Lovosice
	Metal	Povrly
	Paper and cellulose	Štětí
Schwarze Elster	Chemical	BASF Schwarzheide
	Coal	Lausitzer Bergbaureviere
Vereinigte Mulde	Chemical	Chemiepark Bitterfeld-Wolfen
	Paper	Trebsen
	Coal	Mitteldeutches Braunkohlenrevier
Freiberger Mulde	Paper, Metal, Leather	Paper factory Kriebstein, SAXONIA in Freiberg and Halsbrücke, FORON Niederschmiedeberg Sämischleder Nossen
	Abandoned Uran mining	
Zwickhauer Mulde	Abandoned mining	
	Chemical, metallurgic, textile	Baufeld Raffinerie, VW-Werk Mosel, Spindle Factory Neudorf, Schiesser Sachsen AG Niederfrohna
Saale	Chemical	BUNA-SOW, LEUNA-Werke, Dow deutschland Leuna, Solvay Alkali Bernburg, Sodawerke Staßfurt, Addinol Lützendorf
	Metal	Aluhett hettstedt, Mansfeld Kupfer- und Messing GmbH
	Coal	Mitteldeutches Braunkohlenrevier
	Paper	Rosenthal in Blankenstein
Ilm	Glass and ceramic	
	Abandoned mining	
Unstrut	Abandoned mining	
Weiße Elster	Chemical	Chemiewerk Greiz-Döhlau
	Paper	Paper factory in Greiz
	Coal mining	Mitteldeutches Braunkohlenrevier
Pleiße	Coal mining	Mitteldeutches Braunkohlenrevier
Havel	Chemical	
	Metal	Berlin, Potsdam, Brandeburg
Spree	Coal	Lausitzer Bergbaurevier, LAUBAG, Schwarze Pumpe, Braunkohlegrosskraftwerke
	Textile, food	
	Chemical	Dow Deutschland Stade, Deutsche Shell
Elbe (from the inflow of the Havel to the North Sea)	Paper	Hamburg, Glückstadt
	Metal	Norddeutsche Affinerie AG Hamburg

Tab. 6. Main Industrial activities for the Elbe and its main tributaries.

4.2 Water use, water engineering and navigation

While before and soon after the reunification of Germany the Elbe water quality was described as LAWA class III (excessively polluted) to IV (ecologically spoiled), the present state of the Elbe can be described as class II-III (critically polluted) to II (moderately polluted). The main pollutants are heavy metals, chlorinated hydrocarbons, nitrogen compounds. A high concentration of heavy metal and chlorinated hydrocarbons (especially HCB) can still be found in sediments and accumulates in mussels and fishes.
Particularly in the Czech Republic the Elbe is very polluted near the cities of Hradec Králové, Pardubice, Kolín, Štěti and Ústí nad Labem. Pollution of the Moldau downstream of Prague is due to insufficient waste water treatment in this city. During the last period of the centrally planned economy before 1989 the worst degradation of natural resources was in the highly urbanized and densely populated industrial areas of Czechoslowakia. The largest area under threat comprised the Ore mountains in the upper Elbe. Here coal mining has dramatically changed the physical nature of the landscape and caused the highest concentrations of industrial air pollutant emissions and a high degree of pollution of its surface waters.
In Germany the tributaries Mulde, Saale and Schwarze Elster, as well as the Elbe in the area between Pirna and Torgau and from Wittenberg to Magdeburg are highly polluted.
In the time span between 1989 and 1993, due to improvement of waste water treatment plants and industrial production cycles and technologies, as well as to other measures (e.g. phosphate-free detergents), there was a noticeable reduction in emissions: N and P were reduced of about 30% , Hg of 84%, Cd of 22%, and 1,2,4, Trichlormethan of 93%. This first step induced a self regeneration water process, which amplified the results.
It is important to stress that particular hydrodynamic conditions (e.g. high water waves) may lead to higher pollutant concentration due to remobilization of pollutants accumulated in sediments.

The Elbe and its tributaries are mostly used for obtaining drinkable water and water for industrial or irrigation purpose. Due to the still insufficient quality of the river water, the use as drinkable water and industrial water is only possible after adequate treatment (such as filtration) or with the corresponding restrictions. Along the Elbe numerous filtration plants provide water to about 1.8 millions of people.
In the first years after reunification of Germany the water need decreased, due mainly to update of production structures and technologies in the former German Democratic Republic, together with reduction in farming and population emigration to Western Germany, such trend still continued in 1994. In 1995 drinkable water made up 23.5% of the whole water need in the catchment.

4.3 Hot spots and ecological value

In the river Elbe catchment a high ecological value co-exists with pollution hot spots of concern. Some of the major hot-spots issues are:

- The devastation of coal ming areas in Most, Teplice and Usti nad Labem and the discharge of minig waters in the Eger subcatchment (Sokolov) lead to a higher pollution of water cecosystems
- Dredging of contaminated sediments in Hamburg harbour and their storage in a confined disposal site.
- Coal mining (lignite) areas in Brandenburg and Saxony and their impact on water quality

- Increase of the N/P ratio between 1977 to 1998 from 27 to 59 induce negative effects in coastal waters (producing of foam on the beaches etc.).

Due to its dimensions the Elbe basin comprises a broad variety of geographical regions and landscapes. Many areas along the Elbe present an almost undisturbed nature, which is of interregional importance for plants and animals otherwise endangered. For this reason many protected areas have been created along the Elbe and its floodplains, such that in 1999 there was a total of 183 areas protected to different extents (national parks, biosphere reserves, natural protected areas, landscape protected areas and natural parks). About 22% of the river length in the Czech Republic and 86% in Germany are part of protected areas extending on either one or both side banks. All together 9 national parks are found in the catchment: Sächsische Schweiz, Hainich, Harz, Hochharz, Müritz and Schleswig-Holstein Wattenmeer in Germany and Riesengebirge, Bömische Schweiz and Bömerwald in the Czech Republic. More protected areas are planned both in Germany and in the Czech Republic, leading the German protected river length percent to 94 and increasing the Czech protected river length of 11 km.

4.4 DPSIR in the Elbe basin

Following Turner et al (1998, available as report number 11 through: http://www.nioz.nl/loicz/prod.htm), drivers are generally seen as socio-economic actors. They cause environmental pressures, which leads to changes in the state of the environment. These changes have an impact on the economy, environment. A list of policy options can be suggested as a policy response to this process. This policy response can influence the drivers, state and impact of the system. In the EUROCAT project we have the following focus:

- PSI at the coastal zone
- DR at the catchment level

Based on this information we can make the following inventory of a DPSIR in REBCAT.
Drivers in catchment: Farming, fishing, industry, transport over water, recreation/tourism, wastewater treatment.

Environmental **Pressures** in coastal zone: population growth, urbanization, fishing intensification, intensification of tourism infrastructure, industrialization.

Environmental **State** changes in coastal zone: Changes in fluxes of environmental pollutants like nutrients, heavy metals and PAHs. Changes in biodiversity. Changes in fish stock.

Impacts in coastal zone: Changes in number of tourists. Changes in national income. Changes in health, amenity and existence value of the coastal .

Policy **Response** options in the catchment: different policy packages which either use economic, technical or ecological instruments.

Tab. 7: DPSIR Indicators subdivision by spatial and focus objective

DRIVERS	**PRESSURE**	**STATE**	**IMPACT**		**RESPONSE**		
			Coastal Zone		**Catchment**		
Catchment	**Coastal Zone**	**Coastal Zone**	*Ecology*	*SocioEco*	*Policy packages*	*Ecology*	*SocioEco*
Agriculture, Farming	Population growth	Changes in fluxes of environmental pollutants (nutrients, heavy metals, PAH's)	Eutrophication	Tourist impact reduction BMP	Economic instruments	Monitoring	
Recreation, tourism	Urbanization	Changes in biodiversity	Algal blooms	Changes in national income	Technical instruments	Load reduction	Planning
Fishery	Fishing intensification	Changes in fish stock	Sediment degradation	Changes in health value	Ecological instruments	WWT	Definition of objectives
Industry and production	Intensification of tourism infrastructure		Coastal erosion and degradation	Changes in amenity value		Renaturation of riparian areas, protection and restoration	Controls and verification
Transport over water	Dumping		Oil spills				Quality standards
Wastewater treatment	Water consumption						Legislation and policies
	Industriali-zation						Thoughtful authorizations management
	Transport of dangerous substances						

5 References

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ANNEX

Tab. 1 Jahresfrachten der Elbe 1985-1996
Meßstation Schnackenburg (Strom-km 474,5)
(aus Wochenmischproben (1993 Zweiwochenmischproben) berechnet)

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Abfluß (MQ) (Neu Darchau)	m^3/s	558	716	1130	874	520	447	384	515	510	860	908	669
BSB_{21} *	10^3 t/a O_2	-	570	620	590	430	310	210	220	220	240	230	190
CSB	10^3 t/a O_2	1 000	1 100	1 300	1 100	760	640	420	510	450*	780*	(630)*	430*
Chlorid	10^3 t/a Cl^-	3 700	4 400	5 400	4 800	3 500	3 300	2 700	2 400	2 400	3 200	2 700	2 600
Ammonium (filtr.)	t/a N	54 000	49 000	53 000	42 000	32 000	23 000	11 000	7 700	6 900	6 800	6 900	9 400
Nitrat (filtriert)	t/a N	54 000	97 000	180 000	140 000	75 000	69 000	58 000	88 000	81 000	150 000	140 000	100 000
Ges.-N (Koroleff)	t/a N	140 000	190 000	280 000	230 000	140 000	110 000	82 000	110 000	100 000	180 000	170 000	130 000
o-Phosphat (filtr.)	t/a P	3 400	3 500	4 100	2 800	2 200	2 300	1 500	1 600	<1 500	1 500	1 200	1 800
Ges.-Phosphor	t/a P	12 000	10 000	15 000	12 000	9 100	9 100	4 200	4 100	6 400	5 400	5 200	5 200
Quecksilber	t/a	28	23	26	16	12	6,5	6,9	4,2	1,9	4,7	3,2	1,7
Cadmium	t/a	13	13	16	9,7	6,4	6,0	4,9	5,3	5,0	6,0	5,5	5,6
Blei	t/a	110	120	130	180	110	73	70	76	75	52	96	100
Trichlormethan	kg/a	14 000	24 000	22 000	21 000	13 000	8 700	5 300	2 000	860*	430*	1 200*	1 100*
Trichlorethen	kg/a	40 000	31 000	28 000	9 600	7 300	3 400	1 200	1 900	1 100*	1 800*	1 500*	1 200*
Tetrachlorethen	kg/a	13 000	22 000	20 000	7 700	8 300	3 000	1 500	1 600	790*	1 200*	3 900*	1 900*
Hexachlorbutadien	kg/a	300	150	250	150	96	19	< 12	< 15	< 15	< 50	< 50	<20
γ-HCH	kg/a	570	670	970	560	490	270	180	320	440	520	670	380
1,2,4-Trichlorbenzen	kg/a	2 600	610	2 200	950	570	260	320	50	50	<80	340	<160
Hexachlorbenzen	kg/a	110	130	190	140	150	180	40	50	90	110	180	120
p,p'-DDT	kg/a	-	-	< 35	<28	<15	<14	110	< 15	18	<80	260	<20
p,p'-DDE	kg/a	-	-	< 35	<28	<15	<14	<12	< 15	<15	<80	< 28	<20
p,p'-DDD	kg/a	-	-	57	40	30	38	<12	< 15	29	<80	< 99	<20
PCB Nr.138	kg/a	79	64	72	47	29	18	<6	<8	<8	<30	< 30	<9,9
PCB Nr.153	kg/a	55	60	74	64	36	19	<6	<8	<8	<30	< 30	<9,9
Pentachlorphenol	kg/a	2 400	3 000	2 700	2 900	1 800	920	340	480	<150	<80	< 230	<22
AOX	t/aCl	2 600	3 000	3 600	2 400	1 600	990	890	760	760	1 100	1 100	720

* Einzelproben () nur 9 Werte