The river Elbe catchment changes and their impact on the coast, German Bight and Wadden Sea - DE

1. Policy Objective & Theme

- SUSTAINABLE USE OF RESOURCES: Preserving coastal environment (its functioning and integrity) to share space
- SUSTAINABLE ECONOMIC GROWTH: Balancing economic, social, cultural development whilst enhancing environment

2. Key Approaches

- Integration
- Ecosystems based approach
- Socio-economic

3. Experiences that can be exchanged

River catchment and coastal waters are considered as one (social-ecological) system. Scenarios and models for catchment fluxes and coastal ecosystem models were combined in the work in order to calculate the impact of socio-economic drivers and pressures on environmental factors in the catchment and calculate environmental state changes of coastal waters. Different policy response options in the catchment were used to assess different scenarios for the future. It demonstrated the value of combining four tools, DPSIR analysis, scenarios, river catchment models and coastal ecosystem models using nutrient flows.

4. Overview of the case

The Elbe catchment and associated estuary and coastal sea went through a relatively recent and rapid change because of politico-economic changes in the catchment (centred on the market economy) with a corresponding change in fluxes to the coast, e.g. nutrients and pollutants have been strongly reduced due to the breakdown of the former East German industry after German unification. The study analysed the development of nutrient loads in the Elbe and the coastal area on different development scenarios and policies and depicted the impacts on coastal waters.

5. Context and Objectives

a) Context

The Elbe is a transboundary river (length 1091 km) with a total catchment area of 148,270 km2: Germany (65%, 730 km), the Czech Republic (34%, 290 km), Poland (1 %), and Austria (0.2 %). In total almost 25 million people with a population density of 167 persons / km2 live in the catchment. Agriculture uses 61% of the area, 29% are covered by forests, 6% by settlements, 4% are used otherwise. The North Sea coast along the state of Schleswig-Holstein is rural with rather weak infrastructure and low population densities (80 and 94 persons/ km2 in the counties Nordfriesland and Dithmarschen, respectively) with a total population of about 310,000 people. For income and employment in the region, tourism (19%) and public services are most important, agriculture (5%) and fisheries (1%) play a minor role. Directly or indirectly two thirds of the population depend on tourism. Since the end of the 1990s, the windmill industry has become the most import industrial sector. Development potential is also seen in mari-culture and blue biotechnology. Land use is characterized by agriculture and natural or semi-natural areas. Most of the Wadden Sea is designated as a national park and biosphere reserve, since 2009 it is also a world heritage site.

73% of the phosphorus load and 79% of the nitrogen load is from diffuse sources and agriculture along the coast is the main contributor. While fisheries cause impacts (removal of target species, discard, and seabed disturbance), eutrophication and other human activities pose pressures on fisheries. The German Bight and the Elbe estuary belong to the most heavily used shipping routes in Europe, implying a high risk from shipping hazards. Dredged material accounts for 44 million tons / year in the German Wadden Sea (compared to 6 million tons / year in Denmark and the Netherlands), with variable nutrient and pollutant content.

b) Objectives

This study aimed to provide a management tool to co-ordinate the river catchment's sustainable development according to the Water Framework Directive i.e. to achieve a good ecological and chemical status of freshwater systems and coastal areas and to reduce human impact as far as possible. The objectives were to identify the impacts of the river catchment on the coast, to integrate bio-physical catchment and coastal models with socio-economic models, develop regional environmental change scenarios (2001-2020), link scenarios with the modelling toolbox to evaluate plausible futures, and evaluate the research outcomes with regional boards consisting of stakeholders and policy makers. The study was made from February 2001 – January 2004.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

The work was led by IGB Berlin, strongly linked with GKSS and FTZ Buesum (the latter responsible for the coastal assessment and indicators work. International, national, and regional levels of science, policy, and administration were involved in the study.

b) ICZM tools

Nutrient loads of rivers were taken as the strongest factors influencing coastal eutrophication. Researchers from natural and social sciences worked together and used the Drivers-Pressures-States-Impact-Response (DPSIR) scheme to model future nutrient loads and their impact on coastal eutrophication. The three different scenarios, that were the basis to model future changes were: "Global Markets / Business As Usual" (priorities on economic growth and individual consumption, a "Strong EU" (strong policy management by regulations) or "Green Regions" (with strong emphasis on local economies and high individual valuation of the environment).

Related policy targets (level of nutrient reduction target) were employed to calculate the input into the catchment system. Then, the catchment loads depending on the scenario targets were included into the coastal model to calculate coastal effects. The scenario analyses provide tools for managers and stakeholders to establish best management practices for the promotion of a sustainable development of the Elbe basin catchment. The MONERIS model was used for the Elbe catchment modelling. The impact on the coastal ecosystem was modelled with ERSEM. A nutrient reduction in 10% steps compared to the reference year 1995 was used to calculate cost-effectiveness of different measures.

7. Cost and resources

The budget for the Elbe study is not known.

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

The status of catchment and coast were described in great detail and impacts of activities on each other and especially of eutrophication on the socio-economic and natural environment calculated. Different nutrient reduction aims showed that the effective measures depend on local conditions. Methodologically, initial experiences were gained in combining river catchment models and coastal ecosystem models, both developed within different science communities and along different modelling approaches.

9. Success and Fail factors

A major challenge in the project was the co-operation between quantitative models and qualitative social science research, e.g. looking into policy processes or stakeholder perceptions. The project design forced a strong quantitative research focus, which implied working with sometimes over-simplified system descriptions in models. However, the integrated project methodology based on the DPSIR approach served as a predecessor of other integrated research projects like Coastal Futures in Germany (www.coastal-futures.org) or ELME and KnowSeas (www.knowseas.com).

10. Unforeseen outcomes

The impact of nutrient reduction in the river Elbe – without considering further measures in the tributaries – was calculated and showed that even a drastic reduction of Elbe nutrient load leads to comparatively small changes in the coastal ecosystem. On the other hand, coastal stakeholders in the North Sea, like local tourism, do not see any problem with eutrophication mainly because obvious negative impacts like algal blooms near beaches have not been observed since the early 1980s. This is in contrast to, for example, the much stronger eutrophication effects in the Baltic Sea and local stakeholders there.

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13. Sources

- Assessing catchment-coast interactions for the Elbe by linking scenarios, indicators and modelling (2004). Kannen, A., Windhorst, W., Lenhart, H., and C. Nunneri. In: Schwernewski, G. and T. Dolch (eds.) Geographie der Meere und Küsten, Coastline Reports 1 (2004), p.225-237.
- European Catchments: catchment changes and their impact on the coast (April 2004). Salomons, W., Institute for Environmental Studies, Vrije Universiteit Amsterdam, The Netherlands.
- The Elbe catchment and related coastal area: German Bight and Wadden Sea, Part A: catchment profile (May 2002). Behrendt, H., and J. Hofmann, Institute of Freshwater Ecology and Inland Fisheries (FVB-IGB).
- The Elbe catchment and related coastal area: German Bight and Wadden Sea, Part C: socio-economic and institutional profiles (May 2002). Kannen, A., Windhorst, W., and F. Colijn, Forschungs- und Technologiezentrum Westküste Büsum, Germany.
- Nunneri, C., Windhorst, W., Turner, R. K., and Lenhart, H. J., 2006: Nutrient emission
- reduction scenarios in the North Sea: a cost-effectiveness and ecosystem integrity analysis. Ecological Indicators. doi:10.1016/j.ecolind.2006.09.002.
- Hofmann, J., Behrendt, H., Gilbert, A., Janssen, R., Kannen, A., Kappenberg, J., Lenhart, H.,
- Lise, W., Nunneri, C., and Windhorst, W., 2005. Catchment-coastal zone interaction based
- upon scenario and model analysis: Elbe and the German Bight case study. Regional Environmental Change, 5(2-3):54-81.
- Nunneri, C. and Hofmann, J., 2005. A participatory approach for Integrated River Basin Management
- in the Elbe catchment. Estuarine, Coastal and Shelf Science, 62:521-537.
- Nunneri, C. and Hofmann, J., 2002. EUROCAT-Sozioökonomische und Umweltänderungs-
- Szenarien für das Elbeeinzugsgebiet. In W. Geller, P. Punˇcocháˇr, H. Guhr, W. Tümpling,
- J. Medek, J. Smrt'ak, H. Feldmann, and O. Uhlmann, (eds.) Die Elbe-neue Horizonte des
- Flussgebietsmanagements, B. G. Teubner, Stuttgart. 165-166.
- NUNNERI, C., WINDHORST, W., KANNEN, A.: Scenarios and Indicators: a link for PRESSURES and IMPACTS in the Elbe Catchment following the DPSIR-Approach, SWAP Conference Proceedings, Norwich, 2-4 September 2002.
- Project webpage: http://www.iia.cnr.it/rende/big_file/EUROCAT/ELBE.htm

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- 00000361_AMK2004_Artikel_Kannen_etal (491.31 KB)
- 0401 (5.45 MB)
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- Kannen_etal_2002 (1009.72 KB)