SESSION I b

BEYOND FRESHWATER MANAGEMENT: LEARNING FROM OTHERS

Beyond freshwater management – integrating environment and development in coastal lagoon and wetlands areas: lessons learned from the Helsinki Commission's (HELCOM) Management Plans for Coastal Lagoons and Wetlands (MLW) project

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Introduction

The Baltic Sea ecosystem is a semi-enclosed water body connected with the North Sea by narrow and shallow sounds that limit water exchange. Marked natural fluctuations are characteristic of the Baltic Sea ecosystem; the water is largely regulated by the sporadic inflows of saline North Sea water and intermediate stagnation periods. Contaminants and nutrients enter the Baltic Sea via river run-off, direct discharges from land, atmospheric deposition and from human activities at sea.

It is estimated that renewal of the water of the Baltic Sea takes about 25-30 years. Therefore contaminants, especially persistent chemicals and pollutants, remain in the Baltic Sea for a long time. It is an ecosystem under extreme stress. Threats to sustainable development include:

- Degradation of water quality from point and non-point sources of pollution;
- Coastal erosion and conversion of important habitats;
- Eutrophication and algae blooms in coastal and marine waters;
- Overexploitation of fisheries;
- Areas with living marine resources affected by diseases associated with pollution;
- Emerging problems with introduced "alien" species.

Coastal lagoons and wetlands provide an important habitat for wildlife and an abundance of resources and opportunities for the local communities. They also play a significant role in the natural processes of removal of nutrients. It is anticipated that a substantial part of the excess nutrients, brought to these wetlands before entering the Baltic Sea, can be removed by these wetlands. Hereby, well-functioning wetlands constitute a major instrument to address this environmental problem, particularly considering the high cost-efficiency of these "natural waste-water treatment plants".

The need to address the land-based problems and related solutions through an integrated environment and development approach, both in planning and management of these areas, are fully recognised by various international bodies, e.g. Helsinki Commission [1] (HELCOM), EU and the Ramsar Convention [2]. Hence, HELCOM identified the coastal lagoons and wetlands as areas of major importance for the Baltic Sea environment, and prioritised this field of work as element 4 of the Joint Comprehensive Environmental Action Programme (JCP).

However, convincing local communities to deliver such a "service" to the international community - hosting vast wetland complexes, floodplains and meadows, often in combination with significant flooding e.g. during spring - is not a straightforward task. This type of land use puts a certain "stress" on the area in terms of regulation of various types of economic activities. How to replace these activities with alternative income sources, thus allowing for a "trade-off" situation to emerge? How to involve all relevant stakeholders in producing an alternative development strategy, where the resource use allows for highly needed environmental concerns? How to ensure local planning and communications capacity for this task? How to develop and test models for community-based management of natural resources use?

Ecosystem-based planning and management have been addressed all over the world in the last 20-25 years. For coasts it is called Integrated Coastal Zone Management (ICZM), for freshwater ecosystems River Basin

1 The Helsinki Commission (HELCOM) is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area" - more usually known as the Helsinki Convention.

2 The Convention on Wetlands of International Importance especially as Waterfowl Habitat, adopted in Ramsar on 2 February 1971 and entered into force in 1975.

Planning and Management (now incorporated into the Water Framework Directive [3] - WFD) and for marine ecosystems it is the Large Marine Ecosystem model. Despite the fact that these models address different ecosystems and that they all have to be regionally/locally adopted, they also have much in common, e.g.:

- The need to integrate planning and management;
- The need to include all relevant stakeholders (administration, NGOs, scientists, the public);
- The need to address at the same time environmental, social and economic problems.

The experience from the HELCOM Management Plans for Coastal Lagoons and Wetlands (MLW) project, therefore, is highly relevant for other "interventions" in local communities, which impact the prevailing land use: nature restoration projects, implementation of the Habitat Directive [4] as well as implementation of the Water Framework Directive. The experience also calls for specific attention in river basin management for establishing strong links between coastal water issues and the related upstream sources to the problems. Finally, the project experience is of high value in any transboundary water management context.

MLW Phase 1: 1993-1996

In 1993-1996, under the guidance of the Working Group on Management Plans for Coastal Lagoons and Wetlands (MLW), of the HELCOM Programme Implementation Task Force (PITF), and with the World Wide Fund for Nature (WWF) serving as a lead party and performing duties of secretariat, six management plans were developed in a form of pilot projects. The management plans were developed for the following task areas:

- Käina Bay (Estonia);
- Matsalu Bay (Estonia);
- Engure / Kemeri (Latvia);
- Kursiu/Curonian Lagoon (Lithuania/Russian Federation);
- Vistula Lagoon (Russian Federation/Poland); and
- Oder / Szczecinski Lagoon (Poland/Germany).

The long-term goal of these pilot projects was to contribute to ensuring the environmental balance of the Baltic Sea through elaboration and implementation of Integrated Coastal Zone Management (ICZM) plans for sustainable development in the coastal areas of the South-Easter Baltic region mentioned above. Each management plan provides a synthesis of data as well as an overview of potential problems, thus significantly improving the foundation for wetland planning in the areas.

The management plans were adopted at the HELCOM PITF MLW 6 meeting, which took place in September 1996 in Klaipeda, Lithuania. HELCOM PITF on its meeting in October 1996 in Hel, Poland, approved these plans, and further requested that the Governments accepted them.

Altogether, for the recipient countries, the MLW process constituted a significant step forward in the development of techniques for applied nature conservation, involvement of public into the planning process, and for better understanding of sustainable development in general. It also provided an opportunity for direct cooperation of scientists, planners, and decision-makers.

However, as the plans differ in detail and were generally in need for improved operationalisation and wider involvement of public into decision-making process, it was decided to launch an interim project phase, as a basis for facilitating the implementation during Phase 2. The relevant Governments were expected to assume full responsibility for Phase 2, i.e. implementation of the upgraded management plans.

MLW Phase 1b: 1997-1999

The HELCOM PITF MLW has provided, during its 1993-1999 lifespan (Phase 1, 1993-1996, and Phase 1b, 1997-1999), the first comprehensive examples of ICZM planning in the Baltic Sea Region.

[3] Directive 200/60/EC of the European parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, published in the Official Journal L 327/1 of the 22/12/2000.

[4] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora published in the Official Journal L 206 of the 22/07/1992.

The MLW project areas are all shallow coastal areas with great importance for reduction of nutrients, providing significant habitats for biodiversity. At the same time they are of great local and regional importance for a number of resource utilisations, such as coastal fishery, tourism and recreation. This shows that the areas concerned should be protected and managed with the aim of preserving their hydrological, physical, chemical and ecological features.

MLW is so far the only multilateral project in the Baltic Sea region with an agreed set-up aiming at sustainable development at local levels, within all relevant sectors. Quite a number of lessons have been learned, however the most important ones regard the overall, holistic approach towards sustainable development.

The main outcome of the MLW Phase 1b project has been the elaboration of significantly improved management plans for the project areas. Implementation of the plans varies greatly among the project areas, hereby not reflecting the quality of the plans, but the difficulties in establishing links from this ecosystem-based approach to the existing administrative structures, which are still deeply rooted in a top-down, sectoral mode of operation.

Among the improvements, the introduction of a (modified) OECD-concept of sustainable development indicators should be emphasised. This DSR-concept combines integrated indicators for Development, State of the environment and Response to the problems.

Despite the magnitude of international and regional recommendations, strategies for coastal zone management, conventions, etc. emphasising the need for and benefits related to ICZM, the real life implementation of this approach meets continuous obstacles, in terms of lack of buy-in and understanding from authorities, at both local and national level.

Review of the MLW Project

The long-term goal was to give a contribution to secure the environmental balance of the Baltic Sea through elaboration and implementation of ICZM plans for sustainable development in key coastal areas in the South-Easter Baltic region.

The long-term goal was set up with a 5-year horizon, which corresponds to the year 2004. At this stage, a review is not possible. However a preliminary attempt is made below.

Altogether, the projects have led to the following achievements:
- Key biodiversity areas are now protected through establishment of a zonation system;
- Meadow restoration and management activities have been demonstrated, and regional park staff trained;
- Priority sites for red-list species have been identified and protection and management needs analysed;
- International environmental concerns have been accepted in the local “agenda” as priorities;
- Wetlands and coastal lagoons are receiving much higher attention and priority;
- The process towards an environmentally sound development has started;
- Management of the natural resources has been institutionalised;
- Increased analytical understanding regarding relations between development trends, environmental concerns, social problems, public participation and institutional capacity has been established;
- Local institutions capacity to facilitate an integrated approach has been increased;
- Natural values are gradually being seen as a development asset for the local community;
- International and national networks regarding integrated management approach have been established.

Altogether, this has implied that the project has provided the areas with a platform for entering a course towards integrated sustainable development. However, a comprehensive public outreach and stakeholder involvement programme is highly needed in some of the areas.

In most cases, the management plans have taken the shape of:

- Problem analysis at catchment level;
- Concept for an integrated approach;
- Platform for strategic development;
- Identification of indicators;

providing specific actions for strengthening a process towards sustainable development based on ICZM principles.

At an overall level, the management plans have therefore become more an important process tool, rather than being a regulatory tool.

Public participation activities have been handled very differently in the project areas. In some cases (Käina Bay), meetings for the broad public have been held, while in most cases, the work with the management plan virtually has not gone beyond the level of the "inner circle", i.e. technicians, decision-makers and key stakeholders.

The degree to which the public participation programmes may be called "successful", should be handled with great care. In general, it has been more than difficult to reach a level of broad acceptance among the "inner circle" people. Hence, approaching the public in a broader sense is yet to come.

At present, the allocation of resources for Phase 2 varies greatly from area to area. In some cases, the Government bodies have given high priority to the future development of these important ecosystems. This is particularly true of small and well-defined areas in Estonia and Latvia. In other cases, in particular for the large, complex, transboundary areas involving the Governments of Lithuania, the Russian Federation, Poland and Germany, getting sufficient attention and specific resources to address the problems has proven more difficult. This is due to a number of reasons, among others the continuous uncertainties about the division of responsibilities for management of such transboundary ecosystems.

Furthermore, the traditional sector-based organization of the public administrations has in some cases shown lack of ability to engage in cross-sectoral approaches like the ICZM. Accordingly, initiatives to bring the issues "outside" the authorities, e.g. the Ministries of Environment, have been rather difficult. Thus, a comprehensive process involving all relevant national and local stakeholders is needed to reach a situation, in which the assumption will prove to be true.

During the 1990s the pollution loads from contributory rivers have been significantly below the levels of the 1980s. However, unless adequate policies are developed and implemented, it is indeed uncertain whether this will prove to be the picture when the economies of the region have regained momentum.

Furthermore, during the project period, the economic activities in the project areas have stagnated at a rather low level, not least because of the difficulties of the transition period and the economic crises of August 1998. It is yet to be demonstrated whether or not environmental issues are included in the policies and decisions impacting the economic activities.

Altogether, these considerations on achieving the long-term goal reflect the difficulties in implementing a new planning and management concept, i.e. ICZM. For authorities rooted in a very sectoral and top-down system, dealing with cross-border, cross-sectoral, stakeholder-involving and public-oriented approach is almost an unknown world.

The project was based on the expectation that Governments and regional bodies would have had a greater and more active buy-in, as well as they would have been more in line with the national HELCOM policies (giving priority to this field). Moreover, the project assumptions were based on a belief that the project management plans would have reached their final draft earlier in the project period. Neither of these assumptions has been fulfilled at a satisfactory level in all project areas.

Within the project, management and monitoring bodies were supposed to be identified and/or established for conduct of Phase 2 responsibilities. This result has not been fully reached, due to a number of reasons, e.g. in some cases a lack of a proactive participation from Government side in identifying relevant bodies and persons to be involved. This absence of structures to continue the ICZM processes has been highly critical for their future in some of the areas.

In the small demonstration areas, it has been rather evident throughout the process which bodies were responsible for management and monitoring. In this case, the area task team secretaries have been rather close and confident with the staff from this (these) body(ies).

In the larger areas, things have been more complicated. In some cases, e.g. Kursiu Lagoon, the management bodies have been identified only at a late stage during the process, if at all. And mostly only for management of the natural resources or certain environmental protection regimes.

In the case of the Oder and Vistula Lagoons, this process has been hampered by the comprehensive administrative changes at Voivodship level. However, the process has been in quite good hands at the Polish HELCOM secretariat in Gdansk and the Voivodeship Inspectorate of Environmental Protection in Szczecin.

Phase 2 programmes have been developed as part of the management plans. In some cases, these will be implemented through follow-up projects, e.g. within the framework of the GEF "Baltic Sea Regional Project".

Further, it should be noted that several countries in the region as a part of their preparations for EU membership will have to set up plans for compliance with the EU Water Framework Directive and the EU Habitat Directive [5]. This indicates, that the sector-based EU-requirements, not least within the environmental sector, will be achieved, but to some extent at the expense of an integrated approach that takes into account the promotion of sustainable development in all its three dimensions, economic, environmental and social.

One aspect, which needs to be underlined, is the - at times - quite big gap between the discussions, negotiations and agreements at international and regional policy level, and the extent to which these are disseminated at the lower levels of the national administrations.

However, due to the difficulties in implementing a participatory, cross-sectoral and cross-border approach, a comprehensive process involving all relevant national and local stakeholders is still needed to achieve the long-term goal.

Follow-up at regional and international level

A number of outputs based on the project findings and lessons learned should be mentioned, despite the fact that these were not planned for or anticipated during the project period:

- Remarks made on the basis of MLW experience for a special EU hearing to develop a strategy for ICZM;
- Presentation given to the Vilnius Round Table on transboundary waters [6] with a significant footprint on the Final Vilnius Recommendations;
- Presentation to the Tartu Workshop on transboundary lakes [7] within the framework of the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, with a significant footprint on the Final Recommendations;
- Development of the proposal for the BaltWet project, which intends to create a network on wetland management and planning in the Baltic Sea region, and approval by HELCOM structures;
- Establishment of the network on integrated planning and management of freshwater ecosystems within the entire Baltic Sea catchment, based on a participatory, cross-sectoral and cross-border approach. According to the approved BaltWet proposal, the aim of BaltWet should be to continue and strengthen regional networking on integrated planning and management of coastal lagoons and wetlands, as well as freshwater ecosystems. Despite the fact that ICZM, the main project tool, is related to coastal zone management, it may easily and with great relevance be applied to all larger water body ecosystems where cross-border and cross-sectoral cooperation is required to get a complete overview of problems and their causes;

[5] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, published in the Official Journal L 206 of 22/07/1992.

[6] International Round Table on "Transboundary Water Management - Experience in the Baltic Sea Region" that took place in Vilnius (Lithuania) from 6 to 9 June 1999 under the auspices of the Helsinki Commission as an activity of the Programme Implementation Task Force (PITF) for the "Baltic Sea Joint Comprehensive Environmental Action Programme" (JCP).

[7] Workshop on management and sustainable development in international lake basins held in Tartu (Estonia) from 15 to 17 December 1999.

- Presentations of experiences gained focusing on problems related to planning versus management during the MLW project at a VASAB [8] seminar on Integrated Coastal Zone Management and Development, held in Palanga (Lithuania) from 17 to 18 May 2001;
- Decision on continuous priority by HELCOM to coastal zone management within its new and reorganized structure, as part of the HELCOM group "Nature conservation and coastal zone management";
- Continued cooperation with the World Bank on the Baltic Sea environment leading to a priority for location of GEF investments on nutrient retention to MLW areas within the Baltic Sea Regional Project (BSRP). The BSRP has recently been approved by the GEF Council, which implies that this large-scale project will now enter its implementation phase. For the MLW areas (except Oder Lagoon), this will imply additional on-site investments totalling to about 0.7 millions USD;
- Future coordination and leadership by WWF of the coastal activities under the GEF project during the proposed 5 years project phase. WWF will also be a member of the steering group;
- Continuation of the efforts by the HELCOM Habitat group on ICZM in a general coastal context.

Lessons learned

Significant lessons concerning implementation of ecosystem-based planning and management of natural resources as a cornerstone of sustainable development have been learned.

When implementing integrated approaches for land use planning, the following should be taken into account:

- If clear benefits can be explained to the involved communities prior to initiatives leading to dramatic physical changes, e.g. nature restoration, this will increase chances of success;
- Expect an integrated approach to be a long-term process, needing several years to be sufficiently rooted in the society;
- Base the ICZM approach on local, enthusiastic people, as an informal dialogue is a key tool, particularly during initial stages;
- Ensure broad public support to the ICZM plans and their priorities by demonstration of concrete benefits to the local communities;
- Initiate small-scaled pilot/demo projects.

A number of constraints hamper the use of ICZM principles. These were presented to the Vilnius Round Table on transboundary cooperation on water management. The Vilnius Recommendations summarise the main findings from international and regional projects and cooperation on transboundary waters and wetland ecosystems.

[8] Vision and Strategies around the Baltic, an intergovernmental programme of 11 countries of the Baltic Sea Region on multilateral cooperation in spatial planning and development, established in 1992.

Technological constraints – ICZM is heavily based on cross-sectoral communication, addressing conflicts, and public participation; as this is new to many participants, many find difficult to comprehend what is meant by "ICZM as an ongoing process"; – A lot of information is not available; – Sustainable development indicators are a new concept (DSR); – Cross-sectoral orientation appears only sporadically; – Tendency to exclude development side; – No "one-best" analytical framework.	*Institutional constraints* – Local and regional levels have very little capacity and thus a significant need for support; – Cross-sectoral approach, visions and analysis are not part of the "administrative culture": feed-back mechanisms and proactive approach not present in many places; – Requests concerning the results differ between countries, creating uncertainty about Phase 2; – Project executants do not have a clear "domestic" task and mandate; – Uncertainty about the legal status of an ICZM-plan.
Economic constraints – Difficult to find funding for institutional follow-up and public participation; – Green funds should facilitate follow-up activities; – Long-term planning has a weak stand compared to short-term gains; – Difficult to replace regulation with economic incentives as framework is not in place; – Taxes and subsidies are a future tool.	*Environmental Awareness constraints* – Environmental issues are low on the political agenda, get limited resources and attention; – Knowledge about the consequences from environmental degradation to society and development appear to be low, e.g. dams, drainage of wetlands, and regulation and channelling of rivers is still taking place; – The future problems are not recognised, particularly the environmental impact is estimated to increase by at least 40% when the Eastern European countries have restructured their economy.
Culture and Society constraints – Public participation is not part of the culture, many people do not take part in the civil society, many people live at subsistence level; – Transparency and information sharing is only evolving within the Public Administration; – NGOs have small public outreach.	*Ecological constraints* – A substantial part of lagoon pollution comes from upstream sources; – Flooding cannot be solved by further diking, need for upstream wetlands restoration; – Wetlands are vital "organs" for the river functions; – Response to eutrophication requires upstream management of agriculture and households; – Long-term protection requires change of development patterns.

Table 1. Extracts from a presentation on MLW lessons learned

Recommendations

UNECE

- Continue promoting transboundary cooperation on water management;
- Contribute to facilitating public participation in transboundary water management;
- Contribute to linking Russian Federation/Ukraine/Belarus with a future enlarged EU, e.g. in the cases of the rivers Bug, Neman or Daugava;
- Facilitate development of multi-country commitments to nature protection and nature restoration (vis-à-vis the Lower Danube Green Corridor [9]).

EU

- Focus on conceptualising the link between marine, coasts (ICZM strategy) and rivers (WFD), e.g. through particular funding programmes;
- In cooperation with HELCOM organize workshops/meetings, with comprehensive use of ongoing projects;

[9] The Lower Danube Green Corridor between Romania, Bulgaria, Ukraine and the Republic of Moldova, with a commitment for 900,000 ha of existing and new protected areas, as well as restored wetlands, is an example of regional cooperation among governments and NGOs.

- Ensure strong linking between the Habitat Directive, the Water Framework Directive, the Agriculture and Rural Development policies and related financing schemes.

HELCOM

- Establish an organizational platform to exchange experiences and conduct joint model projects related to the implementation of the Water Framework Directive;
- Consider BaltWet as such a platform, eventually within the framework of the Baltic Sea Regional Project.

National levels

- The work on the implementation of the management plans in each of the 5 demonstration areas should be continued, preferably with an intensified effort;
- Continue efforts towards mobilising local communities and the public to implement sustainable development strategies in environmentally sensitive areas, e.g. EU Habitat Directive sites/coastal lagoons and wetlands.

Sustainable development of Wolin Island

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Introduction

The Wolin Island is a naturally separated physiographical unit, which requires a uniform environmental protection strategy, in particular with regard to the comprehensive protection of water.

The area of the Wolin Island is over 250 km^2, 50 km^2 of which belong to the Wolin National Park (Woliński Park Narodowy - WPN). The WPN covers the adjacent waters of the Szczeciński Lagoon and Baltic Sea, over 100 km^2 in total (see Figure 1).

The local population amounts to approximately 30,000 inhabitants; about 5,000 in wintertime and about 90,000 during summer peak: tourists, holidaymakers and health-resort visitors stay on the island. Such proportion results in a wide range of problems in many sectors, which should be solved on the way to sustainable development. Some problems have been solved; others are still waiting to be dealt with.

The waters surrounding the island are of an overregional importance: Baltic Sea in the north, the Szczeciński Lagoon in the south and two straits forming the outlet of the Oder River - Dziwna in the east and Świna in the west.

The area of the Oder Delta on both the Polish and German sides has been recognized as one of the best preserved and most beautiful natural regions in Europe. International Friends of Nature have proclaimed the Oder Delta *The European Landscape of the Year 1993/1994*.

This initiative was the first common Polish-German action for promotion and protection of the Oder Delta, resulting in projects carried out on both sides of the border. Reduction of pollution loads contaminating the Szczeciński Lagoon and the Pomeranian Bay was one of the key concerns of this action.

The quality of the Oder Delta waters depends to some extent on the discharge of pollution from the whole basin; nevertheless it is, especially near the Wolin Island, closely related to proper water and waste-water management within the island.

The local authorities of the Wolin Island found their existence and development on the values of the region related with landscape, climate, health and nature. The management on the areas of abundant nature resources, which are particularly vulnerable, required specific programmes of action that allowed to meet the needs of the environment, of the local population and of the tourists.

Spatial management, nature conservation, environmental protection and water management are tasks requiring integrated, comprehensive activities on the area of the whole island, overcoming such obstacles as administrative borders, together with specific knowledge and, very often, unconventional measures.

As a consequence, the communes of Dziwnów, Międzyzdroje and Wolin established in 1991 a new, special self-governmental unit, Communs' Union of the Wolin Island (Związek Gmin Wyspy Wolin - ZGWW), whose statutory activity is to elaborate and implement the sustainable development programme for the Wolin Island, with particular regard to the management and protection of water resources.

The activities of ZGWW implied wide cooperation, including international one. The obstacles which have been overcome are not just administrative borders, therefore the need for integration has become obvious for all parties interested in the present and future of the Wolin Island.

Communs' Union of the Wolin Island (Związek Gmin Wyspy Wolin - ZGWW)

ZGWW has existed since 1991 as a task-oriented self-government, based on the act on local self-governments. The area of its activities covers the Wolin Island. The statutory activities of ZGWW include:

- Tourism and spatial development;
- Environmental protection, conservation of nature and landscape, in particular:
  - Construction of waste-water treatment plants and sewage systems;
  - Solid waste management;
  - Construction of gas piping for the benefit of air quality;
  - Management of shared drinking water resources.

ZGWW has been carrying out *the Programme of comprehensive pro-ecological undertakings on the Wolin Island* (hereinafter referred to as *the Programme*), elaborated by Urszula Jakuczun and Franciszek Nowacki. The large number of tasks, including development of investment processes, could not be carried out by 3-4 persons employed full-time by the Union. Therefore the ZGWW team has been supported by regular advisors [1]. Elaboration of some pre-feasibility studies, as well as construction designs, services, works and supplies has been contracted as a result of open tenders, very often international ones. In order to support *the Programme* and its goals, the ZGWW has organized debates, workshops and public consultations; has published leaflets; has taken part in conferences and seminars. The ZGWW has made efforts to involve in its activities as many partners from outside the island as possible. The chosen shape of cooperation has allowed the integration of the associated communes, at the same time providing much substantial and financial support both at the planning stage and during the execution.

When ZGWW was established, there were no facilities for biological treatment of waste water on the island. Consequently, the status of many water bodies in the surroundings of tourist resorts could be described as catastrophic. Drinking water in many towns and villages was of insufficient quality. During summer, cones of depression deepened under water intakes in the coastal zone and posed threats to the intakes, such as saltwater intrusion. The most abundant water resources, located in the central part of the island, were not used.

ZGWW became a partner of the Wolin National Park, as the activities of the Union hampered the degradation of nature resources. The two institutions created a model of scientific cooperation for the benefit of the region, based on the principles of sustainable development. Joint statutory objectives were specified and common decision-making on significant issues was introduced.

The Ministry of the Environment, the Regional Water Management Board in Szczecin, voivodeship offices and institutions have simultaneously launched research and documentation programmes, essential for comprehensive solutions to the key problems of the Wolin Island.

International commissions with their environmental programmes, e.g. the “Integrated Coastal Zone Management Plan for the Szczeciński Lagoon”, elaborated under the Helsinki Commission’s Project Implementation Task Force and implemented on the territories of Poland and Germany, or EU programmes of cross-border cooperation in which ZGWW had actively taken part, giving valuable contribution to the complex process of sustainable development of the Wolin Island.

The activities of the Union throughout the years have resulted in the achievement of the goals set for the first decade of the Programme. Moreover, good cooperation with a variety of institutions and organizations in Poland and abroad, allowed meeting the goals more quickly and cost-effectively.

Programme of comprehensive pro-ecological undertakings on the Wolin Island and its execution

The Programme is the basis for the activities of ZGWW. Elaborated in accordance with sustainable development principles and the environmental policy of the State, it was based on models developed by the western European countries. It was one of the first programmes of sustainable development in Poland elaborated at the level of a commune for a whole region, in this case the Wolin Island.

The established goals and the strategy for their achievement have been spread over many years, as the necessary investment processes planned by ZGWW required building framework “from the whole to a part” for all statutory activities.

[1] Teresa Godlewska - international tender and contracting procedures, Franciszek Nowacki - water management, Ryszard Rydzyński - environmental engineering, Jerzy Urban - spatial planning.

Comprehensive master plans elaborated separately for spatial planning, water management, waste-water management, solid waste management, development of gas-piping and tourism involve a wider range of issues than the tasks taken over by ZGWW from the associated communes. The Programme had to be extended with the activities not falling within the responsibilities of the self-government but necessary to reach the goals of the Programme.

The following activities, commanded by the environmental authorities and water management bodies, have been carried out:

- Documentation on the water balance of the Wolin Island;
- Documentation on the protection procedures for the Main Groundwater Reservoir No. 102;
- Documentation on the water economy balance;
- Permanent monitoring of changes in the environment.

These activities aim to enable the communes and ZGWW to make optimal economic decisions, particularly with regard to investments, even if this is not the only objective. Cooperation of ZGWW with an increasingly stronger private sector has been taken into account in the Programme as well.

The Programme included the analysis of the state of the environment before the investments were undertaken. It fixed further administrative, technical, technological and financial steps leading to the achievement of set goals in particular sectors of statutory activities.

The Programme included the assessment of environmental impact of specific investments and the description of public and scientific consultations carried out before the technical and technological solutions were approved. For 11 years, the everyday activities of the ZGWW team have included project evaluation, elaboration of process documentation, preparation of tender documents, carrying out tender procedures, and supervision of the execution of the contracts on services, supplies and works.

The design and investment activities of the ZGWW can be briefly summarized as follows:

- 1991-1992: preparation of the Programme, studies and research on the state of the environment, comprehensive master plans for particular policies;
- 1992-1993: preparation of project documentation for basic investments, scientific and public consultations;
- 1994-2002: execution of basic investments in the field of water protection and air protection (development of gas-piping network);
- 1995-2002: study of conditions and trends of spatial planning for particular communes and its synthesis for the Wolin Island area;
- 1999-2001: elaboration of project documentation for investments planned to be executed in 2002-2006, in order to complete the investment stage of the Programme, involving among others:
  - Development of the sewage system in the central part of the island;
  - Building of water intakes, water-piping, retention reservoirs, waste-water treatment facilities;
  - Reclamation of waste deposit sites, construction of a shared solid waste deposit site with a waste treatment plant and composting plant;
  - Construction of other engineering facilities, such as water gates.

The elaboration of comprehensive master plans for particular sectors in the years 1991-1993, which were the basis for initiation of investment processes, enabled to proceed quickly with the realization of these investments. Having an overall view, it was possible to initiate simultaneous investments in many places and then arrange them to form one system.

All statutory activities of ZGWW were more or less connected with the protection of the Main Groundwater Reservoir No. 102 “Wyspa Wolin” with regard to quality and quantity, and with the protection of the waters surrounding the island.

The investment programme, consistently carried out for more than 11 years, has resulted in many financial, economic, environmental and social benefits, significant for achieving sustainable development.

The following criteria have been set for the selection of technical and technological solutions:

- Application of high standard technologies and devices, with proper recommendations, guaranteeing the environmental effect in accordance with relevant EU directives, selected through international tenders;
- Rigorous observation of the order of task accomplishment, beginning with rescue tasks aiming to improve the status of the most degraded water ecosystems;
- Achieving the goals step by step, conforming to the organizational capacity and the degree to which particular investments are ready to launch, taking into account the legal and financial aspects.

The achieved results have proved that solving environmental issues, including water protection on the Wolin Island, at a regional level and over commune borders was a crucial task and that it has been successfully accomplished.

Elaboration of spatial development plans

ZGWW elaborated, in accordance with its Statute, strategic plans for the spatial development of the Wolin Island area, which are essential for future local plans and consequently for the qualification of areas under various forms of protection as well as the location of infrastructures or economic activities.

The location of undertakings planned by ZGWW and the provisions and arrangements of the plan were aimed at building consensus, eliminating conflicts arising within the society and between the communes, complying with the principles of nature protection contained in the Plan of Protection of the Wolin National Park which was developed in parallel. The studies of spatial development policy and conditions conducted by ZGWW for each commune were subject to wide public consultations in accordance with the European Union procedures.

The issues which have raised the strongest reactions among local communities, e.g. resorts supplied with water from intakes located in neighbouring communes, the location of an inter-communal waste-water treatment plant or shared waste deposit site, have been successfully agreed upon.

Master plan for water management and its realization

The master plan *Water resources management on the Wolin Island* has been developed by F. Nowacki, a hydrologist in charge of the documentation of the resources of the Wolin Island, of the Geological Company Proxima S.A. in Wrocław.

The Programme includes all successively incoming results of the documentation process. The drinking water resources of the Wolin Island require particular protection against pollution and saltwater intrusion, which generally applies to all islands. Wolin Island is a perfect example of connection between surface waters and groundwater. In the water balance of the island, underground flow is the predominant element of supply of lakes and watercourses, retention of water in water-bearing strata and outflow into the Baltic Sea and the Szczeciński Lagoon.

The main issues for water distribution are the following:

- Drying out of polders which affects the major part of the island;
- Concentrated intake of groundwater in the vicinity of the Main Groundwater Reservoir No. 102.

The main characteristic of water exploitation in the coastal zone is the variation of water consumption throughout the year (three times higher in summer than in winter) and increased water consumption in the season of weekend tourism can also be observed. It causes operational problems connected with the protection of the resources of the groundwater reservoir and the proper functioning of water intakes.

In the past few years a necessity arose to verify the volume of exploitable resources of particular intakes and to adjust the distribution of the available water resources, which was stated in the documentation ordered by the Ministry of the Environment and currently elaborated by order of the Regional Water Management Board in Szczecin.

Many years of monitoring carried out in a number of sampling points have shown that apart from excessive and irregular water consumption and pollution, the drying out of polders in the central part of the island is caused by deep agricultural drainage.

There has been no significant improvement in this area so far, yet there is enough will within the institutions responsible for agricultural drainage to cooperate with ZGWW to minimize the disadvantageous impact and to discontinue drainage on particular areas. The programme of small retention for the Wolin Island has been included in the Programme and also in the Integrated Coastal Zone Management Plan developed for the coastal zone of the Szczeciński Lagoon, on the Polish and German territories.

Through the realization of a variety of undertakings (such as forestation, tillage reallocation, restoration of marshy meadows and peat-bogs, construction of retention ponds, biological shaping of watercourses and the surroundings of preserved ponds), the efficiency of water ecosystems could be improved, as well as their resistance to anthropogenic pressure. The upcoming years will be devoted by ZGWW to carrying out these undertakings.

In the tasks that have been implemented so far and which result from the master plan, ZGWW needed to focus its work on the supply of drinking water to these resorts of the Wolin Island where a shortage had occurred in the summer season and posed a threat to water intakes or human health as water quality did not meet the relevant standards.

Constructed water intakes, water purification plants and water piping are part of a large undertaking currently conducted. The undertaking involves, among others, the construction of a water purification plant in the central part of the Wolin Island and the transfer of water by new pipelines to the seaside resorts to make up for the deficits in the summer season and to fill in the cones of depression, existing among others under the water intake supplying Międzyzdroje. This is a “race against time” considering the risk of saltwater intrusion caused by maximum water use during summer peaks and considering the fact that the cone of depression situated around intakes within the boundaries of the Wolin National Park worsens the state of forest ecosystems.

The map below shows the location of water intakes on the Wolin Island and existing and designed water piping systems (see Figure 2).

Investments in waste-water management

The initial project for the whole sewage infrastructure (waste-water treatment plants and sewage systems) has been elaborated by the Danish companies I. Kruger Eng. A.S. and Lemming & Eriksson A.S., thanks to the financial support granted to ZGWW by the Danish Environment Protection Agency in 1990-1993.

The Danish companies elaborated an innovative programme, called “Waste-water treatment plants and sewage systems of the Wolin Island”, consisting of preliminary projects for waste-water treatment plants and for the sewage systems draining waste water from all resorts of the island to the adequate treatment plants.

The projects of the waste-water treatment plants and of over 150 km of sewage systems with 86 sewage-pumping stations were developed using up-to-date geodesic maps and all necessary legal documentation. The overall financial means necessary for the project realization have been estimated at around 44,000,000 euros (in 1992), with the costs for construction of the sewage systems exceeding twice the cost of construction of the waste-water treatment plants.

The primary idea was to carry out all the works under the programme within one contract. However, due to lack of funds, ZGWW divided the programme into smaller projects, prepared separate construction designs and carried out tenders, conforming to the requirements of the financing institutions and funds, which supported the ZGWW programme. The works executed by ZGWW as the main investor involved mainly preparation of applications for co-funding and tender documentation. It must be stated that the execution of the plan does not much differ from the Danish model as ZGWW has elaborated the requirements for all contracted technical designs, works and supplies.

The general characteristics of the investments in water management carried out by ZGWW are shown below. Waste-water treatment plants and sewage systems are presented in Figure 3.

Waste-water treatment plants

Four highly efficient biological waste-water treatment plants were constructed:

- 1993-1995: in Wolin 3,500 m^3/24h;
- 1993-1995: in Międzyzdroje 6,000 m^3/24h;
- 1998-2000: in Międzywodzie 10,000 m^3/24h;
- 1999-2001: in Wapnica 600 m^3/24h (see Figure 4).

All newly constructed waste-water treatment plants are composed of two process lines, operating in parallel during summer and in series outside the summer season, with the possibility to disconnect one of the lines off-season in order to carry out technical inspection and preventive maintenance.

Biological elimination of nitrogen and phosphorus is based on activated sludge. Gravitational pumping systems of sewage network are connected to each of the waste-water treatment plants to ensure sufficient volume of waste water for proper functioning of the plant.

The waste-water treatment plants are modern and equipped with facilities of high standard.

The results of the treatment, the operation of the treatment plants, the stability of their performance and their energy-saving properties are supervised by computerized monitoring and control systems.

All the treatment plants are equipped with sludge de-watering presses. When the ZGWW completes the construction of the organic waste composting plant, the de-watered sludge from the four sewage treatment plants will be transformed into an environmentally friendly product to be reused, e.g. in agriculture.

Sewage systems

90 km of sewage collectors with 45 sewage pumping stations (of the 150 km and 86 pumping stations designed in the Programme) have been constructed so far (see Figure 5). The sewage collectors with pumping stations in the central part of the island are still to be constructed. Complete construction designs for all these investments have been drawn up.

All sewage-pumping stations were equipped with submersible pumps operating automatically and with a uniform system of automation, operation and data transmission. The data on the working status and emergency state of pumping stations is transferred via telephone cable to the computer supervising station located in the control rooms of each waste-water treatment plant.

Solid waste management

In 1995-1997 a Polish company, Ekolog-Systems, from Poznań drew up a feasibility study for solid waste management, which was made possible thanks to the financial support given to ZGWW by the United States of America within the framework of the project titled *Local governments: efficiency and cooperation* managed by a Polish institution named Fund for Cooperation.

The positive effects on the water ecosystems of the Wolin Island are achieved through technical, educational and organizational measures, which are particularly important for the implementation of new solid waste management principles, including selective collection of wastes.

Investment planning and promotion of the new waste management system were preceded by the drawing up of an initial project titled *Comprehensive programme for solid waste management on the Wolin Island - technology, management, financing*. The investments carried out by ZGWW are focused on the reclamation of the existing municipal waste storage sites and the construction of a shared deposit site with a disposal plant and organic waste composting plant.

When the reclamation begins, the solid wastes from the area of the associated communes will be stored at the new storage site shared by the communes and part of the waste will be utilized in the disposal plant.

Air protection

A basic project of ZGWW aimed at air protection in the state border zone was the project of gas-piping development. ZGWW has constructed gas pipelines in the whole town of Międzyzdroje, which is the largest town on the area covered by ZGWW, including 36 km of a medium pressure gas network with 964 reduction points. It perceptibly improved the quality of health-care services offered in the area, the appearance of the town and the quality of life of the inhabitants and visitors.

The ZGWW programme involves other initiatives that influence air quality. The most interesting initiative for the local society are cycling tracks as an alternative to car traffic on the island. The Wolin National Park and the Forest Department of Międzyzdroje have also advanced in tracking and maintaining cycling tracks (on their own territories).

Economic, ecological and social effects of the undertakings carried out by ZGWW

Financing and economics of investments

In the years 1990-2001, ZGWW built fixed assets worth 16 million euros, serving the purposes of environmental protection of the Wolin Island.

Thanks to the preparation of the Programme and its projects in accordance with the requirements of EU Member States, considerable financial support from EU funds and from other national and international financing institutions has been received, reaching 11,300,000 euros in total, including:

- 8,800,000 euros of donations, mostly from the European Union under the Phare programme and from EkoFundusz (financial means coming from the conversion of the Polish debts in western European countries and in the United States of America into environmental investments in Poland);
- 2,500,000 euros privileged loans from the National and Voivodeship Funds for Environmental Protection and Water Management;
- 4,700,000 euros directly from the budgets of the communes.

Additionally, the commune budgets are charged with loan payments for the period of 10 years. Remission of the debt is possible only after meeting certain requirements.

The cost of construction (gross value) per unit of four waste-water treatment plants on the Wolin Island is 1,200 Polish zloty per cubic metre per day, while on average in Poland the cost reaches approximately 1,900 Polish zloty per cubic metre per day. It can be assumed therefore that ZGWW spent every euro or zloty very carefully.

Ecological effects

Waste-water treatment results

The requirements of the Directive 91/271/EEC concerning urban waste-water treatment [2] have been met on the whole area of the Wolin Island.

Biological waste-water treatment plants serve all settlements on the island, including 34 villages (waste transfer or collection). The output parameters are below the limits set by the water law permits for particular plants:

- BOD_5: 15 mg O_2/l,
- Total suspended matter: 15 mg/l,
- Total nitrogen: Wapnica - 12 mgN/l; others: 15 mg N/l
- Total phosphorus: Wapnica - 1.0 mg P/l, others: 1.5 mg P/l

[2] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment, published in the Official Journal L 135 of 30/05/1991.

The total efficiency of the four waste-water treatment plants in the holiday season reaches 20,100 m^3 per day. The basic daily pollution loads will be then reduced as follows:

- BOD_5: 5,800 kg O_2/24h
- Total suspended matter: 5,600 kg /24h
- Total nitrogen: 880 kg N/24h
- Total phosphorus: 170 kg P/24h

Influence of waste-water treatment plants on the state of the receivers

The receiver of the waste-water treatment plant in Wolin is the Dziwna River and for Międzywodzie it is the Kamieński Lagoon in the direct neighbourhood of the Baltic Sea.

To investigate the influence of investments on surface waters, ZGWW used the monitoring data obtained for many years by Proxima S.A., Geological Company from Wrocław, and the results of the research carried out by WPN and scientific institutions for their own needs.

The receiver of the treated water from the treatment plant in Międzyzdroje is Lake Wicko Małe, part of the Szczeciński Lagoon. Before the plant was constructed, the water quality of the lake was defined as out of class. High concentrations of heavy metals and micro-pollutants (pesticides, oil-derivatives, detergents) were found in the bottom sediments.

One year after the waste-water treatment plant was put into operation, the survey of bottom sediments, lake biology, the physicochemical status of the water and the sanitary state of the water confirmed that revitalization took place quickly. This enabled the inclusion of the lake into the territory of the WPN.

Effects of the construction of sewage systems

Due to the constructed leak-proof sewage systems, the diffuse sources of migrating pollution discharged into soil and melioration channels were eliminated. Beforehand, the pollutants had moved through the melioration channel system and pumping stations, and finally into the Dziwna River. The deep drainage system of the island does not play the role of a combined sewage system any more.

As there are no impermeable layers that insulate surface pollution from the strata, all kind of pollution poses a threat to water-bearing layers. This is the main reason for the construction of leak-proof sewage systems in all resorts of the island.

Improvement of the quality of drinking water

Since the construction of sewage systems, the physicochemical status of surface waters and groundwater has improved; this also applies to water quality at individual water intakes.

The quality of drinking water delivered by the newly constructed waterworks complies with the requirements of the Directive 80/778/EEC relating to the quality of water intended for human consumption. [3]
The investments completed so far (water intakes and the water-piping network) have helped to combat the existing deficit of drinking water of good quality in tourist resorts (Wisełka, Wapnica).

Benefits for the society

The environmental protection infrastructure has been designed to improve the quality of life and to enable delivering to tourists services of higher standards than before. The public opinion regards the improvement of the state of environment as the best way of ensuring the further development of tourism.

[3] Council Directive 80/778/EEC of 15 July 1980 relating to the quality of water intended for human consumption, published in the Official Journal L 229 of 30/08/1980.

The most perceived social effects are:

- Securing the possibility of bathing in the Baltic Sea and expansion of water sports on the Szczeciński Lagoon and Kamieński Lagoon;
- Decline in the costs of sewage collection with vacuum trucks;
- Improvement of economic benefits resulting from services for tourism, taking into account agro-tourism as well;
- Reduction of unemployment;
- Improvement of the inhabitants' health.

Projects prepared for implementation

The water management of the Wolin Island demands special attention and much funding.

In 2002-2006, ZGWW is going to complete the investments planned within the Programme, including the implementation of 18 projects that have valid building permits, including among others:

- Completion of the sewage system in the central part of the Island;
- Construction of missing water management infrastructure, including retention reservoirs, waste-water treatment plants and water-piping;
- Reclamation of the existing solid waste deposit sites and construction of a modern deposit site together with a waste treatment plant and composting plant.

All projects prepared for realization aim to improve the water conditions of the Main Groundwater Reservoir No. 102 "Wyspa Wolin".

Having in mind the immense financial means needed for the realization of the above tasks, ZGWW applied in 2000 for co-financing to the European Union's ISPA pre-accession programme.

The application was approved by the Minister of Environment for further submission to the European Commission for acceptance. A final decision has not been taken yet.

Strategic programmes and projects of institutions involved in nature and environmental protection of the Wolin Island

The Programme for the Wolin Island has been elaborated and implemented with regard to the following programmes and documents:

- Partnership for EU Membership (PdC);
- National Programme of Preparation for EU Membership (NPPC);
- Baltic Sea Protected Areas;
- Programme of the Helsinki Commission Project Implementation Task Force *Integrated Coastal Zone Management Plan - Szczeciński Lagoon* (Hot-Spot No. 113);
- International action *The Delta of the Oder River - the Landscape of 1993/1994* - realization of the provisions accepted by Poland and Germany;
- Cross-border partnership programmes of the Wolin National Park: German Nature Parks Usedom Island and Jasmund (scope: nature protection, scientific research, education, tourism, publications);
- Programme and activities of the European Union of Coastal Conservation on the Wolin Island (Rów Peninsula, Bielawki Islands);
- Programme and activities of the Association for the Protection of Birds: ornithological reserve *Karsiborska Kępa*;
- Cross-border cooperation programmes of the European Union financed by PHARE and carried out by ZGWW:
  - Poland - Germany (1996);
  - Poland - Baltic Sea Region (1996 and 1998).

- Documentation prepared by order of the Ministry of the Environment:
  - *Project of geological survey of exploitable resources of groundwater and protection conditions of Main Groundwater Reservoir No. 102 - Wolin Island*;
  - Hydrogeological documentation determining the protection conditions of the catchment of the Main Groundwater Reservoir No. 102;
  - The Protection Plan of the Wolin National Park.
- Documentation prepared by order of the Regional Water Management Board in Szczecin*: Water economy balance and conditions of water use for the region of Międzyodrze, the Szczeciński Lagoon, Wolin Island and Usedom Island.*

All the above-mentioned programmes and documentation have contributed to environmentally sound development of the Wolin Island and were very helpful for the drawing up and implementation of the ZGWW Programme.

Conclusions

In connection with the programmes being realized in the Oder Delta, the ZGWW Programme has good prospects for further realization. The following conclusions can be drawn:

- The Wolin Island as a separated physiographical, natural, hydrogeological and economic unit was an appropriate territory for the implementation of the model of sustainable development and management of the island;
- During the 11 years of its activity, ZGWW as local authority and task-oriented unit has carried out, on behalf of the associated communes, the "Programme of comprehensive pro-ecological undertakings on the Wolin Island";
- The cooperation with the Wolin National Park facilitated further integration with the interested institutions and organizations at national and international level for the benefit of sustainable development of the Wolin Island;
- As a result of the investments carried out by ZGWW, the state of the environment of the Wolin Island has improved, which can be confirmed by the results of many years' monitoring activities conducted in a number of sampling points on the island;
- Social goals have been reached on the island, strictly related with nature conservation and environmental protection;
- The presented achievements of the local authorities of the Wolin Island prove that the programmes and activities of local societies can be very effective for environmental protection. ZGWW, acting on the Wolin Island, which is surrounded by transboundary waters, can be regarded as a pioneer area in Poland with its comprehensive programme of pro-ecological undertakings and development, already implemented in its major part.

The Programme has been accepted by the public as it has been consequently implemented by ZGWW. At the local level, the public has been provided with current information on the implementation of particular projects and has participated in ecological workshops. As a result, the local initiatives supporting the Programme that have emerged apart from the created infrastructure are valuable resources for the improvement of the state of the environment and the quality of life in the region.

Figure 1. Wolin Island in the cross-border area

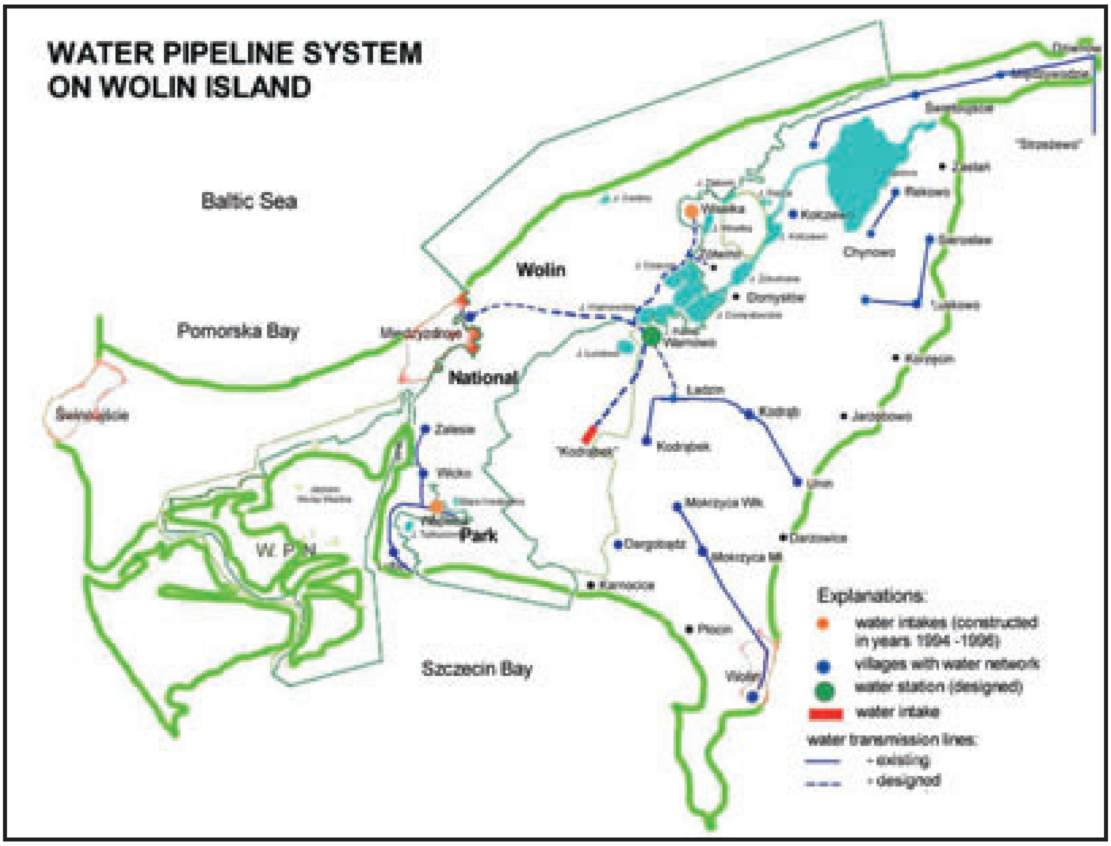

Figure 2. Water pipeline systems' construction to protect drinking-water resources and needs of inhabitants and tourists

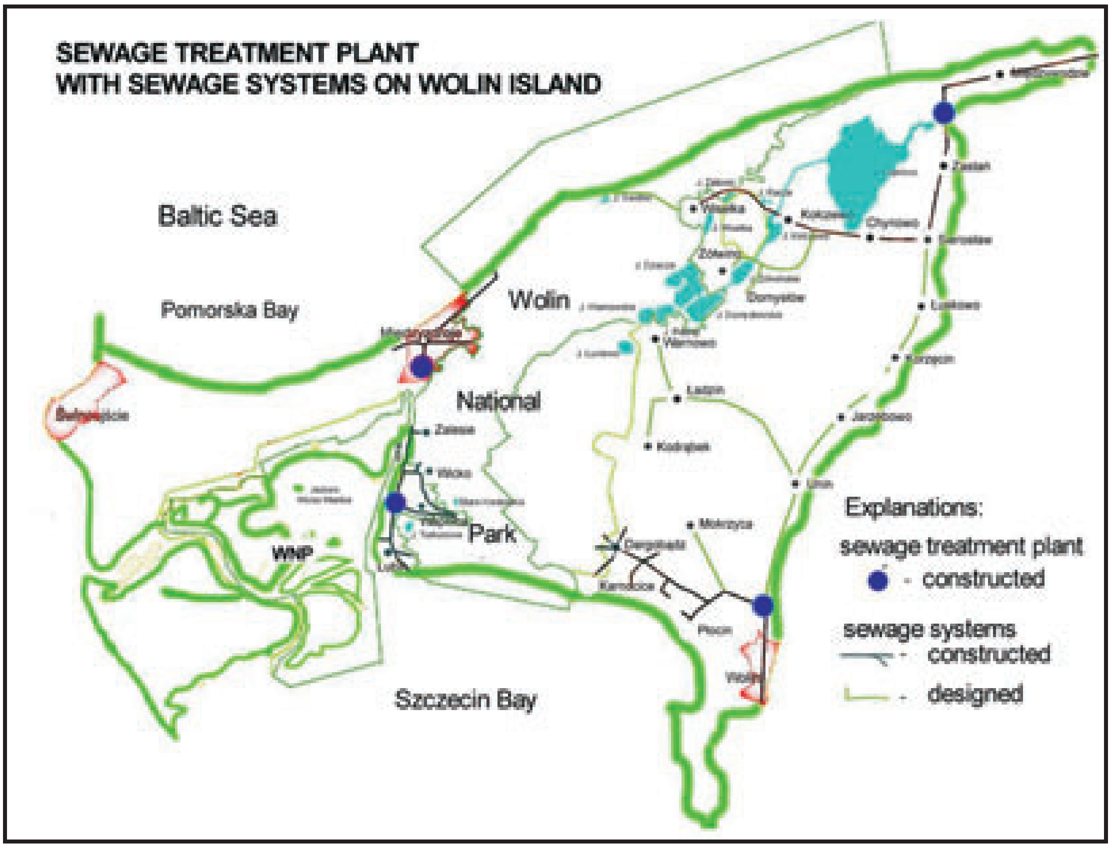

Figure 3. Investments for water protection: waste-water treatment plants and sewage systems

Figure 4. Biological reactor of the automatic waste-water treatment plant in Wapnica, co-financed by European Union's Phare Programme Poland - Baltic Sea Region

Impact of river basin management on the Baltic Sea: ecological and economical implications of different nutrient load reduction strategies

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Introduction

Water quality and eutrophication of coastal seas mainly depend on nutrient input from rivers. Therefore, nitrogen and phosphorus management in river basins is at the same time management of coastal waters and seas. This holds for the Baltic Sea, too. The Baltic Sea is one of the world's largest brackish water bodies (412,000 km²) with a water residence time of about 25-30 years, a drainage basin of 1,734,000 km² and a population in the drainage basin of about 85 millions. In the late 1980's about 70,000 tons/year of phosphorus (P) and 917,000 tons/year of nitrogen (N) were discharged into the Baltic Sea (Finnish Environment Institute, 2002). The result was a severe eutrophication, especially of the coastal waters.

The paper compares the impact of two 50% nutrient reduction strategies on the Baltic Sea using a 3D-coupled physical-bio-chemical model of the Baltic Sea (Neumann, 2000). The first strategy assumes a proportional 50% nutrient reduction in every riparian country, as suggested by the Helsinki Commission (HELCOM). The second approach is based on existing socio-economic calculations by Gren (2000) suggesting an optimal cost-effective 50%-nutrient reduction. In this cost-effective approach the nutrient reduction measures in the river basin are realised in countries like Poland, Russian Federation, Lithuania, Latvia and Estonia, where the costs per reduced ton of N and P are the lowest. The consequence is a reduction of the nutrient loads by more than 50% in the southern and south-eastern Baltic countries and less reduction in Scandinavia. In previous studies the general impact of a 50% nutrient reduction (Neumann et al., 2002) and the short-term effects on the Baltic coastal waters (Neumann and Schernewski, 2001) were analysed. This study focuses on the different effects of the two approaches in different regions of the Baltic Sea in a longer perspective and refers to consequences for river basin management.

Eutrophication abatement in the Baltic Sea

Already in 1974, the riparian States signed the Convention on the Protection of the Marine Environment of the Baltic Sea Area (1974 Helsinki Convention). To improve water quality, the States agreed to undertake all appropriate measures to minimise land-based pollution to the Baltic Sea. The goal of the Ministerial Declaration of 1988 was a reduction of the nitrogen and phosphorus load by 50%. In a recently published report, the Finnish Environment Institute (FEI, 2002) evaluated the nutrient load reductions into the Baltic Sea between the late 1980s and 1995. Altogether the total nitrogen as well as the phosphorus load was reduced by 35%. A fast reduction was observed mainly in countries with economies in transition. Poland and the Russian Federation alone contributed by reduction of about 155,000 t or nearly 50% of the total nitrogen load reduction into the Baltic Sea. The same is true with respect to phosphorus. The Russian Federation and Poland reduced their P-load by about 11,900 t or nearly 50%, as well. Despite that, Poland remained by far the most important N and P pollutant for the Baltic Sea.

The first 35% reductions of nitrogen and phosphorus were achieved within a period of only 7 years. The experience in other regions shows that further reductions are much harder to obtain. There are already doubts, whether a 50% reduction of nitrogen especially from diffuse sources in the Baltic can be reached even until 2005. To obtain the 50% nutrient load reduction is especially problematic for the countries which meet high water quality standards and have already realised load reductions during the early 1980s. Therefore alternatives are under discussion.

Nutrient load reduction strategies: cost effective versus proportional approach

The riparian countries around the Baltic Sea show pronounced differences in land use, economy, intensity of agriculture, population density and especially quality and efficiency of waste-water treatment. The agreed proportional 50%-load reduction from the territory of every country is a political goal without that does not take into account the total costs for the measures. It is called the proportional approach. The alternative approach suggested by Gren (2000), aims to meet the 50%-nutrient load reduction at minimum total costs. This involves that nutrient load reduction takes place in countries and drainage basins where it shows the highest cost-efficiency. It is called the cost-effective approach.

Background for the calculation of the cost-effective approach is the awareness, that the marginal costs of abatement measures are not the same among the riparian States. Marginal costs are defined as the increase in costs to reduce the nutrient load of nitrogen and/or phosphorus to the Baltic Sea by 1 kg. To calculate the scenario, Gren (2000) identified all reduction options and their location, quantified the reduction effect on nutrient loads to the Baltic Sea and calculated the marginal costs for all options.

The marginal costs of different measures reducing the nitrogen load to the Baltic Sea, for example, vary greatly between different types of sources. To reduce 1 kg N-load from agriculture in Germany costs between 3 and 15 euros, from waste-water treatment plants 3-8 euros from wetlands 3-5 euros and from atmospheric deposition 24-450 euros. Similar variations are obvious between different countries. For a reduction of the nitrogen load by 50% wetlands, agriculture and waste-water treatment plants have to contribute about the same share. This is different for phosphorus, where improvements of waste-water treatment plants are the most important and alone can contribute to 80% of the reduction. Most pollution originates from the territory of the Eastern European countries and in general it is cheaper to reduce the nutrient load there. The optimal reduction of nitrogen and phosphorus costs only 23% of the costs of a proportional reduction and has therefore sizeable economic benefits (Gren, 2000). The two approaches have different consequences for the Baltic Sea. The intensity of the load reduction varies between the regions and implies regional differences with respect to water quality in the Baltic Sea.

ERGOM: a 3D-ecosystem model of the Baltic Sea

A 3D-flow and circulation model with a biochemical module was applied for the simulation of the impacts of the two strategies. The circulation model is based on the Modular Ocean Model MOM2.2 and covers the entire Baltic Sea. A horizontally and vertically telescoping model grid with high horizontal resolution in the south-western Baltic (3 nautical miles) and increasing grid size towards north and east was applied. The first 12 vertical layers have a width of 2 m. The vertical thickness of deeper layers increases with depth. Towards the North Sea (Skagerrak) an open boundary condition is applied. An atmospheric boundary layer model derives the ocean surface fluxes from measured and calculated meteorological data.

The chemical-biological model consists of 10 state variables (ammonium, nitrate, phosphate, 3 phytoplankton groups, detritus, zooplankton, oxygen and sediment). Altogether 11 processes are taken into account (N-fixation, denitrification, nitrification, atmospheric input, algae respiration, algae mortality, nutrient uptake by algae, zooplankton grazing, mineralization, sedimentation and resuspension). In most parts of the Baltic Sea, nitrogen has to be regarded as the limiting element for phytoplankton production. The model therefore is focused on a proper description of the nitrogen cycle.

Phytoplankton is divided into three generalized functional groups: flagellates, diatoms and blue-green algae. Diatoms represent large phytoplankton and flagellates smaller phytoplankton. Both groups utilize dissolved nitrate and ammonium. The blue-green algae are able to fix atmospheric nitrogen and act as a nitrogen source for the system. Phosphate is included to limit the growth of blue-green algae and is linked to nitrogen within organic matter via the Redfield ratio. The primary production is driven by solar radiation and uptake of nitrogen as well as phosphorus. Different physiological parameters allow different ecological optima for the algae groups, depending on available nutrient concentrations, temperature and sedimentation velocity. The chlorophyll a concentrations are calculated from the biomass of all three phytoplankton groups. Generally diatoms dominate new production in spring whereas flagellates prevail during regenerated production. Low nitrate and ammonium concentrations are favourable for blue-green algae.

Grazing converts phytoplankton nitrogen into zooplankton and mortality of phytoplankton and zooplankton controls the nitrogen flux into detritus. The recycling process of detritus to nutrients provides an ammonium flux. Depending on oxygen conditions, ammonium is nitrified to nitrate. Oxygen demand and oxygen production is coupled to nitrogen conversion and controls the recycling path (oxic or anoxic) of dead organic matter (detritus). At the bottom, an additional sediment layer is introduced where sinking detritus accumulates. Suspension and resuspension of detritus is taken into account and occur if the currents near the bottom exceed critical values. In the sediment layer detritus can be mineralized and may be released as ammonium. Denitrification of 50% of the mineralized nitrogen takes place within the sediments around a hypothetical redoxcline as long as the water above the sediments remains oxic. Under oxic conditions the sediment is regarded as a sink for phosphorus (precipitation with iron). The chemical-biological model code is embedded as a module in the circulation model and linked via the advection-diffusion equation. For a detailed model description and applications of the 3D-ecosystem model see Neumann (2000).

Freshwater supply and nutrient load of the fifteen largest rivers with their proper spatial location are taken into account as a model input. The rivers are regarded as point sources that carry not only the measured river nutrient load itself but represent additional diffuse and smaller point sources of the surrounding area. The 15 rivers therefore cover the entire diffuse and point source load to the Baltic Sea. Atmospheric deposition is kept separately. A period of 4 years (January 1980 - December 1983) was simulated for both nutrient reduction strategies as well as a control run with no nutrient reduction. The choice of this period was due to the availability of a comprehensive and reliable data set of river loads as well as atmospheric deposition for the entire Baltic Sea.

The first simulation assumed a proportional reduction of every load by 50%. The second simulation was based on the optimal cost-effective nutrient reduction scenario. In both cases the absolute load reduction of nitrogen and phosphorus to the Baltic Sea was similar, but the spatial distribution of the nutrient load differed. Gren (2000) suggested the following allocation of cost-effective reductions of phosphorus and nitrogen: Denmark 60% P / 46% N, Estonia 10% / 54%, Finland 32% / 41%, Germany 55% / 15%, Latvia 55% / 66%, Lithuania 52% / 58%, Poland 58% / 59%, Russian Federation 65% / 57%, Sweden 19% / 42%. This information was used to calculate the rivers loads.

Effect of 50% nutrient load reduction on the Baltic Sea

After four years, the comparison of the simulation without any nutrient load reduction with the 50% cost-effective nutrient load reduction simulation shows pronounced differences. The annual average nitrogen (nitrate and ammonium) concentrations in the south and south-eastern Baltic Sea are reduced by nearly 50% (Figure 1). Near Sweden, the reduction of the nitrogen concentrations is below 10%. Phosphate reduction is less pronounced. A 20% reduction is observed only directly at the mouth of the large rivers. Reduced nutrient loads and concentrations in the Baltic Sea cause an average decline of chlorophyll concentrations, which is an indicator for algae biomass. The highest decline in chlorophyll concentrations, about 15%, is observed in the south-eastern Baltic Sea. Nearly no effect is visible along the Swedish coast. In average the chlorophyll concentration are reduced by less than 10%. Altogether the 50% nutrient load reduction does not cause a similar reduction of the algae biomass. The different algae groups behaved in a different manner.

Diatoms show a strong respond to nutrient reduction. The diatom biomass along the entire south-eastern Baltic Sea shows a drop of more than 30%. The situation with respect to blue-green algae is opposite. Reduced nutrient loads favoured the development of blue-green algae in the entire Baltic Sea. In some parts of the southern and eastern Baltic Sea an increase up to 600% is observed (Figure 2).

Effects of the cost-effective versus the proportional approach

A general feature of the cost-effective scenario is an increased reduction of nutrient loads from countries with economies in transition, Poland, Lithuania, Latvia, Estonia and Russian Federation. To keep the balance, nutrient loads from Scandinavia and Germany were reduced to a minor degree. The increased reduction of loads from large rivers entering the Baltic Sea along the south coast, like the Oder and the Vistula in Poland, causes slightly reduced nutrient concentrations in the river mouths and especially in the Riga bay in winter when compared to the proportional load reduction approach. The simulation of the cost-effective approach shows even more pronounced blue-green algae developments in the south-eastern Baltic Sea.

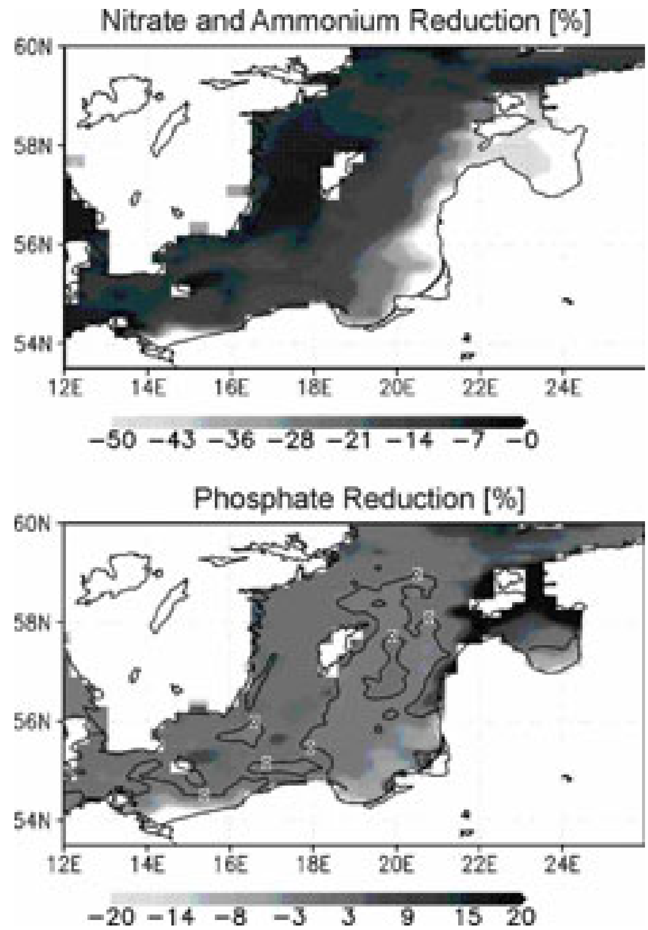

Figure 1. Simulation results with the 3D-ecosystem model of the Baltic Sea

Relative [%] decrease of dissolved inorganic nitrogen (nitrate and ammonium) and dissolved inorganic phosphate concentrations after a cost-effective reduction of N and P load by 50% (diffuse and point sources). The simulation started in January 1980. The results display the average annual concentrations in 1983.

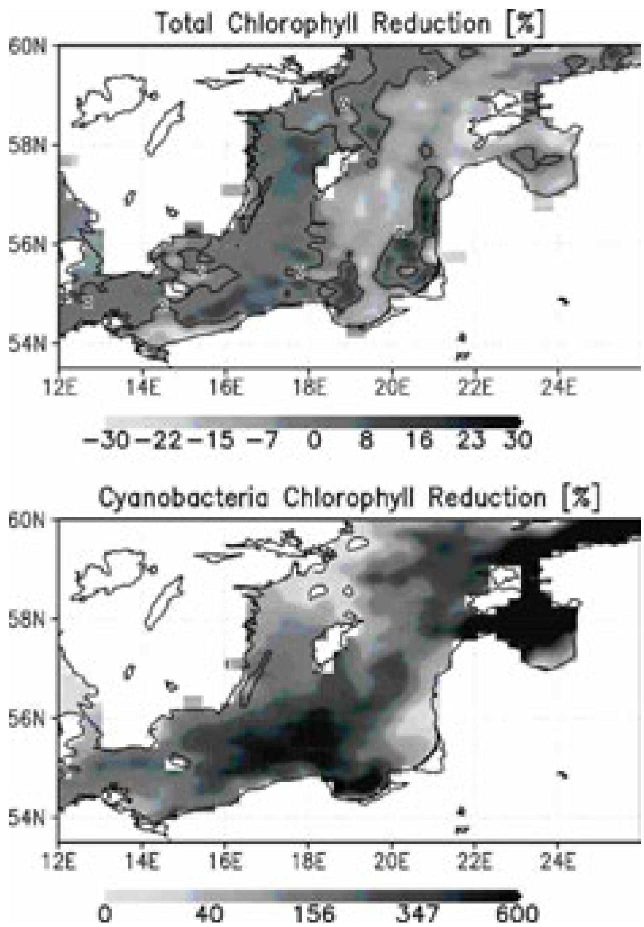

Figure 2: Simulation results with the 3D-ecosystem model of the Baltic Sea

Relative [%] decrease of total chlorophyll a (indicator of algal biomass) and cyanobacteria
(Blue-green algae) chlorophyll a concentrations after a cost-effective reduction of N and P load by 50% (diffuse and point sources). The simulation started in January 1980.
The results display the average annual concentrations in 1983.

Implications for river basin management

With the exception of the blue-green algae development, the differences between the two approaches are not very pronounced. The concentration of all positive and negative effects of the nutrient load reduction in the south-eastern Baltic Sea is a result of the prevailing current systems. In average an anti-clockwise circulation pattern dominates in the central Baltic Sea. The water and the nutrient load of the Oder and the Vistula Rivers is transported along the Polish coast towards east. In front of the shores of the Baltic States, in the south-eastern Baltic Sea, the nutrient load reduction effects accumulate.

Reduced river nutrient load causes reduced nutrient concentrations in the Baltic Sea, but the effect on phytoplankton is not very pronounced. Due to lower nitrogen availability in the water, the spring development of diatoms is less intensive. In summer, the shortage of nitrogen has negative effects on all phytoplankton groups, with exception of blue-green algae. Blue-green algae are able to utilise atmospheric nitrogen and to overcome a shortage of dissolved nitrogen components in the Baltic Sea water. On the contrary, their development is favoured, because the development of competing groups is hampered. The reduced spring bloom due to reduced nutrient availability is compensated by an increased summer development of blue-green algae.

Blue-green algae blooms are a common feature in the Baltic Sea during summer month. Toxic species develop in the open sea (e.g. *Nodularia spumigena*) as well as in coastal waters (e.g. *Microcystis sp.*). Examples of potentially toxic species, toxic effects and incidents in the Baltic Sea are given by Wasmund (2002). Toxic

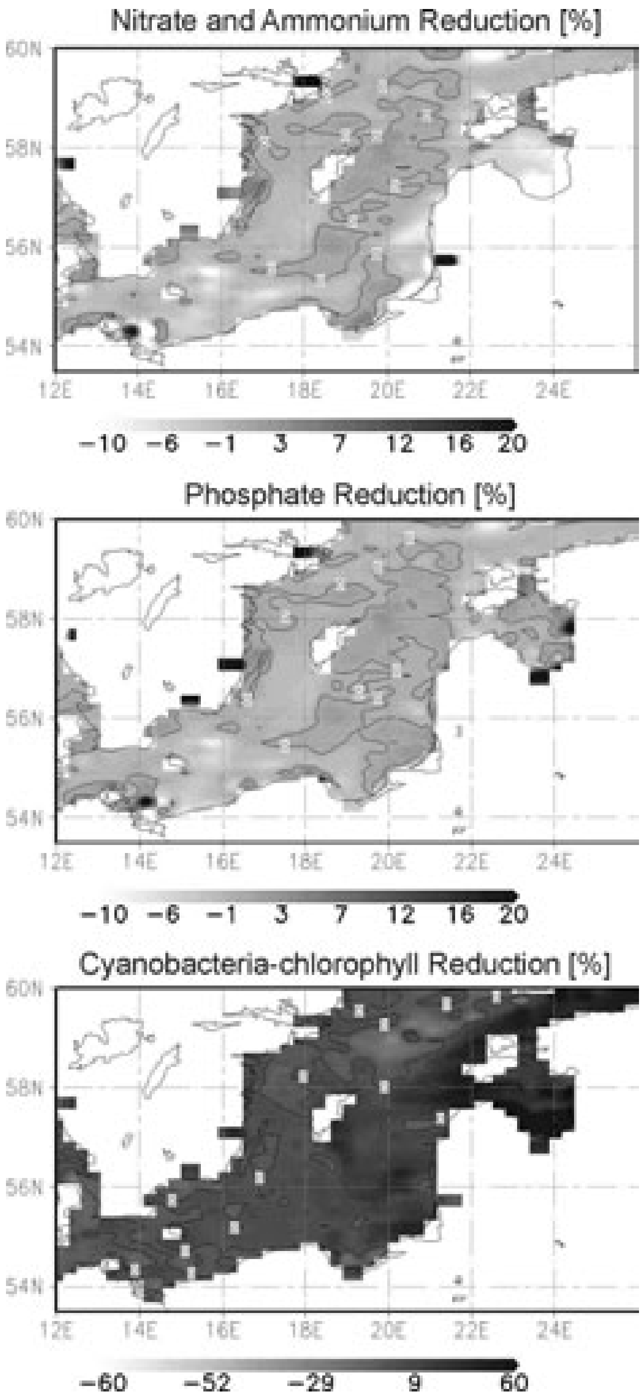

Figure 3: Simulation results with the 3D-ecosystem model of the Baltic Sea

Relative [%] differences in dissolved inorganic nitrogen (nitrate and ammonium), dissolved inorganic phosphate and chlorophyll a concentrations between the proportional and the cost-effective reduction of N and P load by 50% (diffuse and point sources). The simulation started with data of January 1980.
The results display the average effects in August 1983.

blooms are not only harmful for men or animals, but have also high economic relevance for fish and shellfish farming as well as tourism.

The model simulations suggest, that a proportional reduction of nitrogen and phosphorus at the same time does not have the desired reducing effect on phytoplankton development in the open sea. The measures taken seem to be not suitable to abate eutrophication in the Baltic Sea. A possible solution can be an increased reduction of the phosphorus load. Phosphorus is an element that potentially limits the phytoplankton production in the Baltic Sea. In some regions of the Baltic Sea phosphorus is the most important limiting element. A shortage in dissolved phosphorus in the water cannot be compensated by algae.

All groups are affected by a phosphorus limitation more or less in the same manner and the observed shift between different phytoplankton groups is less likely under P-limitation. Additional simulations are needed to prove, whether an intensified phosphorus load reduction management is a suitable way to abate eutrophication in a more efficient manner.

To a high degree phosphorus has its origin in point sources, like municipal sewage. The nutrient load from point sources can be reduced during a short period of several years. Usually, measures to reduce input from point sources are much cheaper compared to measures dealing with diffuse sources. The main sources for nitrogen are the input from groundwater and the drainage from agricultural land. To reduce groundwater nitrogen concentrations is expensive and takes decades. This is why phosphorus load reductions are usually obtained faster. Behrendt et al. (1999) calculated the load reduction of P and N from the German territory between 1993-1997 and 1983-1987. The aim was a 50% reduction. A 60% reduction was achieved for phosphorus during that period but only a 25% nitrogen reduction took place. There is some likelihood that a similar development will take place in the Baltic region as well and that automatically the suggested increased P-reduction will occur in the future.

Söderqvist (2000) compared the costs and economic benefits from a cost-effective 50% nutrient load reduction to the Baltic Sea. He applied the contingent valuation method on the basis of surveys and questionnaires. Individuals were asked about their willingness to pay for the realization of improved coastal water quality. The conclusion was that in the Eastern European countries with economies in transition there is a negative net benefit. This means that the population is not willing to pay the high costs for improved water quality. In the market economies in Scandinavia and Germany, on the contrary, there is a positive net benefit for an improved Baltic Sea water quality.

The analysis did not take into account spatial implications of the cost-effective reduction scenario in different regions of the Baltic Sea. Results of earlier studies showed that improved water quality of the rivers Vistula and Oder in Poland, for example, has an immediate effect on adjacent coastal waters (Neumann and Schernewski, 2001). The discharge of the Oder River directly affects large coastal regions in Germany with intensive tourism which are depending on high water quality. Reduced river loads in Poland therefore have a much higher regional benefit for Germany than indicated in the analysis by Söderqvist (2000).

In general, the simulation results show that the spatial exchange of nutrients in the central Baltic Sea is fairly fast and that in a long-term perspective it is not important where nutrient reduction measures take place. Therefore the cost-effective 50% nutrient reduction approach should be realised within the Baltic. It means that financial resources have to be reallocated among the Baltic riparian States.

Summary

The model takes into account the real meteorological conditions of the 1980s and assumes an immediate nutrient load reduction by 50%, starting in winter 1980. The reduction has immediate effects on all coastal waters. A reduced nutrient availability and shifts between the utilisation of nitrogen and phosphorus are visible in the Arkona, Bornholm and Gotland Sea already in the first summer. After 3 years the mean annual phosphorus and, more intensively, the nitrogen concentrations are reduced in the south-eastern Baltic Sea. The reduction in chlorophyll a, an indicator of algal biomass, shows only a decline of about 10%. The model suggests that the 50% reduction of the nitrogen and phosphorus loads, favours blue-green algae blooms in the south-eastern Baltic Sea. In the cost-effective approach, blooms of the potentially toxic blue-green algae become even more pronounced.

Referring to the simulation results, the scheduled measures to abate eutrophication in the Baltic Sea will partly fail and generate undesirable side effects. These side effects are a result of imbalances in the system and might maintain over decades. A more pronounced reduction of the phosphorus loads might prevent an increase in blue-green algae blooms. The cost-effective approach shows, compared to the proportional load reduction approach, clear positive effects in the western German part of the Baltic Sea and no serious differences along the Swedish coast. Due to an increase of blue-green algae blooms, there are negative implications for the south-eastern Baltic regions. Altogether the cost-effective approach reaches the same objective with one fourth of the costs and is strongly recommendable. It would necessitate reallocating water-quality related investments between the countries in the Baltic.

References

1. Behrendt, H., Huber, P., Kornmilch, M., Opitz, D., Schmoll, O., Scholz G., and Uebe R., 1999. Nährstoffbilanzierung der Flussgebiete Deutschlands. Umweltbundesamt, Forschungsbericht 29625515.
2. Gren, I.-M., 2000. Cost-effective nutrient reductions to the Baltic Sea. Gren, I.-M., Turner, K. and Wulff, F. (eds). Managing a sea. Earthscan Publ., London, pp. 43-56.
3. Finnish Environment Institute, 2002. Evaluation of the implementation of the 1988 Ministerial Declaration regarding nutrient load reductions in the Baltic Sea catchment area. The Finnish Environment, 524, Helsinki: 195 pp.
4. Neumann, T., 2000. Towards a 3D-ecosystem model of the Baltic Sea. Journal of Marine Systems pp. 405-419.
5. Neumann, T. and Schernewski, G., 2001. Cost-effective versus proportional nutrient load reductions to the Baltic Sea: Spatial impact analysis with a 3D-ecosystem model. In: Brebbia, C.A. (ed.). Water Pollution VI - Modelling, Measuring and Prediction. Witpress, Southampton, pp. 269-278.
6. Neumann, T., Fennel, W. and Kremp, C., 2002. Experimental Simulation with an Ecosystem Model of the Baltic Sea: A Nutrient Load Reduction Experiment. Global Biogeochemical Cycles in press.
7. Söderqvist, T., 2000. The benefit of a less eutrophicated Baltic Sea. Gren, I.-M et al. (eds). Managing a sea. Earthscan Publ., London, pp. 66-77.
8. Wasmund, N., 2002. Harmful Algal Blooms in Coastal Waters of the South-Eastern Baltic Sea. In: Schernewski and Schiewer (eds.). Baltic Coastal Ecosystems: Structure, Function and Coastal Zone Management. CEEDES-Series, Springer Verlag, in press.

Connecting rivers and seas - the Danube/Black Sea experiment

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Introduction

Situated in the heart of Europe and virtually landlocked, the Black Sea has become a symbol of human neglect for the health of transboundary waters. Its basin, covering nearly 2 million square kilometres, includes major parts of 17 countries, 13 of which are riparian States of the Danube River and its tributaries. The basin, stretching from Germany to Georgia, Belarus to Turkey, is the stage for recent huge political and social upheavals including armed struggles, radical economic change, democratisation, poverty and environmental disasters. Arguably the biggest change in over a century however is the proposed accession of at least seven of the basin countries to the European Union, where they will take their place alongside current "Danubian" members, Germany and Austria. The fate of the Black Sea will be inextricably linked to the success of the new European architecture and the ability of those joining the European Union to cooperate and forge partnerships with those that will remain outside. The present paper examines some of the problems that must be tackled and the important progress in international cooperation in the Danube and Black Sea in the recent past.

Figure 1. The Black Sea basin includes Europe's second (Danube), third (Dnieper) and fourth (Don) largest rivers

The transboundary environmental issues

As a consequence of the political geography and huge scale of the Black Sea basin, only six countries (Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine) share the coastal and marine environment whereas a further eleven [1] (Austria, Belarus, Bosnia and Herzegovina, Croatia, Czech Republic, Germany, Hungary, Republic of Moldova, Slovenia, Slovakia and Yugoslavia) contribute run-off through the Danube, Dnieper and Dniester Rivers. From the perspective of the Black Sea, these eleven "landlocked" countries are part of the cause of many of its transboundary problems but are not direct beneficiaries of a healthy Black Sea. Addressing this imbalance is the key issue requiring international cooperation and a new frame of reference for practical environmental policies and programmes. There are however, cascades of transboundary issues, from local to global, requiring action. Recognising them one by one helps local communities to understand their own responsibility within the overall environmental jigsaw puzzle.

[1] There are also minor contributions from Albania, Italy, Poland and Switzerland.

During the past few years, both the six Black Sea countries and the 14 Danube countries have each developed a formal "Transboundary Diagnostic Analysis" (TDA) in the context of on-going Global Environment Facility (GEF) interventions (to be described later in this article). These highly participatory analyses provide a good framework to describe how the two subregions define their priority transboundary environmental issues.

Black Sea - Seven priority problems

The Black Sea TDA focussed on seven perceived transboundary "problems" and their immediate and underlying causes. The problems considered are described below.

Decline in Black Sea fisheries

Black Sea fisheries have witnessed major fluctuations in the past two decades. The production of small pelagic fish such as anchovies has generally increased (to yield almost half a million tons annually) but demersal stocks (e.g. turbot) and those of highly prized pelagic predator species, such as bluefish and mackerel, have dwindled. During the period 1990-1991, the entire fishery collapsed but the low value small pelagic species have now recovered. Poor regulation, illegal fishing and industry overcapacity compound the problem further.

Loss of habitats, notably wetlands and shelf areas, supporting important biotic resources

Black Sea wetlands have been lost on a massive scale to development projects. Coastal space is limited and wetlands have often been regarded as environments of low value. Underwater shelf areas have suffered as a result of eutrophication (the excessive growth of algae as a result of overfertilisation of the sea), trawling and dumping. The consequence has been the loss of major habitats and associated species. This is illustrated by the case of the vast red algal (*Phyllophora sp.*) mat that covered most of the north-western shelf of the sea (an area the combined size of Belgium and the Netherlands). This "keystone" species collapsed in the space of about 5 years in the early 1970s as a direct result of eutrophication.

Limited protection of endangered species

Apart from the loss of habitat and the effects of overfishing, endangered species suffer from a lack of consistent legal protection in the Black Sea region. There have been no reliable sightings of the monk seal, for example, for some years and it may have become the first recorded extinction in the Black Sea.

Replacement of indigenous Black Sea species with exotic ones

The Black Sea is particularly vulnerable to "invasions" by species introduced accidentally from ship's hulls or ballast water, or intentionally for the enhancement of fish stocks. This is not a new problem as such invasions have been recorded for over 50 years. However, the arrival in the mid 1980s of the comb jellyfish *Mnemiopsis Leidyi* from the eastern seaboard of America, resulted in a major change in the Black Sea ecosystem. This predator established itself so successfully that its total biomass was reported to be as much a one billion tons (wet weight) in 1990, comparable to the world's fish catch. It is almost certainly the major culprit for the collapse of fish stocks in 1990. Recently, its own enemy *Beroe ovata* (a larger comb jelly) has arrived by accident and appears to be keeping numbers of *Mnemiopsis* down.

Poor protection of the Black Sea landscape

Limited coastal space and poor intersectoral cooperation have resulted in major destruction of the Black Sea's unique landscapes. In eastern Turkey, for example, a major highway has been constructed along the beach. Large clearances of "green field" sites continue in all Black Sea countries for urbanisation, port construction and tourism infrastructure.

Inadequate protection of coastal resources from maritime accidents

The Black Sea has become a superhighway for oil tankers, particularly with the development of Caspian oil reserves. There are also new high-risk projects to transport oil and gas through underwater pipelines (e.g.

the "Blue Stream" gas line from the Russian Federation to Turkey, currently under construction). Accidents such as the loss of the 100,000 tons from the oil tanker Nassia on 13 March 1994, underline the problem, particularly in the treacherous Bosphorus Straits, as little as 750 m wide and 35 m deep, flowing through the middle of megacity Istanbul to connect the Black Sea with the Mediterranean.

Unsanitary conditions in many beaches, bathing waters and shellfish-growing areas

Many coastal towns in the Black Sea lack effective waste-water treatment. The problem appears to have worsened since the collapse of former communist regimes. Poor public information and transparent standards make it difficult to assess the true magnitude of the public health risk associated with raw sewage discharges to the coastal environment.

Figure 2 illustrates the linkage between these problems and their immediate and underlying causes. It is clear that one of the major causes "Eutrophication and chemical and microbiological pollution of coastal and marine areas" can be attributed to non-coastal as well as coastal States. Resolving the problem of eutrophication has been recognised as one of the most pressing priorities of the region as this phenomenon is a significant causative factor in six of the seven problems outlined above. In this context, a study of sources of nitrogen and phosphorus to the Black Sea (Topping, 1999) revealed that 50-60% of the dissolved nutrients discharged to the Black Sea come from the river Danube. This does not automatically imply that the source is from non-coastal countries as a large part of Romania and Bulgaria's emissions are to the Danube River (see Table 1). Furthermore, most of the problems described above are a result of multiple stresses; it is pointless trying to restore *Phyllophora* fields by reducing nutrient inputs if the area is constantly dredged for shellfish. The responsibility for solving the problems has to be a shared one between multiple stakeholders and across country borders.

Table 1. Summary of nitrogen and phosphorus load estimates *(Topping, Elmgren)* **to the Black Sea and Baltic. For the Black Sea, 31% and 27% of the river load for N and P respectively is estimated to be from non-coastal countries**

	Black Sea		**Baltic**	
Total river inflow (km^3/year)	350		440	
Nutrients (t/year)	**Total N**	**Total P**	**Total N**	**Total P**
Rivers	480	51	826	41
Coastal point sources	167	9	94	12
Atmospheric	400	0	329	3
Total	**1 047**	**50**	**1 249**	**56**

Figure 2. Identification of the major underlying causes of environmental degradation in the Black Sea (from the Black Sea Transboundary Diagnostic Analysis)

Perceived major problems	Transboundary elements	Principle underlying causes*
Decline in Black Sea fisheries	Virtually all fisheries resources are shared or straddling and management requires the effort of more than one country	**1, 2, 4, 8** *3, 5, 6, 7*
Loss of habitats, notably wetlands and shelf areas, supporting important biotic resources	Biotic resources are often mobile or migratory. Wetlands provide nursery grounds and may also reduce the inputs of transboundary pollutants	**1, 2, 3, 4, 5, 6, 8**
Limited protection of endangered species	Endemic and/or rare species are of regional and global significance.	**1, 2, 3, 4, 5, 6, 7, 8**.
Replacement of indigenous Black Sea species with exotic ones	Exotic species are a global transboundary problem. Entire Black Sea affected and may become vector for extra-regional contamination	**1, 2, 4, 7, 8** *5*
Poor protection of the Black Sea landscape	Reduction of regional value of Black Sea tourism.	**2, 3, 5, 6, 8** *4,*
Inadequate protection of coastal resources from maritime accidents	Black Sea coastlines are short and transboundary pollution is highly likely following accidental spills.	**3, 4, 5, 8**
Unsanitary conditions in many beaches, bathing waters and shellfish-growing areas	Transboundary human health problems from exposure. Region-wide loss of revenue.	**2, 3, 4, 5, 6, 8** *7*

	Causes
1	*Deficient management of living natural resources* • Overfishing • Poorly regulated destructive fisheries practices • Ill-defined resource allocation
2	*Eutrophication and chemical and microbiological pollution of coastal and marine areas* • Discharges of industrial wastes • Domestic sewage • Nutrients and pesticide residues from agriculture • Operational oil and ballast discharges • Solid waste dumping
3	*Inadequate planning at all levels* Poorly planned urban/ industrial/ recreational/agricultural development • Poor intersectoral coordination • Coastal erosion and inappropriate erosion control
4	*Inadequate implementation of available regulatory instruments* • Inadequate compliance and trend monitoring • Lack of international coordination • Ineffective pollution inspectorates
5	*Poor legal framework at the regional and national level* • Poorly defined environmental laws and regulations • Regionally incompatible laws and regulations • Ineffective EIAs • Inefficient contingency plans
6	*Insufficient public involvement* • Lack of general awareness of environmental issues • Deficient public participation • Apparent lack of transparency
7	*Major uncertainties to be resolved* • Poor data exchange • Inadequate management oriented research
8	*Lack of financial support* • Ineffective economic instruments • Unsustainable subsidies • Low value assigned to environment within national economic policies • Poor perception of opportunities for development

NOTE: Major causes are indicated by bold numbers, lesser but significant causes are shown in italics

Danube: five priority problems

The Danube River Basin Strategic Action Plan [2] identified the following key problems.

Nutrient loads and eutrophication

Eutrophication is perceived as a problem not only for the downstream Black Sea and Danube Delta but also for slow flowing reaches of the river, lakes and reservoirs. It causes oxygen depletion, affects fish stocks, and damages the aesthetic value of the river. Furthermore, high nitrate levels in some tributaries are seen as a potential human health hazard though the Danube itself is relatively “clean”. About 50% of the nutrient load is reported as coming from agriculture, 25% from municipal sewage and 25% from industry and atmospheric deposition.

Hazardous substances, including oils

Though concentrations of hazardous substances in the Danube are relatively low, there is evidence of their accumulation in sediments, particularly in reservoirs. The Iron Gates reservoir between Romania and Yugoslavia has very high sediment concentrations of some heavy metals and oil, sufficient to classify them as toxic waste under some western European regulations. There are additional “hot spots” of substances such as mercury and agrochemical residues. The problem of poorly managed toxic waste repositories was dramatically underlined during the major spill of cyanide-rich mine tailings near Baia Mare in Romania on 30 January 2000. The spill caused major ecological damage to the Tisza River and highlighted the need to examine other potential “chemical time bombs” in the Danube basin.

Microbiological contamination affecting water use

This is a major problem on a local scale in the Danube basin as the river and its tributaries receive untreated waste water from a large number of towns and cities. The degree to which this is a transboundary problem is unclear however, except in situations of towns near borders. Concern over public health is likely to be the most compelling local argument for improved waste-water treatment.

Heterotrophic growth and oxygen depletion affecting water uses

Where large organic loads discharge into slow flowing rivers, oxygen depletion may result in the partial or complete elimination of aquatic animals and plants. The fast flowing Danube is unaffected by this problem, but several of its tributaries suffer from low-oxygen conditions. This has the effect of reducing the capacity of the overall basin to support migratory fish, an important issue of transboundary concern.

Competition for available water and changes in river flow patterns and sediment transport regimes affecting ecosystems

The Gabcíkovo-Nagymaros dam dispute between Slovakia and Hungary became a textbook legal dispute when it was referred to the International Court of Justice in The Hague [3], its first “environmental” case. Hungary argued that the original project and subsequent diversion of the river would have profound environmental consequences. There are many other cases in the Danube of possible transboundary impacts of dam construction. The rapid erosion of the Danube Delta front, for example, has been attributed to construction of the Iron Gates dam between Romania and Yugoslavia. Rechannelling and embanking of the river has also eliminated important flood plain and wetland areas, further exacerbating the downstream eutrophication problem and removing important riparian habitats.

[2] The Strategic Action Plan - SAP - (1995-2005) for the Danube River basin was adopted during a meeting of Danube countries' Environment Ministers and the European Commissioner for the Environment on 6 December 1994 in Bucharest, Romania. The SAP provides directions and a framework for achieving the goals of regional integrated water management and riverine environmental management expressed in the Convention on Co-operation for the Protection and Sustainable Use of the River Danube.

[3] The case was referred to the International Court of Justice in 1993. The Court delivered its judgement in 1997.

It is clear from the above listing that discharges of nutrients and certain hazardous substances are one of the main problems. In its second intervention on the Danube, the GEF funded the Danube Pollution Reduction Programme (DPRP). One of its many outcomes was the publication of a transboundary analysis in 1999. This examined the effects on: downstream users/stakeholders, wetlands, Danube biota, the Danube Delta, and the Black Sea. It focussed on the middle and lower basin where stakeholder workshops defined the core problems in similar terms as:

	Middle Danube	*Lower Danube*
Agricultural sector	Unsustainable agricultural practices	Missing implementation of sustainable agriculture
Municipal sector	Inadequate management of municipal sewage and waste	Inefficient management of waste waters and solid waste
Industrial sector	Ecologically unfriendly industry	Pollution prevention and abatement not achieved

For the upper Danube, it has been pointed out (Bendow, 2002) that despite huge investments the problem of nutrient loads still persists, with Germany and Austria accounting for 26% of the total nitrogen load to the system (most of this probably comes from diffuse sources). The DPRP developed the "Danube Water Quality Model" and a portfolio of 421 investment projects that would lead to reduced nutrient loads as well as major domestic benefits. The cost of these projects would be 5.66 billion USD, 63% of which would be in conventional municipal waste-water treatment systems. This level of investment is estimated to result in a reduction of nitrogen and phosphorus loads to the Black Sea of 14 and 27% respectively. It is also clear however, that if the nutrient problem is to be tackled in a cost-effective manner at source, new agricultural practices must be developed that keep nitrogen and phosphorus on land, rather than trying to deal with it at the point of discharge to the system.

New legal instruments and institutions

"Perestroika" and the fall of the "Iron Curtain" provided an opportunity for cooperation on environmental issues amongst all of the Danubian and Black Sea countries. Even in earlier times however, some cooperation had existed. The European Danube Commission was set up in the 19th century and the International Association for Danube Research (IAD) is a group which has been exchanging scientific information since 1956. However, prior to 1986 a more comprehensive approach was not possible due to the atmosphere of suspicion and mistrust.

Two models were employed to establish legal frameworks for cooperation in the Danube and Black Sea. For the Danube, the UNECE Convention on the Protection and the Use of Transboundary Waters and International Lakes (Helsinki, 1992) provided a useful basic model whereas for the Black Sea, the model developed for the UNEP Regional Seas programme was employed. The legal process was accompanied by policy and institutional capacity building processes largely funded by the Global Environment Facility (GEF) and the European Commission (Phare and Tacis programmes). The main instruments developed are shown in Table 2. The result of these processes was that, by 1996, both the Danube and Black Sea had environmental conventions and agreed detailed policy statements set down in "Strategic Action Plans". In both cases, they also had sufficient trained specialists to make these plans a reality. The considerable delays before beginning practical implementation of the new laws and policies was largely because of the economic and political difficulties faced by the countries with transition economies, particularly those newly independent States of the former Soviet Union. For some of these countries environmental protection was seen as a goal that could not be fully pursued until economic growth had occurred. The environmental "sector" itself is often poorly funded and disempowered. It has taken a long time to gradually move environmental issues up the political agenda.

Table 2: International legal and policy instruments in place in the Black Sea basin [4]

Instrument	Secretariat	Observations
The Bucharest Convention for the Protection of the Black Sea Against Pollution. Signed 1992, In force, 1994	The International Commission for the Protection of the Black Sea with a Secretariat in Istanbul (in place since 2000)	Protocols for land-base source pollution, dumping and pollution by oil and other harmful substances in emergency situations are in force. A biodiversity and landscape conservation protocol is in review.
The Convention on Co-operation for the Protection and Sustainable Use of the River Danube. Signed 1994, In force, 1998	The International Commission for the Protection of the Danube River (ICPDR), Vienna (operative since 1999)	The ICPDR role is rapidly developing following entry into force of the Convention.
The Odessa Declaration on the Protection of the Black Sea. Signed, April 1993	Black Sea Environmental Programme, Programme Co-ordination Unit (became PIU in 1998, see below)	A pragmatic 3-year policy agreement largely implemented with financial and technical support from the GEF and EC.
The Strategic Action Plan for the Rehabilitation and Protection of the Black Sea. Signed and adopted in October 1996	Currently managed by a Project Implementation Unit in Istanbul, now formally part of the Istanbul Commission Secretariat but supported financially by the GEF and the EC.	A wide ranging decadal plan covering many aspects of environmental protection in the Black Sea. Sets goals and milestones. Revision anticipated in 2002.
Strategic Action Plan for the Danube River Basin. Adopted in 1994, covering the period 1995-2005	Originally managed by the Environmental Programme for the Danube River Basin with a co-ordinating unit in Vienna, Austria. Now a responsibility of the ICPDR.	A wide-ranging basin-wide plan developed with the support of the European Commission.
Danube Pollution Reduction Programme. Agreed in 1999	Its implementation is the responsibility of the ICPDR. Practical management is through the Programme Management Task Force. The GEF has provided new (2002) funding for a project to support its implementation.	Developed through a project funded by the GEF, it includes detailed studies of actions to reduce transboundary pollution in the Danube River.
Memorandum of Understanding between the International Commission for the Protection of the Black Sea (ICPBS) and the International Commission for the Protection of the Danube River (ICPDR) on common strategic goals (Nov. 2001)	DABLAS Task Force for cooperation on water protection in the wider Black Sea Region (formed Nov. 2001), Secretariat: EC DG-Environment to arrange.	DABLAS has "effective implementation of the MOU" as its first objective. DABLAS itself was established on the principles of the EU Water Framework Directive [5] and the EC Communication 615 (Oct. 2001) [6]

Though both the Danube and Black Sea processes had recognised the common importance of tackling nutrient discharges as a key issue, little had been done to join forces apart from mutual representation on their decision-making bodies. In 1997 it was agreed to establish a joint working party (JWP) to examine the needs of the Black Sea for a reduced nutrient inflows and to suggest practical ways for achieving them. Again the GEF played a key role in facilitating the process. It led to a Memorandum of Understanding between the Danube and Black Sea Commissions signed in November 2001. The European Commission urged the Black Sea and Danube Commissions to form a Task Force (DABLAS) for cooperation on water protection in the wider Black Sea Region. This met in Brussels for the first time in March 2002 and focuses on practical support for all countries in the Basin to implement the EU Water Framework Directive, including the development of an investment portfolio.

4 For a full description of the Black Sea institutional process see: Mee, L.D., 2002. Protecting the Black Sea Environment: A Challenge for Co-operation and Sustainable Development in Europe. Centre for European Policy Studies, Brussels, 34 pp.

5 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, published in the Official Journal L 327 of 22/12/2000.

6 CEC, 2001. Environmental co-operation in the Danube - Black Sea Region, Communication from the Commission. COM (2001) 615 final. Commission of the European Communities, Brussels, 30.10.2001.

A new approach to basin-wide management

The need for adaptive management

The task facing the joint working party (JWP) described in the previous section was a particularly difficult one. Though it was clear that large parts of the Black Sea had suffered catastrophic damage as a result of eutrophication, there were many pieces of the scientific jigsaw puzzle missing, particularly regarding the acceptable discharge level from the Danube and the optimum nitrogen to phosphorus ratio of the discharge. Additionally, due to economic collapse in many sectors of the economy in countries with economies in transition, discharges had already fallen to the point where some, albeit slight, recovery of Black Sea ecosystems was recorded. In its recommendations, the JWP encouraged the application of an adaptive management approach already embodied in the Black Sea and Danube Action Plans and the EU Water Framework Directive. The idea was to set a clearly achievable pragmatic initial target for nutrient reduction and to monitor the results. At the same time it would be necessary to conduct scientific studies in order to reduce the scientific uncertainties and set new targets in the future. [7]

The Memorandum of Understanding adopted by the Danube and Black Sea Commissions gives the long-term goal and the intermediate one (the first iteration of the adaptive management process) as:

- The long-term goal in the wider Black Sea basin is to take measures to reduce the loads of nutrients and hazardous substances discharged to such levels necessary to permit Black Sea ecosystems to recover to conditions similar to those observed in the 1960s.
- As an intermediate goal, urgent measures should be taken in the wider Black Sea basin in order to avoid that the loads of nutrients and hazardous substances discharged into the Seas exceed those that existed in the mid 1990s. (These discharges are only partially known.).

The intermediate goal recognises that further short-term reductions in nutrient discharge are unlikely. On the other hand, during the development of the economies of the countries in the region, it will be necessary to take measures to control all new and additional sources of nutrients or to compensate them by improvements in the capacity of wetlands to assimilate nutrients. It is a bold step forward for the region.

Financing the adaptive management policy

Having set the new policy goals, the major problem was how to finance the change. In order to kick-start the process, the GEF agreed in 2001 to its biggest single global investment in international waters – a massive programme of grants amounting to some 90 millions USD over a five year period. This will be coupled with support from other donors (notably the European Union), bringing the total to well over 100 millions USD. The grant includes technical support projects (implemented by UNDP) for the Danube and Black Sea Conventions and a GEF/World Bank "Strategic Partnership". The Strategic Partnership consists of "incremental funding" packages (typically of 5 millions USD) for projects achieving a significant reduction in nutrient discharge. The projects normally have a domestic benefit requiring financing from the proposers or another donor, and a transboundary benefit resulting from the GEF grant. Examples of such projects include agricultural reform packages (ensuring that the avoidance of nutrient loss is part of the package), wetlands restoration projects (with benefits for biodiversity, flood control and nutrient assimilation) and waste-water treatment plants (ensuring improved sanitation plus tertiary treatment for nutrient reduction).

It is evident that the 100 millions USD are insufficient to resolve the problem of eutrophication in the Black Sea, even though this sum should "lever" an additional 300-500 millions USD in domestic/donor counterpart funding. The importance of the "experiment" is to create highly replicable projects that demonstrate the cost-effectiveness of the measures undertaken. Currently several sectors (e.g. agriculture, industry, municipal services) are highly sceptical of both the need and feasibility for taking such seemingly expensive measures. It is important to demonstrate that the control of nutrients makes economic sense as well as fulfilling national and international legal obligations.

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7 For a description of the scientific reasoning behind the decision of the JWP see: Mee, L.D. (2001) Eutrophication in the Black Sea and a Basin-wide Approach to its Control. In Science and Integrated Coastal Management (Eds. B. von Bodungen and R.K. Turner) Dahlem Univ. Press, pp. 71-93.

The challenge of balancing economic progress and sustaining the natural environment

Protection of the Black Sea basin represents a dilemma for development policy in many respects. An example is the need to satisfy the health prerogative of connecting more people to sanitation systems. Table 3 illustrates the continuing gap between lower and upper Danubian countries regarding sanitation. At the present rate, about 8 million additional people are connected every decade. Very few of these discharges however are subjected to tertiary treatment. This level of treatment may be prohibitively expensive in many cases (particularly for nitrogen removal) and the operation and maintenance costs of such plants may be a burden that cannot be sustained by local incomes. It is important therefore to view the system in a holistic manner; is there any way of compensating for the increased load rather than constraining access to improved health benefits? Improving the capacity of wetlands may offer one solution.

Table 3. Percentage of population linked to sanitation systems in some countries within the Danube basin

Country	Percentage of population linked to sanitation systems		
	1960	**1990**	**2005 (anticipated)**
Romania	*15*	*40*	*50*
Bulgaria	*25*	*45*	*60*
Ukraine	*39*	*55*	*65*
Germany	*40*	*85*	*94*
Weighted average of 11 countries	**25**	**55**	**68**

There are many examples of the dilemma illustrated above. Changing unsustainable agricultural practices has proven to be particularly difficult in western countries where growing intensification of food production has required heavy fertiliser use or produced huge quantities of animal waste. In an increasingly global market, how can new practices be introduced without causing economic ruin to local farmers that are unable to compete against cheap imports?

In making these choices, the countries with transition economies are facing a bigger political problem. Current management almost exclusively follows a "command-control" paradigm with little or no public participation in environmental decision-making apart from occasional elections where more general issues are at stake. The public in many of the Black Sea and Danube countries is poorly informed about the issues and real choices to be made. Worthy agreements such as the Strategic Action Plans have not been communicated to the general public by Governments. The public therefore regards projects such as wetland restoration with great scepticism. They might argue "Why should money be spent on mosquito infested muddy ponds that could be better used for planting crops?" Where money is spend under these circumstances, the local population will feel disenfranchised and are more likely to be "poachers" than "gamekeepers". Unless the environment is better integrated into education and democratisation, the long-term goal set by the two Commissions is unlikely to be met.

The European Community as a key actor

Six of the eleven non-member countries in the Danube Basin plus Turkey are at various stages in the process of accession to the European Union. This has a considerable bearing on future prospects for the Danube and Black Sea. The accession process includes the "Aquis Communitaire" in which prospective Member States incorporate the European Union's Directives into their own legal framework. Many of these Directives, such as the Urban Waste-water Treatment [8] and Nitrates [9] Directives or the wider umbrella Water Framework Directive will facilitate the goals adopted by the Danube and Black Sea Commissions. This is not automatic of course as many western European countries are currently struggling to implement many of the EU Environmental Directives and the Nitrates Directive is one of the worst cases of non-compliance. Certainly

[8] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment, published in the Official Journal L 135 of 30/05/1991.

[9] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources published in the Official Journal L 375 of 31/12/1991.

however, in terms of environmental directives, increased membership of the EU offers brighter prospects for the Danube and downstream Black Sea.

This conclusion, however, must be expressed with some caution. The major food production policies in the EU, the Common Agricultural Policy and the Common Fisheries Policy have been severely criticised for encouraging overintensification of agriculture on one hand and overfishing on the other. Both policies will be reviewed prior to the completion of accession by most of the candidate countries. In their current form, there is a risk that these policies could exacerbate the environmental problems of the Danube and Black Sea basin.

The other concern with the accession process is the risk of building a new “fortress” frontier around the EU that creates environmental policy divisions through the Black Sea basin. The work of the Danube and Black Sea Commissions and the emergent Dnieper Commission (Belarus, Ukraine and Russian Federation) will be vital if the adaptive management process is to succeed and they should maintain clear independence from direct influence by any individual or sub-group of countries in the region. All countries within each Commission should feel themselves to be equal partners in an on-going process in which they are able to share the benefits and the costs.

Conclusion

The Danube and Black Sea “experiment” is an exciting challenge which was made possible by the recognition that there are common responsibilities throughout the Black Sea basin as well as problems that can be resolved through sub-regional actions. Eutrophication and contamination with certain toxic substances are shared problems involving all 17 basin States. Having accepted common responsibilities, it was possible to move from “blame” to cooperation and to develop an adaptive management strategy strongly supported by the international community. One of the tests of success of this strategy will be the degree to which these long-term solutions become “internalised” within the public policy framework of each of the countries. This will require increased stakeholder participation and careful consideration of the underlying causes of the eutrophication and toxic substance problems.

It is particularly important to point out that the problem of environmental degradation in the Black Sea Basin should not simply be regarded as one of excessive nutrient discharges. The danger of such an oversimplification should not be underestimated. Complex problems require holistic solutions and it is necessary to tackle the other subregional transboundary problems simultaneously if a healthy ecosystem is to emerge. Physical destruction of habitats, chemical time bombs, destructive fishing, human health issues and shipping related problems are also interconnected transboundary issues affecting the Black Sea and its tributaries. Attention must be given to each of these problems and its underlying causes if the goal of a healthy Black Sea basin is to be met. The Danube, Black Sea and future Dnieper Commissions are the only bodies with a sufficiently broad coverage to make this vision a reality.

References

1. Black Sea Environmental Programme, 1997. Black Sea Transboundary Diagnostic Analysis, United Nations Publications, New York. ISBN 92-1-126075-2, August 1997, 142 pp.
2. Topping, G., Sarikaya, H. and. Mee, L.D, 1999. Land-based sources of contamination to the Black Sea. Ch. 1. Black Sea Pollution Assessment (Eds. Mee, L.D. and Topping, G.), Black Sea Environmental Series Vol. 10, UN Publications, New York. pp. 33-56.
3. Elmgren, R. and Larsson, U., 2001. Eutrophication in the Baltic Sea Area. In Science and Integrated Coastal Management (Eds. von Bodungen, B. and Turner, R.K.) Dahlem Univ. Press 15-35.
4. Environmental Programme for the Danube River Basin, 1994. Strategic Action Plan for the Danube River Basin. Brussels, 109 pp.
5. Danube Pollution Reduction Programme, 1999. Transboundary Analysis Report. UNDP/GEF, Vienna, 204 pp.
6. Bendow, J., 2002. Conflicting interests and regional co-operation. (manuscript in press).
7. UNEP/OCHA, 2000. Cyanide spill at Baia Mare Romania. United Nations Environment Programme, Geneva, 57 pp.
8. Haskoning, 1994. Environmental Programme for the Danube River Basin: Danube Integrated Environmental Study, Final Report. European Commission, Brussels, 94 pp.

Recreational water quality and human health in the Caspian region

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The Caspian Sea is an inland lake between Europe and Asia, bordered by Azerbaijan, the Russian Federation, Kazakhstan, Turkmenistan and the Islamic Republic of Iran. The average salinity of the Caspian is 12.3 g/kg compared with that of seawater which is 36g/kg (Peeters et al., 2000). With a basin 1,200 km long and 434 km wide and an area of 371,795 km^2, it is the largest inland body of water in the world. Although it receives many rivers, including the Volga, Ural, and Kura, the "sea" itself has no outlet. It is estimated that the Caspian Sea levels have risen by approximately 2.5 m over the last 25 years (Peeters et al., 2000).

As part of the Caspian Environment Programme [1], the WHO Collaborating Centre Robens Centre for Public and Environmental Health at the University of Surrey undertook to develop and deliver a training course for health-based monitoring of groundwater and recreational water in the Caspian Sea region. Following the training course, pilot monitoring programmes of bathing water were established in Turkmenistan, Azerbaijan and in the Islamic Republic of Iran, and a pilot groundwater monitoring programme in Turkmenistan. The programmes are ongoing, and therefore the results presented here are preliminary and incomplete.

Background and rationale

The training and monitoring programmes were focused at assisting in the implementation of the Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which has the aim of preventing, controlling and reducing the incidence of water-related diseases through collaboration on water management and protection of health and the environment. Under the Protocol on Water and Health, effective systems for monitoring and risk assessment should be established. Procedures for responding to water-related disease outbreaks and incidents and to the risk of them are also to be identified. The process should include the development of inventories on pollution sources, carrying out surveys on high-risk areas for microbiological contamination and toxic substances, and reporting on infections and other water-related diseases. Integrated information systems to handle information about long-term trends, current concerns and past problems and successful solutions to them in the field of water and health, and the provision of such information to competent authorities is also specified.

The major provisions of the Protocol on Water and Health linked to monitoring include "adequate supplies of wholesome drinking water which is free from any micro-organisms, parasites and substances which, owing to their numbers or concentration, constitute a potential danger to human health. This shall include protection of water resources which are used as sources of drinking water, treatment of water and the establishment, improvement and maintenance of collective systems" and "sufficient safeguards for human health against water-related disease arising from the use of water for recreational purposes".

This paper will focus on the recreational water training programme established by the Robens Centre in the Caspian Region.

Recreational training and monitoring programme

Recreational use of the water environment may offer significant financial benefits to the associated communities but its use also has implications for human health and for the environment. Primary concern of researchers in this field of work has been directed towards gastro-intestinal illnesses acquired from recreational waters, although acute febrile respiratory illness and infections of the eye, ear, nose and throat have also been linked with bathing. A number of other health hazards may be encountered during

[1] The Caspian Environment Programme, officially launched in 1998, is a regional programme developed for and by the five Caspian littoral States, Azerbaijan, Islamic Republic of Iran, Kazakhstan, Russian Federation and Turkmenistan, aiming to halt the deterioration of environmental conditions of the Caspian Sea and to promote sustainable development in the area.

recreational water use but these are typically local in distribution. These include: chemical contamination, hazardous animals encountered near the water, venomous invertebrates and vertebrates and non-venomous disease-transmitting organisms. More serious diseases such as hepatitis A and others have been attributed to bathing in contaminated waters but less commonly.

The objectives of the training course were to outline the importance of monitoring recreational water and beach quality to protect human health as well as to promote integrated coastal zone management, and to outline the importance of linking monitoring to management and designing remedial measures. Thus, the emphasis was on practical work focussed on the establishment of the pilot projects to monitor the quality of waters used for recreational purposes. Prior to the course, field and laboratory equipment were supplied to each country participating in the pilot projects (Azerbaijan, Islamic Republic of Iran and Turkmenistan), together with a training manual, translated from English into Russian.

Two representatives from each of the five countries bordering the Caspian Sea were invited to attend the course, held in Turkmenbashi, Turkmenistan. The backgrounds of the participants varied quite considerably, although, where possible, at least one of the representatives had a technical background.

Course content

- Introduction to the WHO Guidelines for Safe Recreational-water Environments and the proposed monitoring programme;
- Background to the use of indicator species, for microbiological quality assessment;
- Rationale for using the chosen indicators (faecal streptococci and coliform bacteria, suitable for marine and freshwaters);
- Techniques for sampling water quality, including sampling methods, location, timing, depth, number of samples, transportation of samples, environmental influences - rainfall, sunlight etc. on bacteria and viral survival;
- Techniques for analysing water quality - membrane filtration method, culture media, equipment;
- Interpretation of water-quality data, data handling, processing and evaluation;
- Resource management;
- Quality control;
- Background to conducting a sanitary inspection - identification of potential sources of faecal contamination, aesthetic and non-aesthetic parameters;
- Management options - short and long-term;
- Application of the collected data to produce action plans to aid coastal zone management and informing the public.

An important element of the course was the discussion of the WHO Guidelines for Safe Recreational-water Environments (WHO, 1998) and standards in place in other parts of the world (Table 1). The WHO Guidelines for Safe Recreational-water Environments propose a range of values expressed in terms of 95th percentile value of faecal streptococci per 100 ml. These represent understood levels of risk based on the exposure conditions of key epidemiological studies. The value of 200 faecal streptococci per 100 ml relates to an average probability of one case of gastroenteritis for a bather having 20 exposures per bathing season.

The standards or guidelines adopted by any country must be adapted to suit the situation within the country, taking into account social, cultural, environmental and economic factors. In doing this, the standard-setting body may develop standards that differ between regions and within regions according to differences in these factors.

Pilot project

Each country coordinator was asked to select a number of bathing beaches comprising a maximum of 20 sampling points. The only criteria for selection were that the beach was used regularly for bathing and that it was within reasonable distance from the laboratory to allow monitoring on a monthly basis.

Country coordinators designated the laboratory to undertake the analysis. The laboratories were provided with all the equipment required to undertake the monitoring programme. This included media, filtration equipment, glassware, sampling equipment, incubators and autoclaves. To ensure results would be comparable between countries, standard recording forms and instructions for the methodology, as demonstrated during the training course were issued to each coordinator, translated as appropriate. Local contracts were issued to the laboratories to carry out the monitoring.

Water quality sampling

Samplers were asked to collect 500 ml of seawater in sterilised sample containers from the same point, and at the same time on a weekly or monthly basis. Sampling was carried out in accordance with the standard procedures outlined during the training programme. Samplers were trained to take the sample at chest depth and 30 cm below the surface, at the point along the beach where most bathers were usually found. This procedure is in accordance with the procedures recommended by the American Public Health Association (APHA/AWWA/WPCF, 1995) and the Bathing Water Quality Directive [2] of the European Union. Details regarding the number of bathers found at the beach at the point of sampling, meteorological conditions at the time of sampling, and temperature and pH of the water were also recorded.

Water samples were immediately labelled and packed in a cool box away from sunlight and transported to the laboratory for analysis. Technicians were instructed to start analysis within 6 hours of collection to avoid changes in the microbial populations. For the purposes of this project water samples were processed using the membrane filtration technique as described in The Microbiology of Water (HMSO, 1994).

Samples were analysed for *E. coli* and faecal streptococci. Faecal streptococci are widely accepted as useful indicators of faecal pollution in natural aquatic ecosystems. Their presence shows a close relationship with gastrointestinal symptoms associated with bathing in marine and freshwaters, as shown by a number of epidemiological studies undertaken in the United States of America and Europe. Slantez and Bartley agar medium was used for the detection of faecal streptococci. Presumptive faecal streptococci usually produce pink, maroon or red colonies after incubation at 37 °C for 4 hours followed by 44 °C for 44 hours.

Thermotolerant (faecal) coliforms are the subset of total coliforms that possess a more direct and closer relationship with homeothermic faecal pollution (Geldreich, 1967). *E. coli* is the only species of the family *Enterobacteriaceae* which is almost always faecal in origin. For this reason it makes a good indicator of faecal pollution. For the purposes of this project membrane lauryl sulphate broth was used for the selective detection and enumeration of *E. coli*. Samplers were instructed to count all yellow colonies after incubation at 30 °C for 4 hours and then at 44 °C for 14 hours (total incubation period of 18 hours).

Sanitary surveys

In addition, samplers were asked to complete a sanitary inspection of the bathing beach area (see Table 2). The aim of the sanitary inspection was to identify sources of microbiological pollution but also to review the adequacy of the sampling programme and any management measures in place to deal with known hazards in the bathing areas. It is recommended by the WHO that sanitary inspections be carried out annually, just before the start of the bathing season as well as prior to any new or proposed activities that could significantly affect the quality of the bathing area.

Results of the water-quality sampling and sanitary surveys are forwarded from each laboratory to the office of the Caspian Environment Programme in Baku, Azerbaijan and to the WHO Collaborating Centre in the United Kingdom on a monthly basis.

Results

A visit was made to the Caspian Sea three months after the training course. The start of the monitoring was delayed in Azerbaijan and in the Islamic Republic of Iran. This was due to the delay in release of the equipment from the customs. Results presented here are therefore unfortunately not from during the bathing season since monitoring began in September.

Figures 1 and 2 shows the counts of *E. coli* and faecal streptococci at the sample sites chosen for this project. Table 3 shows the median and 95th percentile values for both *E. coli* and faecal streptococci.

[2] Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water published in the Official Journal L 031 of 05/02/1976.

Islamic Republic of Iran

The bathing beaches in the Islamic Republic of Iran along the Caspian coast are well developed for tourism but there appears to be very little management particularly concerning solid and liquid waste disposal. There are many hotels and settlements along the coastline discharging waste water directly into the sea. In addition, run-off and river discharges contribute significantly to the contamination of the Caspian Sea.

Ten bathing beaches were chosen for monitoring:

- Ramsar Beach;
- Salman Shahr Beach;
- Noshahre Beach;
- Nashtaroud Beach;
- Chalouse Beach;
- Tonekon Beach;
- Noor Beach, Noor City;
- Zagh-e-Marz, Neka City;
- Khazar Abad, Sari City; and
- Parcking 2 Beach, Babolsar.

Due to the large number of beaches chosen and the distance between the sites, it was decided that analysis would be conducted in two laboratories: the Chalous Environmental Centre and the laboratories of the Department of the Environment in Sari. Monitoring is being conducted on a weekly basis.

The results from the Islamic Republic of Iran reflect the more developed tourism and higher populations in this region of the Caspian Sea. Both the *E. coli* counts (Figure 1a) and faecal streptococci counts (Figure 2a) were several orders of magnitude higher than in Azerbaijan or Turkmenistan. Based on the monitoring conducted between 22 September 2001 and 24 November 2001 Ramsar, Salman, Chalous and Noshahre failed the guide value for *E. coli* of the Bathing Water Quality Directive. Counts of faecal streptococci are generally lower, but there are noticeable peaks in concentrations. However, it should be stressed that the monitoring has been undertaken outside the bathing season. The results are quite variable from week to week which may be attributed to a number of parameters such as weather conditions, particularly heavy rainfall or onshore winds, sewage discharge, riverine discharge etc. The sanitary surveys are ongoing and these analyses will be completed in due course. It should then be possible to ascertain the exact reasons for the higher levels of contamination.

Azerbaijan

Baku, the capital of Azerbaijan, has nine bathing beaches. Three sites for monitoring were proposed. Two of these sites are designated bathing areas - Novhni and Shihof - and one is undesignated but heavily used by the population of a nearby settlement. Site visits were made to the proposed beaches in August 2001.

Novhani is a beach on the north-west side of Baku approximately 30 kilometres from the city centre. It is a developed resort, the beach area is several kilometres long and facilities such as sun umbrellas, pedalos, and refreshments are provided. The beach area is cleaned when required by the local municipality. The total length of the beach is 250 m. Eight sample points were proposed for monitoring along this site, approximately 30 metres apart. Water samplings are conducted weekly and sanitary surveys will be conducted on a monthly basis.

The second proposed site was Shihof. This is south-west of Baku city and is less developed than Novhani. The beach area is segregated - one part of the beach is owned by a hotel, the rest is public. Samples are taken from three sample points at this site on a weekly basis.

The third site – Govsana – is on the south-east coast of Baku. It is an undesignated bathing beach but regularly used by a settlement situated on the coast. The coastline is heavily polluted with oil. Waste water is also discharged into the sea from the settlement. Two sample points were chosen along this stretch of coastline, and sampling is conducted weekly.

The maximum distance between the three sites is approximately 100 km.

Results are presented for two of the sites sampled in Azerbaijan. Low counts of both *E. coli* (Figure 1b) and faecal streptococci (Figure 2b) are recorded. Both sites are below the mandatory and guide values set by the Bathing Water Quality Directive of the EU for *E. coli* and faecal streptococci.

Turkmenistan

Four bathing beaches were selected in Turkmenbashi:

- Hotel Avazar;
- Hotel Hazar;
- Hotel Florida; and
- Resort Ufra.

The first three sites were chosen as sites which are most popular with bathers. The Resort Ufra is an oil base. Ships dump their waste into the waters here and for this reason the site was chosen. However, the site does not have open access to the public. The maximum distance between the sampling sites is approximately 26 km.

In general, the results for Turkmenistan show the water quality to be of fairly good quality. Two of the sites - Hotel Florida and Hotel Hazar – regularly show counts of *E. coli* greater than 100 per 100 ml – thus exceeding the guide value set by the EU (Table 1). However, all the sites are within the mandatory standard (95% of samples < 2000 *E. coli*/100 ml) set by the Bathing Water Quality Directive (Figure 1 c).

Faecal streptococci counts were also low - less than 100 per 100 ml for all sites (Figure 2 c). The Bathing Water Quality Directive does not set a mandatory value for faecal streptococci, only a guide value of 100 per 100 ml (Table 1).

Discussion

The project has highlighted a number of issues concerned with monitoring bathing areas. The microbiological results show considerable temporal and spatial variation, which indicates changing health risks over time. This highlights the inherent difficulties associated with the commonly used practice of defining a bathing water as passing or failing a defined microbiological standard. The WHO advocates moving away from a single standard for this reason. However, it should also be appreciated that the WHO guideline values may need to be adapted to take account of different local conditions. WHO recommends that the guideline values are used within a classification system currently being developed, which takes into account the results of the sanitary survey enabling managers to respond to local or sporadic pollution incidents and thereby improve the condition of the bathing area.

It is particularly important to conduct a sanitary survey together with the water-quality monitoring to identify the existing and potential microbiological hazards that could affect the safe use of the recreational water or bathing beach. It provides the basic requirements for designing a water quality monitoring programme and valuable information required to interpret the results. In addition, it provides public health authorities with information required to help select sampling points, sampling times and frequencies in order to estimate more accurately water quality and make sound management decisions regarding risk to human health. Combined use of sanitary surveys and water quality analysis has been used to good effect in the assessment of potable waters.

The indications from the limited results presented here are that the bathing beaches monitored in Turkmenistan and Azerbaijan were of generally acceptable quality over the period of monitoring, with some peaks in pollution, particularly at Hotel Hazar and Hotel Florida, Turkmenistan. The bathing areas monitored in the Islamic Republic of Iran are generally more polluted.

Continuing work

The results presented here provide only an indication of the water quality over a limited period of time. Monitoring should be continued over the bathing season to see the effect of seasonal patterns on the water quality and a more detailed study of the sanitary surveys needs to be conducted to identify the potential sources of pollution. It is hoped to continue the programme in the Caspian Sea in order to identify trends in the water quality and identify suitable management options.

Conclusions

In addition to implementation of the Protocol on Water and Health, the programmes established by the Robens Centre for Public and Environmental Health have helped to:

- Strengthen the technical cooperation and capacities between countries;
- Provide guidance on the establishment of local capabilities for controlling water-borne diseases;
- Develop and implement country programmes;
- Raise awareness of the WHO Guidelines for Safe Recreational Recreational-water Environments and provide guidance for the harmonisation of national standards with WHO guidelines where appropriate;
- Strengthen regional data collection, increase public awareness and provide an infrastructure for a long-term programme of monitoring and data collection;
- Promote discussion and cooperation between the bordering countries of the Caspian Sea to better manage this unique resource.

Table 1. Current recreational water quality standards/guidelines (microbiological parameters)

Country	Primary contact recreation			References
	Total coliforms	Faecal coliforms	Other	
Brazil	80%<5000	80%<1000		Brazil Ministerio del Interior, 1976
Bulgaria			Faecal streptococci 50/*l*	
Canada			E. coli 2000/l [n] Enterococci 350/*l*	Minister of Supply and Services Canada, 1992
Colombia	1000	200		Colombia, Ministerio de Salud, 1979
Cuba	1000[a]	200[a] 90%<400		Cuba, Ministerio de Salud, 1986
European Union	80%<500[c] 95%<10000[d]	80%<100[c] 95%<2000[d]	Faecal streptococci 100 [c] Salmonella 0/*l* Enteroviruses 0 plaque forming unit (pfu)/*l* Enterococci 90%<100	Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water
Ecuador	1000	200		Ecuador, Ministerio de Salud Publica, 1987
France	<2000	<500	Faecal streptococci <100	WHO, 1977
Israel	80%<1000[g]			Argentina, INCYTH, 1984
Japan	1000			Japan, Environmental Agency
Mexico	80%<1000[i] 100%<10000[k]			Mexico, SEDUE, 1983
New Zealand			35[p] enterococci per 100 ml	Ministry of Health, Ministry for the Environment, 1999
Peru	80%<5000[i]	80%<1000[i]		Peru, Ministerio de Salud, 1983
Poland			E. coli<1000	WHO, 1975
Puerto Rico		200[h] 80%<400		Puerto Rico, JCA, 1983
United States, California	80%<1000[ij] 100%<10000[k]	200[aj] 90%<400 [l]		California State Water Resource Board (no date)
United States USEPA			Enterococci 35[a] (marine) 33[a] (fresh) E. coli 126[a] (fresh)	USEPA Dufour and Ballentine, 1986
Former USSR			E. coli <100	WHO, 1977
UNEP /WHO		50%<100[n] 90%<1000[n]		WHO/UNEP, 1978
Uruguay		<500[n] <1000[o]		Uruaguay, DINAMA, 1998
Venezuela	90%<1000 100%<5000	90%<200 100%<400		Venezuela, 1978
Yugoslavia	2000			Argentina, INCYTH, 1984

[a] *Logarithmic average for a period of 30 days of at least 5 samples.*
[b] *Minimum sampling frequency – fortnightly.*
[c] *Guidelines for Safe Recreational-water Environments.*
[d] *Mandatory.*
[e] *Monthly average.*
[f] *At least 5 samples per month.*
[g] *Minimum 10 samples per month.*
[h] *At least 5 samples taken sequentially from the waters in a given instance.*
[i] *Period of 30 days.*
[j] *Within a zone bounded by the shoreline and a distance of 1000 feet from the shoreline or the 30 foot depth contour, whichever is further from the shoreline.*
[k] *Not a sample taken during the verification period of 48 hours should exceed 10,000/100 ml.*
[l] *Period of 60 days.*
[m] *"Satisfactory" waters, samples obtained in each of the preceding 5 weeks.*
[n] *Geometric mean of at least 5 samples.*
[o] *Not to be exceeded in at least 5 samples.*
[p] *Seasonal median.*

Table 2. Sanitary inspection form – Guide to information for inclusion

Background information:
Area name and code number: _______location:___________
Type of water: Fresh ___ Marine ___ Estuarine ___
Responsible authority: _______ Address:________ Tel .____Fax. ______email______
Laboratory of analysis: Name: ______ distance (km)___sample transport time (h)___
Person responsible for samples during transport:__________________________
What land or human activity surrounds the bathing area? (check all that apply)
forest ___ fields ___ desert ___ hills ___ swamp ___ river/stream/ditch ___ agriculture (specify) ___ urban ___ commercial ___ residential ___ industry (specify) ___ hotel ___ harbour ___ airport ___ road/rail ___ military ___ waste tip ___ other ___ Is the area surrounding the bathing area urban? ___
Additional details: historical information, reason for assessment, other contacts, etc.:
Size of bathing area: area (m2): ___length (m) ___ mean width (m) ___
Is there a beach? ___ average area (m2): ___ length (m) ___ width (m) at high tide ___ width (m) at low tide ___
Prevailing onshore winds: direction ___ typical speed (km/h) ___
Prevailing water currents: direction ___ typical speed (m/sec) ___ shoreline configuration ___ presence of sandbars ___ average wave heights: ___
Rainfall: total annual ___ seasonal patterns ___
Temperature: water: average ___ annual low ___ annual high ___
air: average ___ annual low ___ annual high ___
Public facilities: No. of toilets ___ showers ___ drinking water fountains ___ litter bins ___ Are they animal and/or bird-proof? ___ Are methods in place to warn the public of danger? ___ Are the above facilities adequate? Accessibility :Road ___ Path ___ No access ___ Is there an adequate parking area? ___ Additional details: ___
Microbiological hazards:
a) Sewage and animal wastes - Is the water quality affected, or likely to be affected, by discharges from:
on-site or other private sewage disposal systems? ___ communal sewage disposal or treatment facilities? ___ long sea outfalls?___ agricultural activities? ___ aquacultural activities?___ unconfined domestic or wild animals and birds? ___ confined animals or birds (i.e., feedlots) ___ Are discharges continuous or sporadic? ___Is waste water from toilets, showers, etc. likely to contaminate the bathing area? ___ Will typical bather densities impair water quality? ___
b) Storm water run-off: Is the water quality affected or likely to be affected by non-point discharges from: municipal storm drains or combined sewer overflows? ___
Agricultural fields? ___ natural drainage? ___ Are onshore winds likely to carry polluted water into the bathing area? ___ Are currents likely to carry polluted water into the bathing area? ___ Are tides likely to affect water quality in the bathing area? ___
Note: any of the above with a yes answer require(s) a detailed investigation and risk analysis. This investigation should include:
– Proximity of potential contamination source to bathing area – Background and contamination incident flow rates – Effective rainfall which triggers contamination events (and typical duration of contamination) – For discharges from sewage systems or treatment facilities, include what type of treatment is used, the system capacity, flow rates and variability, and indicator standards – For animals/birds, stocking densities and types of animals – Indicator data will be necessary to support/supplement this information

Chemical and other hazards:
Water quality: Is the water likely to be affected by: discharges from industrial sources? ___ agricultural drainage? ___ water craft mooring or use? ___ urban surface run-off? ___ Are onshore winds likely to carry polluted water into the bathing area? ___ Are currents likely to carry polluted water into the bathing area? ___ Are tides likely to affect water quality in the bathing area? ___
Sand quality:
Is the sand likely to be affected by: discharges from industrial sources? ___ agricultural drainage? ___ water craft mooring or use? ___ urban surface run-off? ___ Are there plastic residues? ___ Are there tar residues? ___ Are there algae? ___ Are there other residues? ___ Supporting chemical water quality data or additional comments:
Note: any of the above with a yes answer require(s) a detailed investigation and risk analysis. This investigation should include:
Proximity of potential contamination source to bathing area - For boats, densities and pumpouts; - For urban surface run-off, the effective rainfall; - For discharge from industrial sites, the type of discharge, treatment being used, flow rates and variability, system capacity and chemical/indicator standards.
Please attach a map of the beach area included in this sanitary inspection, with possible contamination sources (rivers, storm drains, outfalls, etc.) marked. If possible, maps of the entire catchment area indicating land use, topography, and infrastructure networks (i.e., waste-water and storm drain systems, etc.) should also be attached.
Reporting systems:
Are there formal mechanisms for reporting waste discharges, spills, treatment bypasses, etc., to the local health authorities? ___
Is there an illness or injury reporting mechanism in place that would be effective for epidemiological investigations? ___
Sampling or posting recommendations: this section should describe circumstances which indicate the need to post warning notices or close beaches and provide information such as sampling locations, times and frequencies

Table 3. Descriptive statistics of the data obtained for *E. coli* and faecal streptococci from sampling sites in the Islamic Republic of Iran, Turkmenistan and Azerbaijan

	E. coli					**Faecal streptococci**				
	N	**Median**	**Max.**	**Min.**	**95th Percentile**	**N**	**Median**	**Max.**	**Min.**	**95th Percentile**
ISLAMIC REPUBLIC OF IRAN										
Ramsar	10	1550	9300	220	8850	10	215.5	380	22	366.5
Salman	10	1096.5	9500	270	6696.5	10	186.5	380	53	380
Noshahre	10	916.5	5260	95	4432	10	205	350	13	341
Nashtaroud	10	320	4970	38	4151	10	45	340	6	237.85
Chalouse	10	2385	9500	480	9365	10	266	380	70	380
Tonekabon	10	278.5	7760	40	5078	10	27.5	340	8	290.5
TURKMENISTAN										
Hotel Awara	27	7	52	0	40.8	27	1	32	0	12.4
Hotel Hazar	27	14	165	0	55.8	27	3	57	0	48.8
Hotel Florida	27	42	132	0	127	27	9	68	0	42.6
Resort Ufra	27	2	105	0	47.6	27	0	72	0	3
AZERBAIJAN										
Novkhana	53	20	26	14	23.4	53	26	39	20	35.8
Shihovo	27	15	19	11	17.7	27	22	28	18	27.7

Figure 1. Counts of *E. coli* bacteria and faecal streptococci recorded in selected bathing areas in the Islamic Republic of Iran, Azerbaijan and Turkmenistan over the dates shown

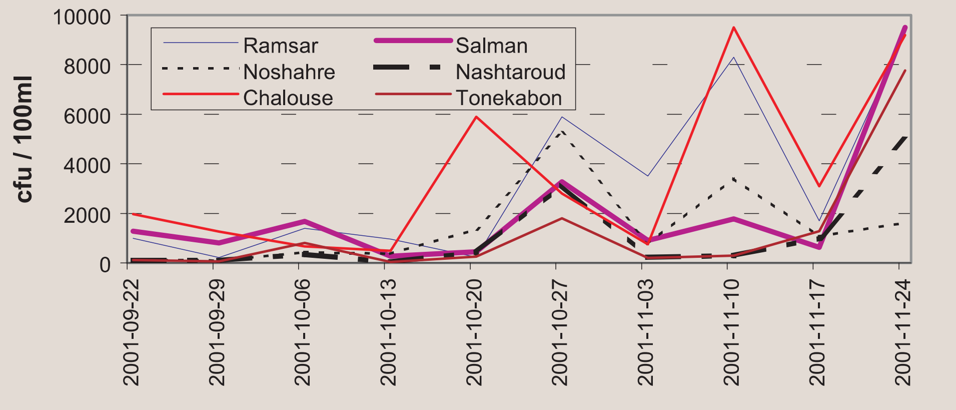


Figure 1 a. Counts of *E. coli* bacteria per 100 ml at six recreational bathing waters, Iran

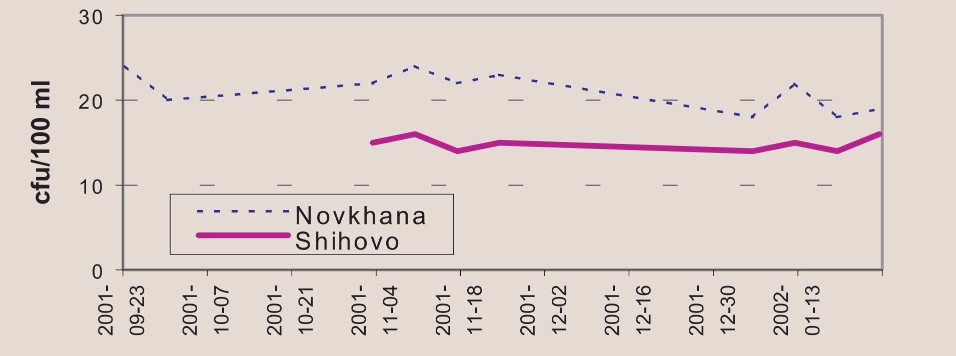


Figure 1 b. Counts of *E. coli* bacteria/100 ml at two recreational bathing beaches, Azerbaijan

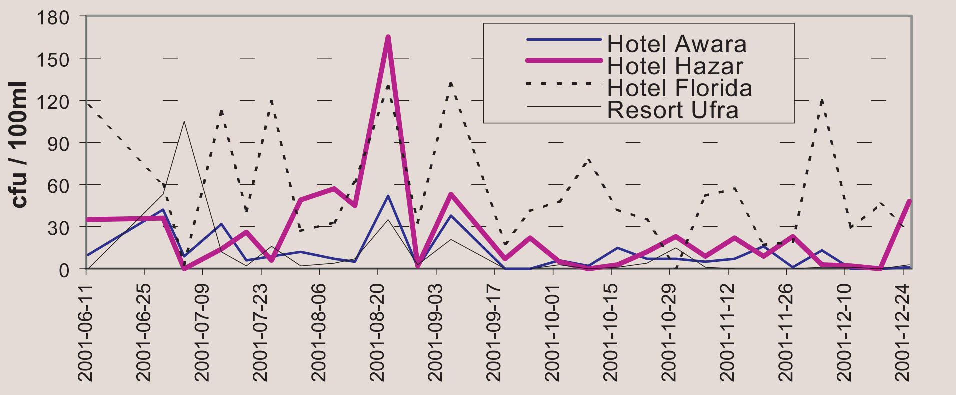
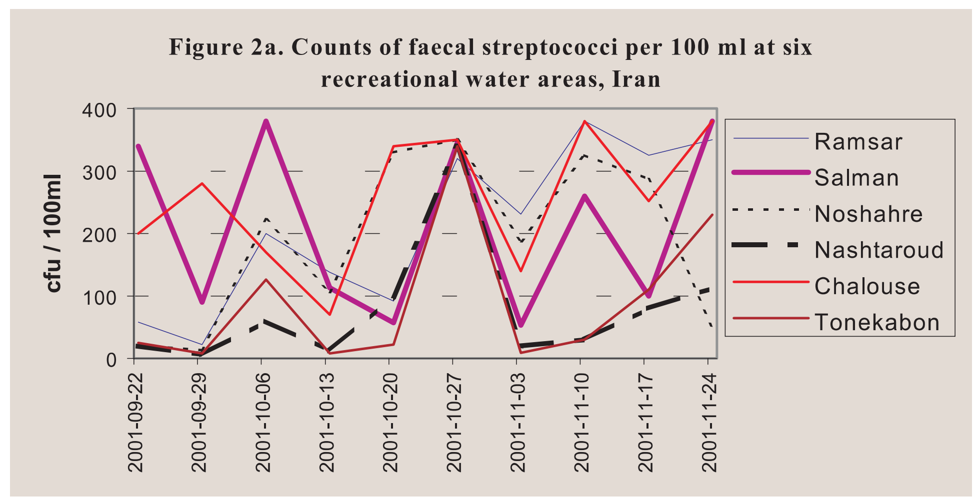
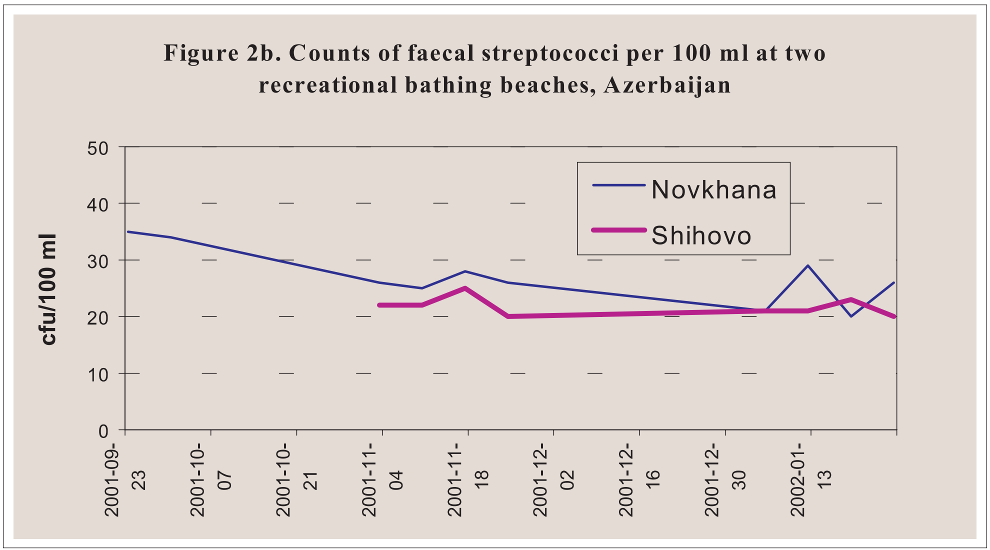
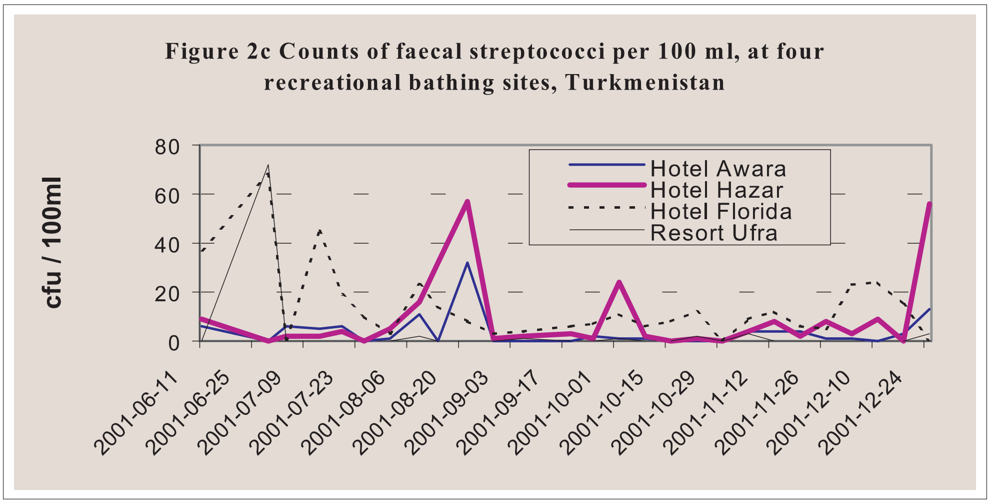


Figure 1c. Counts of *E. coli* bacteria/100 ml at four recreational bathing areas in Turkmenistan

Figure 2. Counts of faecal streptococci recorded in selected bathing areas in the Islamic Republic of Iran, Azerbaijan and Turkmenistan over the dates shown







References

1. APHA/AWWA/WPCF, 1995. Standard methods for the examination of water and wastewater. 19th Edition, American Public Health Association, Washington, DC.
2. Geldreich, E. E., 1967. Faecal coliform concepts in stream pollution. Water and Sewage Works, 114, pp. 98-110.
3. HMSO, 1994. The Microbiology of Water. Methods for the examination of waters and associated material. Report No. 71, (Report 71), London.
4. Peeters F.; Kipfer R.; Achermann D.; Hofer M.; Aeschbach-Hertig W.; Beyerle U.; Imboden D.M.; Rozanski K.; Frohlich K., 2000. Analysis of deep-water exchange in the Caspian Sea based on environmental tracers, Deep-Sea Research Part I: Oceanographic Research Papers, Volume 47, Issue 4, pp. 621-654.
5. WHO, 1998. Guidelines for Safe Recreational-water Environments, Vol. 1 Coastal and Freshwaters. Draft for Consultation, October 1998. WHO, Geneva.

Cooperation in the framework of the Mediterranean Action Plan
Highlights of municipal waste-water treatment plants in the Mediterranean

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The Mediterranean Action Plan

Serious concern about the state of pollution of the Mediterranean Sea, mainly as a result of largely uncontrolled discharges of municipal and industrial effluents, reached its climax in the early 1970s. The widespread population growth in the coastal zone of the Mediterranean, the extension of sewer networks and the higher standards of living have considerably increased the amount of waste water discharged into the Mediterranean Sea. This situation has been aggravated by the continuously-growing tourist population and the production of peak quantities of domestic wastes waters, sometimes reaching a tenfold increase in the usual flow. In addition to actual increases in sewage load, the influx of tourists from different countries contributes to an increase in the diversity of pathogenic micro-organisms in the sewage discharged, with resultant higher risks to human health.

Following a series of intergovernmental meetings between 1971 and 1974, the United Nations Environment Programme (UNEP) convened an intergovernmental meeting on the protection of the Mediterranean Sea in Barcelona in 1975. During this meeting, the Governments of the coastal States of the region adopted the Mediterranean Action Plan, which was the first programme aimed at the prevention and control of marine pollution on a region-wide basis, and also provided a model for similar activities in other areas of the world.

As adopted by the Governments of the region in 1975, the Mediterranean Action Plan consisted of four basic components:

- Integrated planning of the development and management of the resources of the Mediterranean basin;
- A coordinated programme of research, monitoring and exchange of information, and for assessment of the state of pollution and of pollution measures (MED POL Programme);
- A framework convention and related protocols [1] with their technical annexes for the protection of the Mediterranean environment; and
- Institutional and financial implications of the Action Plan.

The MED POL Programme

The pilot phase of the Coordinated Mediterranean Pollution Monitoring and Research Programme (MED POL Phase I) was developed by UNEP and a number of UN Specialized Agencies (mainly FAO, WHO, UNESCO, the Intergovernmental Oceanographic Commission - IOC -, WMO and the International Atomic Energy Agency - IAEA) in 1974 and adopted by Mediterranean Governments in 1975.

The first phase of the MED POL Programme was completed in 1980 and a second phase, the Long-term Programme of Monitoring and Research in the Mediterranean Sea (MED POL Phase II), was approved by the Contracting Parties in 1981. Originally designed to cover the period 1981-1990, the MED POL Phase II programme was extended up to the end of 1996. Its general objective was to further the goals of

[1] The Convention for the Protection of the Mediterranean Sea Against Pollution (the Barcelona Convention) was adopted on 16 February 1976 by the Conference of Plenipotentiaries of the Coastal States of the Mediterranean Region for the Protection of the Mediterranean Sea, held in Barcelona and entered into force on 12 February 1978. The original Convention has been modified by amendments adopted on 10 June 1995 by the Conference of Plenipotentiaries on the Convention for the Protection of the Mediterranean Sea against Pollution and its Protocols, held in Barcelona on 9 and 10 June 1995 (UNEP(OCA)/MED IG.6/7). The amended Convention, recorded as "Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean", has not yet entered into force. The Convention has given rise to six Protocols relating to the dumping of wastes, including hazardous wastes, in the Mediterranean Sea, its protection from land-based sources of pollution, the protection of the region's rich biodiversity, the protection of the Mediterranean Sea from offshore mineral exploration, and emergency such as oil slicks.

the 1976 Barcelona Convention by assisting the Parties to prevent, abate and combat pollution of the Mediterranean Sea area, and to protect and enhance the marine environment of the area.

A new phase of MED POL, designed to cover the period 1996-2005, was approved by the Contracting Parties in 1996. The main goal of this phase of MED POL shall be to serve the Contracting Parties to the Barcelona Convention and Protocols as their long-term programme for the assessment, prevention, mitigation and control of pollution in the geographic area covered by the Convention and the Mediterranean Action Plan. These goals shall be achieved by:

- Assessing all sources of pollution, the load of pollution reaching the Mediterranean Sea, and the magnitude of the problems caused by the impact of pollutants on living and non-living resources, including human health, as well as on amenities and uses of the marine and coastal regions;
- Formulating measures for prevention and control of pollution, and measures for mitigation of impacts caused by pollution, including measures for the restoration of systems already damaged by pollution;
- Monitoring the effectiveness of the implementation of the pollution prevention, mitigation and control measures adopted;
- Assessing the trends in the quality of the marine and coastal environment attributable to pollution in particular, and acting as an early-warning system for potential environmental problems caused by pollution.

Sewage treatment plants in the Mediterranean

Throughout the centuries and long before the start of the industrial revolution, men have been using the sea as the most convenient place for the disposal of wastes resulting from human activities. The sea's self-purification ability has been largely abused. Dumping of domestic, industrial, and radioactive wastes, as well as the run-off from agriculture have not only created considerable hazards to human health but have also endangered the marine environment.

The major problems linked to the uncontrolled disposal of wastes in the marine environment were found to be:

- Dispersion of pathogen organisms capable of endangering human health;
- Toxic effects on aquatic life - including human life - caused by the various chemical substances reaching the marine environment;
- Deterioration of the quality of seawater - eutrophication - resulting from the widespread dispersion of nutrients and other organic and inorganic matters.

The above-mentioned problems do not affect the area of activities of one single international organization or of one single country. Instead, they have an impact at global level, therefore several institutions of international character such as UNEP, WHO, the International Maritime Organization (IMO), OECD and others, developed programmes aimed at finding solutions to their respective priority problems.

One of the important causes of marine pollution is the high rate of population growth that the coastal zones of the Mediterranean basin have experienced since the 1960s and 1970s. This widespread population growth has been accompanied by an increase in the standard of living leading to an equal increase in industrial development to satisfy the needs of the population.

As a consequence of urban and rural development in areas of extraordinary geographical beauty, the tourist population visiting those places has not ceased to grow. This increase in population has had a profound impact on the quantity and quality of wastes produced. Quite often during the tourist season, municipal services in charge of the safe disposal of solid and liquid wastes are totally unable to cope with the additional waste load that invariably reaches the coastal waters.

However, in spite of the importance of pollution loads originating directly from human agglomerations in coastal areas, they appeared to be of minor importance when compared to other forms of pollution originating inland and discharged into the sea by various means. Discharges from “inland” municipal, industrial and agricultural districts, which are only partially treated or even in untreated form, are still reaching the sea through the hydrographic river network of the Mediterranean basin.

Municipal waste water is discharged directly into the immediate coastal zone, either untreated or subjected to various treatment procedures, through outfall structures of variable length, or reaches the sea by seepage as a result of leaks in sewerage systems or other causes. Municipal sewage carries increased loads of nutrients such as nitrogen and phosphorus, and a heavy load of micro-organisms, including bacterial and viral pathogens. In cities and large cities, it usually contains a variety of chemical wastes both from households and from industries discharging directly into the public sewerage system.

The present study which was conducted in the year 2000, is related to the agreement made in 1985, in Genoa, Italy, when the Contracting Parties to the Barcelona Convention reviewed the previous cooperation established, and adopted a new declaration named *The Genoa Declaration*, to cover the second decade of the Mediterranean Action Plan. Ten targets to be achieved by the end of the decade were approved. Amongst the targets approved, one of the priorities was the establishment of sewage treatment plants in all cities around the Mediterranean Sea with more than 100,000 inhabitants and appropriate outfalls and/or appropriate treatment plants for all cities with more than 10,000 inhabitants.

The scope or geographical extension of the study conducted includes all Mediterranean coastal countries. The purpose is the collection of data at country level in order to update and analyse information concerning the population served by waste-water treatment plants and the quality of the treatment provided.

The specific objectives of the Study are quoted below:

Update the list of coastal cities of more than 10,000 persons in all the coastal countries of the Mediterranean Sea, bringing the information as close as possible to the present;

- Collect data in all Mediterranean coastal cities and cities of more than 10,000 persons concerning the existence of waste-water treatment plants;
- Collect data on the years of service of waste-water treatment plants;
- Collect data on the amount of waste water treated per day and per plant;
- Collect data on the quality of waste-water treatment, (primary, secondary, tertiary, or other degree of treatment);
- Collect data concerning the volume of water discharged into the marine environment, treated or untreated, and on the places of discharge;
- Make a comprehensive analysis of the above-mentioned data at country and at regional level permitting an assessment of the present needs and the formulation of appropriate conclusions.

Brief summary of data collection

Data from 19 Mediterranean countries were progressively collected until country summaries were produced using the most reliable information available. The following is a list, in alphabetic order of the countries involved in the study: Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, the Libyan Arab Jamahiriya, Malta, Monaco, Morocco, Slovenia, Spain, the Syrian Arab Republic, Tunisia and Turkey.

Great variations in the data collected between countries and between cities were found. Such variations are considered normal as they reflect the existing differences between the quantity and the quality of waste-water services provided. The procedures and the time that each country adopted for the collection of this kind of data could also explain the differences found. Thus, while some countries have a relatively up-to-date list of coastal cities with the present population, other countries are using figures of a population census carried out several years ago because no better figures are available.

In view of the above-mentioned difficulties, a comparative analysis of data in between countries is not possible because the picture taken of the various countries corresponds to a picture taken at different times.

Constraints encountered

The study faced several constraints that deserve the consideration of Contracting Parties to take the required measures needed to improve monitoring of the quality of the marine environment.

The most important constraints encountered are quoted below:

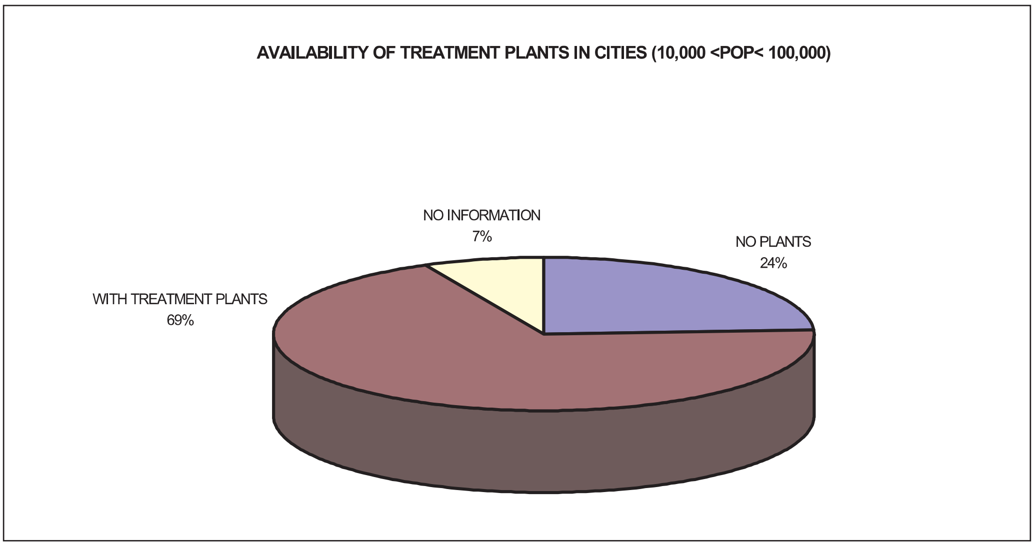
- Data concerning waste-water production, collection, treatment and final disposal was available but sometimes limited, incomplete, or scattered amongst several services and institutions of national or private character;
- In a number of countries, it is literally impossible to ascertain the actual seasonal increase of population because there is no established mechanism permitting the assessment of such increase. In addition, the recording of the fluctuation of population taking place during weekends is almost beyond any possible control. "National tourists" during weekends join the influx of foreign tourists creating "service peaks" exceeding the design capacity of waste-water systems. Therefore, such information is not included in the study although it was intended to cover this aspect;
- The study was also intended to collect data on the population served by waste-water treatment plants. However, many countries reported the absence of waste-water treatment plants while at the same time reported a given number of populations served. Obviously, the figure reported as population served referred to the population connected to a waste-water collection network sometimes having a waste-water treatment plant, sometimes without a treatment plant;
- The study did not permit the establishment of a clear difference between the four situations that can be encountered:
  - A city served totally by a sewerage network and a waste-water treatment plant with the capacity of treating the total amount of sewage produced and collected by the network (discharge of 100% treated sewage);
  - A city served totally by a sewerage network and a waste-water treatment plant, but the capacity of the plant does not permit the treatment of the total amount of sewage produced (discharge of treated and untreated sewage);
  - A city with no treatment plant but with sewerage network covering 100% of the population (discharge of 100% untreated sewage);
  - A city with no treatment plant but with a sewerage network not covering the total population of the city (discharge of untreated sewage, plus existence of autonomous waste-water disposal systems, i.e., septic tanks);
  - A fifth situation can be envisaged. A city with no sewerage networks at all and served only by autonomous systems. However, this situation usually does not exist for tourist coastal cities of more than 10,000 persons.
- In view of above-mentioned constraint, an assumption was made: that a sewerage network covering the total population serves all cities;
- Accurate reporting on the degree of treatment of waste water also proved to be difficult. In many instances the information was not available. There was sometimes confusion with regard to the accepted classification of waste-water treatment. The study proposed to use the standard classification for primary, secondary and tertiary treatments;
- The collection of data on the amount of waste water treated and untreated and on the place and conditions of discharge was equally difficult. Great variations between countries and between cities were found concerning the amounts of treated and untreated waste water. The variations were recorded in terms of cubic metres per person per day or in terms of population equivalent;
- With regard to the year of construction, information was not always available. Some plants were reported open to production as far back as 1950;
- The collection of information concerning upgrading of plants was also difficult and sometimes records were not available. Therefore, some plants were recorded as having primary treatment only, when in reality additional units for secondary treatment are already operational;
- Equally difficult was the updating of information concerning plants that had temporarily interrupted their services. In some cases there is the possibility of plants been reported as "out of service" when in fact, they were back in operation just a few months after the survey.

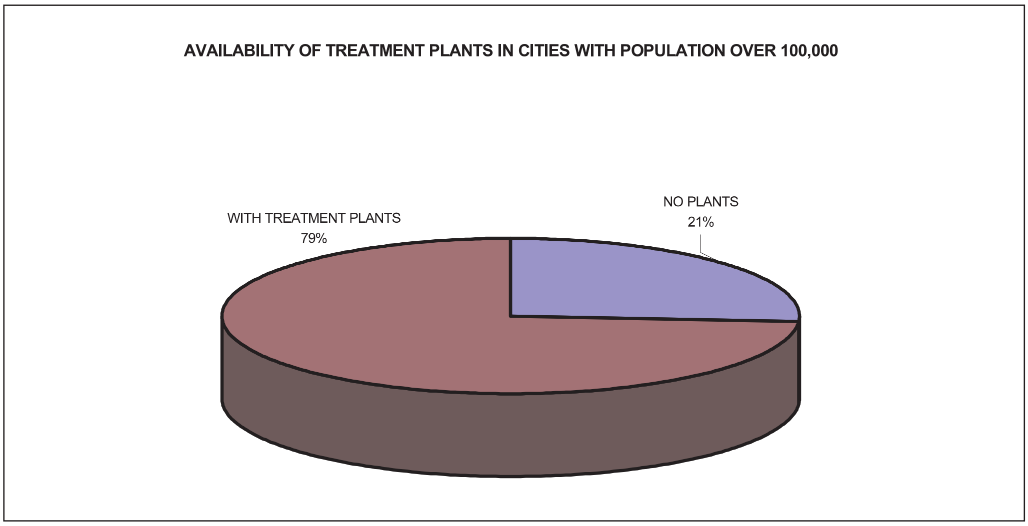
General considerations on the study

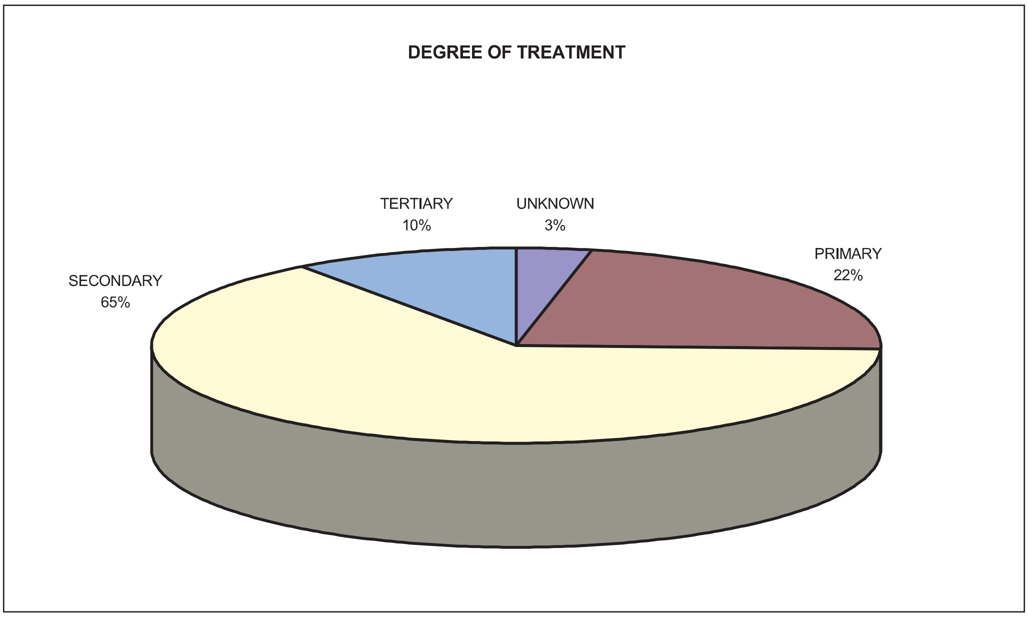
The study is meant to examine the coastal cities that discharge their municipal waste water into the sea, thus contributing in one way or another to the pollution of the sea. Rivers that are the recipients of water discharges from inland cities, treated or untreated, also representing a municipal waste-water pollution point source in the Mediterranean have not been taken into account in this present document.

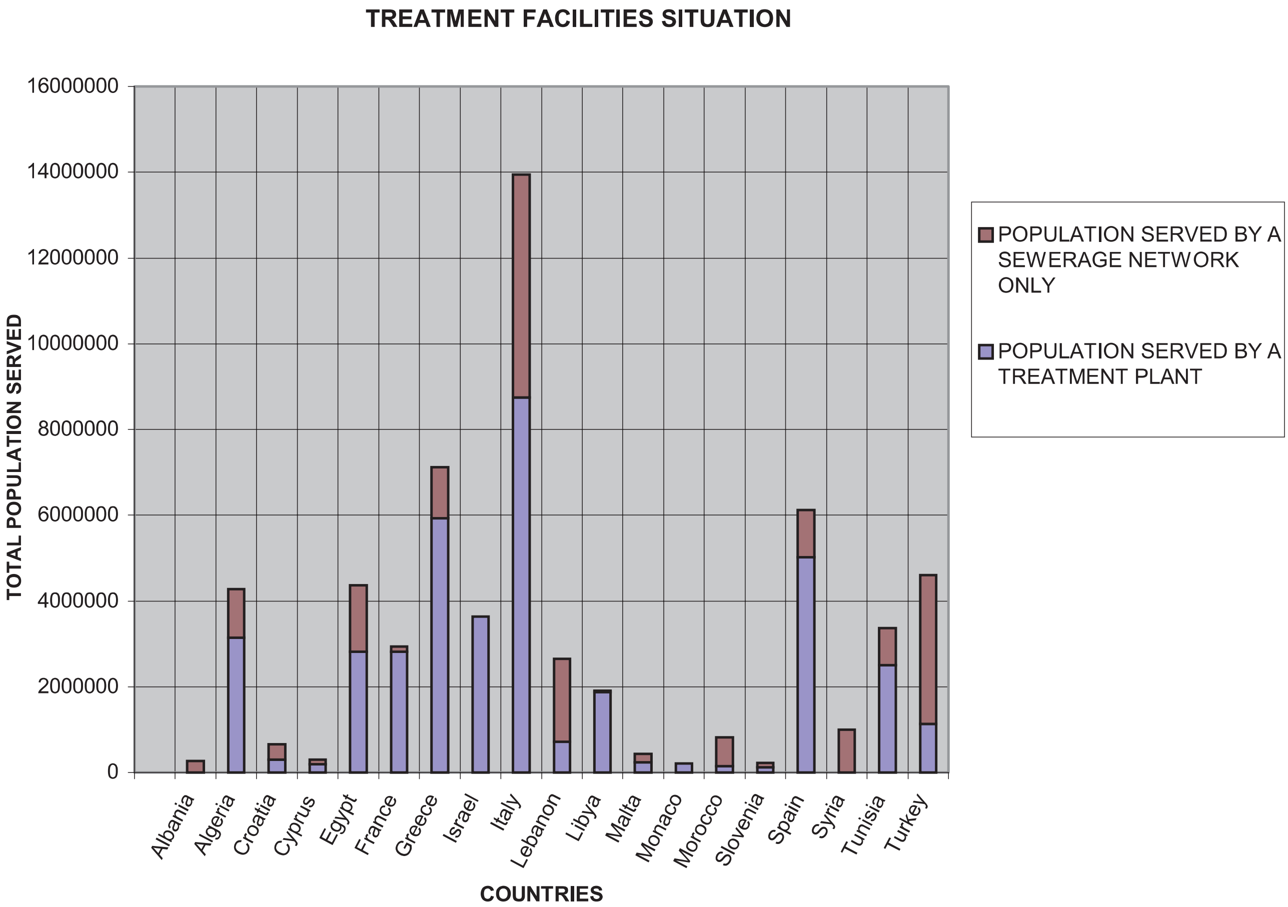
Summary of results

		%
Total number of countries	19	
Total number of cities	545	
Total number of cities with more than 100,000 inhabitants	101	
Total number of cities with more than 100,000 inhabitants served by a treatment plant	79	79%
Total number of cities with more than 100,000 inhabitants not served by a treatment plant	22	21%
Total number of cities with more than 10,000 inhabitants and less than 100,000 inhabitants	444	
Total number of “resident” population found	58,799,000	
Population served by a sewerage network and a treatment plant	41,445,000	70%
Population served by a sewerage network only	17,378,000	30%
Cities without a waste-water treatment plant	132	24%
Cities with no information at all	39	7%
Cities with a waste-water treatment plant	374	69%
Primary treatment	83	22%
Secondary treatment	241	65%
Tertiary treatment	37	10%
Unknown treatment	13	3%
Total cubic metres of waste water treated per day	8,037,000	47%
Total cubic metres of untreated waste water per day	9,001,000	53%
Total waste water, cubic metres per capita per day	0.290	


AVAILABILITY OF TREATMENT PLANTS IN CITIES (10,000 <POP< 100,000)
NO INFORMATION 7%
NO PLANTS 24%
WITH TREATMENT PLANTS 69%


AVAILABILITY OF TREATMENT PLANTS IN CITIES WITH POPULATION OVER 100,000
WITH TREATMENT PLANTS 79%
NO PLANTS 21%


DEGREE OF TREATMENT
TERTIARY 10%
UNKNOWN 3%
PRIMARY 22%
SECONDARY 65%



Conclusions

- The study clearly indicates that in spite of the efforts of Mediterranean countries to improve their information system, there are still important gaps to overcome. Among the most important ones detected are:
  - Inaccurate population data, or existing information not updated, especially that concerning seasonal increases of population;
  - Incomplete or vague information on the generation of waste water treated or untreated;
  - Insufficient information concerning the kind of services being provided to the population. For example: exact population serviced by treatment plants, by a sewerage network only, by other disposal systems; or simply information on the degree of treatment plants in operation, (primary, secondary or tertiary);
  - Data on the year of construction of plants was also incomplete. This information is needed for upgrading services and re-dimensioning systems according to the present needs.
- The importance of maintaining the most recent data on the population cannot be overemphasised. This information is of vital importance for:
  - The design of new waste-water disposal systems;
  - Monitoring the functioning of existing systems;
  - Evaluating the performance of existing systems;
  - Maintaining an "alert mechanism" permitting early detection of any pollution risk of the marine environment and thus protecting the population involved.
- Recording of seasonal population movements is not yet under control. For many countries no information was available. Yet, this information is vital for estimating the "services peaks". It is indispensable for estimating appropriate dimensions of piped networks, of treatment plants, and of the personnel and supplies needed at the time of maximum output of the system units;

- Total protection against waste-water discharges requires other studies involving other forms of pollution. For example, the use of septic tanks, the discharges of sludge from treatment plants, and the discharging of waste water from recreational marine vessels.

Remarks

- The dispersion of data is probably the main cause of the absence of valuable information needed for the control of the quality of the marine environment. To be able to overcome these constraints, a coordinating mechanism can be applied at national levels, and it can be supported by an appropriate legislation covering central, intermediate and peripheral levels;
- Collection of accurate data on seasonal variations of population is not an easy task. Therefore, considering that both the benefits and the problems arising from tourism will impact directly on local population, it is at this level that recording of seasonal population movements should be developed;
  - To this effect and with the collaboration of community authorities, a local community committee can be created with full responsibility for the management of the marine environment of the locality;
  - The responsibilities of such committee can be of a varied nature, including the monitoring of water uses and water quality, as well as the control of population movement;
  - The participation of health and environmental authorities is also indispensable.
- With regard to the collection of technical data, considering that as a result of privatisation a central control of information on waste-water production, treatment and disposal is becoming more and more difficult, the only solution available appears to be to leave the collection of data to the local levels. However,
  - In order to avoid the use of many different kinds of technical reports that nobody will be able to put together, it should be the responsibility of the central level, to produce standard forms;
  - The standard forms can be prepared in such a way so as to permit the reporting of each and all kinds of potential situations that could arise at local level.
- It is proposed that in order to supplement the present study, similar investigations should be conducted in small Mediterranean coastal cities concerning the following waste-water pollution problems:
  - Infiltration of waste water coming from poorly designed septic tanks constructed in the vicinity of the shorelines;
  - Periodical discharge in the marine environment of the content of septic tanks (use of vacuum trucks);
  - Periodical discharge of residual pollutant material coming from existing primary, secondary or tertiary treatment plants.
- The important contribution of large coastal cities to the modifications to the marine environment has to be acknowledged. The large urban agglomerations along the Mediterranean Sea of countries like Spain, Italy, Greece, Turkey, Egypt and Tunisia play a fundamental role in the equilibrium of the marine ecosystem.

Integrating wetland conservation and wise use into river basin management

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Introduction

The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat

The Convention on Wetlands was adopted in the Iranian city of Ramsar in 1971, and came into force in 1975. As of 14 November 2002, 133 states are Contracting Parties, including quasi all European countries. Ramsar Convention is the only global environmental treaty dealing with a particular ecosystem. The Convention's mission is "the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world".

For the purpose of the treaty, "wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres".

Wetlands perform fundamental ecological functions, as regulators of water regimes and as habitats supporting a rich biodiversity. Arguably some of the most important functions are their roles in water supply, water purification and flood control. Wetlands also perform many other important socio-economic functions, such as provision of habitat for fisheries and forestry resources. They constitute a resource of great economic, cultural, scientific and recreational value. Progressive encroachment on, and loss of, wetlands constitute serious and sometimes irreparable environmental damage. Wetlands should be conserved by ensuring their "wise use". Wise use is defined as "sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem". Wetland ecosystems should be restored and rehabilitated, whenever possible

The Convention on Wetlands formally identified the need to integrate wetlands into river basin management at the 6th Conference of the Contracting Parties (COP6) in Brisbane (Australia) in 1996 through Resolution VI.23 on "Ramsar and water". This Resolution recognized "the important hydrological functions of wetlands, including groundwater recharge, water quality improvement and flood alleviation, and the inextricable link between water resources and wetlands" and realised "the need for planning at the river basin scale which involves integration of water resource management and wetland conservation". In 1999, COP7 adopted Resolution VII.18 providing guidelines for "integrating wetland conservation and wise use into river basin management". This approach, recognizing that wetlands are integral parts of ecosystems, requires that managers and planners focus at the river basin level in developing effective management strategies.

River basin management

River basins, or river catchments (the land area between the source and the mouth of a river including all of the lands that drain into the river), and coastal and marine systems influenced by catchment discharges, are important geographical units for considering the management of water resources and wetlands. Rapid and unsustainable development of wetlands, and the river basins in which they are situated, has led to the disruption of natural hydrological cycles. In many cases this has resulted in greater frequency and severity of flooding, drought and pollution. Thus, appropriate protection and allocation of water to wetlands is essential to enable these ecosystems to survive and continue to provide important assets to local communities.

Demands on water resources will continue to increase, as will the levels of pollutants. In the past the water resources and wetlands have tended to be the responsibility of separate sectoral agencies, frequently with very different objectives and modes of operation. As a result there have been, and continue to be, regular conflicts over water resource use and river basin management. Regrettably, in these considerations wetlands have not always been given the priority they deserve based on the important functions they perform in contributing to the maintenance of healthy and productive river systems.

Institutional frameworks

Integrated water resources management

Integrated water resources management is based on the concept of water being an integral part of an ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its use (Agenda 21, United Nations Conference on Environment and Development, 1992). Water scarcity, gradual deterioration, aggravated pollution and infrastructure development have increasingly created conflicts over the different uses of this resource. The river basin management approach is an example of an incentive-based participatory mechanism for solving conflicts and allocating water between competing users, including natural ecosystems.

A critical requirement for integrated river basin management is the introduction of land use and water planning and management mechanisms which focus at the river basin scale. There is also a need to include consideration of the ecological requirements of marine and coastal systems that are influenced by catchment discharges. It is important to realise that water resource planning and management is a multidisciplinary process and therefore has to be promoted in a collaborative framework among all the relevant agencies operating nationally and those involved within the river basin itself, as well as local communities.

Another key issue is the lack of awareness of the cross-sectoral nature of water problems and the need for a new development paradigm towards integrating the technical, economic, environmental, social and legal aspects of water management. The development of administrative units in water resource management has to coincide with river basins' boundaries instead of political boundaries. The lack, or inadequacy, of water legislation and policies is another stumbling block to integrated management of river basin and optimal use of water resources.

Development and strengthening of policy and legislation for integrated water resources management

Contracting Parties to the Ramsar Convention need to put in place appropriate national water policies (e.g. "user-pays" and "polluter-pays") and legislation to enable and facilitate the planning and integrated management of water resources. These policies need to be harmonised with related policies where they exist, such as National Environment Plans, EU Directives, international agreements and national legislative frameworks. It is imperative that all Contracting Parties formulate effective overall policies on the following:

- Allocation of water for the maintenance of all ecosystems including marine and coastal ecosystems;
- Issuance of permits for water abstraction and use;
- Domestic and industrial water use, treatment of effluent and safe discharge of effluent;
- Agricultural water use, mitigation of effects of large water management structures, return of water, limitations of pesticide and other agro-chemical uses;
- Determination of water-quality standards for use for various purposes;
- Rules and regulations regarding abstraction and use of groundwater;
- Tariff policies for drinking water supply, agriculture, industrial and other water uses;
- Land and water conservation;
- Integration of water and wetland conservation within the national socio-economic development agenda;
- Invasive species which have an impact on water.

Establishment of river basin management authorities and strengthening of institutional capacity

The institutional structures in place for land and water use should permit the integrated management of river basins as single units. Fundamental changes in the administrative structure of water resource management can be achieved through a step-by-step process. The first step is to establish a process of cooperation and collaboration between the agencies responsible for water resources management, environmental protection, agriculture, etc. Subsequently, representatives of these agencies assist in the establishment of a coordinating authority that assumes responsibility for managing water resources and wetlands of the river basin.

Involvement of stakeholders, public participation and public awareness

An important element within the concept of integrated river basin management is that planning and management institutions work with and for the entire community of water users in the basin, including wetland users and wildlife, as well as relevant stakeholders outside the river basin. In order to identify the needs and concerns of all water users, public participation in the planning and management of water resources is an important goal.

Until relatively recently there was little consultation on river basin and water resource planning in many countries. A management shift has taken place with a greater role being provided for civil society, with recent experience showing that effective collaboration between agencies and local people increases the chance of success in achieving effective river basin plans. Early consultations with the public can also help identify previously unknown uses and values of resources in the basin and help determine the relative importance of different values.

The local community can play an important role in managing and monitoring wetlands and rivers. Several programmes to involve community groups in wetland and river basin management already exist. For example, the Global Rivers Environmental Education Network (GREEN) promotes an action-oriented approach to education based on a successful watershed (river basin) education model. It works closely with business, government, community and educational organizations across the United States and Canada and with GREEN Country Coordinators in 135 countries around the globe. The network aims to promote and improve the levels of public knowledge through a global education network that promotes sustainable management of river basins. It also supports community-based education through regional partnership activities.

Assessment and enhancement of the role of wetlands in water management

Hydrological functions

Wetlands perform a host of ecological and hydrological functions. These include mitigating the impacts of floods, reducing erosion, recharging groundwater and maintaining or improving water quality. Therefore wetlands can be managed to secure a range of objectives in water resources management.

Assessment of functions

In order to maintain or enhance the role of wetlands in water resource management, it is necessary first to identify and assess the benefits which a particular wetland provides. Three steps are needed in this process:

- Inventory and description of the wetlands;
- Identification of the particular attributes and functions that may play a role in water management;
- Quantification of such functions.

While it may be desirable to have long-term and detailed studies, it is often more appropriate to use rapid assessment techniques to determine the relative importance and functions of wetlands within a river basin. Initial functional assessment is a process whereby the general physical and biological characteristics of wetlands are used to predict which functions are most likely to be present at a site. This assessment should be carried out together with an initial inventory of wetlands. The assessment is neither definitive nor quantitative. Initial assessments put wetlands on relative scales with respect to particular functions. Initial functional assessment is necessary to estimate the capacity and opportunity of wetlands to meet specific needs. These evaluation assessments can be conducted on wetlands to identify their potential roles in flood control, improving water quality, sediment retention and input into groundwater supply.

Examples of such functional assessment techniques include the Wetland Evaluation Technique (WET) and Functional Capacity Index, both used by the US Army Corps of Engineers, and the Functional Analysis of European Wetland Ecosystems (FAEWE) method developed in Europe. These techniques incorporate a number of elements including:

- Establishment of a database from desk and field studies;
- Functional assessment procedures including quantitative and qualitative assessment, assessment of susceptibility to impacts and economic evaluation of functions; and
- Modelling and monitoring procedures.

Enhancement of functions

Once the functions have been determined, it is possible to assess the role that the wetlands could play in the management of water resources within a river basin. Numerous studies throughout the world have shown that it is almost always more cost-effective to maintain natural wetlands than to drain or convert the wetlands to other (often marginal) uses, and then to try to provide the same services through structural control measures such as dams, embankments, water treatment facilities, etc.

In many cases it has also been found cost-effective to restore or even create wetlands to provide these functions rather than create expensive engineering structures.

Identification of current and future supply and demand for water

An essential component of river basin management is knowledge of both current and future supply and demand upon water resources in a river basin, taking into consideration the possible impacts of climate change. Current and future assessments of the resource need to focus on the human uses of water (such as irrigation, hydro-electricity and domestic or industrial water supply) as well as the ecological needs for water within different parts of a river basin. In this respect, water demands should not only be defined in terms of water quantity but also water quality. Ecological water demands are less obvious and more difficult to quantify and consequently have often been ignored or underestimated in terms of water demand. Ignoring such requirements may lead to major environmental and social problems such as collapse of fisheries or downstream saline intrusion. It is also important to recognize that the greatest damage to the environment may occur during extreme events rather than in the average situation.

Socio-economic systems are constantly changing and therefore it is often necessary to develop a range of future demand scenarios and develop flexible sustainable use strategies which can be adapted to a range of circumstances. Linked to the assessment of water demands is the identification and resolution of the significant water-related problems arising from the demand patterns identified in the scenarios. These problems should not be restricted to issues related to human activities but should also include ecological problems such as adaptation to reduced water supply or quality within certain ecosystems.

Water demand is mainly determined by the economic incentives for water and wetland use. Provision of incentives for practising environmentally sustainable water use can minimise the impacts on wetland areas. It is critically important to impose water prices that reflect the true cost of supplying water, and that will encourage the optimisation of water use, ensuring recognition of the economic value of other services from wetlands. Within a sectoral policy context, incentives for sustainable use of freshwater resources need to be provided. Equally, environmentally unsound or inequitable incentives encouraging unsustainable practices need to be identified and removed.

Minimising the impacts of land use and water development projects on wetlands and their biodiversity

Impacts of land use and development projects

Almost all land uses and development projects through their use of water, or their production of pollutants, have some impact on water quantity and quality in the river basin, and hence have an impact on riverine wetlands.

The land uses which can impact most significantly on rivers and wetlands are forestry, agriculture, mining, industry and urbanisation. Inappropriate forestry practices, especially in the upper watershed, can lead to increased soil erosion and reduced water retention capacity. Agricultural activities can also cause significant levels of pollutants from agro-chemicals and agricultural wastes. Upland agriculture through land clearing and subsequent operation can have a major negative impact on water quality and also lead to significant changes in flood and dry season flows. Lowland agriculture can lead to the drainage or conversion of floodplain wetlands leading to loss of biodiversity and natural functions and benefits. In many developing countries, irrigation is the main justification for abstracting water from rivers.

The impact of mining and industrial activities is mainly through the release of pollutants, some of which may be highly toxic (for example, mercury). In addition, industrial activities or mining can instantly jeopardise entire river basins and all the associated wetlands and biodiversity through accidental spills. Urban areas have impacts through encroachment on wetlands, either directly or through associated infrastructure such as roads, ports, water supply and flood control systems. In addition the human populations they support lead to increased demands on resources and direct pollution.

Assessing and minimising impacts

The impact of existing land uses on river systems and associated wetlands needs to be monitored and controlled through the integration of regulations and guidelines on forestry, agricultural, mining or urban waste management. In many cases the implementation of such guidelines may lead to advantages for the land users themselves - for example, reforestation and good forest practices enhance the long-term timber yields; better agricultural practices reduce soil erosion and retain water for the dry season; better waste management improves quality of life and health for urban residents. However, there is normally a need to have a proper monitoring and enforcement mechanism to ensure effective use of the regulations.

In terms of control of new development activities, various mechanisms can be used to minimise environmental impacts.

The first is environmental assessment and zoning, whereby the land use and natural resources of the river basin are surveyed, and the basin is zoned according to the different types of land use that may be permitted in each zone without having a significant impact on other zones or the river or wetland systems. There may also be restrictions on particular activities within a zone in order to ensure sustainability.

The second measure that is more applicable to proposed new development projects is Environmental Impact Assessment (EIA). EIA provides a framework for assessing the implications of development options on the environment (including wetlands).

Thirdly, Cost-Benefit Analysis (CBA) is a tool to calculate the net impact of a project on the economic welfare of society by measuring all the costs and benefits of the project. Although most CBA results can be expressed in monetary terms, some costs such as those arising from the displacement of people and loss of wetland species may be difficult to express in that way. Appropriate decision-making requires an analysis of the economic, social and environmental costs and benefits of water management plans through EIA and CBA.

It is important that multidisciplinary teams conduct the processes mentioned above and seek to engage the stakeholders at an early stage.

Minimising the impacts of water development projects

Water resource development projects are generally aimed at modifying the natural water flows in a river basin for purposes such as storing water for drought periods, preventing floods, transferring water to irrigated agricultural areas, industrial and domestic water supply, improving navigation and generating electricity. Such projects have frequently been developed through the construction of engineered structures such as dams, diversion canals, channelisation of rivers, flood levees, etc. Many of these projects, by modifying the natural conditions which have allowed wetlands to develop, have had a significant negative impact on wetlands and associated biodiversity.

Some of the most significant impacts of such projects include: reduction in river flows, blocking of pathways for migratory fish and other aquatic species, increased water pollution levels, disruption of timing of natural floods which maintain wetlands; reduction of sediment and other nutrient input into floodplain wetlands, drainage or permanent inundation of riverine wetlands, and saltwater intrusion in surface freshwaters and groundwaters.

Assessment and mitigation

In a number of cases it has been found that the social and economic losses resulting from the degradation of the downstream wetlands have been significantly greater than the benefits gained from the water development project itself. Various methodologies have been developed to help identify potential social and environmental costs consequent upon development activities. These include EIA, CBA, Social Impact Assessment (SIA) and Participatory Rural Appraisal (PRA).

However, several of these standard assessment procedures are not so easily applied to water development projects, or to predicting the impacts on complex river-wetland ecosystems. In recent years some specific procedures have been developed for wetland/water resource projects. Since the wetlands and associated biodiversity to be impacted are often of significance to a broad range of local users, it is important that a mechanism for stakeholder consultation is established early in the project cycle.

As discussed in the preceding section, natural wetlands often play an important role in river management and can often be rehabilitated or restored to provide an alternative to generally more costly, engineering solutions to flood control, groundwater recharge and water quality improvements. Alternatives to irrigation and industrial/domestic water supply schemes include water conservation, treatment or recycling and development of alternate crops or industries to suit natural water availability.

Maintenance of natural water regimes to maintain wetlands

Wetland ecosystems depend on the maintenance of the natural water regimes such as flows, quantity and quality, temperature and timing to maintain their biodiversity, functions and values. The natural flow regime can be considered the most important variable that regulates the ecological integrity of riverine wetland ecosystems. The construction of structures that prevent the flow of water, and of channels that carry water out of the floodplain faster than would occur naturally, result in the degradation of natural wetlands and eventual loss of the functions they provide. In response to these concerns, a number of countries have introduced legislation and guidelines to ensure adequate allocation of water to maintain natural wetland ecosystems.

Protection and restoration of wetlands, and their biodiversity, in the context of river basin management

The protection and restoration of wetlands is an important strategy within each river basin, not only because the wetlands perform functions useful for water management, but also because wetlands are critical ecosystems that deserve protection and restoration in their own right.

Many wetland-dependent species, especially fish and amphibians, require management in the river basin context to ensure their survival. In most countries, the protection of habitats and wildlife is conducted according to administrative boundaries and not river basin boundaries. This can lead to protection measures for one site or species being nullified by activities elsewhere in the river basin which, for example, block migration of the fish species or water flow to the wetland site. The restoration of degraded wetlands is one of the most important possibilities for reversing the trend of declining biological diversity within river basins.

International cooperation

Special issues related to shared river basin and wetland systems

In those frequent cases in Europe where a river basin is shared between two or more Contracting Parties, the Ramsar Convention's Article 5 makes clear that these Parties are expected to cooperate in the management of such resources.

The World Water Forum emphasized that riverine countries need to have a common vision for the efficient management and effective protection of shared water resources. One option to consider in order to achieve such outcomes is the establishment of international river commissions, created by several riverine countries to facilitate consultation and broad coordination.

Countries sharing a drainage basin are encouraged to establish frequent specific contacts in order to exchange information on the water resource and its management. Options for this include:

- Establishing networks for monitoring and exchanging data on water quality and quantity in the basin;
- A joint analysis of information on the quantity and type of water used for various purposes in each country;
- Exchange of information on protection measures for groundwater, upper catchments and wetlands;
- Sharing of information on structural and non-structural mechanisms to regulate flow for navigation and flood prevention.

The aim should be the preparation of technical reports on the river basin, including information on the needs of the local population in each part of the basin, as well as existing or potential problems in parts of the river basin that require separate or collaborative efforts to be dealt with.

Partnership with relevant conventions, organizations and initiatives

In order to undertake an effective approach to promoting the integration of wetland conservation and wise use into river basin management, it is important that the Contracting Parties to the Ramsar Convention are aware of, and take into consideration, the related activities of other international conventions, organizations and initiatives, and vice versa.

The sustainable use of freshwater has been identified as a critical component of Agenda 21 and as such has been the focus of a series of meetings under the auspices of the United Nations Commission on Sustainable Development and other UN agencies. Three other international initiatives should be mentioned:

- The creation of the Global Water Partnership to act as a framework to coordinate efforts to promote integrated water resource management, especially in developing countries;
- The development of the Vision for Water, Life and the Environment through the Global Water Commission under the auspices of the World Water Council; and
- The establishment by the World Bank and the World Conservation Union (IUCN) of the World Commission on Dams.

Among other conventions and actions programmes, the most relevant ones at the global level are as follows:

- The Convention on Biological Diversity (CBD) which has identified the conservation of the biodiversity of inland waters as a particular priority. Since 1999, a Joint Work Plan with the Ramsar Convention exists to address this matter;
- The Convention on the Law of the Non-navigational Uses of International Watercourses which requires states to avoid, eliminate or mitigate significant harm to other watercourse states and establishes detailed rules with regard to the changes in use of any international watercourse. Issues covered include EIA, consultation, joint protection of watercourse ecosystems, pollution control, introduction of alien species, prevention of erosion, siltation, and saltwater intrusion; and
- the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).

At the regional and river basin level there are over 200 agreements which provide a basis for cooperation in the management of shared water resources. The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, together with the many bilateral and multilateral agreements on transboundary water in Europe provide an important framework for this. The international commissions set up for the major European transboundary river catchments such as the Danube, Rhine, Elbe, Oder, etc. and their specific experts groups provide a particularly efficient mean to deal in detail with the many different aspects of the wise use of transboundary water resources and related ecosystems.

References

The Ramsar Convention “toolkit” for the conservation and wise use of wetlands, a series of 9 handbooks published in 2000, including:

Ramsar Bureau, 2000. Integrating wetland conservation and wise use into river basin management. Ramsar Handbook for the Wise Use of Wetlands, Volume 4, 32p, available in English, French and Spanish.

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