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# The Benefits of Inter-linking Coastal and River Management

## Twenty case studies world-wide indicate opportunities and constraints

**Editors:**
**A. Pickaver and D. Sadacharan**

EUCC

*The Coastal Union*

*Die Küsten Union Deutschland*

# *Coastline Reports*

## 10 (2007)

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**Alan Pickaver and Dianeetha Sadacharan**

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# 1 Introduction

Since the UNCED conference in Rio de Janeiro, the link between river basins and coastal areas has been increasingly highlighted in several fora. Two key management approaches have been promoted in the post UNCED years to ensure sustainable development within the river-coast continuum - IWRM (integrated water resources management) and ICM (integrated coastal management). Unfortunately, the concepts of IWRM and ICM have mostly been developed independently from each other by separate management bodies and organisations, frequently with very different objectives and modes of operation. Professionals in either field focussed on addressing urgent management issues and maximising socio-economic benefits in their own management area with little or no consideration to the adjacent areas. Estuaries and coastal areas were not considered as a part of the river basin.

The IWRM paradigm encouraged a shift from single sector water planning to multi-objective planning and integrated planning of land and water resources, recognising the wider socio-economic and development goals and entailing cross-sectoral coordination. Coastal management programmes have focussed their attention on managing coastal erosion and ensuring safety to communities and development, regulating and balancing coastal development activities, maintenance and restoration of coastal ecosystems etc. Until recently, ICM programmes did not recognise that the socio-economic development potential of the coastal areas are being somewhat threatened by certain economic activities in upstream areas.

In the coming millennium, demands on water resources will increase, as will the levels of pollutants. In order to achieve sustainable utilization of freshwater resources without compromising the economic viability of the coastal areas, new approaches to water and river basin management are required.

The last ten years have seen the advancement of the concept that the problems dominating the coastal regime or the river basin cannot be solved by ICM programmes and river basin management (RBM) programmes or IWRM working in isolation. UNEP's Global Programme of Action have for some years promoted the view that these two disciplines must work together and the management of the river basins must be linked to the management of the coastal and marine areas. Effective integration of IWRM and ICM will help to minimize the widespread depletion of coastal ecosystems and reduce the frequent mismatch between development objectives in river basins and development objectives in coastal zones. Linked management is the only realistic way to maintain or improve the socio-economic viability of the coastal and marine areas.

In 2000, UNEP published Integrated Coastal Area and river basin Management (ICARM) Conceptual Framework and Planning Guidelines. At the WSSD, 2002, the UNEP/GPA and its partner organisations launched the Hilltops-to-Oceans (H2O) partnership and the FreshCo partnership on linking the management approaches of ICM and IWRM. The FreshCo partnership led to the establishment of an ICARM Expert Working Group. Having supported several regional workshops on ICARM, UNEP-GPA together with the UNEP Collaborating Centre on Water and Environment, have put together a considerable knowledge base on the topic through pilot projects and guidelines. During 2003-2004 an ICARM Issue paper and 12 ICARM Guiding Principles were developed.

ICARM largely aims at a sectoral integration at all levels of governance as a basis for a multi-disciplinary management of the larger catchment area, including the coast. However, it was recognized from the outset that not all rivers would require an integrated management approach with the scale of the management issue and the impact of the management actions largely determining whether or not ICARM should be applied. With some rivers, the management issues may be straightforward with the problems of the river not affecting the coastal zone so that an integrated approach would not be required. However, in those cases where there are many problems which affect the coast, ICARM will be necessary especially in trans-national issues. It must be stressed that ICARM should not be regarded as any sort of new management regime but is merely the inter-linking of the management

approaches of coast and rivers. ICARM simply attempts to promote the linkage between ICM and IWRM.

With this in mind, the ICARM Expert Group of UNEP felt that the key constraints in IWRM and ICM to implementation of linked management need to be further identified. It was on this basis that UNEP GPA took the decision to look in detail at a number of specific river systems to permit the identification of major issues a linked management programme need to deal with, the socio-economic implications of these issues, and to highlight the benefits of linked management and demonstrate why the resolution of those issues are important. Thus an important aspect that the river basin studies examined were any significant success factors that could be applied in other basins as well as the challenges and constraints that a programme would encounter in adopting linked management. This document has, therefore, also made an attempt to highlight the most important issues that need to be addressed on a priority basis.

The river basins considered in this report cover all major geographical continents (table 1).

| Region | Case Study location |
|---|---|
| Africa | Incomati river - S. Africa, Swaziland and Mozambique<br>Rufiji river - Tanzania<br>Senegal river - Guinea, Mali, Mauritania and Senegal<br>Tana river - Kenya |
| Asia Pacific | Attanagalu Oya - Sri Lanka<br>Bang Pakong river - Thailand<br>Chilika lagoon - India<br>Krishna river - India<br>Moreton bay - Australia<br>Red river - China and Vietnam<br>Songkhla Lake - Thailand<br>Jiulongjiang river basin - China |
| America -North | Chesapeake bay - U.S.A<br>Colorado river - U.S.A, Mexico |
| America - Central and South | Samana bay - Dominican Republic |
| Europe | Danube river - Austria, Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Poland, Romania, Serbia, Montenegro, Slovak Republic, Slovenia, Switzerland and Ukraine<br>Odense fjord - Denmark<br>Oder river - Poland, Czech Republic and Germany<br>Rhine river - Switzerland, Liechtenstein, Austria, Germany, France and the Netherlands |
| Middle East | Tigris Euphrates river - Turkey, Syria and Iraq |

Table 1: Overview of the river basin studies

The intended target group for this document is mainly policy makers and managers responsible for decision making as well as ICM and IWRM/RBM professionals who need to understand the need for linked management and what it entails. It is also a compendium of up-to-date information on practical experiences upon which training activities can be based.

## 2 ICARM – an interlinked water management approach

In the river, catchment area and coast continuum, three different categories of issues or impacts can be identified based on the origin and geographic scope of the problem. Solely river basin issues are caused by river basin/catchment activities that, most of the time, can be addressed through catchment specific IWRM or RBM measures e.g. degradation of freshwater wetlands by high levels of nitrogen and phosphorus resulting from upstream agriculture practices or reduced water storage capacity of

dams due to increased sediment loads resulting from poor soil conservation practices in upstream areas. Solely coastal and marine issues are caused by activities in the coastal realm which need to be addressed within local ICM programmes e.g. declining mangrove areas due to coastal shrimp ponds and cutting of mangroves for firewood; construction or degradation of estuarine water quality due to human settlement and industrial development along the estuary. Linked river and coastal issues include coastal and marine issues arising from river basin/catchment activities and river basin issues arising from coastal zone activities. These latter problems can only be mitigated through measures and programmes that link the management of the catchment to the management of the coast and harmonised resource management approaches e.g. declining coastal fishery potential of economically important species due the destruction of nursery and spawning grounds in the river basin, changes in salinity regimes and sediment profiles in estuaries and lagoons due to reduced river flows as a result of dams or water diversion schemes. It is this category viz. linked issues that should receive attention in a linked management programme and hence, linked issues are the focus in this section of the report.

Implications of upstream land use practices and water resources development projects on coastal water resources and communities living in the coastal margin have been known for a very long time. By changing water quality, river discharges and the sediment regime, economic activities and development in the river basin and catchment can drastically affect the water regime, geomorphology and the ecological functions of the delta, estuary and coastal areas. Several of the studies have shown that even if the average annual discharge is not drastically changed, by dams or irrigation schemes, reduction in flood peaks and flow regulation will affect sediment transport which often results in erosion of downstream river sections and coastal areas. The discharges of the Tana, Krishna, Bang Pakong and Red rivers are considerably reduced due to river regulation works thus significantly impacting on the floodplain agriculture. Freshwater wetlands, by virtue of their role in water purification, flood control and provision of habitat for certain estuarine fish species play a critical role in the maintenance of downstream ecosystems. The degradation of these wetlands and their biodiversity imposes major economic and social losses and costs to human populations within the entire basin inclusive of the estuarine and coastal area. An immediate consequence of the vast water resources development works in the Tigris-Euphrates system has been the substantial reduction of water available for downstream ecosystems and the suppression of the spring floodwaters that nourished the lower basin and the Mesopotamian marshes and which washed out accumulated salts.

In the case of trans-boundary rivers that flow through arid or semi-arid areas, water shortages caused by storage or diversion for power generation and irrigation can put the viability of coastal economic activities at risk. The situation of the Colorado amply demonstrates the complexity of managing water resources across borders in arid regions in a sustainable manner. Although the delta needs to be supplied with more water, competing demands for water between traditional communities and urban users; between upper basin states and the more arid and populated lower basin states within the United states; and between two countries with very different economies and development intensities pose significant obstacles to the restoration of the delta. In temperate and tropical areas where water quantity is not usually an issue, pollution becomes the major issue. This is clearly seen in the basins of the Oder, Danube and Rhine where mitigating the impacts of agriculture inputs still remains an important issue.

Having a good idea of the causes, scope and severity of these linked issues on a site specific basis is important for the identification of effective management measures whether they be institutional measures, legislative measures or capacity building measures.

## 3 Five successful factors

Although establishing an operational link between the management of the river basins and the coastal areas has been slow, the first five studies provide operational examples of good practice – approaches that have led to pragmatic outcomes.

### 3.1 Strong institutional leadership

Several of the studies have indicated that no single institution was taking the lead role in promoting a linked management approach at the river basin level. Indeed, clear leadership on sustainable development of water resources in a manner that takes into account the needs of the downstream communities is crucial. In the case of the Chilika lagoon (see Case Study 1), the Chilika Development Authority (CDA) assumed the leadership role and the structure of the CDA facilitated the role. The CDA was chaired by the Chief Minister of the State of Orissa and this provided the necessary political leadership for the CDA, for example, to require environmental flow assessments to be carried out for water resource development activities upstream. Although the CDA lacked regulatory authority over land use in the catchment areas, it attempted to bridge these gaps through strategic partnerships with other organisations and institutions

***Case Study 1. Clear institutional management of Chilika lagoon, India***

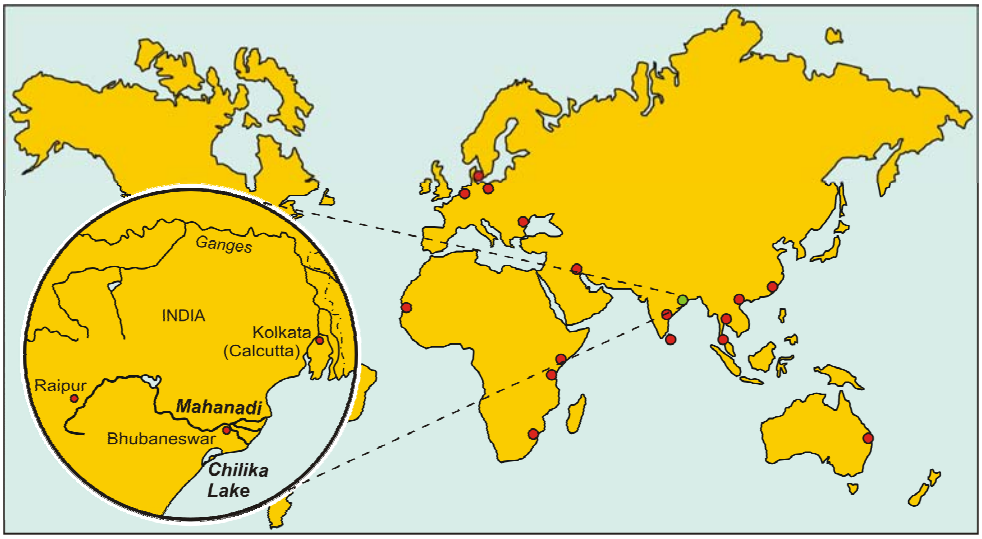


Figure 1: Location of case study 1: Clear institutional management of Chilika lagoon, India

*In 1991, the Chilika Development Authority (CDA) was established by the regional government of Orissa. The CDA was mandated to restore the lagoon ecosystem and promote wise use of the natural resources through integrated management and community participation. The measures taken by the CDA led to a wide variety of improvements in the lagoon and also immensely benefited the community dependant on the lagoon as well as those engaged in farming in the peripheral areas.*

Chilika Lagoon, situated on the east coast of India, is one of the largest coastal lagoons in Asia. It extends over 60 km in length and its width ranges from 5 - 18 km. The lagoon is connected to the sea by a 32 km long channel. The average depth of the lagoon is about 50 cm in the larger northern sector while the maximum depth in the central sector is 3.7 m and it is brackish over most of its area. It is one of the biodiversity hotspots in South Asia containing marine, brackish water and freshwater ecosystems and providing habitat to a number of endangered species listed in the IUCN Red List of threatened species. It is also a designated Ramsar Site. Since the lagoon provides a unique habitat for a

wide variety of resident and migratory birds, a bird sanctuary has been established in one part of the lagoon.

Two river basin systems constitute the relatively large catchment of the Chilika Lagoon. The first is the Mahanadi river, and its tributaries, which plays a critical role in governing the freshwater flows into the lagoon. The second drainage system includes 52 rivers and rivulets originating in the Eastern Ghat mountain range. These rivers drain a total area of area of 1,260 km². The coastal area consists mainly of sandy accreting beaches.

River basin activities that have had significant impacts on the Chilika lagoon are human settlements, expansion of agriculture and hydraulic measures for irrigation management - there are four barrages in the Mahanadi system. The lagoon itself suffers from extremely high sediment loads and the run off from agriculture exacerbates the situation because of the lack of adequate soil management measures. In addition, large amounts of untreated wastewater find its way to the lagoon.

The cumulative impacts of these changes have led to critical changes:

- gradual shifting of the lagoon mouth away from the lagoon proper as a result of both the inlet and outlet channels being blocked,
- progressive decrease in the effective water area of the lagoon and a marked reduction in the depth,
- significant decrease in the salinity within the whole lagoon with impacts on biodiversity,
- reduced fish productivity indicated by decreased fish catches,
- rapid growth of invasive weed species in the northern sector,
- destruction of breeding and spawning grounds of many important fishes, molluscs and prawns, and
- waterlogging of surrounding farmland which has in turn impacted the human settlements and agricultural production in the peripheral areas.

The overall decline in productivity of the lagoon and the drainage basin has had serious socio-economic impacts within the local community. Recognising the need to halt further degradation of the lagoon and restore its socio-economic potential, the government of India took several steps to achieve integrated management of the Chilika lagoon as well as to improve watershed management.

The CDA concluded that the tidal influx into the lagoon was considerably reduced because of the shoal formation along the lead channel and continuous shifting of the mouth resulted in significant hydraulic head loss. It was further concluded that the only means of restoring salinity and tidal fluxes was to move the lagoon mouth closer to the lagoon. Therefore, an artificial mouth was opened in September 2000, which reduced the outflow channel by 18 km and the lead channel was de-silted before opening the new mouth.

The CDA also set up a community-based programme for treatment of the catchment on a micro-watershed basis including an education programme for the watershed communities and empowering them in local level resource management regarding the ecological services provided by the lagoon system.

There have been major improvements including:

a. Societal:

- Higher fish catches: The fish landings, which had declined to 1,600 mt (metric tons) before intervention rose to 12,000 mt in 2001-02 and crab landings increased from 3 mt in 1994-95 to 150 mt in 2002-03.
- Enhanced incomes and employment opportunities: It is estimated that the average annual income increased by more than 50,000 Indian Rupees per year (ca. $ 1,040) per family. At the same time, increased productivity of the farmland and creation of employment opportunities for the landless labourers has significantly decreased emigration (by 80 %).

- Capacity building and awareness raising of local communities and local NGOs: Local communities were made aware of the economic benefits from the ecological goods and services provided by the lagoon system, and which significantly contribute to their livelihood through extensive outreach programmes. A training programme aimed at teaching the community to manage and reverse degradation in the river basin was set up and a visitor centre has been built to enhance community awareness.
- Stakeholder participation: A Watershed Association has been established and a participatory approach has been used to facilitate a community-based co-management strategy for integrated terrestrial and aquatic resource management including treatment of the catchment on a micro-watershed basis. The watershed community shares part of the cost of catchment treatment thus creating an enabling environment for the local community to take decisions and understand the problem in an effective manner. This has been a key feature of the management approach.
- Improved communication and conflict resolution: A network of NGOs and Community-based organisations has been set up. Improved communication and a holistic approach has enabled resolution of long-standing conflicts and differences of opinion in the communities.
- Integrating women into mainstream: The micro-watershed management approach has taken the lead in empowering women from all communities by adopting income-generating activities to supplement the family income.
- Community self-initiated good practices: Recognising that the local communities have considerable relevant knowledge of the ecosystems, local knowledge has been used throughout. This has facilitated self-initiated good practices by the community as they are the immediate beneficiaries of successful management.

b. Environmental:

- Improvement of the salinity gradient: Considerable increases in the salinity levels especially in the northern sector have now been recorded.
- Improved species composition: After the opening of the new mouth, several marine species re-appeared after 2 decades absence. At the same time, invasive species decreased and the weed free area increased.
- Improvement of the water level variation and increased depths: This has led to a reduction in drought conditions in the wetland area and to significant flushing of sediment through the channel.
- Reduction of the water-logging problems and enhanced agricultural output: There was an immediate improvement of the rice harvest and crop failure was eliminated. Farmers were also able to introduce a 2nd cash crop. Even in the monsoon season the peripheral lands were not flooded.

## 3.2 Strategic partnerships and full stakeholder involvement

Ultimately it is the public's attitude that determines society's response to management decisions. Efforts to protect and develop an area in a sustainable way can only succeed if all those who work and live in an area are committed to this objective. When stakeholders, including the public, do not "buy into" the decisions taken by being actively engaged in the decision-making process, the public can often substantially delay, or even prevent, linked management initiatives. Creating public awareness and fostering public participation – and this does not mean solely consultation – may mean that more time is required for decisions to be taken, but experience shows that such an approach is ultimately more cost-effective. The absence of public awareness and the loss of confidence in management decisions and the regulatory process can be extremely damaging. Spatial development planning without the support of the local community may be a doomed exercise. Conversely, carrying the public into the decision-making process can be enormously rewarding.

Strategic partnerships are an effective way for a programme to address broad issues that it cannot address on its own. Partnerships also provide the means to have ongoing engagement with community and NGO organisations to identify and address issues of community interest. In the case of Samana bay (see Case Study 2), the local associations (the Junta de Regantes) of farmers, served by a common irrigation outlet, manage the irrigation water.

In another example, the cornerstone for the implementation of the South East Queensland Regional Water Quality Management Strategy for Moreton bay (see Case Study 3) was the Waterways and Catchment Partnership. This partnership enabled collaboration among government, industry, community and local political leadership and provided a coordinated process for the development of management actions to deal with water quality impacts from activities and point and non-point pollution sources in the region. In the programme for the restoration of the Chilika lagoon (see Case Study 1), a Watershed Association was established and a participatory approach has been used to facilitate a community-based co-management strategy for integrated terrestrial and aquatic resource management including treatment of the catchment on a micro-watershed basis.

In both Moreton bay and Chilika lagoon, the participation of local communities and other stakeholders in planning and implementing the management of the natural resources was actively promoted and supported. In Moreton bay, the South East Queensland Regional Water Quality Management Strategy, was developed directly by stakeholders thus facilitating implementation. Contributions from the general public and special interest stakeholders were encouraged in discussions and workshops. In the Chilika lagoon, the CDA actively promoted community-based small scale watershed management programmes and conducted education programmes on ecological services provided by the lagoon among the watershed community. Partnerships and stakeholder involvement has enabled these programmes to understand what the society's expectations are and helped to improve performance.

## *Case Study 2. Stakeholder involvement in the future scenarios for the Samana bay, Dominican Republic*


Figure 2: Location of case study 2: Stakeholder involvement in the future scenarios for the Samana bay, Dominican Republic

*The local associations (the Junta de Regantes) of farmers, served by a common irrigation outlet, manage the irrigation water. Partnerships and stakeholder involvement has enabled these programmes to understand what the society's expectations are and helped to improve performance.*

Samana bay is the most important estuary in the Dominican Republic and it is the largest semi-enclosed bay in the Caribbean. The Yuna and Baracote rivers flowing into the head of the bay creating

a salinity gradient that supports a mosaic of habitats between the bay's head and mouth. The watershed of the Yuna river provides 20 % of the runoff for the country and contains six dams with a seventh under construction. Two of the dams are multipurpose dams and hydropower stations; the reservoirs also supply water for municipal, industrial and agricultural needs and help to prevent cyclic flooding of the lower reaches of the river.

"Thalassia" or sea turtle grass is abundant on the south shore and coral reefs are present around the bay's mouth. The largest single mangrove stand in the country and Antilles region is at the mouth of the Yuna river. The mouth of the bay is the most important gathering place for humpback whales in the North Atlantic. Endangered species such as the green, hawksbill and leatherback sea turtles as well as the West Indian manatee are also found in Samana bay.

Rice production is a major land use in the watershed and represents 88 % of total water demand in the country. The growth of irrigation over the past 20 years has reduced normal dry season water flows in the Yuna watershed by up to as much as 50 %. This has affected downstream freshwater habitats, the estuary and its role as a nursery for shrimp and several species of finfish. The estuarine fishery declined significantly from 1986 to 1997.

There are two major sources of toxic contaminants in the estuary: agro-chemicals, primarily from the rice farms, and wastewaters from mining operations. They have been detected in oysters and molluscs that grow in the Yuna delta. The mining of sand and gravel from the Yuna river is common even though it is prohibited.

There have been many conservation projects focused on the Samana bay region, the majority of which have been led by the Centre for the Conservation and Eco-Development of Samana bay and its Surroundings (CEBSE) - a non-profit organization created in 1991. The governance strategy that has been promoted by CEBSE is to involve community organizations and resource users in the planning and management of natural resource use in coordination with government institutions and the private sector. Given the threats to freshwater inflows and the pressures listed above, the major stakeholder groups are the users dependent on renewable ecosystem goods and services e.g. fishermen and their families, subsistence farmers in the upper watershed, rice farmers, and local environmental groups as well as national and international institutions (such as international conservationists and the mining industry and associated governmental agencies).

*Co-management strategies for fisheries and tourism have been the primary areas of focus. Some of the key governance outcomes to date for Samana bay include an integrated management plan for the Samana region, tourism and fisheries development strategies, a proposal for designation of Samana bay and its surroundings as a biosphere reserve and implementation of a co-management plan for whale watching. Within the national government a comprehensive water law was recently approved and is bringing about the restructuring of agencies of government with responsibilities over freshwater allocation and use.*

## 3.3 Integration with regional planning

Integrating river basin and coastal planning within the wider regional planning process ensures that issues of concern are addressed within the relevant areas of regional policy development and that any new development is undertaken in a manner that reduces impact on the ecosystems.

In Australia, integration with regional planning was seen as a vital component of the management regime for Moreton bay. Coastal pressures led to the recognition that a system, able to manage the catchment areas, waterways and the coastal and marine areas in a coordinated manner was an immediate imperative. Therefore, government, industry and community stakeholders worked in close cooperation to develop a Regional Water Quality Management Strategy- a combination of continuing local initiatives and new management actions determined by stakeholders and based on good scientific information. During the early stages of the Strategy development, a common and coherent vision until

2020 was agreed upon by all stakeholders. In June 2001, the Moreton bay Waterways and Catchment (Healthy Waterways) Partnership was formalized to facilitate the implementation of the strategy. This approach ensured consistency with the regional plans and legislation and the implementation of the South East Queensland Regional Water Quality Management Strategy. In this way, the Strategy incorporated a variety of mechanisms already in force at a regional level and it also provided information to a variety of local and sub-regional plans and projects (see Case Study 3).

## *Case Study 3. Regional planning provides a framework for sustaining the economic and environmental benefits of Moreton bay and its catchments, Australia*

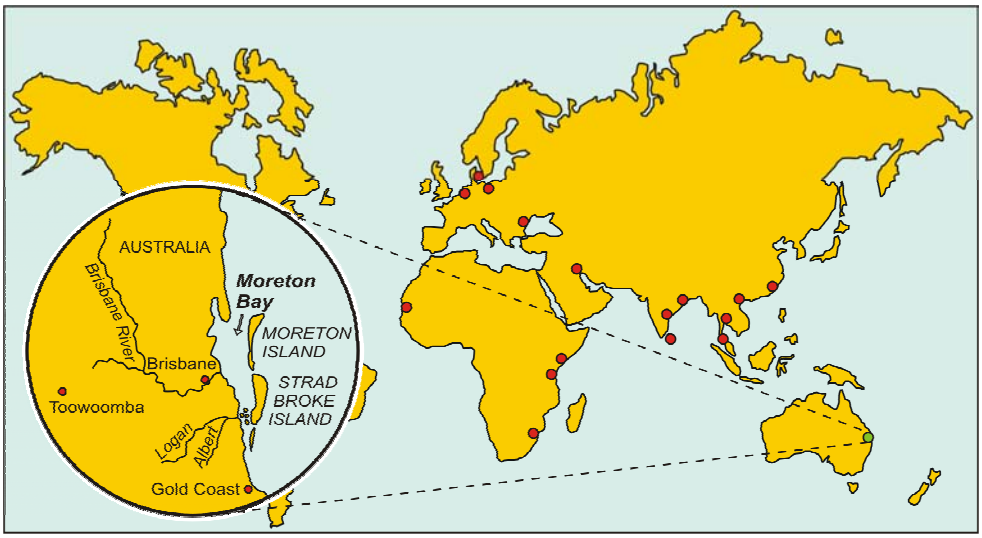


Figure 3: Location of case study 3: Regional planning provides a framework for sustaining the economic and environmental benefits of Moreton bay and its catchments, Australia

*An innovative regional planning approach to the management of the waterways and catchments of Moreton bay addresses the key environmental issues facing the South East of Queensland. It is based on the findings that restoring the ecological balance of both land and water are crucial to sustain the waterways and derive the benefits that accrue from healthy waterways. Healthy Waterways is the inclusive identity that was developed to represent all the work that is required across the catchment. It was developed as a co-operative identity and is used by all stakeholders to give clear, single focus to all the actions being taken. This together with the common vision that was developed was used to rally focus and attention of the stakeholders.*

Moreton bay is a semi-enclosed basin with two of the largest sand islands in the world on its east side. The bay forms a large coastal wetland which is important as a refuge for flora and fauna. There are several catchments that feed directly into Moreton bay, the largest of which is the Brisbane river. Within, and around, Moreton bay are found a diverse range of ecosystems, including forests, mangroves, mudflats, sea-grass beds, bay islands, sand islands, coral and oceanic waters. These varied ecosystems support significant biological diversity viz. over 270 species of birds, 60,000 migratory birds during the summer months, 120 recorded coral species, 740 species of fish all six species of sea turtles found in Australian waters and home for the only dugong population known to occur close to a major capital city.

Along the mainland shore, the bay is bordered by extensive estuarine flats and behind the salt marshes, there are freshwater marshes and lakes along river deltas. A series of low, small islands form the deltaic complexes of the Logan, Albert, Coomera and Pimpama rivers. Between the islands there are mudflats and channels.

The bay is also important for fisheries and tourism, Queensland's second largest industry. Therefore, sound economic management require that Moreton bay's natural assets and the resources base that supports these two sectors are protected. The variety of uses of the bay and the waterways are, in turn, influenced by activities on land surrounding the catchment areas. The agricultural districts of the region contribute significantly to the local and regional economy. These districts rely heavily on good quality water supplies and the protection of the productive soils to maintain economically viable yields. Queensland's rapidly growing human population in the recent past have placed many of the above values under threat and has resulted in significant land clearing in south-east Queensland.

Although some positive measures for water quality management existed in State and local government regulations as well as city and shire development plans and were backed by community action and political commitment, these measures tended to be uncoordinated. A major coordinated programme of Moreton bay showed that the drivers for a new approach for improved water quality in south-east Queensland were:

- Increased flows, erosion and delivery of both nutrients and sediments from the South East Queensland catchments and waterways, due to land use changes and vegetation clearing,
- Sewage treatment plants, which deliver 90 % of nitrogen to waterways during dry weather and storm water, which delivers 50 % of nutrients during wet weather,
- Declining water quality, due to increased levels of nutrients (particularly nitrogen), fine sediment and, to a lesser extent, toxic substances (pesticides and heavy metals),
- Declining ecosystem health in fresh and tidal waterways especially Moreton bay, as demonstrated by decline in dugong numbers and seagrass, increased algal blooms and threats to fisheries,
- Lack of secure water supply (quality and quantity) for agriculture production, industry and urban growth,
- Potential and actual loss of opportunities for tourism, fishing and agriculture,
- Increasing community expectations about improved quality of waterways and access.

The Moreton bay Partnership and Strategy has resulted in several "on-the-ground" management actions which were developed directly by stakeholders. Performance standards for the implementation of these actions was obtained by consensus through a peer process ("peer pressure"/"peer support") rather than through traditional "command-type" regulatory approaches. The main management actions include an increase in local wastewater re-use, a reduction in total nitrogen concentrations and achievement of sustainable loads, storm water management through a coordinated and integrated programme across State and local governments, catchment management through catchment management plans to be finalised by 2007, management of navigation and dredging and implementing an environmental management system for port activities, managing water quality impacts of shipping, and maintaining cultural heritage by developing specific environmental goals and objectives.

The important achievements of the Partnership and Strategy to date include improved understanding of ecosystem processes and effects of pollutants, an integrated marine estuarine and freshwater monitoring programme, definition of environmental values, goals and water quality objectives for marine and estuarine waterways, determination of sustainable point source nitrogen loads for different waterways, a framework for sewage management for the next 20 years, and determination of sustainable storm water discharges and management within the catchment.

The successful development of the Strategy is attributed to the strong local political leadership and advocacy. A number of local government leaders provided effective support to the Strategy and more importantly these leaders accepted key roles within the Partnership to oversee the delivery of the Strategy.

Furthermore, stakeholder involvement and collaboration resulted in over sixty organizations undertaking management actions in the Strategy. An Implementation Group of a range of stakeholders was established to regularly assess the status of the management actions committed to within the Strategy and report progress to the Regional Coordinating Committee of the Queensland government. This arrangement effectively provided an on-going audit of stakeholder commitments, a step often overlooked in the resource management planning process.

*Much time and effort was spent on collecting and disseminating information e.g. on technical feasibility and the social, cultural and economic aspects of environmental choices as well as the effectiveness of communication methods used and the communication skills of the scientific personnel involved. This greatly increased confidence within the community and the decision makers in the information presented and the management actions developed.*

## 3.4 Binding agreements

Regional directives and agreements can be an effective means of desired actions being taken at the national level. This has been shown to be the case in some of the trans-boundary river basins in Europe. For example, the 1963 Bern Convention on the Protection of the Rhine became the initial legal instrument for co-operation and trans-boundary water management in the Rhine river basin. With the main objective of achieving and maintaining sustainable development and use of water resources including groundwater, together with the conservation and restoration of ecosystems in the river basin, the Convention, together with the Rhine Action Programme provides the platform for cooperation on fundamental water management issues. The equivalent organisation in the Oder river (see Case Study 20) is the International Commission on the Protection of the Oder against Pollution and in the Danube (see Case Study 5) it is the International Commission for the Protection of the Danube river.

Within the EU, legally binding directives that demand clear implementation targets have also led to accelerated cross border cooperation as well as accelerated action at national levels towards improving water quality. The Water Framework Directive (WFD), to which the member states are committed, is a good example. The most important element of the WFD is that it requires the preparation of river basin- and coastal area management plans which can contribute significantly to linking RBM and ICM. Other important elements are that it encompasses the freshwaters as well as the coastal waters (up to 1 km); sets clear targets to be achieved and sets dates for action by member states and sets out measures to be taken and monitoring procedures. The WFD will play an even more significant role in the future since the development of water policy in the member states will be largely influenced by the conditions therein stipulated. In the Odense fjord (see Case Study 6), the progressive actions plans on the environment that also incorporates the objectives of the WFD have achieved considerable success in reducing agriculture inputs within the catchment.

## *Case Study 4. Binding agreements transform the trans-boundary Rhine river basin*

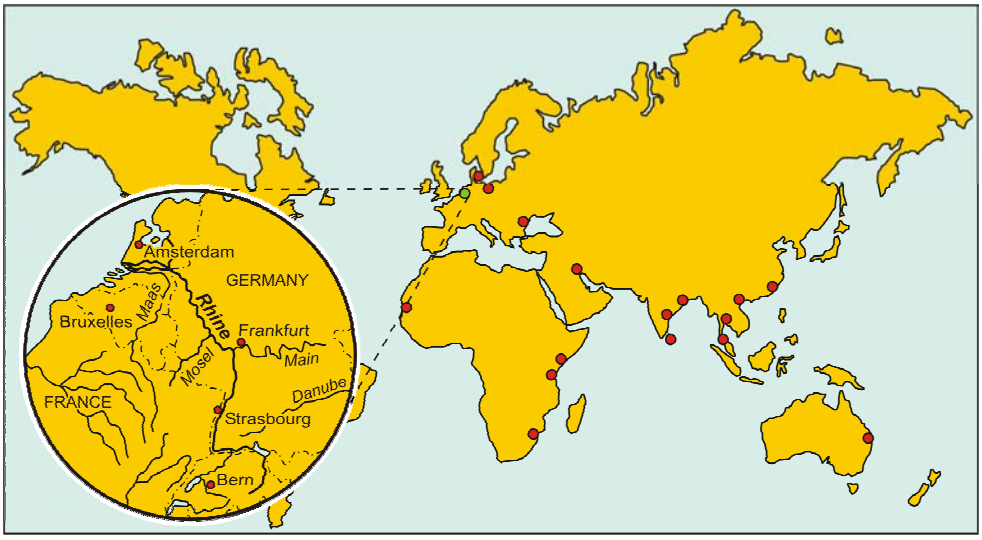


Figure 4: Location of case study 4: Binding agreements transform the trans-boundary Rhine river basin

*The Rhine has been transformed from "an open sewer" to one of Europe's cleanest trans-boundary rivers in a matter of a few decades. 63 species of fish including migrating salmon, sea-trout and lamprey are again living and breeding in the river after an absence of over 30 years.*

The Rhine is one of Europe's major rivers. From its source in Switzerland it flows through six countries, Switzerland, Liechtenstein, Austria, Germany, France, and the Netherlands before reaching the North Sea, a distance of 1,320 km. The quality of the river water has been the long-standing problem of the Rhine. Industrial renovation following the second World War led to the growth of important chemical, pharmaceutical and other heavy industries along the river's banks. With no purification systems in place the water soon became very heavily polluted with large concentrations of heavy metals, pesticides, organic chlorine compounds and other hydrocarbons. This contamination was so severe that the river became almost lifeless as dissolved oxygen levels also plummeted. By the end of the 1960s, the Rhine was widely regarded as an open sewer. All of these chemicals carried downstream also had the effect of finding their way into the sediments and the coastal waters and sediments of the affected North Sea states. Another issue has been the loss of the natural character of the Rhine and the adjacent coast. The meandering nature of the river has been transformed, through damming and straightening, so that it now flows through a fixed bed, largely separated from its flood plain with no natural outflow at its mouth.

It was clear that international action needed to be taken. Initially, an International Commission for the Protection of the Rhine (ICPR) was set up by the governments of Switzerland, France, Germany, Luxembourg and the Netherlands. In 1963, the Bern Convention on the Protection of the Rhine was signed and this was followed in 1976 on a Convention on the Protection of the Rhine against Chemical Pollution. The ICPR agreed internationally binding limits for hazardous substances which were implemented at national level. However, the whole process of implementation was delayed due to fair trade disputes. As a result, a new Convention on the Protection of the Rhine was agreed in 1999 which was more comprehensive looking to work towards sustainable development of the Rhine ecosystem, the river, its banks and alluvial areas as well as groundwater but also taking into account the improvement of the ecosystems of the North Sea. Nonetheless, the slow progress being made over twenty years after the first agreement led the riparian states to begin a second, parallel approach, the Rhine Action Programme.

This Programme ran from 1987 - 2000. It had its origins in the fire at the Sandoz insecticide storage site in 1986, near Basel, after which tonnes of dead fish and other animals were recovered from the Rhine. New, clearly defined, long-term objectives were adopted for the Rhine with the ultimate aim of rehabilitating migrating salmon, as a symbol not only of the Rhine river itself but the coastal waters of the North Sea and the estuary. The inclusion of the whole basin into a river programme was very new but apart from the other major goal of reducing pollution to such an extent that not only supplies of drinking water could be guaranteed and that Rhine sediments could be used as land-fill it also sought to improve the ecology of the North Sea. The latter was needed because of the enormous algal blooms of the late 1980s due to nitrogen and phosphorus loads from the river. Thus the Rhine Action Programme was a watershed in international water management because an explicit commitment was made to broaden the scope of co-operation beyond water quality aspects and embrace clear ecosystem goals in an integrated water management regime for the Rhine river Basin.

Implementation of the anti-pollution measures, ahead of the target dates, means that the Rhine fully meets the standards for drinking water for all but a few substances and it has been transformed into one of the cleanest trans-boundary rivers in Europe. It has been accompanied by ecological progress as well with Atlantic salmon and sea trout not only returning 700 km inland to the river's tributaries but naturally reproducing there as well.

*What is interesting about this approach is that the Programme is not a legally binding international instrument showing that treaty-related legislation and instruments are not necessarily a pre-requisite for national implementation. This Programme has now been superseded by the Rhine 2020 plan which is running from 2000-2020. It's mandate is to concentrate on flood prevention and, further, on the rehabilitation of natural landscapes and habitats. Targets are also more ambitious with respect to water quality with fish, mussels and crayfish fit for human consumption, being caught in the Rhine and bathing quality reached in suitable places.*

## 3.5 Effective communication and sharing relevant information

Effective, interlinked management requires coordinated actions and shared roles and responsibilities among a number of governmental and non-governmental agencies in multiple tiers of governance. Designing such a system involves the development of workable communication strategies which include articulately written information. Indeed, to achieve full participation, it is vital to have an effective means to communicate relevant information to all stakeholders involved in the decision-making process. In some cases, there might be a lack of connection between the different – national, regional and local – layers of government. Equally, there might be a block between those agencies which are responsible for implementing different aspects of coastal management. Mis-information or lack of information can also create problems between the various decision-makers and those experiencing the problems of the coastal zone on a daily basis. Clearly, too, the various sectoral stakeholders – all with their own interests – need to be fully informed at all stages of the planning process to enable them to reach consensus. Such vertical and horizontal information flow is not easy to achieve but without it, successful interlinked management will not succeed.

There is a need for decentralisation, with more involvement of local authorities who are in a better position to engage with the community. It is only through decentralised implementation that the gap between the policy goals created at the national level and the activities implemented at the local level can be narrowed. However, local management efforts should be fully supported by the national government via national policies and budgets. The institutional framework should also recognise and support co-management, and empower resource users to take part in management and to enforce regulations.

The quality of the information is also of great importance. Whilst there is a substantial amount of information available concerning river basins and coastal areas, the texts are sometimes difficult to

understand, if not incomprehensible, for those who need to read them, being too technical, too scientific or too bureaucratic in style.

The Danube delta (see Case Study 5) shows that, even with a river basin shared by nineteen different countries, effective measures can be taken to reverse the significant impacts from anthropogenic pressures suffered during the last 50 years, provided that there is an effective means to communicate relevant information to all stakeholders effectively.

The Moreton bay study (see Case Study 3) illustrates the value of a strong body of scientific information to support the call for effective management and the value of communicating that information to stakeholders to motivate them to be involved in the work and decisions made. One of the main drivers for change in Moreton bay was the increasing community expectation about improving water quality access and uses and the recognition of the potential loss of industry viability for tourism, fishing and agriculture. A major coordinated scientific research programme highlighted the key assets being endangered and the potential of the bay to improve the citizen's quality of life. The effective communication of scientific information to all stakeholders and decision makers increased the confidence in the information that was presented to them.

## *Case Study 5. International co-operation on fundamental water management issues in the trans-boundary Danube basin*

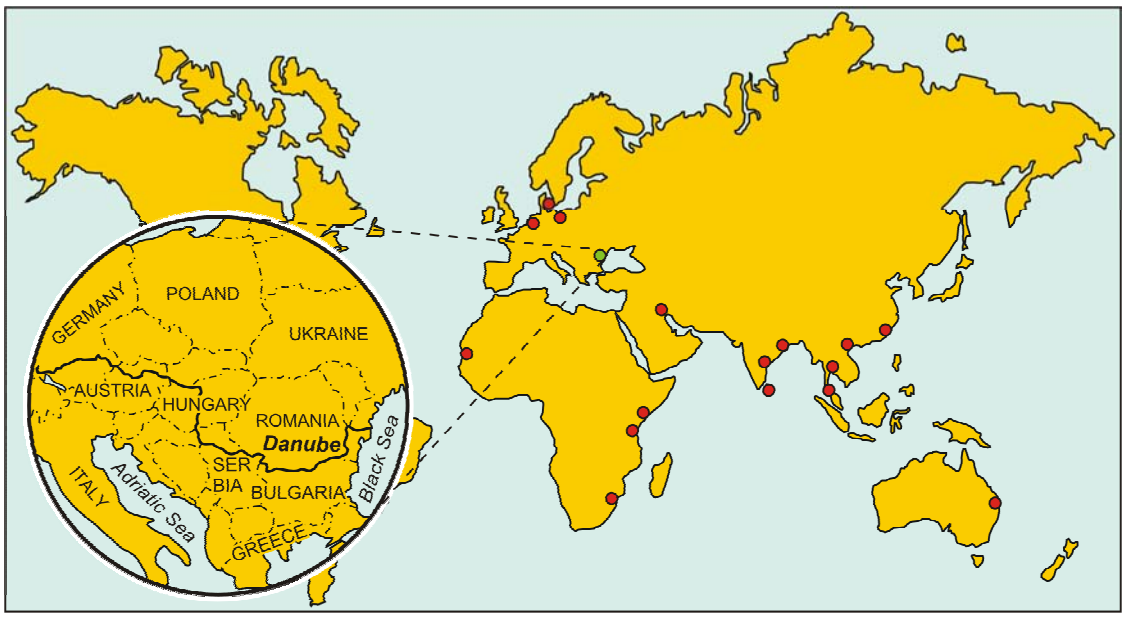


Figure 5: Location of case study 5: International co-operation on fundamental water management issues in the trans-boundary Danube basin

*The active involvement of the public is a core principle in sustainable water management under the Danube Convention. To date, 10 organisations have become observers to the ICPDR. including NGOs, organisations representing private industry and intergovernmental organisations. This co-operation grants observers the right to full participate at ICPDR decision-making meetings.*

The Danube river Basin is the second largest river basin of Europe covering territories of 19 states including EU-Member States, accession countries and other states that have not applied for EU Membership *viz*. Austria, Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Poland, Romania, Serbia, Montenegro, Slovak Republic, Slovenia, Switzerland and Ukraine. The river shows a tremendous diversity of habitats through which it flows.

The coastal waters of the Danube extend along the full length of the Romanian coastline and along parts of the Ukrainian coastal waters. The water quality of the river, however, also affects the other Black Sea states of Bulgaria, Russia, Georgia and Turkey. The Black Sea has little or no tide and consequently slow renewal processes and sensitive ecosystems prevail. The main management challenge for the Danube river and Black Sea is to address the marine trans-boundary problems by land-locked countries affecting the river system which are not direct beneficiaries of a healthy Black Sea.

Five key problems have been identified as major underlying causes of environmental degradation in both the river and the Black Sea.

- Eutrophication caused by nitrogen and phosphorus loads from agricultural run-off, domestic sewage & industry and atmospheric deposition. The high nutrient concentrations have led to the intensification of eutrophication in the Danube delta contributing to the extinction of (economically) sensitive species e.g. sturgeon,
- Hazardous substances including oil show an increasing profile from the upper to the lower Danube whilst cadmium and lead are the most serious inorganic micro-contaminants in the Danube river Basin. The recent accidental spills of cyanide and heavy metals from sedimentation ponds in the mining industry show that an accident in one state can have huge trans-boundary effects many hundreds of kilometers downstream,
- Microbiological contamination from untreated waste water from a large number of towns, generally near borders,
- Oxygen depletion and heterotrophic growth has the effect of reducing the capacity of the basin, coastal and marine areas to support migratory fish, and
- Increased sedimentation, competition for water and changes in river flow patterns to improve access has fundamentally altered the natural water and sediment transport system such that the new regime allows much of the nutrient-containing silt to pass directly into the Black Sea. One quarter of the Danube delta has been dyked and water regulation works, largely hydropower dams as well as improvements to navigation, have resulted in an increased sediment deficit for the entire Danube basin due to a much reduced transport of suspended solids and soil sediments downstream.

As a result of these activities, the lower Danube has a significant decrease in biodiversity, simplification of the food chains and reduction of bio-productivity. Wetland habitats and floodplain forests, in particular, have been drastically altered in the last two centuries and high nutrient concentrations cause frequent algal blooms.

A Strategic Action Plan (1995-2005) for the Danube river Basin was adopted in 1994 by the Environment Ministers of the Danube countries and the European Commission. The Plan provides directions and a framework for achieving the goals on regional, integrated water management and riverine environmental management.

The “Convention on the Protection and Sustainable Use of the Danube river” (The Danube river Protection Convention - DRPC) became, with its entry into force in 1998, the overall legal instrument for co-operation and trans-boundary water management in the Danube river basin. The objective of the DRPC is to achieve and maintain the sustainable development and use of water resources and groundwater and includes the conservation and restoration of ecosystems in the Danube river Basin. The operational body is the International Commission for the Protection of the Danube river (ICPDR) and is responsible not only for international co-ordination with the Contracting Parties cooperating on fundamental water management issues but also taking all appropriate legal, administrative and technical measures to maintain and improve the quality of the Danube river and its environment.

Furthermore, a Memorandum of Understanding between the International Commission for the Protection of the Black Sea and the ICPDR should form the basis for an interlinked management

regime between the river Danube and the Black Sea. It has, as its long term goal, the recovery of Black Sea ecosystems to conditions seen in the 1960s.

*The actions taken to remove N and P nutrients from waste water in Germany, Austria and the Czech Republic is beginning to decrease eutrophication in the Danube delta. The situation in the north-western Black Sea shallow waters has also improved considerably since the early 90s. Furthermore, the destruction of floodplains and wetlands has stopped, due to protection status under different national or international legislation, and the restoration of original river beds has started due to the successful implementation of various projects; it can be expected that this recovery of the Danube delta floodplains will be an ongoing process. Already there are some indications that biodiversity is increasing with the re-appearance of benthic macro flora and some invertebrate species. The involvement of concerned stakeholders has been a vital element in this success.*

## 4 A multi-basin and waterway management approach

The concept of ICARM applying only to a single river basin and the coastal zone is too restrictive. Three of the studies show that the principles of interlinked management have been applied to other aspects of inter-connected marine, brackish and freshwater systems. In Denmark, one interlinked management programme has been used for all the water systems reaching the Odense fjord (see Case Study 6). Moreton bay (see Case Study 3) and Samana bay (see Case Study 2) equally show that effective, holistic management of a bay with more than one river system is achievable. In these situations, where several river systems and waterways feed into a single estuary or bay, it is not necessary for each basin to have its own management plan. On the contrary, managing all the waterways in a single programme has been very advantageous and cost effective.

### *Case Study 6. Interlinked management in the Odense fjord catchment, Denmark*

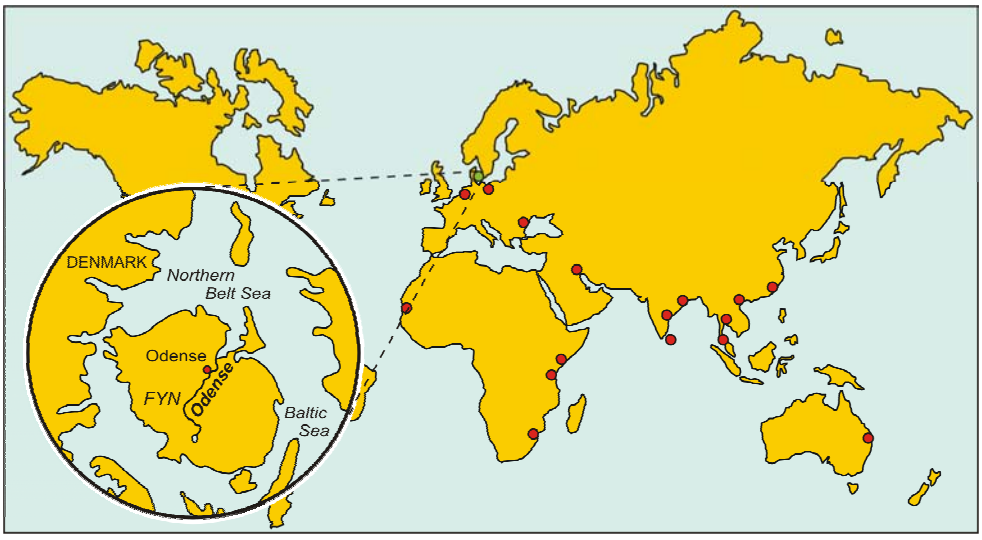


Figure 6: Location of case study 6: Interlinked management in the Odense fjord catchment, Denmark

*Odense fjord has been managed at a county level as a single system embracing not only the main river but all the other run-off streams flowing into it.*

The Odense Fjord is a shallow estuary located in the northern part of Fyn County. Although the major runoff to the fjord is the river Odense there are 1,100 km of streams draining the catchment which is over 1,000 km². The fjord exchanges its water with the Northern Belt Sea. Land use in the catchment is dominated by agricultural activities including cattle and pig farming and cereals. There are also

urban areas, woodland and natural/semi-natural areas (meadows, bogs/fens/swamp forests, dry grasslands, lakes and wetlands).

Eutrophication, resulting from nutrient enrichment, has been one of the major threats to the environmental quality of the Odense Fjord and related mainly to non-point sources of nutrients originating from the agricultural activities. Urban and industrial point sources are secondary inputs.

Past developments in the river basin have led to dramatic changes having implications in the coastal waters. Firstly, artificial drainage and land reclamation have led to the draining of large cultivated areas in order to optimise the possibilities for cultivation. In addition, bogs/fens/swamp forests, meadows, watercourses and shallow lakes and areas of the fjord have undergone major physical changes or have been reclaimed into farmland. Many watercourses and ditches have also been piped or straightened.

Secondly, developments within the agriculture sector – fewer but larger farms, increase of specialised cattle or pig holdings, exclusively crop holdings, replacement of grass by cereals and increase of fertiliser use – have increased nitrogen and phosphorus loading to coastal waters.

A number of action plans and strategies have been adopted by the Danish Parliament to regulate development of the agricultural sector to diminish eutrophication in Danish coastal waters.

Reduction targets for nitrogen and phosphorus have been continuously set and ever tighter measures introduced to ensure they are met. Fyn County Council has enacted several generations of Regional Plans to reflect the national policies; the regional plan 1997-2009 sets out objectives that most areas should be “suitable for fish and for recreational and/or commercial fishing and allow the reproduction and growth of fish where appropriate natural conditions prevail”.

Denmark has implemented the provisions of the EU Urban Wastewater Directive which requires wastewater discharges to be subjected to a level of treatment appropriate to the environment at the place in question and the use to which the recipient water bodies in question are put. The national target of an 80 % reduction of phosphorus from sewage plants and industry to fresh and marine waters was achieved by 1996. The reductions of nitrogen discharges from sewage treatment plants have also been met.

Industrial discharges have been reduced separately using the EU Directive on Pollution Prevention and Control. This aims at integrated prevention and control of pollution by major industries. Industry had to reduce its discharges through application of Best Available Techniques understood as the level of treatment that is technically attainable and economically viable for the industry in question.

Fyn County has invested significant financial resources in monitoring the environmental conditions in watercourses, lakes, coastal waters and groundwater in the region.

*Much success has been achieved in domestic and industrial waste water emissions. The majority of houses and industries in the County are now connected to the sewerage system and wastewater treatment plants, using tertiary treatment remove the majority of the phosphorus and nitrogen, respectively, 87 % and 72 %. Separate industrial discharges have also decreased markedly during the 1990s – phosphorus by 95 % and nitrogen by 85 %. However, it has proven to be much more complicated to control the non-point sources from agriculture. This is particularly critical for the coastal waters, as these sources are the main cause of marine eutrophication and related oxygen deficits. Phosphorous input to the coastal waters has been reduced by approximately 75 % but land based nitrogen inputs has varied considerably from year to year and has only registered an overall reduction of 20 - 25 %.*

## 5 The added value of linked management

Recognising the upstream-downstream linkages of a linked management approach ensures that development activities upstream in the river basin are initiated with full knowledge of the potential impacts on the ecosystems and economic activities and livelihoods in the coastal and marine areas.

river basins or river catchments and the coastal and marine systems influenced by catchment discharges are important geographical units that cannot be considered in isolation. By promoting the idea that the coastal area is an integral part of the river basin, linked management also provides a framework for achieving the benefits of the ecosystem approach in the protection of the marine environment from land-based sources.

Adoption of a linked management approach will lead to the systematic integration of the inshore and coastal waters into the regional planning process and plays a vital role in regional development. It also provides the context to consider explicitly aspects of natural and socio-economic systems that have previously been seen as outside the scope of interest of policy makers and planners, concerned only with the sectoral development of river basins or coasts proper. For example, there is direct linkage between soil erosion control in headwater basins and reduced sedimentation in salt marshes and mangrove areas. Recognition of this leads to better co-ordination of policy making and action across sectors (water, forestry, agriculture, urban development, environmental protection, etc.) and geographically, ultimately leading to a more rational use of resources and more effective environmental protection. The following fifteen case studies are examples of good management practices which show the opportunities that can be gained if linked management is further developed.

## 5.1 Reducing coastal water degradation

A linked management approach is indispensable to managing coastal water quality degradation. Water quality benefits that would thus accrue are enormous. Maintenance of water quality would assure ecosystem health, fishery potential and recreational/tourist value and would benefit the local and national economy. One of the key benefits of a linked management programme is in relation to eutrophication. The experiences from the Danube and Oder rivers (see Case Studies 5 and 20) demonstrate very clearly the close relation between agriculture development and coastal water quality with concomitant effects on the socio-economic development of the coastal areas. The experience of the Chesapeake bay (see Case Study 7) and Odense (see Case Study 6) catchment water quality management programme clearly show that managing the point sources will not lead to mitigating estuarine and coastal water quality. In both cases, it was imperative that the non point sources, mainly from agriculture, also be addressed.

### *Case Study 7. Tackling water quality in Chesapeake bay, United States*

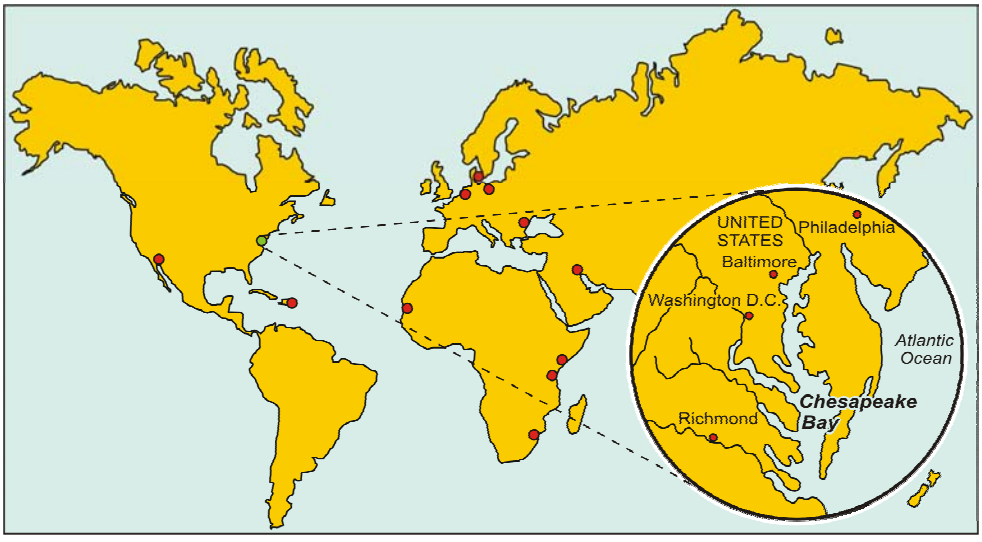


Figure 7: Location of case study 7: Tackling water quality in Chesapeake bay, United States

*The Chesapeake lies along the nation's eastern seaboard and its watershed includes all, or portions of, six states which funnel in nutrient-rich freshwater from six tributaries. Much of the Chesapeake's watershed is forest and agricultural land that contains some of the highest concentrations of livestock and intensive cropping in the United States. Nutrients and pollution are among the main factors responsible for adverse downstream impacts despite construction of sewage treatment plants. The burning of fossil fuels is also an important contributor to air pollution that ultimately finds its way into the bay's waters.*

For centuries, the bay supported a rich abundance of valuable fisheries: striped bass, shad, herring, oysters and blue crabs. Extensive oyster reefs once supported a large and lucrative fishery. In the first half of the twentieth century, oysters began a precipitous decline as a result of over-fishing and habitat destruction. The loss of oysters contributed to the overall decline in water quality and increasing turbidity that in turn contributed to the disappearance of the once extensive sea-grass beds.

Now, oysters no longer carpet the bay's bottom, which has changed from a hard bottom covered with shells to a soft muddy bottom. Submerged aquatic vegetation covers less than half the area it did ten years ago (despite a partial comeback).

The degradation of the Chesapeake attracted national attention and the following steps have been taken:

- In 1974, the US Environmental Protection Agency investigated the bay's status and threats.
- In 1981, it created a task force to review the research that had been done and propose management recommendations. The later inclusion of the public turned the programme into a practical attempt at ecosystem restoration that recognized the vital roles of the bay's many stakeholders.
- In 1983, the first Chesapeake bay Agreement was adopted which committed to specific goals for restoring the bay's living resources.
- In 1985, a management plan with 29 goals addressed living resources, water quality, population growth and development, public education, public access to the bay and governance.
- In 1992, the programme was extended to include the bay's tributaries.
- In 2000, the latest agreement set the most stringent targets for the bay's restoration by 2010 e.g. an increase of native oysters by tenfold, restoration of 25,000 acres of wetlands, achievement and maintenance of the 40 % nutrient reduction goal agreed to in 1987.

A major recent development is that atmospheric input is a major contributor to the bay's declining water and must be taken into account in the management effort.

As a result of these measures, there have been major environmental improvements e.g. an increase in the quality of fish spawning habitat and improved fish passage on spawning streams, restoration of streamside forests, designation of 11,000 acres (ca. 4,400 ha) of bay bottom as aquatic reef habitat, increase of sea-grass beds and reduced nitrogen and phosphorus loads. However, despite these successes, even after decades of sustained effort at resuscitation, the bay's overall water quality remains poor. Native species have not rebounded. Populations of canvas back ducks remain at about half their 1957 numbers, oysters are still only about 1 % of the 1950s population level, blue crabs are still a threatened fishery and other fisheries have made only modest comebacks.

Nonetheless, their have been some marked benefits that have arisen from an interlinked management approach:

- The management plan made a strong investment in public education which has contributed to sustained popular support.
- Temporary task forces proved useful to address specific and potentially controversial issues.
- Scientific research aided in setting critical targets. and provided guidance and a sound foundation on which politicians and decision makers built policies and legislation.

- Unambiguous goals signed by top-level elected state representatives and national government officials avoided difficulties associated with negotiating all-encompassing and detailed plans.
- Freedom for regional and local bodies to come up with their own solutions and plans, take practical steps and implement innovative ideas which included local communities and non-governmental organisations.

*However, while point sources have been dealt with non-point source pollution, funnelled in from the bay's large watershed, remain difficult to control and reduce - particularly the pollution arising from a chemically intensive agriculture and urbanization e.g. deforestation, destruction of wetlands, and automobile-associated pollution.*

## *Case Study 8. Management challenges in meeting upstream water demands whilst maintaining the environmental and socio-economic potential of the delta and the coast in the Senegal river basin, West Africa.*


Figure 8: Location of case study 8: Management challenges in meeting upstream water demands whilst maintaining the environmental and socio-economic potential of the delta and the coast in the Senegal river basin, West Africa.

*The Senegal river basin is located in West Africa and the basin is drained by the 1,800 km long Senegal river and its tributaries, lying within the territory of four countries; Guinea, Mali, Mauritania and Senegal. River flow is controlled by two dams, one in Senegal to stop intrusion of seawater along the river bed during the dry season and the other in Mali. The river discharges into the Atlantic Ocean through a delta which is about 80 km long and consists of numerous estuaries that form a complex canal system.*

The climatic regime in the basin can be divided into a rainy season from June to September, a cold and dry season from October to February and a hot and dry season from March to June. Rainfall in the basin can be as high as 2,000 mm per year although in the valley and the delta it is generally low: flooding can occur in the rainy season. This has enabled farmers to grow crops during the dry season, after the waters have receded and the low-water period has started. In areas of low rainfall, the river's annual flood is a necessity for life in, and around, the basin.

There are a number of issues arising from river basin activities which affect the socio-economic and environmental situation in the basin:

- Water-borne diseases from the permanent presence of standing water in the valley and the suppression of the periodic increase in salt concentration favours the growth of aquatic plants and

pathogenic bacteria. As a consequence, the incidence of water-borne diseases has increased viz. malaria, urinary schistosomiasis, diarrhoea, and intestinal parasitic diseases. The delta has become a hotbed of bilharzia and prevalence rates of 80 % are seen in certain villages.

- Flooding of St Louis City due to the reduction in the cross-section of the river mouth because of sediments.
- Water quality changes due to the accumulation of salt and pollutants is of primary importance to the delta and results from drainage of irrigated areas or stagnant water, inappropriate domestic use, poor management of solid waste and discharge of industrial wastewater.
- Loss of mangrove forest due to salinity increase. With the loss of mangroves, the formerly flooded mud holes gradually turn into islands of salt.
- Reduced wetland areas and resultant loss of biodiversity
- Reproduction areas are not accessible to fish because of the absence of a fish ladder in the downstream dam and the presence of gates and embankments which prevent fish from migrating to spawning areas. This leads to the reduction of the fish population of the river as well as in the marine area. The abrupt changes of water salinity related to the discharge of the dam are often the cause of fish mortality.
- Reduced water access in spite of the water availability in the basin because the natural reservoirs and lakes, as well as irrigated perimeters, are poorly supplied.

Management and development of water resources in the basin are carried out within the framework of the Organisation for the Development of the Senegal river basin (OMVS) which represents Mali, Mauritania and Senegal. During the last 30 years, water resources development activities in the basin, particularly the implementation of hydro-agricultural and hydro-electric infrastructure as well as the extension of urban areas, have led to significant changes in the estuarine and coastal regime. However, among the positive impacts, which are limited to the upstream areas, is the possibility to practise agricultural activities without having the risk of saltwater intrusions during the dry season. Nonetheless, modification of river flow, loss of biodiversity, degradation of soils and water have had far reaching economic impacts in the downstream areas, in terms of loss of fisheries and a declining agricultural productivity in the delta area and increasing the need for investment in mitigating erosion and flooding in St. Louis.

Human modifications of the flow regime of the lower part of the Senegal river has heavily impacted the environment and thus the living conditions for the local population especially in the delta area. The needs of the downstream communities have not received due attention as benefits derived from irrigated agriculture and electricity generation are not compensating those experiencing the negative impacts.

*Reversing these changes can be best addressed through linking the management of the river basin to the management of the estuary and coast. The OMVS provides an inter-governmental structure through which river basin activities could be linked to better management of the coastal and marine areas, although coastal issues will need to be given more prominence in the agenda of the river basin management. Recent work has contributed towards greater understanding of the pressures and driving forces generating the issues of concern as well as promoting awareness and a certain level of consensus amongst user groups of the need for action.*

## *Case Study 9. A strong integrated coastal management programme is the platform for comprehensive river basin management in the Jiulongjiang river basin, China*

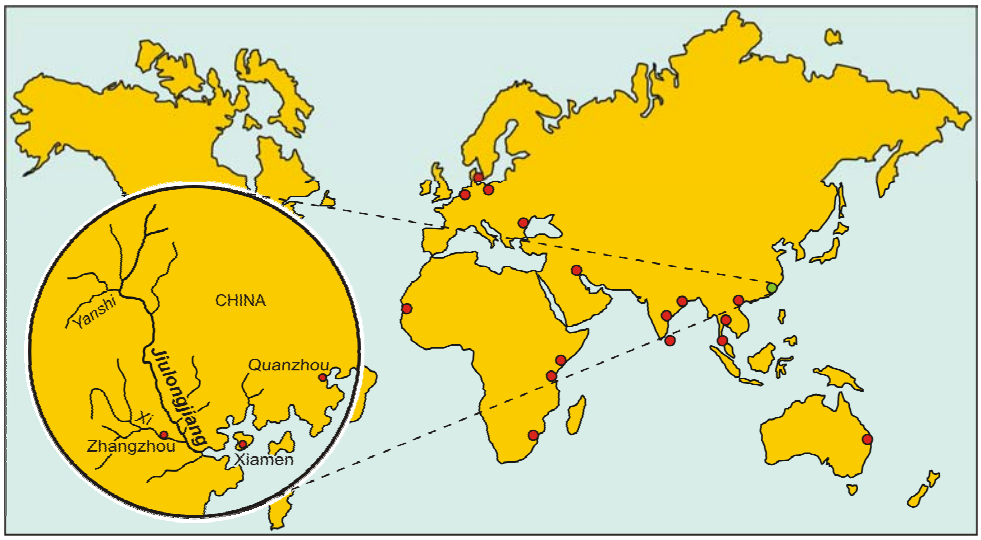


Figure 9: Location of case study 9: A strong integrated coastal management programme is the platform for comprehensive river basin management in the Jiulongjiang river basin, China

*A very different approach has been taken in the case of the Jiulongjiang river basin where management of the river basin has been the logical follow through for a strong management programme which started at the estuary and coastal area.*

There has been an infrastructural, development frenzy in the mouth of the Jiulongjiang river since the 1980s as a result of the city of Xiamen being granted the status of a Special Economic Zone. This was part of the initial experimentation of economic liberalisation, a feature of the administration's reform policies. This meant that foreign direct investments were legalised. Income-generated opportunities improved access to market-oriented activities and increased employment through economic expansion. These economic reforms led to spectacular economic growth with an annual average growth rate of 1.9 % over 15 years; the city population increased 5 fold over the same period. However, in so doing many facets of the environment were neglected and the newly-found affluence brought a host of environmental problems. Mushrooming coastal aquaculture farms contaminated the coastal waters and damaged the ecosystems due to untreated aquaculture waste; red tides (algal blooms) became a perennial occurrence. The sheer number of these farms resulted in the narrowing of the shipping channel. Compounding the situation was deforestation and land conversion which silted-up the naturally deep waterways. Pollution was also a factor in the destruction of the marine habitat and many species were driven to the verge of extinction including symbolic species such as the Chinese white dolphin, Chinese egret and lancelet (an ancient fish-like species).

By the late 1980s, the coastal waters of the Jiulongjiang river were extremely polluted. Fish catches decreased and fish mortality increased. The market value of the dead, unharvested fish alone was estimated at $ 3 million in 1996. At this time the city municipality was annually dumping 200,000 tons of solid waste and 55.5 m tons of untreated sewage into the coastal waters. The Yuandang lagoon was squalid, noxious and biologically dead. Residents started moving out of the area because of the stench and real estate prices fell.

Strong political leadership was then shown by the city administration as they recognised that a dirty environment was not good for the city and bad for business. They began a programme to promote clean, sustainable development within the city. Newly devolved autonomy and the state's encouragement for international assistance were key factors in the clean-up. Some of the measures

taken were encouragement of light industry instead of heavy industry, new, local laws which, whilst not contradicting national laws, could require stricter environmental standards with penalties for non-compliance.

So began an integrated coastal management approach which, in being implemented, needed to overcome seemingly unbridgeable constraints – weak institutional capacity, sector-oriented policies, lack of coordination, insufficient legal frameworks and enforcement, a low understanding of marine environmental issues and, last but not least, a scarcity of funds! An inter-agency, coordinating mechanism for coastal management was established to improve synergy among the different institutions. Initial funds were obtained from a GEF/UNDP/IMO regional programme but when the project ended the municipality continued the funding. New laws concerning land-based pollution and environmental protection were passed. A Strategic Environmental Management Plan (SEMP) was drawn up which zoned the coastline into nine different user groups so that conflicts would be reduced and compatible activities could be clustered. This approach has also proved to be cost-effective since measures can be taken for zones where activities generate similar impacts. Rehabilitation of the lagoon was an initial focus of the programme and within ten years, at a cost of ca. $35m, the waters have been reclassified as suitable for boating and recreation. Most of the aquatic animals and plants have returned and real estate and land prices have soared. Waste recycling and treatment plants have eliminated direct inputs to the lagoon. A strong part of the programme has been public involvement, something new in China.

The ICM programme has been an unmitigated success in terms of controlling pollution and reversing the environmental trend of the previous decennia in, and around, the river mouth. The next stage is to address the upstream problems. The Jiulongjiang river still receives over 200 m tons of largely untreated industrial and domestic sewage each year. A large quantity is also discharged from the animal husbandry sector. A riparian cooperation council has been established between the downstream administrations and those upstream as well as the provincial government. A comprehensive river basin planning approach has been developed. The initial stages have been to identify and prioritise the environmental issues. This has let to a management plan on pollution prevention, treatment and ecological protection of the Jiulongjiang river.

*The implementation of ICM has led to great improvements in the state of environmental quality, habitats and resources. The SEMP has now been updated to include the development of a Jiulongjiang estuary management framework in collaboration with upstream communities. The link between coastal and river management has been made.*

## 5.2 Minimising changes to river discharges and salinity intrusion

A closely related benefit is the possibility to reduce drastic fluctuations in water flows and to maintain pulsing and salinity gradients. Several basin studies have shown that reduced average flows and diminished peak flows threaten the downstream ecosystems and their economic viability in several ways.

Linking the management of the Tana basin and delta (see Case Study 10) would ensure that development activities upstream of the basin are initiated with full knowledge of the potential impacts in the delta and bay areas whose ecosystems and fisheries are partly sustained by nutrients and sediment discharged by the river. Application of a linked management approach has numerous benefits that could form the pillar for sustainable development in the Tana river basin. With continued population growth and urban and industrial development, water demand in the Incomati basin (see Case Study 18) has continued to grow and by far surpassed the water available in the basin. Hence, there is a need to build consensus and a shared vision on the river's future development; a vision that incorporates the basic principles of equity and sustainability in the water allocation and management of the river basin. In the basin of the Bang Pakong river (see Case Study 11), a large dam has recently had to be temporarily decommissioned because its operations resulted in serious consequences both

upstream and downstream. In the dry season, saltwater intrusion reaches to a distance of approximately 170-210 km from the mouth of the river and the river water cannot be used for potable and non-potable uses during the dry season. Restoring the natural discharge patterns will alleviate problems caused by salinity intrusion especially the impacts on agriculture potential in floodplains.

## *Case Study 10. Improving the hydrology in the Tana basin, Kenya*

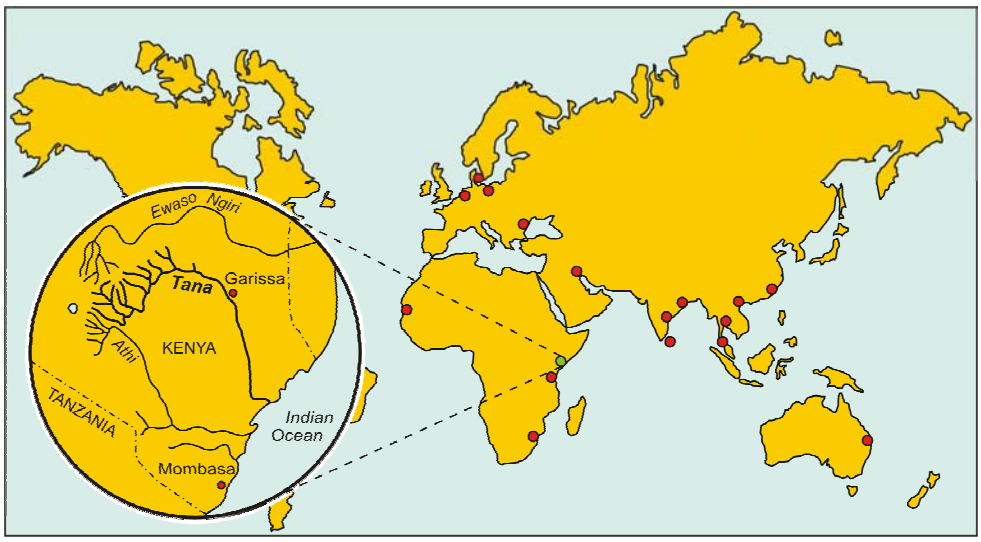


Figure 10: Location of case study 10: Improving the hydrology in the Tana basin, Kenya

*With a total area equivalent to about 23 % of the area of the Republic of Kenya, the Tana river, in terms of both its annual discharge and as a source of water for rural and urban use, is the most important river in the country. It is about 1,100 km from its headwaters in the Central Kenya highlands to the Indian Ocean.*

There are several hydropower schemes in the Upper Tana Basin that generate 65 % of hydroelectric power used in Kenya. The peak river discharge of the Tana before the construction of the dams was almost double that following construction. The reduction in the peak flows, that enriched the floodplains, has had drastic impacts on the flood-plain agriculture practiced by the communities living in the Lower Tana Basin. It is an important source of water for rural and urban areas along the basin with water abstraction equivalent to about 10 % of the average daily discharge of the river.

The Tana river branches into several tributaries forming a 3,350 km² delta which is an ecologically important site in Kenya. This delta is associated with wetlands of freshwater and brackish water, streams and lakes mixed with sand dunes and grasslands. It has one of the largest expanses of mangrove forest in Kenya. Sea-grass meadows are found in the shallow waters within Ungwana bay which is one of the most productive national fisheries, supporting a thriving prawn and finfish fishing activity. The delta is also an important feeding area for migrant birds with high concentrations of wildlife including crocodiles, hippopotamus, elephant, lion, bushbuck and hirora antelope as well as an important site for endangered species such as dugongs and marine turtles. In view of the fact that 80 % of the delta/estuary system is still intact and functional, there is a need for a comprehensive management programme in order to avoid destruction of the highly fragile ecological systems.

Most of the impacts in the Tana delta and Ungwana bay are related to changes in the hydrology of the river. Due to reduced peak river flows, a huge volume of high salinity water flows into the estuary from the sea, thus raising the salinity in the delta. The brackish water flowing into the floodplains has contaminated soils making cultivation within the delta unsustainable. Intrusion of salt water also

affects the aquatic community structure and, in particular, the riverine species cannot withstand the increased salinity.

Other effects are a high sediment loading of the river due to serious soil erosion in the upland areas caused by deforestation; accelerated coastal erosion leading to loss of land for recreation, agriculture and settlement in the Tana delta as well as a decline in the area covered by mangrove forest; impaired ecological functioning due to the extremely high turbidity of the Tana river limiting the primary production within the delta and bay; and reduced fisheries potential in the delta, a critical issue given that more than 150,000 people living along the coast benefit from the fishing industry.

The government has put in place several measures to safeguard against negative impacts of development projects on water resources. At catchment scale, management institutions are in place and several coordinate development and protect the environment and water resources. There are also several national policies that are relevant to the integrated water resources management including plans and a country strategy for IWRM and ICM.

Application of a management approach that links the management of the river basin to the management of the coastal and marine in the Tana basin would yield many benefits including the sustainability of the productivity of the Tana delta and Ungwana bay to which many livelihood systems are linked:

- Enhancement of fisheries productivity in the Ungwana bay.
- Improvement of floodplain agriculture and irrigation within the Tana delta leading to significant socio-economic benefits including increased foreign exchange earnings, improved income levels of local people, increased employment opportunities and alleviation of poverty.
- Improvement of opportunities for sustainable tourism development through protection of archeological sites situated along Ungwana bay including protection of beaches and mangrove forests within the Tana delta.
- Reduction of coastal erosion and, hence, protection of coastal infrastructure, settlements, agricultural lands and archeological sites.
- Prevention of the detrimental alteration or modification of the aquatic community structure within the Tana delta and Ungwana bay.
- Protection of critical coastal-marine habitats such as mangroves and seagrass beds that are nursery and feeding grounds for prawns and finfish that sustain the Ungwana bay fishing industry.
- Establishment of sustainable mechanisms for institutional co-operation to improve co-ordination in the implementation of development projects and enforcement of regulations.

*The crucial and intricate linkages clearly demonstrates that drastic levels of downstream degradation, both at the ecosystem level and in the socio-economic conditions prevailing in the delta and the coastal areas can only be prevented by managing the activities in the river basin in a manner that takes into account the needs of the delta and the coastal area.*

## *Case Study 11. Recent integrated water resources management efforts leading to linked management of the catchment and coast in the Bang Pakong river basin, Thailand*


Figure 11: Location of case study 11: Recent integrated water resources management efforts leading to linked management of the catchment and coast in the Bang Pakong river basin, Thailand

*The Bang Pakong river Basin, located in the eastern region of Thailand, has been a target of considerable economic development. The basin region has a flat topography in low-lying areas which is ideal for rice and other farming activities but makes it prone to flooding. The Bang Pakong is a tidal river, with brackish water reaching 120 km upstream during the dry season when freshwater runoff is minimal.*

The estuary consists of a narrow upper estuary about 50 km long and a wider lower estuary which extends over 18 km. It has high biological productivity and the diverse estuarine plant communities, especially the mangrove forests, provide an important habitat, feeding grounds and nursery areas for a variety of fish species. Economically important biological resources include shrimp and crab larvae which are more abundant in the dry season and may be used by some shrimp farmers who are practicing a semi-intensive system. The coastal area flanking the river mouth consists of sandy and rocky beaches with mangroves and other small forests.

The basin population is mostly rural and agriculture is by far the most important activity with more than 70 % of the total land area dedicated to rice, cassava and maize production with mango, coconut and rubber plantations as well as livestock farms fairly common in the basin. Shrimp farming has become an increasingly important and an expanding activity with a rapid expansion of marine shrimp farming away from the coast into the freshwater areas of Thailand's central plain, previously under paddy cultivation. Since shrimp farming generates higher income than can be obtained from rice cultivation, this trend is expected to continue. In addition, the seasonal availability of brackish water within streams and irrigation canals has encouraged the concentrated development of intensive shrimp farming along the river in excess of 100 km from the coast. Besides shrimp farms, there are also freshwater finfish farms along the lower reaches of the river. Industrial development within the basin has grown considerably in recent years and many of the factories discharge wastewater into the river.

Several water development projects have been planned and implemented to address increasing water needs in the basin. The major facility within the basin is the Bang Pakong Diversion dam, located about 70 kilometers from the river mouth - the largest dam in the area, but it is not currently in service. The dam, a barrage in the Bang Pakong river, was constructed by the Royal Irrigation Department (RID) to divert and store freshwater for different uses, mainly urban, and to prevent saltwater intrusion

into irrigation areas during the dry season. The dam came into operation in early 2000 but due to critical environmental problems, both downstream and upstream of the dam, RID was compelled to cease operations and evaluate options for future operation of the barrage. During the short period in which the dam was operational, several impacts were manifested. Downstream impacts of the dam included flooding by brackish water resulting in damage to houses and agriculture, erosion and collapse of the riverbanks and structures along the river downstream of the dam. At present, the dam is kept fully open as approval or consent of the public is necessary before further actions are implemented. However, demand for new dams and reservoirs will continue in order to ease urgent problems of water shortages, irregularity in supplies and water use conflicts.

Over the years, the national authorities have recognized that a holistic approach to water resources management requires stronger local management and hence the need for decentralization. The Bang Pakong basin was selected as one of the pilot areas for development of an effective river basin organisation and, in 2001, the National Water Resources Committee established the Bang Pakong river Basin Committee (BPRBC) having the mandate for management, coordination and water resources regulation for the Bang Pakong river Basin. The BPRBC consists of representatives from relevant governmental agencies, local governments, and from every group of stakeholders.

In 2004, an IWRM plan was developed for the river basin with stakeholder participation. It specified strategies to mitigate and prevent pollution of water sources by reducing pollutants from domestic, agriculture, aquaculture, and industrial wastewater and to operate the dam in a way that will maintain a freshwater-brackish water boundary, as would occur naturally, in order to provide benefits from mitigating saline intrusion and more freshwater for various uses.

Most recently, the Bang Pakong Dialogue Initiative of the BPRBC and the Department of Water Resources and the Asian Development Bank is aimed at establishing dialogue among users of the river. It is seeking to help the parties involved find solutions to the river's problems while at the same time strengthen the work of IWRM in the basin and the capacity of the river Basin Committee to fulfill its mandate in reducing conflicts within the river basin. A public awareness campaign has also been launched targeting about two million people who live in the basin. The Ministry of Natural Resources and Environment has also initiated a pilot study for the integration of inland and coastal management.

*The adoption and implementation of a linked management approach will ensure that operation of any water infrastructures such as dams or reservoirs will take fully into account the downstream impacts, hence preventing negative consequences to the environment and the welfare of the populace and subsequently save considerable resources that could have been used for remedial measures or for other important management initiatives. It will improve water quality, reduce sedimentation and conflicts on the use of freshwater or brackish water will also be reduced. Moreover, cost efficiency of development and management initiatives will be enhanced.*

## 5.3 Reducing sedimentation and coastal erosion

The need for a linked management approach cannot be overestimated in the case of shoreline management. A comprehensive approach to shoreline management must incorporate upstream areas of both coast and river basin, since management practices in either system can impact further down the coast. In the case of the Songkhla basin (see Case Study 12), agricultural practices have led to negative downstream effects. Elsewhere, damming waterways often leads to estuarine and coastal erosion reduction in the sediment supply. In the Red river, the sediment loads decreased by ca. one third after the construction of the dam, leading to considerable erosion along the delta shoreline. Other river systems in this study show similar erosion problems e.g. the Tana and Senegal rivers (see Case Studies 8 and 10).

## *Case Study 12. Action at national and regional level set to reap rewards in Songkhla lake basin, Thailand*

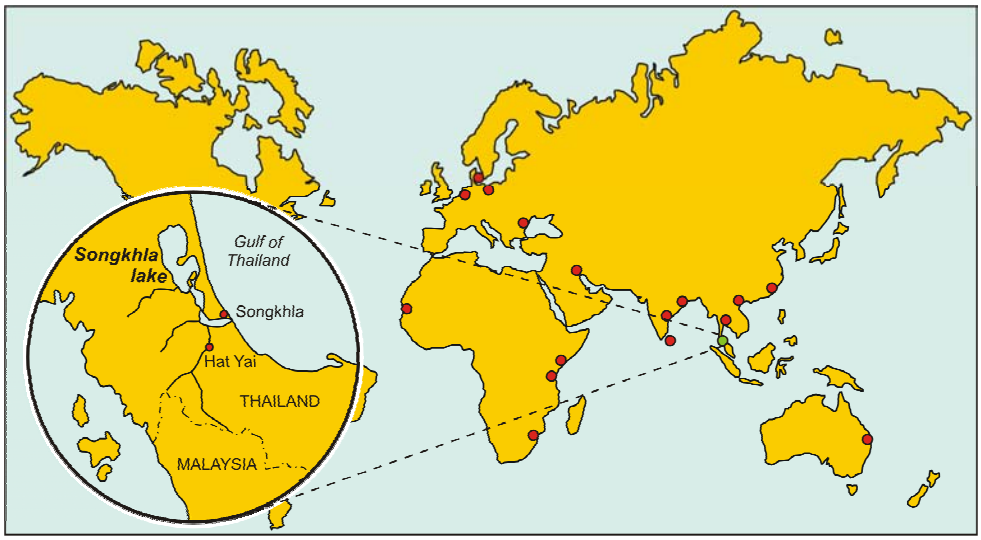


Figure 12: Location of case study 12: Action at national and regional level set to reap rewards in Songkhla lake basin, Thailand

*The Songkhla lake basin, the largest in Thailand, consists of shallow (average depth 1.5m) coastal, freshwater to brackish lagoons. It is connected to the Gulf of Thailand through a deep narrow outlet. The coastal area is often inundated by flooding every rainy season. However, it is a zone of major economic activity related to fisheries and harbours. The basin has experienced a significant population expansion in the last few decades with the majority of the population living in rural areas.*

The basin supports a range of land uses of which agriculture is the most important including natural forests, rice paddy fields, rubber plantations and orchards. Aquaculture (shrimp farming and fish cage culture) and pig farming are other important land uses in the basin. Fishing is most intensive in the lower Songkhla lake where the majority of the population depend solely on fishing for their livelihood. Although it is mostly a small scale fishery using a variety of stationary fishing gear, it's contribution to improving livelihoods is significant. Tourism and industrial development are also important economic sectors.

The demand for water has increased recently with domestic and industrial water demands met by groundwater extraction while the demand by the agricultural sector is largely met by extraction from the lake. The lakes and swamps provide a natural storage and drainage system and therefore function as a natural flood mitigation mechanism. Recent changes in land use have resulted in land use conflicts, watershed degradation and a decline in the quality of life of the basin population. Due to extraction of lake water for irrigation, salinity intrusion now occurs into the upper, freshwater lakes.

The rapid urbanization in the sub-urban areas and development of shrimp ponds in mangrove areas in the Lower lake, estuary and the delta areas have led to eutrophication in the estuary and coastal waters. Domestic waste water discharges are generated from the larger communities of which only 7 % are currently being serviced by wastewater treatment plants. The extensive aquaculture activities along the lake shores cause eutrophication as a result of overstocking of shrimp, fertilizer application and inefficient feeding practices. Other sources of contamination are industrial wastewater sources, most of which are situated along main highways, and wastewater from swine farms.

Sedimentation and erosion in the Lower Songkhla lake also occurs as a result of forest clearing, shifting agriculture, cultivation of rubber and other crops on too-steep hills and lack of soil management. Removal of mangroves and construction of shrimp ponds also add to sedimentation

problems downstream and stationary fishing gear in the Middle and Lower lakes drastically reduces water circulation. As a result, the water is becoming 5 - 15 mm shallower every year.

In addition, construction of sea water intakes and other shore installations have led to modification of long-shore sediment transport patterns causing substantial local sedimentation and erosion along the coast. Depletion of mangroves as a result of conversion to shrimp ponds further contributes to the loss of habitat and nursery grounds for aquatic species as well as reducing coastal stability during storms. Between 1961-1996, mangrove forests in some areas have been decreased tenfold.

Several governmental agencies are involved in watershed or river basin management activities. To enable coordination of activities of the relevant agencies and facilitate resolution of water resource issues in a holistic manner, the National Water Resources Committee (NWRC) was created in 1989. The National Water Policy (2000) provides a clear policy framework on the management of water resources at national and river basin levels and calls for increased efforts to approve a Draft Water Act to guide national water management, develop river basin organisations, and promote a participatory approach to water management. The recent drafting of a Water Resources Law which is awaiting Cabinet approval is a major step forward.

Two organizations at the basin level have been established to coordinate activities within the basin. The Songkhla Lake Basin Development Committee established in 1993 is an inter-ministerial committee at the national level with responsibility for policy formulation, coordination and advice. It also has the authority to screen projects (which have crucial environmental effects on the basin's natural resources and environments). A sub-committee has an increasingly important role in river basin management and various working groups set up under this sub-committee will include representation from stakeholders groups thus ensuring stakeholder participation.

In 1999, an Environmental Action Programme for the Songkhla Lake Basin was prepared and subsequently approved by the Songkhla Lake Basin Development Committee although it has yet to be implemented. In 2005, the Office of Natural Resources and Environmental Policy and Planning developed a Master Plan for Songkhla Lake Basin Development, which was approved by the Cabinet in November 2005. The Master Plan provides guidelines for the development in the basin in the future and encourages the execution of the Plan through an Action Plan in 2006.

Regarding the management of the coastal zone, several policy measures are in place, the most important being the National Ocean Policy and Action Plan for Coastal Resources and Environment Management, the National Plan for Mangrove Management, the Master Plan for Coral Reef Management and the Action Plan for Coastal Aquaculture. The responsibility for formulating coastal policy is under the Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment which is attempting to integrate these policies into a national plan for managing all coastal resources. Furthermore, after the tsunami in December 2004, the Government has implemented the Urban Planning Act and the Building Control Act to control the development in coastal areas.

Recently, collaboration has been initiated between the community and government officials within the Departments of Local Administration, Fishery and Forestry for formulating plans for conservation and recovery of coastal resources. Examples of such collaboration include the establishment of 41 conservation zones around Songkhla Lake.

*A linked management approach will result in improved water quality in the coastal areas and reduce sedimentation and erosion of coastal areas. It will also lead to resolution of conflicts between freshwater and saltwater communities and reduce flash flooding and salt water intrusion into the upstream areas.*

## *Case Study 13. Combating erosion in the Red river delta, Vietnam*

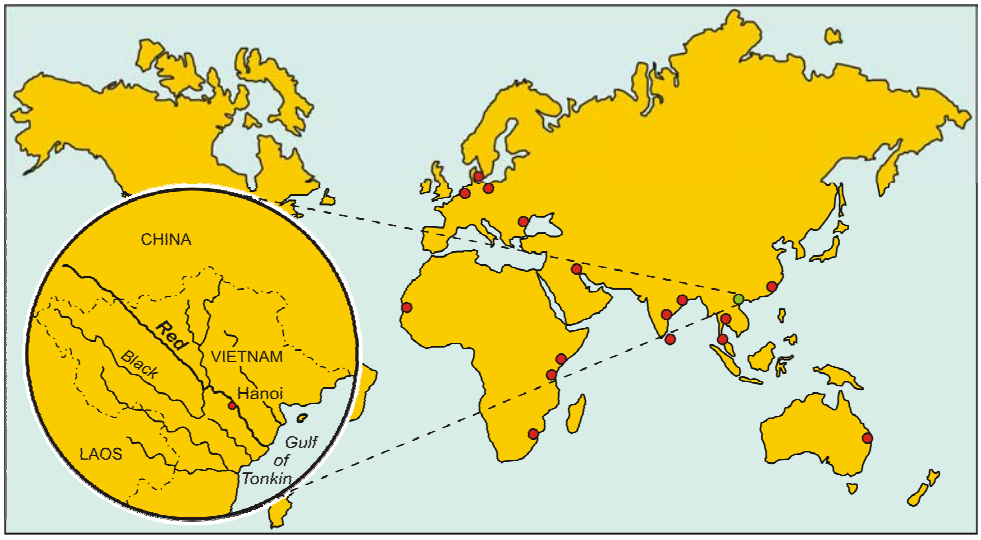


Figure 13: Location of case study 13: Combating erosion in the Red river delta, Vietnam

The Red river originates in the Yunnan province of China and flows in a northwest-southeast direction into the delta in Vietnam. The total length of the river is 1,140 km with 640 km in the mountainous upper reaches and 500 km in Vietnam. The Red river is one of the most densely populated areas of the world and the urban population is increasing by about 10 % annually. In the delta province, almost 60 % of the land is under agricultural use.

For centuries, flood control has been an integral part of the delta's culture and economy. An extensive system of dykes and canals has been built to contain the Red river, to irrigate the rich rice-growing delta and to reduce vulnerability to flooding. Dykes have been built on the two side of the rivers with a complicated drainage system for irrigation along more than 3,000 km. This ancient system has sustained a highly concentrated population and has made double-cropping, wet-rice cultivation possible throughout about half the region, where ca. 20 % of Vietnam's annual rice production is produced. The basin is also important for power generation.

The coast along the delta is about 150 km, largely protected by sea-dykes, is used for wet rice cultivation, settlement, aquaculture and salt production. The coastal zone exhibits rich biodiversity and includes nearly 100,000 ha of coastal wetlands. The area is also rich in mangroves which have been reduced considerably in recent years due to the expansion of aquaculture. The most important issue in the Red river delta is coastal erosion, a process which has been accelerated by the construction of the Hoa Binh Hydropower station barrage. There is also a shortage of fresh water in the dry season due to abstraction for irrigation and the construction of dams for hydropower generation which also can cause salinity intrusion into inland areas. This has serious implications for agriculture and threatens food security and livelihoods. Other problems are decreased sediment loads, pollution and reduced water flows leading to degradation of wetlands and reduction of fish catches.

In 2003, a Management Committee under the Government Council was established with the main goal to guarantee the clean status for domestic and aquaculture uses. Furthermore, an ICM strategy has been produced embracing the problems of erosion and accumulation, sea dyke protection, salt production by local people and various habitats e.g. mangroves and sea-grasses. A reserve at Xuan Thuy for the mangrove forest has also been established. Furthermore, a plan has been made for combating marine oil spills.

*Linked management would encourage policy makers to consider downstream impacts of upstream development especially with respect to sediment trapping in the dams. Other benefits would include regulation of the amount of water available leading to equitable distribution to all the provinces and for all users in industry, agriculture and aquaculture; domestic users will also have access to water. This is very important if a higher level of development has to be reached in the basin. Improved water quality and reduced salinity intrusion will promote agriculture and fisheries productivity and will thus contribute to ensuring food security whilst improved water quality will also support salt production and the tourism industry. Furthermore, restoration of wetland areas and the feeding and nursery grounds for many kinds of fish, prawn, crab, shellfish could be protected.*

## 5.4 Socio-economic benefits

Many of the river basins illustrate the significant socio-economic benefits that linked management will, in a variety of ways, provide through improved fisheries productivity, enhanced coastal/delta agriculture and improved tourism potential. This is more pronounced in the case of river basins with large populations which are dependent on subsistence level farming or small scale fisheries in the deltas or estuaries: Chilika lagoon, the Tana delta & Ungwana bay and Samana bay are good examples (see Case Studies 1, 2 and 10). In the Muthurajawela marsh and the Negombo lagoon in the Attanagalu Oya basin (see Case Study 14) nearly 5,000 fishermen are engaged in the estuarine fishery and the lagoon provides anchorage facilities for about 3,000 fishing boats. In Tanzania, agricultural and fishing communities would benefit if upstream-downstream linkages were coordinated in the Rufiji river basin (see Case Study 15).

### *Case Study 14. Optimising the ecological and economic potential of a coastal marsh-lagoon system, Attanagalu Oya river basin, Sri Lanka*

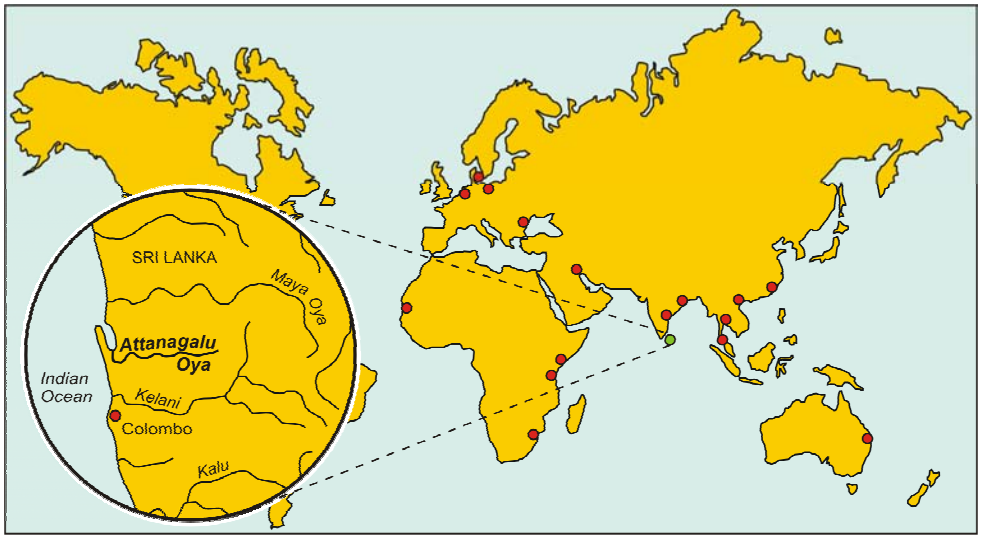


Figure 14: Location of case study 14: Optimising the ecological and economic potential of a coastal marsh-lagoon system, Attanagalu Oya river basin, Sri Lanka

*The Attanagalu Oya river basin is approximately 45 km long and 35 km wide and two major streams from the north and from the south join the river. The lower catchment is predominantly cultivated with paddy by the Attanagalu Oya Irrigation Scheme (AOIS) where the climatic conditions in the lower basin also permit the cultivation of a wide range of perennial, annual cash and food crops. The upper basin has a higher rainfall and is better suited for rubber and forest plantations.*

River flow is considerably reduced during the dry season due to the high demand for water and uncontrolled abstractions whilst in the wet season, due to inadequate drainage, the lower catchment

areas flood and inundate the agricultural lands. There are no major water resources development projects in the basin. However, the river basin is of significant socio-economic importance as it plays a critical role in regulating the structure and functioning of the Negombo Lagoon and Muthurajawela wetland system.

The Negombo Lagoon is a shallow coastal body of water approximately 13 km in length and a width of between 0.6 to 3.6 km. Its mean depth is ca. 0.7 m. To the south of it is located the Muthurajawela marsh, a coastal wetland (over 6,000 ha) that is an important component of the river basin-coast system. The lagoon is connected to the sea by a single, narrow opening. The entire wetland is separated from the sea by a sand barrier formed during past sea level changes.

More than 300,000 people live in the Muthurajawela-Negombo area with large numbers of industrial units in the area. Nearly 5,000 fishermen are engaged in the estuarine fishery. Together with the adjacent Negombo lagoon, Muthurajawela forms an interlinked coastal wetland system which by virtue of its high biodiversity and ecological significance, has been listed as one of the 12 priority wetlands in Sri Lanka. An economic valuation study in 2003 revealed that the total benefits derived from the marsh translate into benefits of just over $ 2,600/ha/year.

Many of the threats that undermine the functioning of the marsh-lagoon system originate from human activities within the system, notably the intense population pressure and the resulting demand for land reclamation, inappropriate location of housing without proper sanitary and infrastructure facilities, overfishing etc. Coastal erosion is also a major issue in the area.

A major influence of the Attanagalu Oya on the Muthurajawela-Negombo lagoon system is the input of high levels of agricultural and industrial effluent and sewage. Agriculture inputs of nitrogen and phosphorus are considerable. Industrial wastewater effluents, together with sewage, are generally discharged into the Attanagalu Oya or its tributaries. Sludge produced in the treatment plants is often disposed of in the marshy low lying land that is often flooded, a process which mobilises the pollutants into the surface waters.

High levels of sedimentation are also threatening the wetland/estuarine functioning: increased sedimentation has caused loss of effective water area, siltation, shoal formation, shallowing of the estuary and narrowing of the ocean entrance channels. In recent years, there has been a reduction in salinity intrusion into the upper parts of the estuary which has led to effects on the productivity of the Negombo lagoon. A number of initiatives have been taken to alleviate the problems:

- An Integrated Resource Management Plan for the Negombo lagoon and Muthurajawela marsh has been developed by the Central Environmental Authority. It had a major focus to establish community-driven management of natural resources so that they can be sustainably exploited.
- A Special Area Management Plan is being implemented by the Coast Conservation Department.
- The Negombo Special Area Management Community Coordinating Committee has been established to coordinate the implementation of the plan.
- The Ministry of Fisheries has established a Negombo Lagoon Management Authority to promote integrated management of the lagoon and enhance fisheries revenues.
- Several interventions have been implemented in the recent years to improve the ecological conditions and water circulation within the wetland system (e.g. dredging, removal of unauthorised construction, provision of sanitary facilities).
- A number of initiatives to promote public participation in the management of the lagoon including setting up of citizen committees and empowering the community have been undertaken.

In addition to the above measures which are mainly lagoon management measures, action has been taken to reduce pollution levels in the industrial estates by encouraging cleaner production practices. In addition, several tree planting programs have been initiated to reduce river bank erosion. The

Council has stopped dumping solid waste along the river and introduced a house-based compost bins system.

*Most of the management activities are focussed on the lagoon. The current approach needs to link the management of the lagoon and marsh to that of the river basin. This will enable the coastal management authorities to address some of the root causes of the problems e.g. addressing riverine inputs of agricultural and industrial effluent and reduction in the sediment loads. The resulting improved water quality will significantly increase productivity of the Negombo lagoon and yield increased fish catches and improved livelihoods.*

## *Case Study 15. Enhancing fisheries and agricultural potential in the Rufiji river basin, Tanzania*

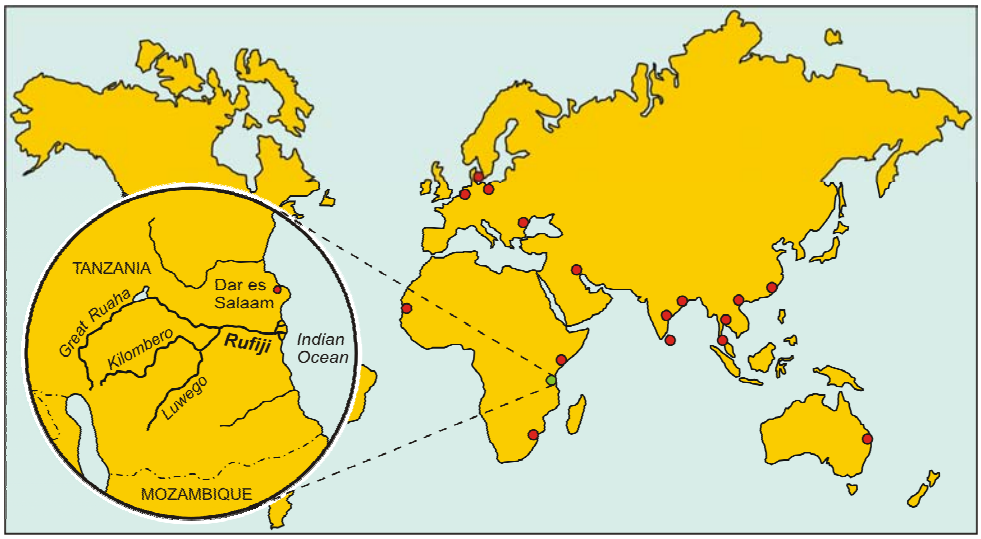


Figure 15: Location of case study 15: Enhancing fisheries and agricultural potential in the Rufiji river basin, Tanzania

*The Rufiji river basin is the largest river basin in Tanzania. The highland areas of the upper Rufiji are characterized by fertile volcanic soils and high rainfall. The lower Rufiji river flows to the shores of the Indian Ocean, running into a deep alluvial flood plain which is seasonally inundated. An important feature of the flood plain is the presence of 13 permanent lakes. Major water resources developments in the basin are mainly associated with hydropower generation and irrigation agriculture.*

The Rufiji river basin supports almost three quarters of Tanzanian irrigated agriculture land and about 80 % of all power in the National power grid. Agriculture is still the main occupation of 90 % of the households in the lower Rufiji catchment. The agricultural system of the lower Rufiji has for a long time been influenced by a combination of both rainfall and flooding of the river.

The crescent shaped Rufiji delta has extensive, estuarine mangrove forests which are the largest in East Africa and constitute almost half of Tanzania's mangrove forests. The Rufiji delta also offer habitats for migratory birds, feeding and breeding sea turtles, small remnant populations of dugong, and nursery areas for marine animals (especially shrimps). The Mafia Island Marine Park covers an area of 822 km². Fishing is an important economic activity in the lower Rufiji and the delta. Within the floodplain, fishing is carried out in the permanent lakes which provide suitable breeding habitats for fish and are regularly replenished by the seasonal floods. Over 80 % of the Tanzanian shrimp catch originate from the Rufiji delta and over 90 % of all the catch is exported.

Coastal sedimentation and siltation of coastal waters due to agricultural expansion on the highlands is the main coastal and marine issue arising from river basin activities. Of secondary importance is the reduced stream and peak flows due to damming. Another issue is saltwater intrusion and coastal salinisation due to water abstraction for irrigation. A proposed river impoundment, with the associated trapping of sediment, is expected to have significant consequences with respect to increased salt water intrusion and diminished nutrient availability affecting agriculture and altered natural vegetation in the floodplain and delta. Another future threat is the basin's estimated potential for oil and gas.

The Rufiji Basin Development Authority and Rufiji Water Basin have been established with the prime objective of promoting the resources of the Rufiji basin, including monitoring, regulating and controlling water use. Several projects have been implemented with a view to harmonizing conservation activities and human development needs in the lower delta areas.

*Having the whole of its catchment in the country is an advantage when planning, and implementing, coordinated upstream-downstream linkages. A linked management approach would ensure that activities in the upstream areas are undertaken with reasonable consideration of the downstream ecosystems and the goods and services rendered by these ecosystems. It will provide the framework for assessing the feasibility of projects such as the water impoundment plan and keep to a minimum the factors that are responsible for the changes occurring in the lower Rufiji and delta. Since agriculture and fishing are the main sources of income to the communities living in this area, any action to increase their potential would lead to considerable socio-economic benefits.*

## 5.5 Protecting and restoring ecosystem functioning and viability

The Moreton bay study (see Case Study 3) exemplifies how the recognition of a linked approach to the management of the catchment has benefited all stakeholders of the Moreton bay catchment area. This led to the development of a Regional Water Quality Management Strategy, the establishment of Moreton bay Waterways and Catchment (Healthy Waterways) Partnership to implement the Strategy and a major coordinated scientific research programme and a monitoring programme of Moreton bay, northern and southern coastal regions and their catchments. The Chilika lagoon experience (see Case Study 1) also demonstrates that even small scale watershed improvement activities coupled with lagoon management initiatives can have significant socio-economic benefits in the coastal community as well an environmental benefits. The Tigris Euphrates study (see Case Study 16) clearly shows that, in the continuum that comprises the river basin, the Mesopotamian marshlands, the Shatt-al Arab estuary and the northern Persian Gulf, it is only a linked management approach that can restore the ecosystem viability and the economic viability of certain Gulf fisheries.

## *Case Study 16. Ecosystem and socio economic links in the transboundary river basin-marsh-estuarine ecosystem of the Tigris Euphrates river basin*

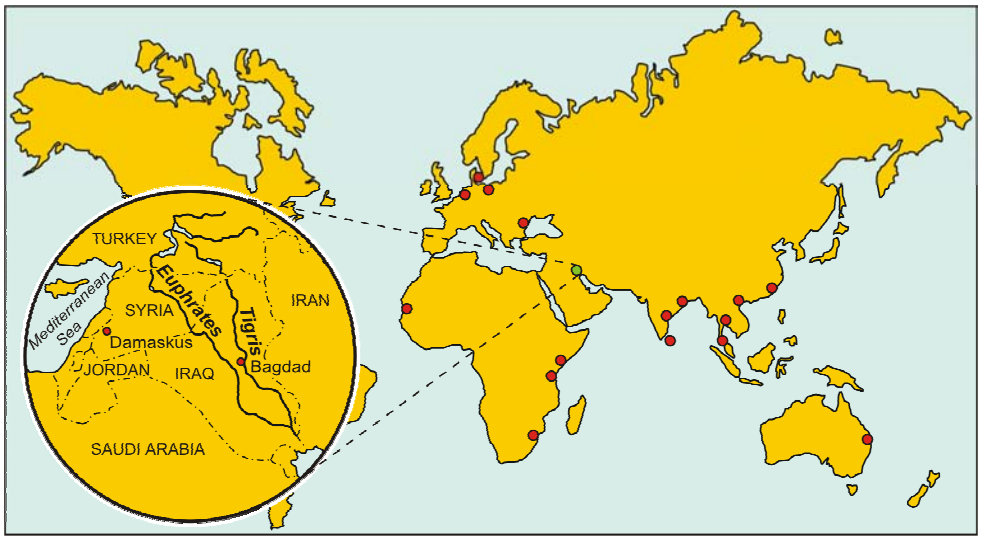


Figure 16: Location of case study 16: Ecosystem and socio economic links in the transboundary river basin-marsh-estuarine ecosystem of the Tigris Euphrates river basin

*The Tigris and Euphrates is a complex international river system, with several countries controlling the upper, middle and lower courses of the twin rivers. The Euphrates rises in Turkey and flows through Syria and Iraq, while the Tigris catchment, whose source is also in Turkey, is shared with Iraq and Iran. The Euphrates drains a larger surface area than the Tigris and an overwhelming 88-98 % of its runoff originates in the highlands of southeastern Turkey while the remainder of its catchment is an arid region that contributes little inflow. In contrast, the Tigris is less dependent on the headwater region in Turkey with most water originating in Iran and Iraq. This has important implications for water management as a single country, Turkey, is able to exert almost full control over the Euphrates river's hydrological regime.*

The rivers form, due to the geography of the area, a double delta composed of a continental marshland complex and a marine estuary. They finally drain into the Persian (or Arabian) Gulf, a semi-closed shallow sea, bounded by arid tropical and semi-tropical coastal areas. The gulf fisheries are important in the economy of the bordering countries.

In the lower Tigris-Euphrates basin, shallow but extensive marshlands are found that are an integral part of the freshwater-marine continuum. They are the largest wetland ecosystem in the Middle East and Western Eurasia and are situated, for the main part, in southern Iraq. The wetlands in 1970, covered an estimated area ranging from 15,000 - 20,000 km². The core of the marshes is centred in the area around the confluence of the Tigris and Euphrates. It is typically divided into three major areas viz. the al Hammar marshes, the Central marshes and the Al Hawizeh marshes. The eastern margins of the marshlands extend over the border into southwestern Iran. Marsh water flow finally joins the Shatt al-Arab via the Al Swaib river. The Shatt al-Arab plays a very important role in the sustenance of the economically important shrimp and finfish fisheries of the northern Gulf. Along the estuary was once located the largest date palm forest in the world and millions of people depended on the date palm forest for livelihood and income.

Being one of the world's most significant wetlands, the marshlands are an important habitat for populations of wildlife, including endemic and endangered species. They also serve as spawning and nursery areas for some marine species and provide habitat for several migratory species. For five thousand years, these marshlands have been inhabited by marsh Arabs who entirely depended on the

wetland ecosystem which provided them numerous economic benefits from fishing, hunting, rice cultivation and reeds for construction and paper milling.

The Tigris and the Euphrates are among the most intensively dammed rivers in the world. In the past 40 years, more than 30 dams have been built with a storage capacity several times greater than the volume of both rivers.

The immediate consequences of these development works have been the substantial reduction of water available for downstream ecosystems and the suppression of the spring floodwaters that nourished the lower basin and washed out accumulated salts. These dams and massive drainage works implemented in southern Iraq in 1990, following the first Gulf war, as well as the draining of the marshes, have led to reduced discharges, changes in river flow patterns and quality in the Tigris- Euphrates system resulting in destruction of the marshlands with considerable impacts on marsh wildlife and biodiversity. Between 1973 and 2002, almost 93 % of the core marsh had been lost. With their life-supporting ecosystem vanishing, the marsh Arab community is now much dispersed. These changes have also impacted the marine environment in the northwestern Gulf. The impacts are most severe at the head of the Shatt al - Arab estuary and the impacts on the Gulf system are generally more diffused. The most significant impacts are:

- Poorer water quality of coastal waters,
- Loss of spawning grounds,
- Reduced fish species diversity,
- Significant changes in salinity, nitrates and phosphate levels in the marshes,
- Increased salinity of seawater around the Northwestern Persian Gulf, and
- Destruction of palm forests.

Several measures have been taken recently to improve the situation:

- In 1990, the Gulf countries, excluding Turkey, signed the Protocol for the Protection of the Marine Environment against Pollution from land-based sources. This Protocol calls for action inter alia to control pollution at the source level, to take individual and or joint action to develop and implement effluent treatment programmes and conduct environmental impact assessments. It also calls for monitoring and data management, scientific and technical cooperation, development of necessary guidance and exchange of information.
- In 2003, re-flooding of the marshlands began by direct action of the marsh dwellers and the Ministry of Water Resources and active drainage operations were also stopped. By November 2005, 40 % of the former core marshes had been re-flooded although not restored.
- In 2005, the Regional Organisation for the Protection of the Marine Environment facilitated dialogue among the riparian countries, both at policy and technical levels, on the means available to re-establish the freshwater-marine continuum between the marshes and the Northwest Gulf area.
- In 2003, the International Technical Advisory Panel, an inter-disciplinary group of scientists was established to provide advice on the technical aspects of restoring the marshes and re-establish the ecological functions and the connectivity with the estuarine and coastal ecosystems.
- A Marshland Information Network has been established to monitor conditions and stakeholder meetings to engage the marsh community in the restoration process have been initiated.

*Both regional and international action has been focussed on the restoration of the Mesopotamian marshlands. This is considered to be an important first step and, in the process, several enabling conditions needed for further action to link river basin management to the management of the estuarine and coastal areas have been established. The recent regional and international action to restore the marshlands have resulted in increased awareness of the coastal and marine issues that could be resolved through trans-boundary co-operation. Some dialogue among the riparian countries*

*has been initiated and several projects to develop a good knowledge base has started. A regional policy on river basin management that recognises the need to maintain the ecological functioning and links within the river-coast system would go a long way to provide many environmental benefits (improved water quality, halting biodiversity decline) as well as socio-economic benefits in the estuarine and coastal areas especially in the fisheries sector and date palm industry.*

## 5.6 Improved management in trans-boundary rivers

The benefits of linked management in the case of trans-boundary river basins are considerable. There are over 200 major river basins world-wide that cover more than one country. Initiatives to establish a collaborative framework for the management of these common resources, or to manage the impacts of upstream activities on downstream riparian countries is an increasingly important issue. The trans-boundary river basins considered here have clearly shown that linked management is not an option but an imperative if the economic conditions and the environmental integrity of the downstream are to be maintained. The Colorado river (see Case Study 17) is an example of the complete bifurcation of management of the watershed and the estuary. To date attempts to restore flows over the border to Mexico have failed. Attempts within Mexico to manage fisheries since the 1950s – the second major agent of ecosystem change – have proved difficult and are only now beginning to produce positive results. Within the United States the allocation of the Colorado's waters in an arid landscape with a rapidly growing human population has also been highly complex and is subject to overlays of local, state and federal regulations.

The Incomati river basin (see Case Study 18) shows that in the absence of a linked management programme, the distribution of water resources is not equitable – the upper riparian countries are at an advantage and the downstream countries receive inadequate amounts of the river's water resources. Experiences in the management of Rhine and Danube basins (see Case Studies 4 and 5) have demonstrated that water quality improvements can be reached through cooperative efforts of riparian countries.

### *Case Study 17. The complexity of sustainably managing water across borders, the Colorado river, United States and Mexico*

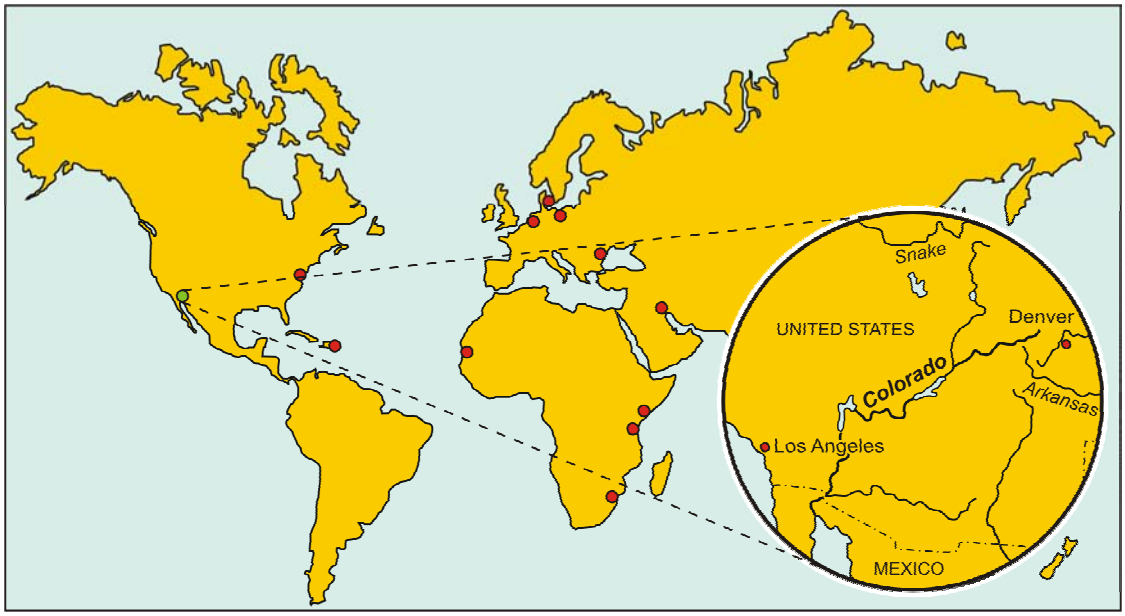


Figure 17: Location of case study 17: The complexity of sustainably managing water across borders, the Colorado river, United States and Mexico

*The Colorado river is about 1,400 miles long, beginning in the United States and ending in Mexico. The primary source of water supply to this river is snowmelt. The majority of the river basin flows through dry areas and the Mexican portion of the river and the estuary is in a desert. The Colorado river used to flow unimpeded through the western United States and formed a large estuary and associated wetlands at the northern end of the Gulf of California in Mexico. The fertile, silt-enriched delta extended over two million acres. Since the mid 1930s, little or no water reaches the Gulf of California and the estuary of one of the largest rivers in North America has ceased to exist. The two most important agents of change were upstream water diversion - 10 major dams (including the Hoover) and about 80 diversions leading water away from the river to irrigate farms and supply drinking - and fishing pressure.*

With the reduction in freshwater inflow to the lower river and estuary, the annual flood pulse has dwindled. This had a catastrophic effect on the wildlife with the demise of the clam, the totuaba (a large white sea bass), and the Gulf of California harbour porpoise (vaquita), which now teeters on the brink of extinction. The river once sustained the livelihood of many Native American tribes in the delta and the gulf. The Cocopahs, a native American tribe, traditionally fished, hunted, harvested native plants and depended on the river to sustain them for over 2,000 years. As the river dried up, they were forced to relocate, and suffered much economic hardship.

Contamination of the Colorado's waters by toxic pollutants and nutrients is another important issue. Parts of the Colorado were contaminated with radioactive waste, sewage wastes from overwhelmed septic tank systems and per-chlorate (a chemical used in rocket fuel). The diminishing quantity and quality of water from the Colorado river has had political as well as ecological impacts. The United States is bound by treaty to ensure that a stipulated quantity of Colorado river water enters the river in Mexico, but there are conflicts over the quality of this water.

Various elements of this very large system are being managed to address different concerns and achieve different goals:

- Management of land development and fisheries.
  In 1993, "a Protected Area with the characteristics of a Biosphere Reserve named the upper Gulf of California and the delta of the Colorado river" was created by Mexico and the Management Plan prepared a year later responded to the needs of the population which was backed by legislation. As a result, shrimp trawling ended but artisanal drift netting, the major threat to the vaquita, increased. A vaquita refuge has been proposed for the entire area that is believed to be its home ground although there is still no agreement about fishing in the refuge.
- Management of water within the US.
  A measure towards more integrated management of the Colorado's waters is the Glen Canyon Dam Adaptive Management Programme established in 1996. This was established to monitor and analyse the effects of dam operations on the Grand Canyon ecosystem and recommend adjustments intended to preserve and enhance downstream physical, cultural, and environmental values. The Colorado river Water Agreement allows the seven Colorado states to take water for urban and agricultural use within authorized limits to meet future needs. Representatives of the three lower basin states, along with various stakeholders and water and power agencies along the Colorado, have formed a regional partnership, which is developing a multi-species conservation programme aimed at protecting sensitive, threatened and endangered fish, wildlife, and their habitat.
- Management of flows across the border.
  In 1944, the United States legally acknowledged Mexico's right to its own share of the river, and guaranteed 1.5 million acre-feet per year for use south of the border. In the 1960s, Arizona began to pump highly saline water back into the river before it reached the border, in order to be able to deliver the legally-required volume of water. This water conflict reached a crisis in the 1970s. An attempt to address the problem of delivering adequate quantities of freshwater to Mexico was to

construct a desalination plant at Yuma. This plant was meant to remove salt from the agricultural wastewater before it was sent to Mexico although it has never operated. In the interim, low-quality irrigation drainage was routed away from the lower Colorado river by a concrete channel that crosses the border into Mexico where it has given rise to a wetland, La Cienega de Santa Clara. But this has created a new problem: if the Yuma plant were to come on-line, the Cienega de Santa Clara might disappear - a situation that further emphasizes the need for bi-national planning on the river.

*For the past few decades, freshwater in this region was regulated with a view to benefit the users in the watershed alone, with no concern for the people living downstream or the ecology of the estuary. If the river was within a single nation or within nations that did not have a long history of military conflict and mutual suspicion, an interlinked approach could have successfully conserved a magnificent ecosystem in the Mexican portion of the river and its estuary. In the absence of such an integrated approach, the result has been widespread devastation of the ecology of the lands traversed by the great river, as well as the various aquatic habitats within its waters. Lack of an interlinked approach has also had adverse societal repercussions. The livelihoods of native communities that traditionally depended on the river have been altered, drastically and forcibly. Conflict over the distribution of the river's waters has also affected many modern populations in the region. If an international management effort were to take root and grow, potential benefits would include: conservation of the vaquita, restoration of ecosystems in the upper Gulf of California and the Colorado delta, capacity building and raising awareness of local communities and non-governmental organisations, stakeholder participation, improved communication and conflict resolution, and improvement in fishery resources.*

## *Case Study 18. Shared management of the Incomati river basin, Southern Africa*

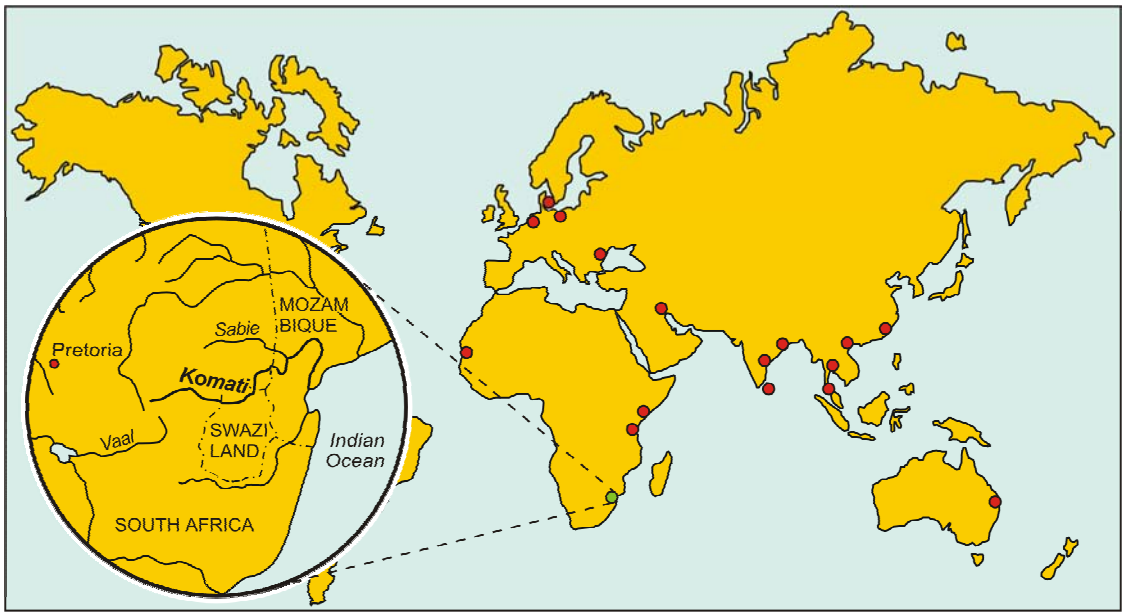


Figure 18: Location of case study 18: Shared management of the Incomati river basin, Southern Africa

*The Incomati river Basin is one of the most important river basins in Southern Africa, originating in South Africa and subsequently flowing into Swaziland before finally reaching Mozambique, where it discharges into the Indian Ocean. There are large numbers of dams in the basin, 22 of which can be classified as large, and most of them located in South Africa. Mozambique has one large dam which serves mainly as the storage component of an irrigation system.*

The estuary has an extensive mangrove forest covering near the mouth of the estuary. By serving as nursery grounds, the estuary and adjacent mangroves play a major role in the life cycles of economically important fish and shell-fish species and therefore sustain a considerable proportion of local population and the fish industry. There are about 24 freshwater and estuarine fish species of significant social and commercial value in the lower Incomati and lake Chuáli, one of the large natural lakes in the lower Incomati. The estuary discharges into the Maputo bay which can be considered as a dual ecosystem, receiving freshwater from the river through the eastern side while influenced by open seawater, with flourishing corals, on the western side. The two overriding issues in the Incomati river Basin are the modification of stream flow leading to both drought & flood situations and water shortages. These are caused mainly by the dams and reservoirs, water abstraction from these and inter-basin transfers to meet the increased demand for agriculture, urban and industrial developments. There are plans to increase the irrigated areas in all three riparian countries. Population growth and expansion of urban areas and industry demand more water than the river can supply, consequently more dams are being constructed and water from the Incomati is transferred to other basins. Flooding occurs at irregular intervals, with impacts on agriculture, natural habitats, damage to infrastructure and loss of life.

The main coastal impacts of modification to the stream flow and water shortages are deterioration of water quality resulting in pollution and consequent occurrence of water born diseases e.g. diarrhoea, dysentery and cholera and salinity intrusion that threatens the agriculture potential in the lower Incomati basin. Coastal erosion, due to sediment deficiency, is also a problem with the peninsula seriously eroding.

There has been a major effort, in the individual countries and collectively, towards the management of this shared water course. The most recent measures taken include:

- In 1983, the establishment of a Tripartite Permanent Technical Committee by the Governments of South Africa, Swaziland and Mozambique to provide technical advice to the governments regarding management of the shared water courses,
- In 1991, the Piggs Peak Agreement was signed to establish a minimum run-off for Mozambique,
- In 1992, the Treaty on the Development and Utilisation of the Water Resources of the Incomati river Basin was signed,
- In 1996, the establishment of a Joint Water Commission to provide a forum through which the management of shared water course issues are discussed and advice given to the respective governments, and
- In 2003, a protocol on Shared Watercourse Systems to foster closer cooperation for judicial, sustainable and coordinated management, protection and utilization of shared watercourses and to advance regional integration and poverty alleviation.

*Linked river basin - coastal area management in the Incomati basin would assure cooperation and strengthen the partnerships between the water/land use sectors, build consensus, support biodiversity/wetland conservation and integrated development from catchments down to coast; as well as improve understanding of the system structure and functioning through sharing of information and knowledge among the countries. Thus, a linked management approach would benefit the economy sectors, the population and the ecosystems along the river basin to the coast by:*

- *Reducing the impacts of droughts and floods through sharing of information along the river basin from upstream to downstream riparian countries,*
- *Assuring equity in the water allocation between the sectors and across the countries,*
- *Contributing to sustainable development and to reduction of potential conflicts in water use, through dialogue and mutual understanding between the stakeholders,*
- *Reducing water pollution and degradation of downstream ecosystems and ecotomes,*

- *Enhancing productivity of coastal ecosystems, in particular of fisheries in Maputo bay, assuring the development of the industrial and agricultural sectors in the lower as well as in the upper Incomati, and*
- *Bridging the gap, in terms of data and knowledge, across the river basin.*

*These changes would lead to transparency and equitability in water allocation, which in turn would contribute to conflict resolution both at the national level as well as across borders.*

## 5.7 Meeting future demands and threats

In the future, demands on water resources will continue to increase as will the need for structural water management interventions, changed flow regimes and levels of nutrient inputs. In order to achieve the goals of sustainable development both in the river basin and the contiguous coastal and marine areas, new approaches to water, river basin and coastal area management will need to be found. The responsibility for river basins and coastal areas tends to be the responsibility of separate agencies and uncoordinated efforts, frequently with different objectives and different approaches. The adoption of a linked management approach provides a means of rectifying the past mistakes and ensuring that continued development in the upper area of the freshwater- coast continuum will not be at the expense of losing the ecosystem functioning or the socio-economic development in the downstream areas or vice versa.

Traditionally, the Krishna river basin (see Case Study 19) has been managed only in terms of water supply. It is now evident from the freshwater and coastal issues highlighted, that this river basin should be managed in an integrated way. Sustainable development of the river basin as a whole can only be achieved by coordinated policy interventions that promote the inclusion of the needs of the delta and the estuary in any plan or proposals for developments in the upstream areas Ongoing political and social changes can also pose threats to environmental and economic viability of the coastal areas. By recognising the catchment coast linkages, river basin managers and coastal zone managers will be in a better position to harmonise resource management approaches and deal with these future threats.

### *Case Study 19. The beginning of change in the management of the Krishna river, India*

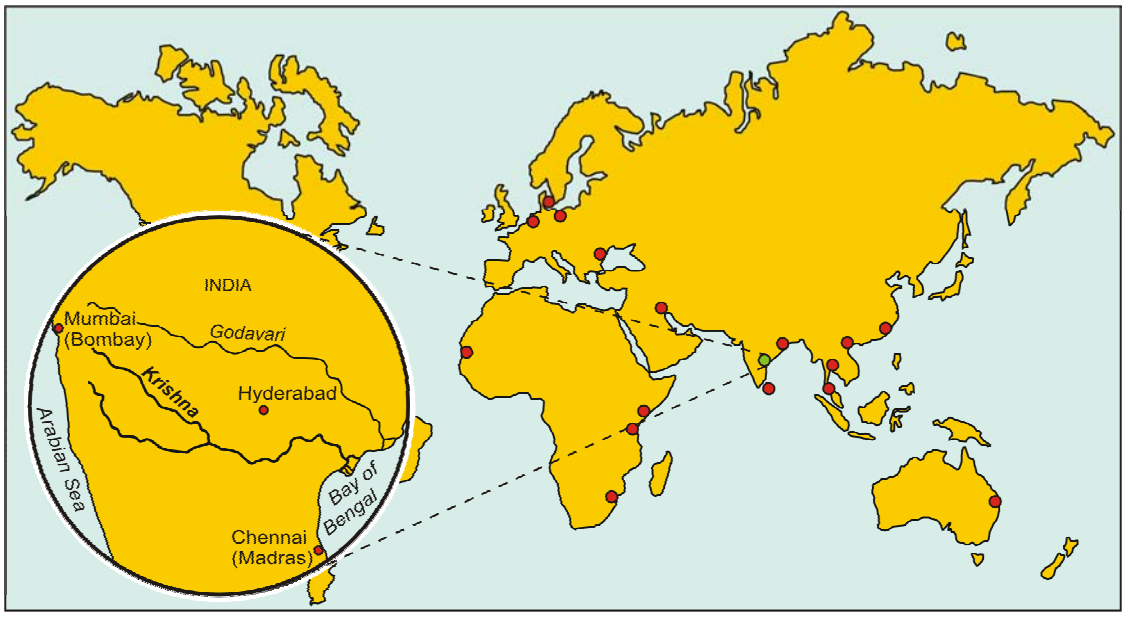


Figure 19: Location of case study 19: The beginning of change in the management of the Krishna river, India

*The Krishna river basin is located in the Central Indian states of Karnataka, Andhra Pradesh and Maharashtra. The basin area is suitable for agriculture which is the main source of income for about 70 % of the population. The river also has numerous dams to generate electricity and divert water for irrigation.*

The Krishna delta extends over an area of 200 km² and is characterised by extensive mangrove forests with a network of narrow channels. The coastal zone is potentially a rich area for agriculture, fisheries, commerce and communication. Between 1986 and 2004, the delta area experienced a major change in land use - the development of prawn farms and exploitation of mangroves by local communities for firewood, fencing material, fodder and house construction.

The stress on water resources in the Krishna river originates from multiple sources and their impact takes diverse forms. The growth of urban areas, increased industrial activity and dependence of the agricultural sector on chemicals and fertilizers have reduced the capacity of water bodies in this basin to assimilate and decompose wastes. These impacts are exacerbated by impacts from dam construction and reservoirs and changes in land use upstream. Since it plays an important role in the socio-economic development of the downstream communities, the changing patterns of land and resource use in upstream areas have affected not only the ecological integrity of the coastal ecosystems in the Krishna delta but has also impacted the socio-economic development of the dependent communities. The main effects of these activities and their coastal impacts are:

- Reduction in freshwater flow: river discharges have declined to such an extent that fisheries productivity has declined and a sand bar has formed in the mouth preventing free flow of tidal water in and out of the mangroves.
- Reduced sediment discharges: The sediment load has also decreased sharply reducing the nutrient availability in the downstream ecosystems.
- Water quality degradation: The intensive agricultural and industrial development, together with high population density, has resulted in very high levels of water pollution. Domestic wastewater contributes mainly towards organic pollution, whereas industrial wastewater is responsible for both organic and inorganic pollution – and in certain cases, contains toxic and hazardous substances. Agricultural run-off laden with nutrients and pesticides adds to the pollution load of the river basin.
- Decreased fisheries: The downstream river fishery has reduced by over 60 %.
- Declining agriculture potential: The farming populations in the delta experience water scarcity for irrigation, ground water depletion, seawater intrusion in the ground water and a decline in soil fertility.
- Shoreline changes: Both erosion and accretion occur in the west and east coast of the delta, while considerable accretion has occurred in the south.

A number of actions have been taken by national, regional and local government to improve the situation in the river basin. In December 2001, central government inaugurated the National river Conservation Plan project that recognises that a multi-faceted programme is required to ensure that water demands of the country are met. The Andhra Pradesh government has enacted legislation to regulate the exploitation of ground and surface water resources in order to lead to improved conditions in the downstream areas. Alternative wood and fodder resources have been sustainably provided to the local communities and large-scale planting of timber trees has been recommended in the sandy areas to reduce the pressure on mangroves. The produce from these plantations will be shared with the local community. A pilot project to build the capacity of local communities, local NGOs grass roots organizations and government institutions to restore, conserve and sustain mangrove wetlands through participatory analysis and action has also been initiated.

*In the Krishna river basin, there are direct linkages between dam construction and reduced water flow and reduced sedimentation in salt marshes. Recognition of these linkages is a prerequisite for better*

*co-ordination of policymaking and action across sectors (water, forestry, agriculture, urban development, environmental protection etc.) ultimately leading to a more rational use of resources and more effective environmental protection.*

## *Case Study 20. Balancing upstream economic activities with coastal sustainable development in the Oder river basin, Germany and Poland*

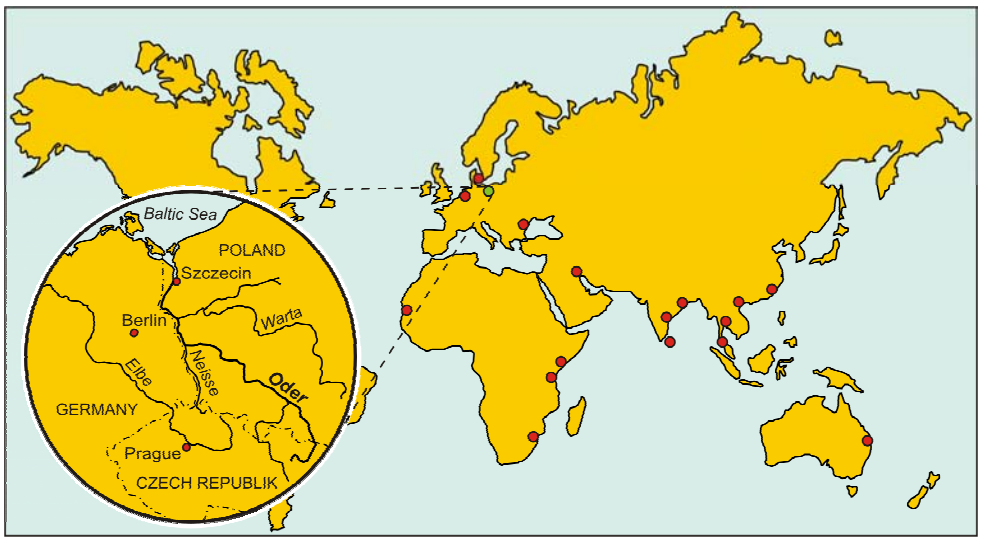


Figure 20: Location of case study 20: Balancing upstream economic activities with coastal sustainable development in the Oder river basin, Germany and Poland

*The Oder (850 km length) originates in the hilly Polish-Czech boundary region and shares its basin with Poland, the Czech Republic and Germany. For centuries, the river basin has supported the socio-economic development of the region yet has been subject to strong human influence and intervention. Today, the river basin supports a population of over 15 million and the important land and water uses are human settlements and industries, agriculture, hydropower generation and navigation. In spite of the intense level of development, large parts of the river are surrounded by floodplains and floodplain forests which are of outstanding ecological value and under nature protection. Floods are a rare phenomenon.*

The estuarine and coastal region is a complex of lagoons, islands and the large Pomeranian (Oder) bay that is shared between Germany and Poland. The largest lagoon is the shallow and highly eutrophic Szczecin (Oder) Lagoon which serves as a storage pond for sediment, nutrients and heavy metals and protects the Baltic Sea from pollution. Intensive sediment transport causes accretion and erosion along the shore, although erosion dominates. The estuary region is only sparsely populated and broad reed belts and artificial sandy beaches characterize the coastline. Tourism, agriculture, fishing and shipping are important economic activities in the coastal zone. Most of the coastal area is under nature protection.

The most urgent issues in the basin are:

- Eutrophication and poor water quality caused by nitrogen and phosphorus loads from intensive agriculture, industries and cities. The lagoon is eutrophic, lacks submerged vegetation and suffers from severe algae blooms. Eutrophication in the lagoon still remains a central issue that hampers the development of tourism and nature protection.
- Flooding from storm surges and river floods. Storms can result in flooding, increased coastal erosion and damage to harbours and coastal infrastructure. Storm surges cause temporary intrusion

of seawater and the increased water masses discharge increased amount of nutrients and pollutants into the coastal waters.

- Dredging and engineering measures to maintain the navigation channels. Dredging removes most of the sediment as well as large amounts of nutrients. The waterway through the lagoon is to be deepened to allow the passage of larger ships. In addition, new polders and storage reservoirs and a new barrage are planned.
- Obstruction to fish migration (e.g. eel, salmon and trout) by the large number of engineering structures in place. The introduction of many alien species by ships is also an issue.

Implementation of EU directives e.g. the Water Framework Directive (WFD) which demand clear implementation targets have led to accelerated cross-border cooperation and will continue to be a major driving force in fostering cooperation in European trans-boundary regions. In the Oder region, there are several agreements aimed at cooperation between Poland and Germany that relate to coastal zone and river basin management. The International Commission on the Protection of the Oder against Pollution (ICPO) is the most important mechanism. It has the task of coordinating the implementation of the WFD within the international Oder river basin. Both Poland and Germany have prepared coastal management plans. These have, however, been prepared independently and are advisory, with no legal status.

In the last ten years, a number of municipal and industrial waste water treatment plants have been constructed around the river basin. These plants together with a decline of agriculture and industries in the early 1990s and particularly low rainfall in these years have led to a significant reduction of the riverine nutrient loads.

*The Oder demonstrates the interrelationships between river basins and the coast and the benefits that could be derived by linking coastal zone management and river basin management. River basin activities are linked to many of the environmental problems in the Szczecin (Oder) Lagoon and the Baltic Sea - flooding, eutrophication and degradation of water quality and blocking of migration pathways of fish. Two general issues relating to coastal development that demand a river basin - coast link are balancing shipping, industrial and agriculture development in the region with the maintenance of water quality and biodiversity and meeting the constant demand for flood management, coastal protection and structural interventions to support navigation, irrigation and hydropower generation. Furthermore, the region faces a threat from predicted climate change and sea-level rise, a threat that will significantly worsen the present situation, placing tourism infrastructure at risk and increasing the chances of flooding.*

## 6 Four common needs for effective implementation

Creating the enabling conditions for the linked management of river basins and coastal zones will, naturally, encounter many challenges. IWRM, ICM and other natural resource management programmes have taught us that quick fixes and short programmes cycles are not to be expected: a programme cycle is approximately 5-12 years and establishing the enabling environment for management is the most problematic and time consuming. Managing and regulating human activity over large areas, often densely populated, urbanised and offering enormous potential for industrial and agricultural development remains a major challenge. The situation is further complicated when more than one country, with different cultures, differing economies and different development contexts, are involved.

River basin management and coastal zone management basically come from two different traditions and are implemented by professionals who come from different disciplines. River basin management stems from a water resource management perspective and focuses on a single resource (water) with multiple uses placing emphasis on environmental management through multi-sectoral coordination with some elements of land-use regulation. Coastal zone management, on the other hand, focuses on

multiple resource and multiple use management based on physical planning with a strong emphasis on land-use regulation and physical interventions.

For river basin managers, maintaining a sustainable water resource system is complicated owing to the large number of potential uses. Political ramifications and trans-boundary situations makes this even more difficult. One of the most serious problems facing water managers is the effective allocation of an essentially limited resource among rapidly growing and competing demand. In addition to abstraction for irrigation and drinking purposes there are the in-stream uses which require no abstraction and water management interventions for flood hazard mitigation and drought management.

Addressing the impacts of non-point sources, especially agriculture inputs, which is one of the principal drivers for coastal water quality degradation in many developed economies, has proven to be extremely difficult and very challenging even with current technological advances. Nitrogen and phosphorus loads from agriculture runoff account for 50 % of the total load carried by the Danube. The Odense river basin management programme shows that in spite of almost 20 years of implementation of various measures specifically targeted at reducing agriculture inputs, three successive action plans and enormous financial investments, the coastal water quality issues, especially eutrophication, still remain a problem.

Analysis of the river basins, show that the main constraints relate to a biased attention to socio-economically more profitable activities, institutional and policy/ legislative inadequacies, lack of thorough analysis of linked issues making decision-making difficult, lack of public awareness and, therefore, public demand for linked management.

## 6.1 More attention to socio-economically equitable development

A major challenge is to find a good balance between the socio-economic demands and the imperatives of continued ecological functioning of the river basin – coastal system. The river basins studied in this report show that there is biased attention to socio-economically more profitable activities. The problem is compounded by the fact that very often goods and services provided by the coastal and marine ecosystems are not validated and benefits of maintaining the ecological and hydrological functions of these ecosystems cannot be defined in monetary terms. Thus, when diversion of water for irrigation or storage of water for hydropower are considered, the impact of reduced and irregular supplies of freshwater on the coastal ecosystems is often ignored (examples are Krishna, Oder, Senegal, Tana, Chilika lagoon). This also stems from the fact that generally river basin management and the authority of the river basin organisations stops at the estuary. An additional dimension highlighted in the example of the Oder basin, is that the coastal area – river basin cooperation is often overshadowed by the urgency to promote cross border cooperation on resolving cultural, economic and social differences and foster regional economic development.

In the case of several of the river basins considered, it was found that the coastal part of the system is much smaller in geographic extent and socio-economically less developed than the upstream regions. In the case of the Oder, a fundamental reason for the inadequacy of coast-river cooperation is the fact that the coastal area is small in comparison to the catchment. Thus the coastal communities have little backing and coastal issues do not get due attention at the political and administrative levels. A similar situation prevails along the Incomati and Krishna rivers.

## 6.2 Strengthening the enabling environment

**Lack of political will:** The study has highlighted many institutional barriers to establishing a link between the management of the catchment and the coast. The political – administrative organization of marine and freshwater management is often complex, involving different ministries or departments of the governance system and spread at national, regional and local government levels, the latter of which may be autonomous in some countries. Addressing these issues and challenges and providing the enabling environment to support linked management requires a strong and sustained political will at

all levels. In many countries new institutional structures and legislative reform aimed at integrated approaches to water management are emerging. Changes anticipated by these reforms will materialise only if there is commitment at all levels to combat vested interests and allocate the financial resources and additional investments required. International organisations need to continue their efforts in ensuring that linked management stays high on the political agenda.

**Inadequate comprehensive water policy and legislation:** This is a common constraint seen across most of the basins studied. The major problems related to lack of co-ordination of water sector activities is partially attributed to the absence of comprehensive water policy accommodating integrated water management in the context of harmonising national economic development plans and water sector plans. A clear example is the agricultural policies in many countries which point to expansion of agriculture leading to increased use of fertilisers. For example, the agriculture policy of 1998 in the Mahanadi catchment (Chilika lagoon), which aimed at doubling the agriculture production would mean a considerable increase of fertiliser use.

A second element regarding water policy is the need for water policies that are equitable across geo-political boundaries. As seen from the Colorado study the lack of a water policy agreed upon by the basin states of US and Mexico is a major constraint to ensuring that the lower basin part in Mexico, including the delta and the coastal region, receive adequate water (it now receives only 10 % of the water). Several countries included in the study have recently developed water policy and/or new legislation on water e.g. Thailand and Vietnam. In Mozambique, national water policy (1995) and legislation (Water Act of 1991) have been available for some time; these policies, however, do not always acknowledge the need to incorporate the imperatives of the coastal ecosystems and coastal communities.

**IWRM not in place:** The need for IWRM, its concepts and general principles for implementing IWRM has been consistently promoted since the United Nations Conference on Development and Environment (1992). Several conferences and institutions, global and regional, have focused their attention on defining inter alia the enabling conditions, institutional and legislative context, developing guidelines and providing the necessary capacity building inputs.

The study clearly shows that integrated management of water even within the river basin catchment is not practiced. If there is some IWRM experience, the efforts do not match the broad objectives of water management covering the utilisation and development of water resources in an efficient, environmentally sound, equitable and reasonable manner in order to satisfy society's demand for water, water-related goods and services, as well as to safeguard the ecological functions of water resources. Water management activities are often split among a number of ministries and departments at the national level. The fragmentation of responsibilities among sectoral ministries and administrative agencies hinder coordination and impede attempts to integrate water management activities. Some studies reveal that one of the limitations is that basin committees are not effective in encouraging cross-sectoral management of water resources and related development in the basin.

**ICM not in place or weak at sub-national level:** Although most of the countries where the studies are located now have ICM programmes at the national level, its practice at the local level is, in general, not very strong. This is the case in Thailand where there is a national ICM programme but implementation at the coastal part of the Songkhla lake and its environs and the estuarine area of the Bang Pakong basin is not practised. In the case of the Attanagalu Oya, there is a reasonably strong ICM programme in the Negombo lagoon where even a lagoon Management Authority has been established. However, the mandate of both the coastal management programme and the Negombo lagoon Management Authority does not extend beyond the coastal zone or the lagoon boundary. In contrast, the Chilika Development Authority established to restore the lagoon ecosystem and promote wise use of the natural resources, has devised a mechanism to extend its authority indirectly, but effectively, beyond the lagoon. Although it has limited regulatory authority over catchment activities, coordination with key water management institutions is obtained through the governing body of the

CDA which includes Secretaries of several ministries with responsibility for Integrated River Basin Management and it is chaired by the Chief Minister of the State of Orissa. Through these strategic links the CDA is attempting to gradually influence the management of the Mahanadi river basin.

## 6.3 Improvement of the institutions

**Lack of co-ordination:** Institutions for water resources planning and management and institutions for coastal zone management have their responsibilities fragmented among various sectoral ministries and administrative agencies. This has resulted in proliferation of authorities and uncoordinated planning for water development giving way to overlap of activities and waste of scarce resources with little or no consideration to the impact of these activities on coastal ecosystems and economic activities. This situation is seen throughout the study. In the case of the Oder basin, both Germany and Poland have prepared coastal zone management plans but they have been prepared independently from one another. In the Songkhla lake, the responsibility for surveillance and administration of permits, licenses etc. is split between the fisheries departments of two different provinces and reportedly there is no coordination between the two institutions in this respect. Fragmented and shared responsibility is a reality and they needs to be addressed by effective coordinating mechanisms.

**Inadequate regional co-operation on trans-boundary basins:** In the case of trans-boundary river basins, it is clear that the most serious problem is absence of, or weaknesses in, common co-ordinating mechanisms through which the development of trans-boundary water resources for socio-economic development of riparian countries on an integrated and equitable basis could be addressed. All five trans-boundary river basins considered have some kind of co-operative arrangements having a certain degree of responsibility for development of common resources. In the case of Senegal, efforts of the OMVS to date have been directed to the development and management of the basin and did not specifically address the coastal problems caused by developments in the upper basin or the valley.

The Tigris-Euphrates, Senegal, Colorado and Incomati basins amply demonstrate that a formal protocol between river basin authorities (in riparian states) and the coastal authorities goes a long way to promote integrated management of the coastal waters and the fresh water basin. In the case of the Tigris-Euphrates, the lack of an institutional mechanism to promote discussion and consensus on the need to ensure the sustainability of estuarine and marine ecosystems has also been a major constraint.

**Inadequate capacity:** The majority of the basins highlighted the limitations imposed by lack of capacity within the organisations that deal with river basin management and coastal management. Capacity relates to skilled personnel and financial resources. Lack of capacity often leads to weak coordination among institutions and weak enforcement of existing regulations that can, to some extent, control land use and human activities such as deforestation, unsustainable agricultural practices, industrial and sewage inputs etc. in the basins. Shortages of skilled personnel is an issue highlighted in several of the river basins. Recently established river basin organisations such as the Bang Pakong river basin Committee lacks the experience and know-how to effectively manage the water resources under their control.

Lately, there has been a trend towards decentralisation of authority for resources management and IWRM has been decentralised in several countries. However, in several studies it was found that the national authorities do not provide adequate financial resources to the local or provincial governments to support the management bodies at the local level to carry out their functions.

In response to recent global calls for strengthening IWRM, many countries are developing new institutional structures and legislative reforms and new water policies and laws are being formulated. In many countries, the capacity to manage the changing process is limited. Other issues regarding institutional capacity are lack of continuity due to various factors including the practice of placing political appointees in mid and upper level positions, highly decentralised decision-making and unclear and overlapping functions.

**Lack of a thorough analysis of the linked issues:** The basin studies have shown that management interventions in river basins, deltas and coasts are often hampered by lack of ecological information, inadequate inclusion of all stakeholders, inadequate data on extent and scale of land use changes and inadequate baseline data.

Analysis of pressures and driving forces behind linked issues is complicated by several factors. The cause-effect relationships are not linear or direct. Interpretation of the underlying causes of habitat changes is further complicated by the fact that many different human activities are contributing to the environmental problem simultaneously. Further, environmental issues in the coastal and marine areas are often caused by coastal and marine activities themselves and it is difficult to apportion the effect of upstream activities from effects of localised activities. In the deltas of the Krisha, Rufiji and Tana rivers, for example, it is not possible to indicate the impacts of dams on the degradation of mangroves because of the impacts of activities in the delta itself (expanding shrimp ponds, cutting of mangroves for construction and fuel wood). A third reason is the unavailability of time series data needed for analysis. In most of the river basins, there has been no long term multi-disciplinary research and monitoring programme in the delta coastal areas. Therefore, there is incomplete understanding regarding the scope of the downstream impacts and the problems caused. A significant challenge to the scientific community is therefore to provide more precise data, for example, on sediment budgets and water quality and flow changes along the full continuum of river basins, estuaries and coastal zones.

In addition to the analysis of the linked issues, ideally, the potential for environmental change and societal response should be explored. Such lack of full understanding and scientific data support is a major constraint to decision making in allocation of water and other economic activities in the catchment areas.

The Chesapeake bay shows another aspect of need for thorough analysis. Although it represents a heavily funded and long-term linked watershed-estuary management programme, its weakness lay in certain conclusions drawn at the early management stages. Following long term studies it was assumed that the priority was to address steadily declining water quality by taking measures to control point sources of discharge along the bay’s shoreline. However, it subsequently became clear that the regulation of non-point sources was as important if the water quality was to be restored.

Past unwillingness to share information as well as lack of an institutional mechanism to promote discussion and consensus on the need to ensure the sustainability of estuarine and marine ecosystems is also a major constraint.

## 6.4 Involvement of the stakeholders

Several studies have identified lack of awareness as a constraint. In the Oder, for example, as a result of the lack of public awareness regarding water-related problems and consequences of not employing integrated management approaches, there is no strong civil society demand for measures to improve environmental quality. Watershed communities need to understand the implications of activities in the watershed on the coastal communities and the coastal communities need to understand how their livelihoods may be threatened by ill-coordinated upstream activities. The coastal communities need to be made aware of and be empowered to encourage their political leaders to take action necessary to reverse current trends in upstream resource development activities.

Full participation of all stakeholders, including the general public, is considered to be a cornerstone for successful implementation of interlinked management. When local communities are faced with national government decisions in which they have had nothing to say, lack of understanding can quickly lead to distrust and feelings of resentment. A successful programme need not necessarily have the best technical content, but it does require public approval whilst meeting the needs of a large number of stakeholders. Those who depend upon the river basin are often the ones most aware of its value although they may still prefer short-term exploitation.

Ultimately it is the public's attitude that determines society's response to management decisions. Efforts to protect and develop an area in a sustainable way can only succeed if all those who work and live in the area are committed to this objective. When it does not "buy into" the decisions taken by being actively engaged in the decision-making process, the public can often substantially delay, or even prevent, initiatives. Creating public awareness and fostering public participation may mean that more time is required for decisions to be taken, but experience shows that such an approach is ultimately more cost-effective. The absence of public awareness and the loss of confidence in management decisions and the regulatory process can create enormous constraints to implementation. Spatial development planning without the support of the local community may be a doomed exercise, yet there is still a widespread lack of public participation in freshwater and coastal management worldwide.

## 7 Conclusion

Whilst the biophysical, economic and developmental context in the studies considered are variable, there is much similarity in the many linked issues they have highlighted. It is also clear that the majority of the linked issues are those coastal and marine issues that are caused by river basin/catchment activities. Another element that is seen from these basin studies is that cause-effect linkages are neither linear or direct. The major economic and development activities that are the key driving forces of change are construction of reservoirs and dams mainly for hydropower and irrigation, water diversion schemes, agriculture and industrial development, human settlements, abstraction for drinking water and ports and harbour development.

These activities in the river basin/catchment result in the following bio-physical effects:

- Changes in water quality
- Changes in river discharges
- Changes in sediment loads
- Changes in salinity regimes
- Obstruction to migratory pathways of anadromous and catadromous fish

From the studies, it can be concluded that the most important environmental impacts of these effects in the coastal and marine area are:

- Eutrophication and pollution of coastal waters
- Coastal flooding
- Decline in fisheries productivity and agriculture potential in downstream areas
- Loss and impaired ecological functioning of mangroves and other wetlands
- Increased coastal erosion
- Geo-morphological changes such as shoaling, blocking of estuary/lagoon entrance and decrease in the effective water area of lagoons and estuaries

Economic implications arising from these impacts are considerable and touch various sectors of the national economies. Direct economic costs are often reflected in loss from tourism, fisheries and coastal agriculture, increased investment in stabilizing beaches, managing coastal erosion and maintaining estuary/lagoon mouths open, in purification of drinking water supplies and maintaining depths navigation channels. These also have a bearing on social conditions in the downstream communities, for example, increased use conflicts, reduced food security and loss of livelihood.

The experience in the last few years show that, although the benefits of linked management are most of the time obvious, operationalising such a management regime has been very slow indeed. IWRM, ICM and other natural resource management programmes have taught us that quick fixes and short

programme cycles are not to be expected: a programme cycle is approximately 5 - 12 years and establishing the enabling environment for management is the most problematic and time consuming.

An overview of these river basin studies reveals that they very broadly fit into three categories.

**Category I:** Sites where linked issues have been identified

**Category II:** Sites where some action to link the two management regimes have been taken but policy or sustainable institutional and legislative mechanism for linked management are not yet in place

**Category III:** Sites where policy, institutional or legislative mechanisms for linked management are in place

| Category | River basin |
|---|---|
| Category I | Attanagalu Oya, Krishna river, Rufiji river, Senegal river, Songkhla Lake, Tana river, Red river, Colorado river |
| Category II | Chilika lagoon, Tigris Euphrates rivers, Oder river , Odense fjord, Moreton bay, Incomati river, Samana bay, Bang Pakong river, Jiulongjiang river |
| Category III | Danube river, Rhine river, Chesapeake bay |

Table 2: River basin studies classified into three catagories

There are some factors which appear to be vital with respect to successful implementation of an interlinked management approach. Perhaps the most important of these is a strong political will and strong administration to push events forward in the first place. A number of the studies e.g. Chilika and Juilongjiang show that with the necessary intervention at a high level, a real start can be made. Another important factor related to this point, especially in international, trans-boundary rivers, but also national rivers traversing different regional borders, is signing binding agreements to allow a concerted, even coordinated programme of change to take place. Much progress has been made in Europe with both the Danube and Rhine which both have a river basin Convention as the basic building block for improved management. Another significant factor in successful implementation is taking into account the wider regional planning so that specific basin management falls into the whole picture rather than having its own place in the planning process. This was particularly well illustrated with the Moreton Bay study. One of the cornerstones of any form of integrated management is the involvement and participation of all stakeholders, including the general public. This is being increasingly realised and, again, a number of the studies either had stakeholder participation embedded in the management process or were about to begin to do so. The fifth cornerstone of good management practice for coast and river is good and effective communication of relevant knowledge amongst those who need to know.

Not surprisingly in all cases where problems were seen with integrated management, it was these themes that kept recurring as constraints. Institutions needed to be strengthened as did the involvement of the stakeholders. There was often little political will and appropriate legislation was often lacking. Capacity needed to be built, there was a perceived lack of coordination and often little awareness of the shared issues or the consequences downstream of an upstream development activity. In fact, one of the main socio-economic problems downstream is that insufficient attention has been paid to profitable activities upstream. It appears that these predominating problems are the key issues which need to be addressed but once successfully targeted are the gateway for a successful management programme.

The majority of the basin studies showed some elements of interlinked management or the precursors for such elements. No two were the same, although in many respects there was great similarity between the problems they were addressing. The studies all give certain good examples of the various elements that are needed to conduct an interlinked management between coast and river and should

form the basis for examples of best practice which can be applied to other river basins. In all cases there is a basis for a continued effort which should be expected to reap rewards in the future.

## 8 References and source material

Anukularmphai, A.; Sompongchaiyakul, P.; Rivas, A & Sangganjanavanich, P. (2005): A Case Study for Interlinked Coastal and River Basin Management for Songkhla Lake Basin, Thailand. A background paper.

Carmo Vaz, A. & Lopes Pereira, A. (2000): The Incomati and Limpopo International River Basins: A View from Downstream. Water Policy 2, 99-112.

Carriquiry, J. D. & Sanchez, A. (1999) : Sedimentation in the Colorado River Delta and upper Gulf of California after nearly a Century of Discharge Loss. Marine Geology, 158(1), 125-145.

Chesapeake bay Foundation (2005): The Chesapeake Bay Watershed. Retrieved 11/16, http://www.cbf.org

Chufamanee, P.; Boromthanarat, S. & Lønholdt, J. (2003): Partnership Policy in Songkhla Lake Basin. A Case Story Presented at the Songkhla Workshop on Linking Management of Catchment and Coastal Ecosystems on 27-30 January 2003. Songkhla, Thailand.

Conference of Rhine Ministers (2001): Rhine 2020 Programme on the Sustainable Development of the Rhine.

Convention on the Protection of the Rhine (1999).

DaNUbs (2005): Nutrient Management in the Danube basin and its Impact on the Black Sea. DaNUbs-Project Final Report, EVK1-CT-2000-00051.

Davis, R. & Hirji, R. (eds) (2003): Water Resources and Environment - Technical Note C1: Environmental Flows: Flood Flows. The World Bank.

Dyson, M.; Bergkamp, G. & Scanlon, J. (eds) (2003): Flow - The essentials of environmental flows. IUCN - The World Conservation Union

Eden again project (2003): Building a Scientific Basis for Restoration of the Mesopotamian Marshlands. Findings of the International Technical Advisory Panel Restoration Planning Workshop, 12. March 2003, Eden again project, The Iraq Foundation.

Emerton, L. & Kekulandala, D.C.B. ( 2003): Assessment of the Economic Value of Muthurajawela Wetland. IUCN - Asia Regional Environmental Economics Programme and IUCN - The World Conservation Union, Sri Lanka Country Office.

European Commission (1999): Towards a European Integrated Coastal Zone Management (IZCM) Strategy: General Principles and Policy Options: a reflection paper. Office for Official Publications of the European Communities.

Ghosh, A. (2003): Experience Brief for Chilika Lake Orissa, India.

Global Water Partnership Technical Committee (2005): Catalysing change: A Handbook for Developing integrated Water Resources Management (IWRM) and Water Efficiency Strategies.

Harding, B. L.; Sangoyomi, T. B. & Payton, E. A. (1995): Impacts of a Severe Sustained Drought on Colorado River Water Resources. Journal of the American Water Resources Association 31 (5), 815–824. http://www.hcn.org Retrieved 11/16/05.

Hoguane, A.M.; Motta, H.; Lopes, S. & Menete, Z. (2002): Mozambique National Report on Integrated Problem Analysis. Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa. GEF MSP Sub-Saharan Africa Project (GF/6010-0016).

Horton, T. (2005): Chesapeake: Why can't we save the bay? National Geographic Magazine. Washington, D.C., Vol. 207, Issue No: 6, 22-45.

ICPDR - International Commission for the Protection of the Danube River (2005): The Danube River Basin District. River basin characteristics, impact of human activities and economic analysis required under Article 5, Annex II and Annex III, and inventory of protected areas required under Article 6, Annex IV of the EU Water Framework Directive (2000/60/EC). Part A – Basin-wide overview, (WFD Roof Report 2004)

ICPDR - International Commission for the Protection of the Danube River (2000): The Joint Action Programme for the Danube river basin.

ICPR - International Commission for the Protection of the Rhine (2005): No Frontiers for the Rhine: Inventory 2004 in the Rhine River Basin.

International Resources Group, Ltd. (2001): Dominican Republic Environmental Assessment. Report. USAID Contract No. PCE-I-00-96-00002-00.

Jønch-Clausen, T. (2004): "...Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005" - Why, What and How? Global Water Partnership.

Ipsen, N.; Dyhr-Nielsen, M.; Lyngby, J.E., Adriaanse, M. & Hassing, J. (2006): Linking Freshwater Resources Management and Coastal Zone Management. UNEP.

Kitheka, J. (2005): Background Paper on The Tana Delta and River Basin. In: Report of the Workshop on Integrated Coastal Area and River Basin Management in the South Asian Region.

Kitheka, J. & Ongwenyi, G.S. (2002): The Tana Basin and the Opportunity for Research on the Land-Ocean Interactions in the Tana Delta. In: African basins. LOICZ Global Change Assessment and Synthesis of River Catchment-Coastal Sea Interactions and Human Dimensions.

Lizardo, M. (2003): The Dominican Republic: National Report. Roles of Agriculture Project. International Conference, FAO, Rome, Italy, October 2003 (http://www.fao.org/es/ESA/Roa/ROA-e/case_studies-e.htm, accessed February 7, 2004)

Lizardo, M. & De los Santos, J. (2003): Farming Sector Incentive Framework During the 90s in the Dominican Republic. Roles of Agriculture Project. International Conference, FAO, Rome, Italy, October 2003 (http://www.fao.org/es/ESA/Roa/ROA-e/case_studies-e.htm, accessed February 7, 2004)

Lockwood, H. (2001): Operations and Maintenance Strategy for Community-Managed Rural Water Supply Systems in the Dominican Republic. Environmental Health Project, USAID, 37 pp.

Matuszeski, W. (1996): Case study 1- The Chesapeake Bay Programme, U.S.A. In: Reports and Studies No. 61. IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP. Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), Food and Agriclture Organization of the United Nations, Rome.

Mee, L.D. (2003): Connecting Rivers and Seas –The Danube/Black Sea Experiment. Proceedings of the Conference on Sustainable Management of Transboundary Waters in Europe. 21-24 April 2002 Miedzyzdroje, Poland, 53-62.

Moreton bay Waterways and Catchment Partnership (2004): A paper presented at Global H2O Conference 10-14 May, 2004 Cairns, Australia.

Partow, H. (2001): The Mesopotamian Marshlands: Demis of an Ecosystem. UNEP, Division of Early Warning and Assessment (DEWA).

Patnaik, A.K. (2004): Restoration and Conservation of Chilika Lagoon. An Overview. In: Lake 2004. International Conference on Restoration and Management of Lakes and Coastal Wetlands.

Patnaik, A.K. (2004): Integration of River Basin and Coastal Processes in the Restoration of the Chilika.

PEMSEA (2006): Xiamen - An ICM Journey. PEMSEA-Project Technical Report No. 18, 93 pp. GEF/UNDP/ IMO PEMSEA Programme.

Premaratne, A. (2005): Report on Implementation of Integrated Coastal Area and River Basin Management in the Attanagalu Oya Basin. A report prepared for the UNEP/GPA ICARM Project.

Ramesh, R. (1985): Geochemistry of the Krishna River Basin. PhD thesis, Jawaharlal Nehru University, New Delhi.

ROPME - Regional Organisation for the Protection of the Marine Environment & UNEP (2005): Report of High-Level Meeting on the restoration of the Mesopotamian Marshlands (Al-Ahwar) and the marine Environment.

Schernewski, G.; Löser, N. & Sekscinska, A. (2005): Integrated Coastal Area-River Basin Management (ICARM): The Oder/Odra case study. In: Glaeser, B., Sekscinska, A. & Löser, N. (eds): Integrated Coastal Zone Management at the Szczecin Lagoon: Exchange of experiences in the region. Coastline Reports No. 6.

Selvam,V. (2004): Atlas of Mangrove Wetlands of India. Part 2–Andhra Pradesh. M.S. Swaminathan Research Foundation, Chennai, India.

Shaghude, Y.W. et.al. (unpublished): Interlinkages between the socio-economic dynamics and climatic variability on Lower Rufiji catchment. LOICZ Report on African basins: AFRICAT 2.

Shiva, V. (1991): Large dams and conflicts in the Krishna basin. In: Ecology and the Politics of Survival – Conflicts over Natural Resources in India. United Nations University Press, Tokyo, Japan. Chapter 8.

Special Area Management Plan for Negombo (2003): Coastal Resources Management Project. Prepared by the Negombo lagoon Special Area management Community Coordinating Committee.

Strengthening the Implementation Capacities for Nutrient Reduction and Transboundary Cooperation in the Danube river basin (2003): ANNEX 6 - Assessment of Nutrient Emissions and Loads. Project Brief for the Danube Regional Project (Tranche 2).

Tayaa, M.; Saine, A.; Ndiaye, G. & Deme M. (2005): Global International Water Assessment. Canary Current, GIWA Regional Assessment 41. UNEP, GEF, Kalmar University.

Tobey, J.; DeCurtis, M. & Ortiz, A. (2004): Impact of altered freshwater flows to estuaries, Yuna bay watershed and Samana bay, Dominican Republic. Unpublished summary, project document.

Townsend, C. H. (1901). Dredging and other records of the United States Fish Commission steamer "Albatross," with bibliography relative to the work of the vessel. U. S. Commission of Fish and Fisheries report of the commissioner for the year ending June 30, 1900, 387-570. Washington, D.C.: Government Printing Office.

TRD - Tropical Research and Development (1991): Intensive Survey of Rural and Urban Activities Impacting Water and Coastal Resources. Tropical Research and Development, Inc. for USAID/DR, 113 pp.

UNEP - United Nations Environment Programme (2002): Towards an Integrated Management of the Coastal Zone and the Senegal river basin. Pilot Study. UCC-Water and Tropis.

UNEP - United Nations Environment Programme (1999): Conceptual Framework and Planning Guidelines for Integrated Coastal Area and River.

UN WWAP - United Nations World Water Assessment Programme (2003): UN World Water Development Report: Water for People, Water for Life. Paris, New York and Oxford, UNESCO (United Nations Educational, Scientific and Cultural Organization) and Berghahn Books.

US Army Corps of Engineers (2002): Water Resources Assessment of the Dominican Republic. Mobile, Alabama. (http://www.sam.usace.army.mil/en/wra/DominicanRepublic/DominicanRepublic.html, accessed February 6, 2004)

Vidal, O. (1995): Population Biology and Incidental Mortality of the Vaquita, Phocoena sinus. Report of the International Whaling Commission, Special Issue 16, 247-272.

WEHAB Working Group for the Johannesburg Summit on Sustainable Development (2002): A Framework for Action on Water and Sanitation

www.gwpforum.org

Zaag, P. van der & Carmo Vaz, A. (2003): Sharing the Incomati waters: Cooperation and Competition in the Balance. IWA publishing. Water Policy 5, Number 4, 349-368.

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