Glaeser, Sekścińska & Löser (eds.): Management of the Oder/Odra coastal zone
***Coastline Report No. 5 (2005)**, ISSN 0928-2734*
S. xx - xx

Integrated Coastal Area - River Basin Management (ICARM): The Oder/Odra case study

Gerald [1,2], Nardine [1,2], Agnieszka

[1] Baltic Sea Research Institute Warnemünde, Germany
[2] European Union for Coastal Conservation (EUCC)
[3] Social Science Center Berlin, Germany

Integriertes Fluss-Küste Management: Die Oder Fallstudie

Flüsse beeinflussen ihre Mündungsgebiete und Küstenzonen maßgeblich. Daraus ergibt sich die Notwendigkeit eines integrierten Managements von Flusseinzugsgebieten und Küstenzonen. Diese Notwendigkeit schlägt sich auch in internationalen Programmen, wie UNEP-ICARM, nieder. Im Falle der Oder (polnisch: Odra) stellen Hochwässer und Meeresspiegelanstieg, Schifffahrt und technische Maßnahmen, Wasserqualität und Eutrophierung sowie die Wanderung von Fischen und eingeschleppten Arten entlang der Flussläufe, zentrale Themen dar, in denen sich die Wechselwirkung zwischen Fluss und Küste widerspiegelt. Vor dem Hintergrund der anhaltenden sozialen, ökonomischen und politischen Veränderungen in diesem Raum, der Bedrohung durch Klimaänderungen sowie durch konkrete Anforderungen, wie der EU-Wasserrahmenrichtlinie oder Natura 2000, ergibt sich erheblicher Handlungsbedarf und macht ein integriertes Fluss-Küste Management in der Oder erforderlich. Diese Notwendigkeit schlägt sich allerdings in den derzeitigen Abkommen, Aktivitäten und Strategien nicht nieder. Sowohl das Einzugsgebiet, als auch die Küste werden derzeit weitgehend separat voneinander betrachtet und die grenzübergreifende deutsch-polnische Kooperation steht im Vordergrund. Zudem besteht die Gefahr, dass in einem großen und komplexen Einzugsgebiet, wie dem der Oder, die Belange der relativ kleinen Küstenzone aus den Augen verloren wird. Aufgrund der ausgeprägten Wechselwirkungen zwischen Fluss und Küste sowie der Herausforderungen wurde die Oder als internationale Fallstudie des UNEP-ICARM Programms ausgewählt. In enger Zusammenarbeit mit dem Projekt „IKZM-Oder“ wird versucht, ein Bewusstsein für die Notwendigkeit eines integrierten Managements zu schaffen und den Dialog zwischen Küste und Einzugsgebiet zu fördern.

Zintegrowane Zarządzanie Rzeką i Wybrzeżem: precedensowe badania Odry

Rzeki maja decydujący wpływ na swoje dorzecza i strefę wybrzeża. Z tego wynika potrzeba zintegrowanego zarządzania obszarami dorzecza rzek i strefami wybrzeża. Potrzeba ta znajduje także swoje odbicie w międzynarodowych programach, m.in. takich jak UNEP-ICARM. W przypadku Odry (po niemiecku: die Oder) głównymi zagadnieniami są powodzie i wzrost poziomu morza, żegluga i techniczne urządzenia, jakość wody i eutrofizacja, wędrowka ryb i gatunków zwierząt zabranych przez statki do rzek, jak również wzajemne oddziaływania jakie zachodzą pomiędzy rzeką i wybrzeżem. Z uwagi na zagrożenia, jakie niosą z sobą zmiany klimatyczne oraz konkretne wymagania prawne t.j. Ramowa Dyrektywa Wodna lub Natura 2000, istnieje zwiększona potrzeba działania oraz Zintegrowanego Zarządzania Obszarami Przybrzeżnymi rzeką i wybrzeżem w regionie Odry na płaszczyźnie społecznej, gospodarczej i politycznej. Niestety ta konieczność nie ma odzwierciedlenia w aktualnych umowach, działaniach i strategiach. Isniejąca współpraca transgraniczna nie uwzględnia ujednoliconego programu dla obszaru dopływu i wybrzeża. Poza tym istnieje niebezpieczeństwo, że w porównaniu z tak dużym i zróżnicowanym dorzeczem jakim jest dopływ Odry, pas wybrzeża straci na znaczeniu. W ramach programów UNEP-ICARM Odra została wybrana do przeprowadzenia badań precedensowych wzajemnych oddziaływań rzek i obszarów wybrzeży oraz wyzwań przed którymi stoją tego rodzaju obszary. W bliskiej współpracy z projektem „ZZOP-Odra” podjęta zostanie próba uświadomienia potrzeby zintegrowanego zarządzania oraz wsparcia dialogu pomiędzy wybrzeżem i obszarami dorzecza.

1. Background

Large rivers have a strong influence on their adjacent estuary and the surrounding coastal area. During the last decade it became more and more obvious that coastal zones in the vicinity of large rivers cannot be management independently from the rivers and their catchments. The Baltic Sea e.g. is an excellent example how an entire regional sea is controlled by the catchment and riverine nutrient loads (Gren et al. 2000, Schernewski & Neumann 2002, 2005, Neumann & Schernewski 2005). The idea of an integrated coastal area - river basin management (ICARM) is reflected in the UNEP-ICARM approach, in the European Water Framework Directive and partly in LOICZ (Land-Ocean Interactions in the Coastal Zone). All these programmes are focussed on water related topics. The spatial integration of river basin and coastal waters does not always reflect the interaction between terrestrial and aquatic systems well. Therefore, it is not a replacement, but a supplement to traditional Integrated Coastal Zone Management (ICZM). Objectives are to raise awareness as well as to promote and to ensure a sustainable integrated coastal water – river management.

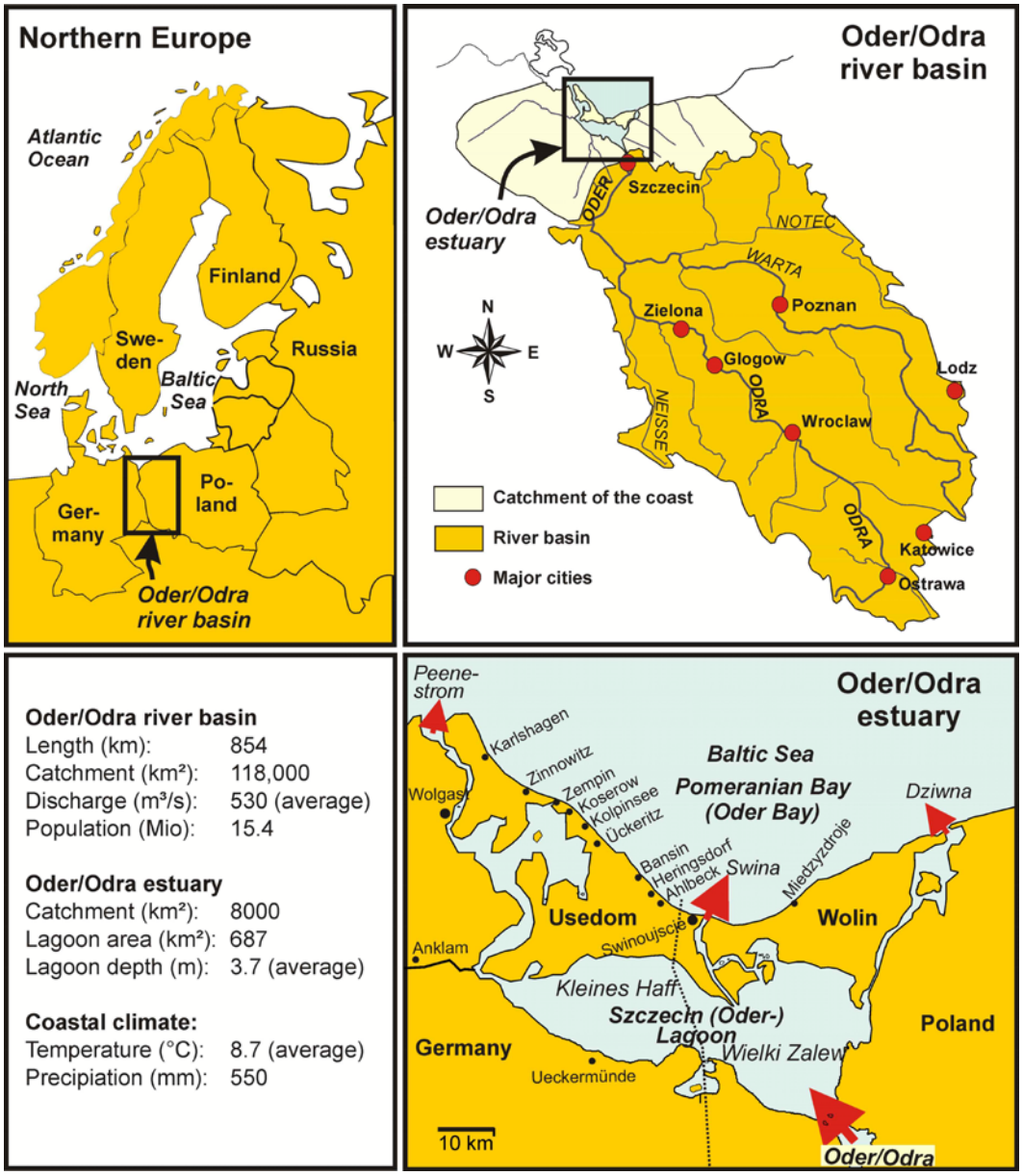

Figure 1: The Odra river basin and the adjacent coastal area

The Odra river (German: Oder; Polish and Czech: Odra) in the Baltic region is an outstanding example to show the interrelations between river basin and coast and to prove the dependency of coastal management on river basin management. Therefore, the Odra became an international case study of the UNEP-ICARM programme and of LOICZ. The Odra activities are supported by the project IKZM-Oder (www.ikzm-oder.de). This short report is an outline of Odra case study.

2. Oder/Odra river basin and coastal area

2.1 River and basin

The **Odra** (854 km length) is one of the most important transboundary rivers in the Baltic region. Its basin (118,000 km²) is shared between Poland (89 %), the Czech Republic (6 %) and Germany (5 %). The Odra is a lowland river with its origin in the hilly Polish-Czech boundary region. Due to the warm-temperate climate with sufficiently rain in all seasons, the water discharge shows only a limited annual cycle with an average discharge of 530 m³/s. Floods are a rare phenomenon and are not necessarily linked to snow melting. The last extreme flood with a discharge up to 2,800 m³/s took place during late summer 1997 and caused severe damage.

The Odra river is partly canalised and sluices allow intensive shipping between about 30 harbours and on 717 km water ways. The largest harbours at the Odra, Kostrzyn and Schwedt, have a turn-over below 500,000 t/a. Szczecin is the gate to the Odra river system and most important trans-shipment centre. The Odra is linked to other river systems via canals and e.g. 2 Mio t, mainly sand, gravel and coal, are transported between Szczecin and Berlin. Altogether 450 hydro-technical objects, like weirs, flood-gates, water-power plants, polders, storage reservoirs and water swings have been inventoried in the river basin. 46 water power plants contribute to the energy supply and the 48 storage reservoirs possess a total volume of 968 million m³. However, large parts of the river are framed by floodplains and floodplain forests, which are of outstanding ecological value and under nature protection. The floodplains host a large variety of birds, insect, amphibians, molluscs and fishes.

Commercial fishery is concentrated in the lower river, but with about 100 t/a it plays only a minor economic role. For public water supply over 1 billion m³ water are annually taken from the river basin, but due to the humid climate, water shortages are no serious problem. However, river and ground water quality is a problem and sewage water is often not, or insufficiently treated.

Already for centuries, the river basin is under strong human influence. Agricultural land covers 70% of the upper river basin and 58 % of the middle basin. However the contribution of agriculture to the gross product is only 3.9 %. Several larger cities and many industries are located in the river basin (total population 15.4 millions). According to Behrendt (pers. com.) the nitrogen (N) and phosphorus (P) loads in the early 1960's were already high (N: 50,000 t/a; P: 6,000 t/a), increased further and reached its maximum during the 1980's (N: 116,000 t/a; P: 16,000 t/a). Due to economic changes, warm and dry years as well as improved sewage treatment a significant decrease of nutrient loads took place until the late 1990's (N: 94,000 t/a; P: 8,500 t/a). Compared to other rivers, heavy metal loads in the Odra play only a minor role, but the sediments are in some areas polluted. Sediment load is about 400,000-500,000 t/a with additional river bed sediment transport of 200,000 t/a.

2.2 Coastal area

The **coastal region** is a complex pattern of lagoons and islands and shared between Germany and Poland. With about 840,000 inhabitants (414.000 in the city of Szczecin) the estuary region is only sparsely populated. Neglecting Szczecin and Świnoujście, the population density is around 50 inhabitants per km². The Odra river flows through Szczecin and enters the large, shallow **Szczecin (Oder) Lagoon.** The river and its loads are responsible for the poor water quality in the lagoon and its highly eutrophic state. Through the lagoon runs the waterway, which links the Baltic Sea with the city of Szczecin, its large harbour and important ship-building industry. The water way is permanently dredged to maintain a depth of more than 10 m. In average, dredging removed about 1.5 million /a sediment during the last decades. Most of the entering Odra sediment as well as large amounts of nu-

trients are removed with this dredging and stored at land. Intensive denitrification removes about 15 % of the entering nitrogen load. Therefore, the lagoon serves as a storage pond for sediment, nutrients and heavy metals and protects the Baltic Sea from pollution. The water flushing time is only 55 days and the lake-like salinity around 1.5 $^{0}/_{00}$ shows that the lagoon is only to a minor degree influenced by the Baltic Sea.

The landscape around the lagoon is flat and dominated by agricultural land and forests. In some areas sand, gravel, oil and gas are exploited. Broad reed belts and artificial sandy beaches near the few small towns characterize the coastline. Due to its outstanding ecological value and beauty, most of the coastal area is under nature protection. A detailed description of the lagoon's ecology is given in Radziejewska & Schernewski (in press).

Figure 2: The quiet Odra lagoon suffers from severe eutrophication.

The lagoon water is discharged into the **Pomeranian (Oder) Bay** via three outlets. The bay is part of the Baltic Sea. Seaward boundaries are the Arkona Sea towards north-west and the Bornholm Sea in the north-east. The bay has an average depth of 13.2 m and covers an area of approx. 6.000 km². The bay is influenced by the Odra river water, but intensive wind-induced mixing and large-scale currents maintain a good water quality. Especially the Oder bank and shallow coastal waters are of high ecological value and are under nature protection or suggested as Marine Protected Areas (MPA). The bay's shoreline is characterized by seaside resorts, coastal forests, cliffs and long sandy beaches. Intensive sediment transport causes accumulation and erosion areas along the shore. In average erosion dominates and causes a coastline retreat between 0.35 – 1.2 m per year.

Tourism, agriculture, fishing (3000 t/a in the lagoon) and shipping are important economic activities in the coastal zone. The large Polish harbours Świnoujście, Szczecin and Police have an annual turnover above 22 million t (2002). With 400,000 t the German harbours are of minor importance. Above 1 million persons arrive annually in these harbours. Along the coastline tourism is the exclusive economic factor and it is likely that altogether more then 10 million tourists visit the estuary region per year. Details about the river basin and the coast are given in Löser & Sekścińska (2005) and Behrendt & Dannowski (2005).

3. River basin-coast issues

3.1 General regional issues

A large amount of development plans and strategies, expert's reports, official documents and scientific paper exist for the Odra case. A systematic analysis and evaluation of these documents provided a detailed overview about the major concerns, issues and challenges in the region. The results are reported in detail in Löser & Sekścińska (2005). For the coastal area the following general issues are of major importance:

1. Economic and infrastructural development of the city of Szczecin and the countryside, preservation of cultural heritage and a sustainable strategy to deal with a shrinking population
2. Improved cross-border cooperation in planning and administration, strengthening the identification with as well as the integration and advertisement of the region
3. Reduced and sustainable resource consumption as well as waste and sewage treatment
4. Sustainable tourism and agriculture against the background of fast changing social and economic framework conditions
5. Flood management, coastal protection and shipping
6. Environmental quality (air, radiation, noise) with focus on water quality
7. Preservation of biodiversity and nature, strengthening of cooperation in environmental protection as well as harmonisation of multiple uses with nature protection
8. Environmental education, improvement of educational systems and access to information.

At the moment, the German-Polish cross border integration and cooperation receives much more attention than a river basin-coast cooperation and management. This is true for the coast and even more pronounced in the river basin. Only the issues "flood management, coastal protection and shipping", "Environmental quality with focus on water quality" and, to a certain degree, "preservation of biodiversity and nature…" possess a clear river basin - coast dimension.

Figure 3: The Baltic Sea coast (Ahlbeck, Usedom) with traditional architecture and flourishing tourism.

3.2 Future threats and challenges

The Odra region faces dramatic political, social, economic and natural changes. These threats and challenges are only partly reflected in existing regional documents:

1. **Political and social changes:** The German part of the Odra region belonged to the former socialistic German Democratic Republic (GDR). With the German re-unification on 3. October 1990 important social, political and economic changes took place and are still ongoing. Despite huge financial efforts the Odra region fell behind the development of other parts of Germany. Ongoing economic problems cause an unemployment rate around 23 %, the movement of labour and a declining population. In 1989 Poland elected its first non-communist prime minister after 40 years of socialism. Like eastern Germany, Poland was subject to social changes and its transitional economy is still facing serious ongoing problems and changes. During the last decade the economic and social developments in Germany and Poland were largely independent and caused

strong social and economic gradients. In the coastal area social problems are increasing and the gap between the flourishing seaside resorts and the hinterland is still deepening.

2. **EU-membership and transformations:** With Poland's EU-membership in 2004, the entire Odra region became part of the European Union. The new agriculture and industry policy, but also the implementation of new standards will cause dramatic changes. Cross-border cooperation as well as competition will increase and cause social and economic transformations. This will have multiple effects on the Odra basin, the river and the coastal area.

3. **Legal challenges:** The active European environmental policy has led to the Marine Strategy, the recommendations on Integrated Coastal Zone Management, the Habitat Directive (Natura 2000) and the Water Framework Directive (WFD). Especially the WFD and Natura 2000 are now being implemented in Germany and Poland. Natura 2000 will lead to a large number and a network of protected areas in the Odra region which require a management. Even more important is the WFD which has the aim to ensure a good water quality in all member states. The WFD is a cross-border and river basin - coast approach and requires e.g. the development of an integrated catchment-coast management plan during the next years.

4. **Climate change:** Climate change scenarios predict an increased risk of extreme weather events. Ongoing sea-level rise and a sinking coast as well as changes in precipitation (Verschiebung auf Winter = kommt 1997 öfter ?? in the catchment, with subsequent changes in river discharge, will increase the flooding risk in the river basin and at the coast. Along the Baltic Sea coast, an increased risk of storms and storm surges will have immediate negative effects on coastal erosion, protection measures and tourism infrastructure (sport boat harbours, beaches, piers, promenades). Warme Jahre = interne Eutrophierung

3.3 River basin – coastal area interaction and issues

The general regional issues were picked up, subdivided into more detailed issues, analysed according to their river basin – coastal area relevance. In a second step these issues were be linked to future threats and challenges, to ensure that they have not only relevance in the present situation but are of growing concern. The resulting issues are:

Flooding: The Odra is a lowland river with only a low hydraulic gradient. The tides in the Pomeranian Bay are in the range of only one decimetre. Strong northerly wind can cause storm water levels at the Baltic Sea coast of one meter and more. During these situations backwater in the Odra is observed far south of Szczecin and a temporary intrusion of Baltic Sea water with a salinity of 6 $^{0}/_{00}$ into the lagoon is observed. A sinking coast and climate change caused a relative water-level rise of about 1 mm/a during the last century in the region. An even faster increase is assumed for this century. Therefore the effect of storm surges on the river water level will increase, backwater will penetrate even farther into the river basin and cause a hazard. Climate change will affect not only the coast but also the river basin itself. Recent calculations do not suggest a significant increase in precipitation in the Odra basin, but the likelihood of extreme events and floods might become higher. The region has to face danger from two sides, due to sea-level rise as well as due to increased floods. Therefore, an integrated coastal and flood protection is needed.

Shipping and technical measures: Shipping plays an important role in the coastal area and the river. To increase transportation, to allow larger ships to enter the harbour of Szczecin and to increase the importance of Szczecin as a gateway to Berlin and the cities in the river basin, the canal through the lagoon shall be deepened from 10.5 m to 14.5 m. In the Peene Strom, close to the lagoon, a deepening of the water way to 7.5 m will be carried out until 2006 to foster maritime tourism. According to the programme Odra 2006 the water level and flow in the middle and lower Odra shall be regulated to allow the passage of class 3 ships. Further, new polders and storage reservoirs and a new barrage near Brzeg Dolny are planned. The flood protection systems and dams of major cities in the upper river shall be modernised, as well. All these measures will alter the course and flow velocity of the Odra,

endanger ecologically valuable ecosystems and bayous and might enhance the risk of floods. An integrated concept for nature and flood protection, taking shipping and technical measures into account is required.

Eutrophication and water quality: Intensive agriculture, industries and cities cause loads of heavy metals and organic pollutants and especially high loads of the nutrients nitrogen and phosphorus. The river water quality suffers from these loads, but the major consequences are visible in the coastal area. The lagoon can be regarded as a hypertrophic, degraded ecosystem. It largely lacks a submerse vegetation, suffers from severe algae blooms (partly of toxic species) and the water transparency in summer is often below 50 cm. On sunny days without wind, anoxic situations temporary occur and cause fish kills as well as a damage of benthos. Untreated sewage water of the city of Szczecin is source of human pathogenic viruses and has potentially negative impacts on the hygienic (bathing) water quality. Due to regular dredging of the canal and denitrification processes, the lagoon still serves as a retention pond for nutrients and protects the Baltic Sea to a certain degree from pollution, but the poor water quality hampers bathing tourism and nature protection. Water quality will gain importance because most parts of the coastal zone became Natura 2000 sites and EU-Water Framework Directive (WFD) demands a good water quality. The WFD further asks for a river-basin coastal water management plan.

Species migration: Linked river-coast systems provide a convenient path for the spreading and migration of species. Intensive shipping caused the intrusion of many alien species in the Odra system, which partly already replaced the original fauna. So far over 20 makrozoobenthos species are spreading in the coastal waters and the river. Much more alien species are expected and are a serious threat for the ecosystems. Several fish species, like eel, salmon and trout migrate within the Odra water system or enter it to spawn. The degradation of the ecosystems in the river and the coast is a serious threat and altered the fauna already. The huge number of technical obstacles in the river hampers the fish migration seriously. The suggested large number of Natura 2000 sites in the Odra system calls for an integrated river-coast nature protection management.

4. Present regional cooperation

Coastal area management: In the coastal zone, several mutual agreements concerning cross-border cooperation between Germany and Poland exist. Results are e.g. the joint Euroregion Pomerania, the regional Agenda 21 “Szczecin Lagoon” and the joint Environmental Commission. They form the basis for cooperation and concrete projects. However, spatial planning and the development of Integrated Coastal Zone Management (ICZM) plans are carried out independently. In 1996 a first Polish ICZM plan was provided by the HELCOM PITF MLW Odra Lagoon Area Task Team. In 2004, a draft ICZM-Plan for the German side has been prepared. Both plans are not legally binding and were so far not integrated in spatial planning.

River basin management: Several agreements between Germany, Poland and Czech Republic ensure a close cooperation in the river basin. The International Commission on the Protection of the Odra against Pollution (ICPO) has the aim to protect rivers, lakes and the sea. In May 2002 ICPO received the mandate to coordinate the implementation of the EU Water Framework Directive within the international Odra river basin. Another ICPO task is the flood protection which is the major issue in the Polish “Program Odra 2006”. So far, a river basin management plan does not exist.

River basin - coastal area cooperation: A river basin – coastal area management plan has to be prepared for the WFD during the next years. However, this plan will only be focussed on water quality and spatially limited to the immediate coastal waters (1 nm off the shoreline). A systematic cooperation between river basin and coast does not exist at the Odra and a comprehensive and integrated coastal area - river basin management (ICARM) is lacking.

Löser & Sekścińska (2005) give more details about agreements, cooperation, organisations and responsibilities.

5. Constraints, needs, and lessons learned

Constraints for ICARM: The major issues in the Odra region clearly reflect the growing need for a coastal area - river basin cooperation and management, but it still receives only minor attention. The trans-national Odra region reflects the cultural, economic and social differences especially between Germany and Poland. Therefore, focus of recent efforts was to improve the cross-border cooperation between Germany and Poland and to foster a joint regional development. In general, the lack of a joint language reduces the efficiency of cross-border activities.

A survey among authorities and regional stakeholders as well as a media analysis has been carried out to get an impression of the public perception of river basin – coast problems and issues. Especially regional authorities are well aware of major problems and clearly see the links between catchment and coast, but without taking action. The public awareness of water related problems and the consequences of a lacking integrated management is only poor. Future threats, like climate change and sea level rise, and their potential consequences are not well perceived. Problems and issues in the neighbouring country are not sufficiently reflected in the media, as well. In the Odra case, an awareness and information deficit clearly exists.

The coast mainly suffers from activities in the river basin, but at the same time, the coastal area is small compared to the large catchment. Experiences concerning the implementation of the WFD in other river basins revealed that a small coastal community usually faces many representatives from the river basin. Therefore, the coastal community is not well able to attract attention for their issues and problems.

Needs: There is a general need to raise awareness about river related problems, to improve cross-border information and to promote the integrated management of the Odra river and coastal zone. Cross-border coastal dialogues are required (and were already initiated) to bring together the coastal community and to develop a joint identity. In a next step, coast-river dialogues, addressing a concrete topic like the EU-WFD, are important to support the river basin – coastal zone planning. The coastal perspective needs to be included in priority actions and the International Commission on the Protection of the Odra against Pollution (ICPO) should be supported in the development of implementation programmes.

Evaluation and lessons learnt: Large river systems like the Odra, with a large population, a high number of authorities and organisations as well as complex political and legal structures require high ranking political commitments, clear objectives and structures as well as an adequate body as a basis for cooperation and management. In this respect, the ICPO is a suitable body. However, their coastal perspective is not well developed. Recent EU-directives have accelerated the cross-border cooperation and, due to clear implementation time schedules, ask for concrete plans and actions until a given deadline. Especially the EU-Water Framework Directive is nowadays the major driver for cooperation in the river basin and, hopefully, will enhance basin-coast activities as well.

An organisation, like UNEP, adds an international dimension and allows to share experiences with river-coast case studies in other parts of the world. It can assist, support, and complement existing structures and bodies. The project IKZM-Oder (ZZOP-Odra), which is supported by UNEP, successfully contributed supporting activities in this respect:

- Contribution of background reports about major issues and uses (tourism, fisheries), legislation, planning, and competences in the region as well as an identification of stakeholders and the regional implementation of the WFD. A first German coastal management plan has been published. All reports serve as a basis for the dialogue meetings and management.
- The coastal regional Agenda 21, which is a political commitment and the basis for cross-border cooperation is supported. The size and population of the Odra system does not allow full public participation and stakeholder involvement in a river basin – coast dialogue, but the regional Agenda 21 does support coastal public participation and education.

- Organisation and documentation of a first cross-border stakeholder dialogue with 90 participants. The dialogues are accompanied by information and awareness rising activities. A strategy for the establishment of a river basin – coast dialogue is being developed.
- Provision of an internet-based regional information and GIS-planning system. The system contains different types of compiled and prepared information (maps, reports, pictures etc.) and gives stakeholders direct access to relevant ICARM information. A first evaluation of its utilization was very satisfying.
- Contribution of diagnostic analysis e.g. on the impact of future land use changes and climate change on pollution in the catchment and on the eutrophication of the coastal waters and the Baltic Sea. Recommendations towards an adaptive management will be given.
- Compilation and application of a set of indicators and criteria for evaluating the effectiveness of sustainable development of the Odra river and coastal area.

References

The following literature is only a small selection. A more comprehensive overview is given by Löser & Sekścińska (2005) or can be found under ://www.ikzm-oder.de/ and http://www.eucc-d.de/ikzmdokumente.php.

Behrendt, H. & R. Dannowski (eds) (2005): Nutrients and heavy metals in the Odra river system. Weißensee Verlag, Berlin 345p.

Chojnacki, J.C. (1999): Description of Ecosystem of the Lower Odra and the Odra Estuary. In: Acta hydrochim. Hydrobiol. 27, 5, S. 257-267.

Dolch, T. & G. Schernewski (2002): Eutrophication by the Odra River: Implications for tourism and sustainable development of the coastal zone. Proceedings of the International Conference 'Sustainable Management of Transboundary Waters in Europe', UNECE, 21 – 24 April 2002, Miedzyzdroje, Poland, ISBN: 9036954800, 301-304 (://www.ikzm-oder.de/dokumente.php?dokid=61).

Feilbach, M. (2004): Entwurf eines Integrierten Küstenzonenmanagementplans für die Odermündung, Neufassung des deutschen Teilbeitrags, Diplomarbeit am Institut für Geographie, Universität Greifswald, IKZM-Oder Berichte 2, (http://www.ikzm-oder.de/ergebnisse_ikzm-oder_berichte.php).

Gren, I.-M., Turner, K. & Wulff, F. (eds) (2000). Managing a sea. Earthscan Publ., London, pp. 43-56.

Gruszka, P. (1999): The River Odra Estuary as a Gateway for Alien Spiecies Immigration to the Baltic Sea Basin, Acta hydrochim. Hydrobiol. 27, 5, 374-382.

HELCOM PITF MLW Odra Lagoon Area Task Team (2000): Guidelines for Integrated Coastal Zone Management of the Szczecinski Lagoon (the Polish side). Unpublished.

Humborg, L., Schernewski, G. , Bodungen, B. v., Dannowski. R., Steidl, J., Quast, J., Wallbaum, V., Rudolph, K.-U., Mahlburg, S., Müller, C. & W. Erbguth (2000): Meereswissenschaftliche Berichte Nr. 41 (://www.uni-rostock.de/andere/wvu/Texte/OBBSI.pdf).

Jakóbik, A. & W. Mateuszuk (1997): Fischerei in den polnischen Gewässern des Stettiner Haffs. In: Ergebnisse des deutsch-polnischen Seminars zur fischereilichen Bewirtschaftung des Stettiner Haffs und der Pommerschen Bucht, Fisch und Umwelt Mecklenburg-Vorpommern e.V., Rostock, S. 42-46 (http://www.fischumwelt.de/html/jakobik.html)

Janssen, G., Czarnecka-Zawada, S., Konieczny, B. & V. Vodova (2004): Bestandsaufnahme der IKZM-relevanten Rechts- und Verwaltungsstrukturen der Bundesrepublik Deutschland und der Republik Polen unter Berücksichtigung des Internationalen Rechts und des Gemeinschaftsrechts, Leibniz-Institut für ökologische Raumentwicklung e.V., Dresden, IKZM-Oder Berichte 5, (http://www.ikzm-oder.de/ergebnisse_ikzm-oder_berichte.php).

Lampe (Hrsg.) (1998): Greifswalder Bodden und Oder-Ästuar-Austauschprozesse (GOAP), Synthesebericht des Verbundprojektes, Greifsw. Geogr. Arb. 16.

Leipe, T., Eidam, J., Lampe, R., Meyer, H., Neumann, T., Osadzuk, A., Janke, W., Puff, T., Blanz, T., Gingele, F.X., Dannenberger, D. & G. Witt (1998): Das Oderhaff, Beiträge zur Rekonstruktion der holozänen geologischen Entwicklung und anthropogenen Beeinflussung des Oder-Ästuars. Meereswissenschaftliche Berichte 28, Warnemünde, 61 S.

Löser, N. & A. Sekścińska (2005): Integriertes Küste-Flusseinzugsgebiets-Management an der Oder/Odra: Hintergrundbericht [Integrated Coastal Area – River Basin Management at the Oder/Odra: Background report; German with extended Polish and English abstract]. IKZM-Oder Berichte 14, (http://www.ikzm-oder.de/ergebnisse_ikzm-oder_berichte.php).

Michaelsen, L. (2005): Fischerei und Meeresnaturschutz im Bereich der Odermündung, Diplomarbeit an der Technischen Universität Berlin, IKZM-Oder Berichte 10 (2005), 130 S (http://www.ikzm-oder.de/ergebnisse_ikzm-oder_berichte.php).

Mohrholz, V. & H. U. Lass (1998): Transport between Oderhaff and Pomeranian Bight – A simple Barotropic Box Model. In: German Journal of Hydrography, S. 371-381.

Mutko, T., J. Stechman, M. Landsberg-Uczciwek, A. Garbacik-Wesołowska, M. Protasowicki, E. Niedźwiecki, W. Ciereszko & E. Meller (1994): Zalew Szczeciński, Wielki Zalew, Zmiany jakościowe w wieloleciu (The Szczecin Lagoon – Wielki Zalew – Long-term qualitative changes), Bibl. Monit. Srod. Warszawa, S. 83 ff.

Neumann, T. & G. Schernewski: (2005): An ecological model evaluation of two nutrient abatement strategies for the Baltic Sea. Journal of Marine Systems, Vol 56, No 1-2, 195-206.

Radziejewska & Schernewski (in press): The Szczecin (Oder-) Lagoon

Schernewski, G., W.-D. Jülich (2001): Risk assessment of virus infections in the Oder estuary (southern Baltic) on the basis of spatial transport and virus decay simulations. International Journal of Hygiene and Environmental Health 203, 317-325, (http://www.ikzm-oder.de/dokumente.php?dokid=61)

Schernewski, G., T. Neumann, V. Podsetchine & H. Siegel (2001): Spatial impact of the river Oder plume on water quality and seaside summer tourism at the south-western Baltic coast. International Journal of Hygiene and Environmental Health 204, 143-155.

Schernewski, G. & T. Neumann (2002): Impact of river basin management on the Baltic Sea: Ecological and economical implications of different nutrient load reduction strategies. Proceedings of the International Conference 'Sustainable Management of Transboundary Waters in Europe', UNECE, 21 – 24 April 2002, Miedzyzdroje, Poland, 43-51, (http://www.ikzm-oder.de/dokumente.php?dokid=61).

Schernewski, G. & U. Schiewer (eds.) (2002): Baltic Coastal Ecosystems, Springer Verlag, Berlin.

Schernewski, G. & T. Dolch (eds.) (2004): The Oder Estuary - against the background of the European Water Framework Directive. Mar. Sci. Rep. 57. 288 p, (http://www.eucc-d.de/ikzmdokument.php?infoid=174).

Schernewski, G. and N. Löser (eds) (2004): Managing the Baltic Sea, Coastline Reports 2, ISSN 0928-2734, 280 p, (http://www.eucc-d.de/coastline_reports.php).

Schernewski , G. & T. Neumann (2005): The trophic state of the Baltic Sea a century ago: A simulation study. Journal of Marine Systems, Vol 53, 109-124.

Steingrube, W., Scheibe, R. & M. Feilbach (2004): Ergebnisse der Bestandsaufnahme der touristischen Infrastruktur im Untersuchungsgebiet, Institut für Geographie und Geologie Universität Greifswald, IKZM-Oder Berichte 4, (http://www.ikzm-oder.de/ergebnisse_ikzm-oder_berichte.php).

Wielgat, M. & G. Schernewski (2002): Impact of the Odra River nutrient load reductions on the trophic state of the Szczecin Lagoon: A modelling approach. Proceedings of the International Conference 'Sustainable Management of Transboundary Waters in Europe', UNECE, 21 – 24 April 2002, Miedzyzdroje, Poland, ISBN: 9036954800, 347-350.

Winkler, H. (1991): Changes of structure and stock in exploited fish communities in estuaries of the Southern Baltic Coast (Mecklenburg-Vorpommern, Germany). In: Int. Rev.ges. Hydrobiol. 76 (3), S. 413-422.

Wysokiński, A. (1998): Fishery management in the Szczecin Lagoon. In: Bulletin of the Sea Fisheries Institute 3 (145), S. 65-79.

Contact address:

PD Dr. habil. Gerald Schernewski
Institut für Ostseeforschung (IOW)
Seestraße 15, D – 18119 Rostock-Warnemünde
EUCC – Die Küsten Union Deutschland e.V.
Poststraße 6, D – 18119 Rostock-Warnemünde