PROCEEDINGS

Stockholm Water Symposium

STOCKHOLM, August 10 - 15, 1997

WITH RIVERS TO THE SEA

Interaction of Land Activities, Fresh Water and Enclosed Coastal Seas

The Joint Conference
7th Stockholm Water Symposium/
3rd International Conference on the Environmental Management of Enclosed Coastal Seas (EMECS)

organized by
Stockholm International Water Institute/EMECS

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PREFACE

Joint Stockholm Water Symposium & EMECS Conference August 1997
Nearly three-fourths of the world's people live within 100 km of the seacoast or one of the world's greatest lakes, where their physical as well as economic well-being depends on such activities as fishing, shipping, tourism, and recreation. The ongoing degradation of coastal waters constitutes a major threat to the global quality of life. Some 80 % of the pollutants responsible for this degradation originate from land-based human activities in the drainage basins of rivers that discharge into coastal bays, estuaries, fjords, and inland seas. The growing demand for freshwater places increasing burdens on its supply, replenishment, and quality as provided by coastal aquifers and reservoirs. Maintaining this supply can lead to large-scale management projects that can alter water movement through the drainage basin and threaten the health of both tidal and non-tidal wetlands.

The growing magnitude of effects of man's use of natural resources requires the development of significantly improved management policies. The scope of these policies in turn requires an increased understanding of human behaviour, social driving forces, and the natural processes that act to determine the quality of coastal waters and the ecosystems they support. Upland deforestation leads to turbidity problems in coastal bays; mangrove loss destroys nurseries and decreases the productivity of coastal fisheries; water extraction from aquifers causes salt water intrusion and places additional demands on freshwater supply far upstream. The increased scales of time, size, and complexity are unprecedented in the history of environmental management.

The 1997 Stockholm Water Symposium "With rivers to the sea - Interaction of land activities, freshwater and enclosed coastal seas" was organized as a Joint Conference with EMECS (Environmental Management of Enclosed Coastal Seas). The main focus was on the strong interaction between land use and coastal ecosystem health as mediated by the quality and movement of freshwater. It included topics central to more effective coastal management, such as the need for an ecosystem approach, the role of freshwater as a carrier of nutrients and pollutants, and the relationship between land use and water quality. Special attention was paid to the problem of scale, i e the significance of laboratory-based studies as well as local management efforts for larger and more complex ecosystems. Well-structured discussions promoted the interaction of freshwater and marine scientists and managers across their respective disciplines.

Cases from six coastal sea areas
A basic aim of the Joint Conference was to stimulate the interaction of freshwater and marine scientists in order to produce a holistic perspective. Such interaction was facilitated by focusing on a limited set of cases from different parts of the world, covering differences in climate, socio-economic development, cultural, institutional and politicial systems etc. The six coastal water systems particularly highlighted were the following:

* Baltic Sea
* Black Sea
* Seto Inland Sea
* Chesapeake Bay
* Gulf of Thailand
* Lake Victoria

Workshops and co-convenors

The interaction between freshwater and marine scientists took place within the altogether twelve workshops (one workshop was cancelled), organized along five different tracks:

* *track 1: Understanding land/sea interactions: workshops 1 - 5*
* *track 2: Minimizing pollutants from land-based sources - workshops 6 - 8* (Co-convenor United Nations Environment Programme)
* *track 3: Polices for overcoming barriers in governance - workshops 10*
* *track 4: Citizen involvement - workshops 11 - 12*
* *track 5: Global information exchange - workshop 13.*

Co-convenors of individual workshops were the following: workshop 4, National Committee for the International Hydrological Programme (Swedish Natural Science Research Council), workshop 7 World Business Council for Sustainable Development, and workshop 8 Food and Agricultural Organization.

1997 Proceedings

This volume contains the proceedings of the 1997 Joint Stockholm Water Symposium/ EMECS Conference. The authors are fully responsible for the views expressed in their respective papers.

The report is organized in the following way. It starts with the Stockholm Statement. Part 1 contains the Summary and conclusions from the Joint Conference as a whole, and the contributions of Keynote and Plenary Speakers. Part 2 contains the conclusions from the Chairmen and Rapporteurs of the individual workshops, followed by the written contributions of Invited Workshop Speakers, a report from the Poster Session, and, finally, lists of workshop speakers, posters and participants.

Stockholm 25 November 1997

Malin Falkenmark
Professor, Chair Scientific Programme Committee

Joint Stockholm Water Symposium/EMECS Conference
14 August 1997

THE STOCKHOLM STATEMENT

ON INTERACTION OF LAND ACTIVITIES, FRESHWATER AND ENCLOSED COASTAL SEAS

BACKGROUND

The ongoing degradation of coastal seas and large inland lakes and rivers constitutes a major threat to global quality of life and to coastal and marine ecosystems. Nearly three-fourths of the world's population live within 100 km of the sea-coast where their physical as well as economic well-being depends on such activities as fishing, shipping, tourism, recreation, farming and industries. Some 80 percent of the pollutants responsible for this degradation are carried with rivers and groundwater flows to the sea and originate from land-based human activities in the drainage basins of rivers that discharge into coastal waters. Also pollution caused by shipping, mining and drilling, as for oil exploitation, are causing concern.

Past Conferences on the Environmental Management of Enclosed Coastal Seas (EMECS) have resulted in a network linking many scientists and others studying enclosed coastal seas. A similar network has been created through previous Stockholm Water Symposia. The Joint 7th Stockholm Water Symposium/ 3rd EMECS Conference 10 - 15 August 1997 in Stockholm brought together over one thousand participants from these two networks of respectively marine and freshwater specialists.

The Joint Conference participants, representing over eighty countries and intergovernmental and non-governmental organizations, expressed deep concern about the difficulties experienced around the world as nations attempt to cope with this threat to our planetary life support system. The Conference reviewed the experience and provided a forum for the dissemination of lessons learned. The application of these lessons and the development of management innovations is vital.

RECOMMENDATIONS

The Joint Stockholm Water Symposium/EMECS Conference recommends that all Governments, intergovernmental and non-governmental organizations and other policy and decision making bodies take action aimed at reducing the pollution loads to safe levels, to enclosed coastal seas, based on the following four principles:

Principle no 1. **Pursue an holistic approach**
We must see the drainage basin and corresponding coastal sea as a dynamic whole, treating them as one complex system. The physical linkage between drainage area and coastal sea through the mobility of water - a unique solvant that moves

continuously from land to sea - demands an integrated approach to land use and water management. A systematic approach to the land-sea complex will facilitate diagnosis of physical and chemical problems, and hasten identification and implementation of remedies through holistic and proactive management.

Principle no 2. **Improve understanding**
We must base the long-term sustainable management of coastal resources on the access to synthesized information about their inherent ecological, social, economic, and political importance. Finding effective solutions to prevent further pollution and restore ecosystems will depend on identifying the causal chain between destructive and polluting human activities in the drainage basin - and the driving forces behind them - and the degradation of coastal ecosystems. Only then can we reverse the unfortunate social and economic impacts that result from misuse of our resources.

Principle no 3. **Develop an active dialogue**
We must base our decisions and actions on specific regional targets, and on realistic assessment of social, economic, technical, and professional resources in individual countries. International cooperation among concerned countries, and administrative responsibilities for the enclosed coastal seas should be considered as important factors to prevent continued degradation. Decisions will thus demand careful priority-setting, a process that in turn requires constructive dialogue and exchange of information between major stakeholder groups: citizens, industry leaders, farmers, fisheries, resource managers and decision-makers. Non-governmental organizations could function as active bridge-builders facilitating regional cooperation among stakeholders, municipalities and countries surrounding the world's coastal seas.

Principle no 4. **Act locally - Think regionally**
We must pursue the implementation of needed technical and legal measures on the local level. By targeting activities at the level of sub-basins, while maintaining a focus on ecosystem-wide goals based on an integrated land-sea approach, we can substantially improve efficiency and success. Building awareness among politicians, administrators, and the general public will be a crucial component in these efforts. Educational measures play an important role to achieve these goals.

FINAL COMMENTS

The participants of the Joint Conference have finally taken note, with satisfaction, of an opportunity for further dialogue between freshwater and marine specialists at the Fourth EMECS Conference to be held in Antalya, Turkey, in November 1999, jointly with the Fourth International Conference on the Mediterranean Coastal Environment (MEDCOAST 99).

For information please contact:

Stockholm Water Symposium, SIWI
Tel: +46 8 736 20 21
Fax: +46 8 736 20 22

International EMECS Center
Tel: +81 78 332 2202
Fax: +81 78 332 2311

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PART 1

PLENARY SESSIONS

S U M M A R Y   A N D   C O N C L U S I O N S

Highlights

The focus of the Conference was on the degradation of enclosed coastal seas and how they are influenced from societal activities in the drainage basin. The water in enclosed coastal seas reflects the influence of human activities in the drainage basin. In spite of tremendous progress in the last 25 years, equally tremendous challenges have to be faced for the next 25 years. In spite of increased basic understanding of the marine systems, and its translation into policy, legislation and action, problems are coming back in a new shape with diffuse sources, multiple causalities and interaction between biogeochemical cycles. Many systems are in a transient stage and the expected effects of restoration efforts are delayed by unknown buffet systems. Slow processes and long accumulation times, and an often quite limited water exchange make enclosed coastal seas slow to react to both destructive and" healing" forces. Where this is not well understood by politicians and policy makers, they may easily loose patience before intended results of unpopular decisions to reduce outflow of pollutants become visible.

The overriding issue - how to reconcile upstream socio-economic development with protection of crucial ecological services of the coastal waters - remains unsolved. Proper analysis will demand a shift in conceptual scale: from the scale of the marine consequences to the scale of the landbased causes of deterioration. Close interaction between freshwater and marine scientists will be fundamental. Universities will have an important task both in synthesizing current understanding, and in securing bridges between different disciplines. One major lacuna in past approaches has been the neglect of groundwater and its role in shaping mangrove forests, coral reefs and other coastal ecosystems.

Fundamental differences between coastal seas

Six water systems were especially highlighted:

Water system	***Drainage basin population***
Baltic Sea	85 millions
Black Sea	160 "
Chesapeake Bay	15 "
Lake Victoria	34 "
Gulf of Thailand	65 "
Seto Inland Sea	30 "

Since there are considerable differences in terms of both level of assault, coping capability, and readiness to act towards restoration, comparisons are useful to improve the scientific problem diagnosis. In both Chesapeake Bay, Seto Inland Sea and on the west side of the Baltic there is an openness to and a readiness to act towards restoration. Both Baltic Sea and Chesapeake Bay have succeeded in terms of curbed outflow of

DDT/PCB, resulting in some biodiversity rehabilitation. In the latter citizen involvement played a crucial role. In western countries, industry is increasingly aware of their responsibilities.

Remaining assaults in these systems, not yet coped with or where measures taken have not yet resulted in detectable responses, is the atmospheric input from traffic and leaching of agricultural nutrients. In the Black Sea and the Southeast side of the Baltic, remediation challenges include large resource problems in terms of both financing and expertize.

The drainage basins of both Lake Victoria and Gulf of Thailand are subject to rapidly expanding population, urbanization and industrialization, which increases rather than decreases the assault (intensified crop production, economic development). Curbing outflow of pollutants from domestic waste is still difficult to implement. The unsolved conflict between development of human life security in the catchments of Third World systems and the coastal ecosystems is a fundamental one, that has to be addressed with greatest possible urgency. It may also limit the immediate transferability of western experiences.

Remediation principles and challenges
The Stockholm Statement, adopted at the end of the Joint Conference highlights a set of principles aimed at reducing the pollution loads to safe levels:

* Principle 1: Pursue a holistic approach, by taking an ecosystem-based approach to the land-sea complex.
* Principle 2. Improve understanding to identify the causal chain between destructive and polluting human activities in the drainage basin and the degradation of coastal ecosystems.
* Principle 3. Develop an active dialogue between major stakeholder groups: scientists, citizens, industry leaders, farmers, fisheries, resource managers, and decision makers.
* Principle 4. Act locally - Think regionally, in implementing the needed technical and legal solutions.

A successful restoration of deteriorating coastal seas will demand on a number of fundamental challenges being overcome, namely:

* scientific problems: development of methods to distinguish natural changes from man-induced changes in the water system; radical improvement of an interdisciplinary communication between different disciplines; bridge-building activities to facilitate this improvement; clarification of limitations in interregional transferability of solutions; shift in conceptual scale from consequences to causes;
* societal problems: finding ways to compensate the farreaching institutional fragmentation of basin countries; finding mechanisms for reconcilitation of competing interests; clarification of respectively human rights and human responsibilities;

* emediation problems: clarifying how to handle the numerous stakeholders; the problems introduced by the slow response of the coastal water system; the technologies available for curbing outflow of pollutants; and the most cost-effective measures for different coastal waters.

Most essential - vision, leadership and persistence of efforts

Seeing humans as part of the large-scale ecosystem will be essential. This will demand some conceptual development. The challenge is not development or environment, but development and environment. Crucial ecological services that have to be protected have to be identified. Problems will have to be addressed at the proper conceptual scale, in time as well as space.

Due to the slow responses, highest level of leadership is essential, based on both a vision and long-term persistence. To this end, public understanding and involvement will be essential, with NGO's as important actors and useful channels of communication. Local identity and a sense of responsibility for the next generation will help to build up awareness and willingness to act. Public advisory committees may be useful in seeking compromises between different stakeholder groups. There is a need for creative development of partnerships that include also the business communities. The development of ecological economics is essential to reduce the current dominance of neo-classical economics in trying to reconcile development with protection of crucial ecological services of coastal ecosystems. A major switch is needed in both behaviour and attitudes to secure action now, not some time in the future by a not yet born population.

OPENING ADDRESS - JOINT STOCKHOLM WATER SYMPOSIUM/ EMECS CONFERENCE 1997

Mrs *Birgitta Dahl, Speaker of the Swedish Parliament and Chairperson of the UN Secretary-General's High-Level Advisory Board on Sustainable Developmen*

Ladies and Gentlemen,

Every day here in Stockholm, on the embankment or on the bridge over the whirling waters between the Houses of parliament and the Ministry for Foreign Affairs, you can see amateür fishermen trying their luck. Tourists from abroad gasp when the fishermen catch giant salmons.

Stockholm is a city on the water. On clean water.

It wasn't always that way. Only a few decades ago, the Stockholm waters were filthy and hazardous to the health of the inhabitants.

Today the Stockholm water is so clean that there are public beaches in the inner city and sensitive fish like salmons thrive there.

The credit for this spectacular improvement goes to pioneer hydroecologists, strong-willed scientists and farsighted politicians. Several of them are here today.

It took about thirty years to get the Stockholm water this clean again. It was a gigantic project, which can serve as a good illustration to the complexity of the theme of this year's Stockholm Water symposium, which is focusing on "the strong interaction between land use and coastal ecosystem health as mediated by the quality and movement of freshwater". Water can obviously not be separated from the rest of the ecosystem.

The roots of the problem of the filthy water in Stockholm were, of course, to be found also outside the capital, at an earlier stage in the water cycle: In the region of the lake Mälaren with its numerous tributaries a flourishing economic life had developed. During the fifties and the sixties, industry, forestry and agriculture produced riches that were supposed to create the basis for the good society - prosperous and caring, with good social security and good housing, including sanitary systems moving the waste and the risks from the human beings to the water in our nature. But it was a matter of ecological ignorance. Even if it was not spelled out, there was in reality an atmosphere characterised by the concept of "development first, environment later".

In this situation all contributors to the pollution had to be activated, all institutions had to be stimulated to rally around the aim of cleaning the water of the lake Mälaren. The local governments, the industry, the agriculture, a whole network of actors were to join in a "pioneer workshop". It took some thirty years, but it was a success and a signal that it is possible to achieve a practical and well defined goal in the field of sustainable development.

It was partly against this background that it seemed natural to organize the first Stockholm Water Symposium in 1991. The Stockholm Water Company wanted to capitalise on the eminent knowledge of different aspects of water that exists in Sweden, to encourage further research and development of the world's water resources and to give a scientific background to the Stockholm Water Prize, which was initiated by the Stockholm Water Foundation.

The symposia have generated important and interesting contributions to the scientific as well as the popular awareness of different aspects of water.

The Comprehensive Freshwater Assessment, which was elaborated by, a number of United Nations bodies and co-ordinated by the Stockholm Environment Institute, served as a basis for the work in this sector of the United Nations General Assembly Special Session in June this year. It was based on Chapter 18 of the Agenda 21, which pointed specially at the need for "the holistic management of fresh water" and an "integrated water resources management" as "based on the perception of water as an integral part of the ecosystem, a natural resource and social and economic good".

I myself, had the privilege of chairing another group that contributed to the Rio plus five: The UN Secretary-General's High Level Advisory Board on Sustainable Development. That is a group of independent personalities who were judged to be able to make valuable contributions in the form of creative and constructive ideas about sustainable development. I am happy to say that one of the renowned members of the group was last year's Stockholm Water Prize Laureate, Dr. Jörg Imberger of the University of Western Australia.

When this Board was to select the three most important strategic sectors, it came as no surprise that it chose energy, transportation and water.

The Board noted that the increased scarcity of water risks causing grave crises and that water resources of all kinds have to be managed within the framework of local, regional and international collaboration to avoid conflicts.

Water cannot automatically be seen as a "free good". Taxes and subsidies have to be designed in such a way that they do not exclude the poorest from access to water, but on the other hand, do not encourage wasteful use.

It was also pointed out by the Board, that adequate access to water which is essential for all sectors of society - must always be seen in connection with adequate waste water management. This goes for urban as well as for rural areas. New technologies must urgently be developed. Not least to this end the Board, among other things, proposed the establishment of an international consultative research group on water. If such a group is formed, I think that it will include a number of the participants in the Stockholm Water Symposia.

This year's event is a Joint arrangement of the Stockholm Water Symposium and the Environmental Management of Enclosed Coastal Areas Conference.

The issue of the coastal areas is another crucial one in our efforts to attain sustainable development. Here we find some of the most heavily populated areas in the world. To secure energy, transportation, water and waste management for these megacities is a strategically important task. Quick positive results here will affect an enormous number of people. It will also have a catalytic effect on other efforts in the field of sustainable development.

It was against this background that the High-Level Advisory Board on Sustainable Development called for the swift elaboration of programmes of action for city areas with collaboration between city authorities, urban planners and bilateral and multilateral sources of finance.

What we need now is, essentially, to find a formula or concept for common efforts to tackle, in a comprehensive manner, the problems of poverty, development and environment. The outcome of the UN General Assembly Special Session was certainly a disappointment in terms of real commitments. I believe, however, that we all have a duty to do our utmost to make use of all international fora and instruments that are actually at hand. Through them we will have to concentrate on areas of strategic importance and make our contributions to secure the better future, that we so urgently need. **And time is short!**

One such instrument at our disposal is the Conference of the Parties of the International Agreements on Climate Change (CoP 3), that will have its next session in Kyoto this year. Another one is co-operation around water and coastal areas management, an issue to be focused upon at this symposium.

In this connection 1 would like to stress the importance of the very interdisciplinary approach, that you have chosen as basis for this conference. The motto of the conference "With the Rivers to the Sea" has suddenly become a very topical one, in the light of the recent, devastating floodings in Poland, Germany and the Czech Republic, Hopefully, this tragic event will prove an eye-opener and an strong inducement for governments to take concerted action in order to prevent future disasters.

I am honoured and pleased to have been asked to open this important joint arrangement.

I hereby declare it opened.

WELCOMING ADDRESS - JOINT STOCKHOLM WATER SYMPOSIUM/ EMECS CONFERENCE 1997

Mr Toshitami Kaihara, Governor of Hyogo Prefecture and Chair, Executive Committee International EMECS Center, Japan

The Honourable Birgitta Dahl, Speaker of the Parliament of Sweden; the Honourable Ingemar Ingevik, Mayor of Stockholm; the Honourable Parris N Glendening, Governor of Maryland; ladies and gentlemen, and the more than 900 participants from 80 countries around the world whom I see here today: it's a great honour for me to speak at this 3rd EMECS Conference, jointly held with the 7th Stockholm Water Symposium in this wonderful city of Stockholm, which is so famous for the beauty of its waterfront.

First, I'd like to take this opportunity to thank all of you here on behalf of the people of Hyogo Prefecture for all the help you offered us in January 1995, when we were hit by a powerful earthquake. The earthquake, which registered 7.2 on the Richter scale, devastated a major part of Kobe, the capital of Hyogo Prefecture, and the surrounding area, seriously affecting more than 4 million people. At that time, we received relief funds and goods from 72 countries and areas of the world, which not only helped us sustain our daily lives but also gave us great encouragement. Although we still have a lot of problems to solve, we are determined to overcome those problems and proceed with the reconstruction.

The United Nations Conference on the Human Environment was first held here in Stockholm on 5th June, 1972. It was then that our commitment to the protection of the global environment began. Twenty-five years on, it is no exaggeration to say that "the environment" is now a key word with a substantial meaning. On the 23rd of June this year, a Special Session of the General Assembly was held with the aim of verifying the progress made in the five years since the opening of Agenda 21.

On the 1st of December, the UNFCCC COP3 will be held in Kyoto, a neighbouring city of Kobe, with the object of finding ways to deal with the problem of global warming and determining carbon dioxide reduction targets. Today's conference in Stockholm is also one of the most important conferences addressing a series of global environmental problems.

The 3rd EMECS Conference is an epoch-making event in that this is the first time the Conference has been held jointly with the Stockholm Water Symposium renowned world-wide as a very high level symposium on fresh water and water resources.

Enclosed coastal seas are deeply connected with the way we live. If coastal waters are not properly maintained and are contaminated as a result, it take years of difficult operations to return them to a clean state. In this Conference, researchers of land areas and sea areas will discuss various subjects under the main theme, "With rivers to the Sea", and I believe it will contribute a great deal to our effort to find out just how we can maintain the rivers and seas in a healthy condition from a global perspective.

I founded the International EMECS Center in 1994 with the support and co-operation of many people around the world who had common concerns. Around the world, with some exceptions, there are still many coastal seas into which huge amounts of contaminated substances are flowing from the inland areas, causing such problems as eutrophication, low oxygenation, toxic substance contamination, and oil contamination. These problems are leading to the deterioration of biological habitants, decreasing both the numbers of species and individuals as well as reducing fish hauls.

Although national and local governments that have interests in enclosed coastal seas are making action plans based on related treaties and agreements in an effort to tackle the problems, there are still many places where improvements haven't been made, or if at all, are being made very slowly. Coastal areas facing enclosed coastal seas around the world, especially those in the developing countries, will be increasingly populated as they are developed and industrialized. Unless we start taking effective counter-measures, these enclosed coastal seas will only be more contaminated, which will eventually affect the environment on a global scale.

The International EMECS Center has nurtured a human network through the international conferences held in the past. With the help of this resource, we can further increase our investigation and research into what is necessary for the protection of the environment regarding the enclosed coastal seas around the world. We are now thinking of making a system for carrying out this investigation and research and are further committing ourselves to solving the problems.

Last but not least, I'd like to express my most sincere appreciation to those people in Sweden who have made preparations for this joint conference with friendship and dedication over the past one and a half years, especially to Mr Sven-Erik Skogsfors, managing director for the Stockholm Water Company; Dr Malin Falkenmark, chair of the Executive Programme Committee; Dr Lars Ulmgren, vice chair of the Executive Programme Committee; and all other committee members, staff, and faculty members of the Stockholm Water Symposium and The University of Stockholm; and many other people in Sweden.

I am now thinking of the time in history when the relationship between Sweden and Japan first began. In the 18th century, in 1755 to be exact, the first man to came to Japan from Sweden arrived on a Dutch ship. The Netherlands was the only foreign nation permitted to send vessels to Japan, which at that time was isolated from the rest of the world. The man was Dr Carl Per Thunberg, who is still revered in Japan as the father of Japanese botany. After 200 years, the peoples of the two countries still enjoy a strong friendship, sharing a common interest in the field of global environment, for which I'd like to express my deepest appreciation.

Thank you very much for your kind attention.

WELCOMING ADDRESS - JOINT STOCKHOLM WATER SYMPOSIUM/ EMECS CONFERENCE 1997

Mr Parris N Glendening, Governor of Maryland, USA

Introduction

Good morning and thank you for that kind introduction. My wife, Francis Anne, and I are very pleased to be here in Sweden.

I am deeply grateful to our hosts for this joint conference: to King Carl Gustaf, the Mayor of Stockholm, Dr Lars Ulmgren and Professor Malin Falkenmark, and to all the members of the Executive Program Committee and the Organizing Committee. Thank all of you for your vision, your commitment, and your hard work in making the next four days the success I know they will be. Very often when I speak to people I talk about the importance of having a vision. In the Bible, the Book of Proverbs, it is written: "Where there is no vision, the people perish."

The EMECS Legacy

I publicly acknowledge the instrumental role, and the vision, of Governor Kaihara. And, being a university professor for 27 years before becoming Governor, I want to take a moment and give you a little history lesson. I will not, however, speak for 55 minutes, the usual length of a University class.

More than a decade ago, Governor Kaihara met the late Professor Ian Morris, Director of what was then the University of Maryland's Center for Environmental and Estuarine Studies. At that time, Dr Morris was conducting a site visit to Japan's Seto Inland Sea. Professor Morris was in Seto because he was participating in Maryland's Coastal Seas Governance Project that was developing the framework for an ambitious program to restore the Chesapeake Bay's water quality and living resources.

Professor Morris was fond of asking "How do they do these things in other countries? Surely we could learn something from their successes and failures." At the same time, Governor Kaihara had initiated the landmark Governors' and Mayors' Confernce on the Seto Inland Sea. These two fertile minds met -- two men with great vision came together -- and EMECS was born.

EMECS '90, the first conference, fittingly took place in Kobe. It was Maryland's pleasure to host the second conference in 1993. Since then, Governor Kaihara established the International EMECS Center in Kobe, a permanent legacy to a vision shared by two remarkable people.

Today, I feel that we have come full-circle. My friend, former Maryland Governor Hughes, came to Stockholm in 1985 to learn about Baltic Sea protection initiatives. He wanted to learn how to better shape Maryland's Chesapeake Bay restoration activities. Now, Governor Kaihara and I are back here to link the EMECS forum with the prestigious Stockholm Water Symposium. Thank you, Governor Kaihara, for the leadership, vision, and commitment that has brought us here today. [Lead round of applause for Governor Kaihara]

Personal Perspective

Later today, Ms Ann Swanson from the Chesapeake Bay Commission will tell you about some of the lessons learned from 12 years of experience of managing and restoring the Chesapeake Bay. Right now, I will briefly discuss my personal perspective.

First, we must always remember that the water quality for our great estuaries starts land side. Not just along the shore line, but up river, often hundreds of miles away. For example, over half the water of the Chesapeake bay flows from the Susquehanna River starting in New York State, through Pennsylvania, and into the Bay -- a journey of over 450 miles.

Second, we can no longer afford to focus solely on individual problems. We must consider the whole system. By this I mean more than just the uplands and tributaries of a watershed. It also includes social and economic issues.

Third, no coastal program can succeed without the participation of all segments of society. The restoration of the Chesapeake Bay requires the involvement of all levels of government, participating businesses, agriculture, environmentalists, and, especially the average citizen. Representatives from all these elements are here today. Let us listen to their perspectives in the conference workshops.

Fourth, the control of point-source pollution is only the first step. Like a child learning to walk, we must take that first step, but we also need to move forward to address non-point pollution as effectively as possible. It is appropriate that this conference is entitled "With Rivers to the Sea". That is precisely the path that pollution takes to degrade our coastal waters and destroy the sea grasses and other habitats that are so critical to living resources.

Fifth, we need more dialogue with those who are breaking new scientific ground. We need to know the things scientists know: we need to know about groundwater movement, landscape ecology, multi-species resource management, and environmental valuation.

Finally, we need to promote what we in Maryland call "Smart Growth and Neighborhood Conservation".

Challenges

I firmly believe that environmental protection does not need to hinder economic development, and economic development does not need to come at the expense of a clean environment. I believe that economic prosperity and environmental protection, are in fact -- interdependent and mutually reinforcing, and we must achieve both goals to improve the quality of life for all Marylanders.

The history of the Chesapeake region taught me that unplanned growth is a threat to both our regional environment, our local economy, and our quality of life. This year I worked with my colleagues in the Maryland Legislature to pass a package of legislation designed to help us redevelop our older more established communities. Likewise, we are directing future development to specific areas of our state in order to reduce sprawl and preserve our farmlands, forests, and open spaces.

In a nutshell, we are using the state's $15 billion budget as a tool -- as an incentive. We do not tell local governments where they can or cannot grow -- we tell them that if they want state dollars for roads, bridges, sidewalks, they must grow in already established areas where water and sewer lines, police and fire stations, already exist.

We also give financial incentives to promote industrial development on previously industrialized sites -- what we call Brownfields -- rather than on our increasingly threatened undeveloped areas -- or Greenfields.

Unplanned development is a challenge to all of us who would conserve and mange our threatened coastal seas. Smart Growth is an initiative which will change how Maryland develops and grows, protecting our Chesapeake Bay and our quality of life.

Conclusion

Governor Kaihara and I are looking forward to learning the results of your workshops. We challenge you to challenge us with recommendations that will lead to more effective coastal programs not just in Japan, Sweden, and the United States, but throughout the world. Challenge us so our children and our children's children will look back at what we have done and will say we did well as they experience and enjoy our waters around the world.

In closing, as we discuss the challenges ahead, let us remember to celebrate the progress that has been made. While it is true that we have much to do to achieve our environmental protection goals, we often lose sight of how far we have come. The callenge is to recognize our successes, learn from our failures, and change the way we don things in the future.

This joint meeting grew out of a vision shared by two individuals from different parts of the world. I challenge each of you to continue that vision.

FROM LANDSCAPES TO THE SEA: CHALLENGES TO UNDERSTANDING HOW HUMANS INFLUENCE AQUATIC ECOSYSTEMS

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Lars O. Hedin, Associate Professor, Section of Ecology and Systematics, E213 Corson Hall, Cornell University, Ithaca, NY 14853, USA.

INTRODUCTION: Since the first United Nations Conference on the Human Environment, 25 years ago in Stockholm, the world has seen rapid progress in the understanding of how human activities are impacting aquatic ecosystems. There are several notable successes, in which basic scientific understanding has played a central role in the development of management solutions to difficult problems. For instance, research in the 1960's and 70's on the causes of freshwater eutrophication (e.g., Hutchinson 1973; Dillon and Rigler 1974; Schindler 1974 and 1977) led governments in Europe and North America to reduce phosphorus (P) emissions to natural waters, and to institute widespread treatment of sewage effluents. Similarly, studies in the 1970's and 80's on surface water acidification (e.g., Odén et al. 1968; Likens and Bormann 1974; Schindler et al. 1985) induced many governments to curtail atmospheric emissions of sulfur dioxide, one of the major precursors of acid rain (Hedin et al. 1987; Hedin and Likens 1996).

Yet despite these successes, stresses on aquatic ecosystems have not gone away. Inputs of P remain above natural levels in many freshwaters and estuaries (e.g., Forsberg 1994; Justic et al. 1995; Nixon 1997). Nitrogen (N) is increasing in many regions, and is thought to contribute to a host of ecosystem responses, including increased algal productivity, shifts in algal species composition, hypoxia, acidification, increased emissions of the greenhouse gas nitrous oxide, and other ecological and biogeochemical effects (e.g., Forsberg 1994; Howarth et al. 1996; Smil 1997; Hedin et al. 1998; Vitousek et al. 1997). In a similar manner, acid deposition continues to deplete the buffering capacity of many sensitive soils, preventing aquatic ecosystems from recovering as expected in response to the recent reductions in atmospheric sulfur emissions (Hedin and Likens 1996).

Here I will argue that our understanding of how humans are stressing aquatic ecosystems is changing in important ways, and that some of our early successes are now being re-evaluated in a context that differs dramatically in nature and scope. These early successes are giving way to problems that are manifested at conceptual and causal scales that are much more difficult to tackle, by policy makers as well as scientists. By focusing on the question of how nutrients are transported from terrestrial landscapes to freshwaters and estuaries, I will examine some key challenges that now face scientists, managers, policy makers, and the public. My treatment is by no means complete, but represents three topics that I believe pose particular urgency: (1) The need to expand scales of our understanding; (2) The need to comprehend how nutrient cycles interact to trigger ecosystem responses; and (3) The need to include humans as explicit parts of ecosystems.

1. Scales of Understanding: Management policies have traditionally focused on curbing local emissions of single nutrients or single pollutants. While such point-source controls often have been successful, controls of non-point sources have been largely unsuccessful. The problem of controlling nutrient fluxes has thus shifted in scale and nature: from well-defined local emissions to more diffuse sources that occur throughout landscapes. Several properties make non-point sources especially difficult to understand and predict: they are manifested over large scales and in the context of heterogeneous landscapes, they are linked to multiple and often poorly understood sources, and they change in strength at temporal scales that are slow and often difficult to predict. For example, Forsberg and Rengefors (1993) demonstrated that while efforts to cut point-sources of P have been successful in urban regions of Stockholm, it has remained difficult to predict the temporal and spatial dynamics of non-point P emissions from pools that turn over slowly in the landscape. Since some forms of pollution control depend on the redirection of element fluxes, point and non-point sources can at times be linked in surprising ways. One illustration is the practice of spreading of P-rich sewage waste onto agricultural fields which, in effect, translocates a point source into a non-point source (Forsberg 1994).

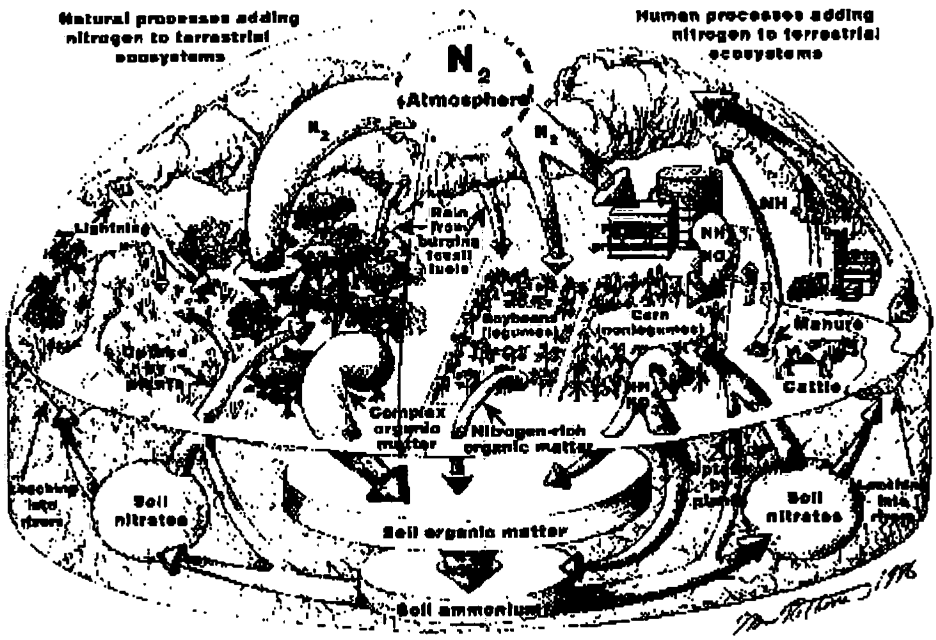

Fig. 1: Human alterations of the natural N cycle, as portrayed in a recent New York Times article (published with permission). Illustration by Michael Rothman.

The N cycle may provide one of the best examples of the kinds of problems that are inherent in efforts to understand, predict, and manage non-point sources. While we know that humans have altered the N cycle perhaps more than any other element cycle on Earth, it remains very difficult to clearly discern either causes or consequences of these changes (Vitousek et al. 1997). Accelerated mobilization of N in landscapes is associated with elaborate responses by terrestrial and aquatic ecosystems, causing the N cycle to display exceedingly complex spatial and temporal dynamics. I show in Fig. 1 a recent effort by the New York Times (Dec. 10, 1996) to translate some of these complexities to the lay public, including the existence of spatially distant causal links between human activities and ecosystem responses. For example, atmospheric ammonia emissions from animal husbandry can be transported over hundreds of kilometers as atmospheric ammonium sulfate (Hedin et al. 1990), deposited on terrestrial ecosystems, lost to downstream aquatic ecosystems as a consequence of terrestrial "nitrogen saturation" (Ågren and Bosatta 1987; Aber et al. 1989), and finally contribute to increased algal productivity in distant rivers, estuaries, and coastal seas (Rosenberg 1985; Andersson and Rydberg 1988; Justic et al. 1995; Howarth et al. 1996). Thus, at a time when policy makers and many public citizens call for heightened standards of proof for environmental cause-and-effect relationships, scientists are confronted with problems that are increasingly multi-causal and that are manifested at scales that are difficult to study with traditional scientific approaches and tools.

The difficulty of linking effects on aquatic ecosystems to specific human land activities is illustrated by a recent study of N transport to estuaries and coastal shelves. Robert Howarth and colleagues (1996) found that N efflux from 14 temperate regions that drain into the North Atlantic was, in all cases, dominated by non-point sources. Furthermore, they found it difficult to discern clear cause-and-effect relationships between N fluxes and individual non-point sources (atmospheric N inputs, N fertilizer inputs, N fixation by crops, and inputs/export in agricultural products). While river N efflux was closely correlated with the sum of anthropogenic N inputs to a region, only ca. 25 % of all landscape inputs were on average accounted for in river export. These and similar results (e.g., Aber et al. 1989) provide two important implications: i) that, on average, N inputs are strongly buffered within landscapes; and ii) that ecosystem responses are likely dominated by transient (rather than equilibrium) dynamics. This means that predictions of future N loadings to rivers and estuaries will be exceedingly difficult since they not only depend on trends in non-point emissions, but also on changes in the inherent abilities of ecosystems to store or transform any new inputs of N. For example, the ability of European and North American forests to keep atmospheric N inputs from reaching aquatic ecosystems appears to be a highly transient phenomenon that is expected to saturate within decades to centuries, depending on future trends in N loading, in internal ecosystem processes, and in the management regimes of forests (Ågren and Bosatta 1987; Aber et al. 1989; Hedin 1994).

Further complexity arises from the strong and large-scale links that exist between the N cycle and other nutrient cycles, including carbon (C), P, and base cations (also see section 2, below). For instance, atmospheric N deposition has over the past decades contributed to depletion of base cations from sensitive soils throughout Europe and North America which, in turn, is linked to delays in the recovery of surface waters to reductions in acidic sulfur deposition (Hedin and Likens 1996; Likens et al. 1996). There also are inherent potentials for complex feedbacks, positive and negative, to develop at various temporal and spatial scales. For example, atmospheric N deposition can cause sensitive forests to become less efficient at neutralizing harmful effects due to elevated nitrate in the soil, thus threatening to set in motion a positive feedback in which both forest damage (from increased nitrate) and nitrate loss to downstream ecosystems (from increased forest damage) accelerate rapidly in a non-linear fashion (Hedin 1994; Durka et al. 1994).

How can we improve our understanding of how human activities within landscapes affect aquatic ecosystems? This is a difficult question and I can offer only a few ideas that extend beyond the immediately obvious: Studies of ecosystem response might benefit greatly from focusing on the mechanisms and lag-times that are associated with dominant buffering reactions in landscapes, preferably those that occur along hydrologic flow paths (Hedin et al. 1998). While the use of landscape-level tracers such as stable isotopes holdw promise (e.g., McClelland and Valiela 1997), their usefulness is severely hampered by fractionations during internal ecosystem transformations, and by difficulties in resolving end-members (Durka et al. 1994; Hedin 1994). Our perhaps most important challenge, however, is to train the next generation of scientists and managers to better comprehend the ecological consequences of complexity and scale.

2. INTERACTIONS BETWEEN NUTRIENT CYCLES: We tend to teach and study one nutrient cycle at a time. For instance, textbooks typically keep nutrient cycles separate in chapters with titles such as "The Nitrogen Cycle" and "The Phosphorus Cycle." And yet, we know that some of the most important biological responses in ecosystems are not driven by isolated cycles, but by how two or more nutrient cycles interact. The dichotomy is one of static description vs. dynamic function: while individual nutrient cycles can serve to describe ecosystem structure, the underlying dynamic behavior of ecosystems is often determined by how different nutrient cycles interact. For example, Alfred Redfield proposed as early as 1958 that cycles of C, N, P, and silica (Si) are closely integrated with algal growth throughout the world's oceans (Redfield 1958) - a view that continues to influence studies of marine ecosystems (e.g., Tyrell and Law 1997). A century earlier, Justus Freiherr von Liebig (1855) argued that the growth of plants is not constrained by single isolated nutrient cycles, but by the one nutrient that, compared to other nutrients, remains in shortest supply relative to biological demand.

There are more modern illustrations of how dynamic understanding of ecosystems emerges from considerations of how nutrient cycles interact. One example comes from my own laboratory where, among other things, we study the transport of N from terrestrial to aquatic ecosystems. One key focus has been to understand the factors that control whether the process of microbial denitrification (by which dissolved nitrate is converted to gaseous nitrogen forms) can remove large amounts of dissolved N along the hydrologic flow paths that move nutrients from terrestrial soils to drainage streams (Hedin et al. 1998). The practical implications are significant: denitrification can potentially protect, or "buffer," downstream ecosystems from adverse effects due to non-point N pollution.

Rather than solely focusing on the N cycle, we asked whether denitrification might be limited by other nutrients along flow paths from upland soils to streams (in this case, "nutrients" specifies donors and acceptors of electrons that are used in microbial metabolism) (Hedin et al. 1998). By applying a thermodynamic perspective on how microbes transform nitrate and other nutrients in natural environments (sensu Stumm and Morgan 1981), we predicted that denitrification should be most strongly controlled by supplies of oxidizable C (as succinate or acetate) to a well-defined area near the soil-stream interface. Field experiments supported our theories: experimental C additions to this area caused dramatic increases in denitrification, and a near-complete removal of nitrate along groundwater flow paths. This example illustrates that one of the central processes of the N cycle - microbial denitrification - can not be fully understood without also understanding how it interacts with the C cycle in landscapes.

A second example comes from studies of estuaries and enclosed coastal seas. There is general consensus that many coastal ecosystems are affected by elevated nutrient loadings, with ecosystem responses that include increased algal productivity (eutrophication), shifts in algal diversity, and increased extent and severity of hypoxia (Rosenberg 1985; Andersson and Rydberg 1988; Justic et al. 1993; Rabalais et al. 1996). In addition to these eutrophication effects, a particular concern has been whether blooms of algae that are noxious to invertebrates, fish, and mammals (so-called "Harmful Algal Blooms" or "Red Tides"), are increasing in frequency or severity due to elevated nutrient loads.

While primary productivity often is considered N-limited in estuaries and coastal areas (Howarth et al. 1996; Nixon 1997), recent studies suggest that certain key ecosystem aspects are influenced also by other nutrients, particularly P and Si. Building on early studies of Lake Michigan (Schleske and Stoermer 1971) and on ideas by Officer and Ryther (1980) and Smayda (1990), Justic et al. (1995a,b) have proposed that human activities are causing similar shifts in nutrient fluxes in many of the world's large rivers. They propose that abundances of N and P have increased sharply relative to abundances of Si, causing nutrient inputs to approximate the "ideal" Redfield (1958) growth ratio of algae (Si:N:P = 16:16:1). They further argue (Justic et al. 1995a,b; Rabalais et al. 1996) that reductions in Si:N and Si:P ratios have not only increased algal production, but also caused the algal species composition to shift from a community dominated by Si-rich diatoms (e.g., *Melosira*) to a community that favors the growth of noxious flagellates (also see Officer and Ryther 1980, Smayda 1990). Such species shifts can also have wider consequences: several authors have proposed that changes in algal composition can propagate to higher trophic levels, triggering losses in species of zooplankton and/or fish (e.g., Greve and Parsons 1977; Blomqvist 1996). Blooms of toxic flagellates can have particularly strong impacts on higher trophic levels, including humans (Smayda 1990).

The importance of these ideas rests on using interactions between different nutrients to understand how aquatic ecosystems work. These ideas replace the more traditional focus on single nutrient cycles by a more textured approach, which includes subtle responses such as in abundances of particular species of algae. In addition, these ideas are supported by theories that connect nutrients to competition (e.g., Schindler 1977; Tilman 1982) or bacteria to electron donors and acceptors (e.g., Stumm and Morgan 1981).

Do nutrient interactions receive enough consideration in current ecological studies? I believe the answer is no, and particularly so at the larger scales of ecosystems and landscapes (but, see Bolin and Cook 1983). Better knowledge of how nutrients interact at a range of spatial and temporal scales promises to deliver much-needed mechanistic understanding of how physiological responses of organisms are linked to large-scale human perturbations on nutrient cycles.

How do nutrient cycles become coupled and interdependent within ecological systems? I propose four broad classes of processes, each differing in underlying mechanism: 1) "Stoichiometric coupling," caused by the synthesis or decomposition of biotic tissue, in which ratios of different nutrient are maintained within narrow physiological ranges (e.g., Redfield 1958; Reiners 1986; Elser et al. 1996); 2) "Thermodynamic coupling," caused by the predictable coupling of particular electron donors and acceptors as organisms extract energy from environments, such as in the above example of C limitation on denitrification (Hedin et al. 1998); 3) "General geochemical coupling," caused by a broader and less predictable collection of geochemical processes that link behaviors of nutrients, including acid-base reactions (e.g., mobilization of aluminum in soils by acid rain; Cronan and Schofield 1979), interactions between charged molecules on ion exchange surfaces (e.g., depletion of base cations in soils by aluminum mobilization; Hedin and Likens 1996), or the release of nutrients in predictable ratios during weathering (e.g., Berner and Berner 1987); and 4) "Anthropogenic coupling," caused by human effects on how nutrient cycles are linked in landscapes, such as the predictable disruption of fertilizer applications on the ratio of N and P fluxes in landscapes.

The lack of emphasis on nutrient interactions may have several roots. While it is relatively easy to teach students pieces and parts of how ecological systems work, it is much more difficult to emphasize the inherently complex interactions and feedbacks that give ecosystems their dynamic properties. There also are limits to our ability to directly probe how nutrients interact in nature: it is certainly easier to manipulate a single nutrient than several nutrients (and their interactions) in most field experiments. And yet, nutrient interactions are at the heart of some of our perhaps most timely ecological and environmental questions: The future role of temperate forests as sinks for atmospheric carbon dioxide depends, to a great degree, on how atmospheric N deposition interacts with the forest C cycle (e.g., Schindler and Bayley 1993; Townsend et al. 1996). Whether atmospheric N inputs ultimately leak through forests into downstream ecosystems depends on how microbial decomposer communities interact with soil organic matter with variable ratios of available C and N (Ågren and Bosatta 1987; Aber et al. 1989; Hedin et al. 1998). Whether regional-scale acid deposition affects the acid-base balance of lakes and streams depends on exceedingly complex interactions between N, S, base cations, and aluminum cycles in soils (e.g., Hedin and Likens 1996).

3. HUMANS AS PARTS OF ECOSYSTEMS: It is now clear that no ecosystem on earth is fully insulated from human activities. Use of fertilizers, legume crops, and fossil fuels have placed humans as the dominant force within the global N cycle (Galloway et al. 1995; Vitousek et al. 1997; Smil 1997). Burning of fossil fuels and biomass has changed atmospheric nutrient and pollutant fluxes over local to regional scales (Odén et al. 1968; Likens and Bormann 1974). Desertification, changes in land use, and industrial activities have affected worldwide transport patterns of atmospheric dust (Andreae 1996; Hedin and Likens 1996). Fossil fuel emissions, deforestation, and human-accelerated emissions of greenhouse gases are jointly threatening the Earth's heat balance (e.g., Mitchell et al. 1995), and have increased carbon dioxide fluxes to forests and oceans (e.g., Schlesinger 1991). More locally, landscapes have been subject to changing land use, and to translocations of nutrients in sewage, fertilizers and other products (e.g., Forsberg 1994).

The central issue is changing from one of documenting the extent of human effects on ecosystems, to one of predicting and anticipating future effects, and of prescribing ecologically reasonable solutions. This necessitates the inclusion of humans as explicit and interactive components of the ecosystems that we study - an inclusion that historically has been difficult to accomplish in the discipline of ecology (Pickett 1993). In fact, given the pervasiveness of human activities, it appears rather remarkable that many, if not most, ecosystem models still treat humans as an external factor. Charles Perrings, Carl Folke, and Karl-Göran Mäler (1992) noted that while proximate causes for ecosystem change belong in the domain of ecology, ultimate causes of change - or "true drivers" - rest in the domain of economics and/or social sciences. And yet, I know of no current introductory textbook in ecology that attempts a serious and quantitative treatment of how ecological processes respond to, and feed back on, social and economic drivers.

It is instructive to note that many atmospheric scientists and climatologists do not hesitate to include different scenarios of human actions in their efforts to forecast the Earth's climate (e.g., Trenberth 1997). In similar ways, it ought to be relatively straight-forward to explicitly include scenarios of human activities in ecosystem models. Robert Costanza recently (1996) summarized the limited literature that exists on linked ecological-economic models. Progress may, in part, be limited by technology. For example, advances in geographical information systems (GIS) and spatial modeling will likely provide tools that permit more explicit translations of social and economic trends into future effects on local ecosystems.

Efforts to put monetary values on ecosystem services and functions can provide a mechanism by which ecological processes are permitted to feed back on economic drivers. For instance, Costanza et. al (1997) have recently provided an interesting and daring effort to value the services performed by all ecosystems in the world. This and similar approaches place ecosystems inside the rules of market economies, permitting the economical system to respond quantitatively to ecological services or natural capital. As a result, the estimated per-hectare value is high for ecosystems that provide "important" services, such as the many aquatic ecosystems that buffer fluxes of nutrients and pollutants in landscapes. In contrast, ecosystems that are deemed to provide fewer or less important services, such as deserts or tundra, are valued substantially less per hectare.

While this approach can point out the great value of some ecosystems, it may also seriously underestimate the value of others. Valuations are by necessity based on the current best knowledge of ecosystem services, and are thus confined by the inherent inability of the scientific process to identify the future (or even current) significance of every function in every ecosystem. For example, the value added to riparian wetlands due to their ability to buffer downstream ecosystems from eutrophication could not have been quantified at a time when there was no scientific or public concern about eutrophication. This and similar examples raises important questions about how to link the human construct of economic markets to natural ecosystems and, as well, about the role of legislation as an alternative tool for protecting aggregated social values of different ecosystems.

It is often not appreciated that the ways in which humans stress ecosystems - one of the key concerns of modern ecology - are very difficult to determine because we generally lack information on how ecosystems once functioned in the absence of human influence (Hedin et al. 1995). And yet, management policies are often based on assumptions of how human activities have changed the natural, or "baseline," ecological conditions in ways that are perceived to be unfavorable. For example, the idea that coastal eutrophication has increased the incidence of harmful algal blooms is difficult to verify without baseline information on how frequent and extensive such blooms were before the advent of excess nutrient inputs. The question of whether human activities have increased N inputs to estuaries, triggering eutrophication and hypoxia, similarly depends on assumptions about rates of N inputs and extents of hypoxia at a time before humans imposed significant disturbances on river drainage basins (Nixon 1997). Both these cases illustrate the value of knowing natural baseline conditions of ecosystems - conditions of minimal human influence.

Based on work in remote Chilean forests that are largely unpolluted and undisturbed, I have with colleagues suggested that ecosystems that are minimally influence by humans are of particular scientific value (Hedin et al. 1995). Such ecosystems can provide baseline information about natural ecological patterns and processes, against which human disturbances can be compared and understood, and against which the effectiveness of management policies can be judged. For example, our studies support the hypothesis of Justic et al. (1995a,b) that human activities have caused export ratios of Si:N and Si:P in rivers to shift to lower values. In fact, our measures of nutrient losses from undisturbed forested watersheds show Si:N and Si:P ratios (ca. 50 vs. 500, respectively) that are much greater than those reported by Justic et al. as representative of disturbed drainage basins (Si:N 16 and Si:N 16). Our values are similar to those reported by Justic et al. as representative for "pristine" rivers. Analyses of N and base cation cycles similarly point to strong differences between unpolluted Chilean forests and regions of the world that are strongly disturbed by human activities (Hedin et al. 1995).

CONCLUSIONS: Despite much progress since the first United Nations Conference on the Human Environment, the next 25 years will bring entirely new challenges and expectations on how we study aquatic ecosystems, and for how we train the next generation of scientists, managers, and decision-makers. While no one can pretend to know the future of our scientific discipline, I have here discussed three broad areas that I find particularly important for our progress.

I conclude that the nature of how we conduct our science will likely change dramatically over the next 25 years. Relatively straight-forward cause-and-effect relationships will be replaced by more complex multi-causal effects that, in turn, translate into exceedingly complex interactions between human activities and natural ecosystems. This is certainly not "business as usual" for our discipline - spatially and temporally complex causalities are not only difficult to understand by traditional scientific methods, but are also difficult to communicate to decision makers and the public. There are strong parallels with historically difficult multi-causal problems, such as the extended controversy over the health effects of smoking.

Perhaps equally important is the conclusion that most terrestrial and aquatic ecosystems are still adjusting to accelerated human inputs of N and other nutrients. This means that, at heart, the phenomenon of human-accelerated nutrient cycling is a transient phenomenon, with future trajectories that are difficult to predict. We have particularly poor knowledge of whether, and for how long, ecosystems will continue to retain (or "buffer") nutrient fluxes from landscapes to surface waters. What are the key factors that, over time, control the ability of landscapes to retard fluxes of nutrients to aquatic ecosystems?

This temporal aspect of ecosystem response can confound the link between human nutrient emissions and ecosystem effects. Non-linear or self-accelerating responses to nutrient inputs (e.g., Aber et. al 1989; Hedin 1994), or the control of ecosystem nutrient retention by factors other than the rate of nutrient input, can substantially modify the dose-response relationship. Practically, this means that future efforts to curb N inputs may not cause equivalent drops in N fluxes to surface-waters. For example, an ecosystem that is becoming gradually less able to retain N (increasing "N-saturation": Ågren and Bosatta 1987; Aber et al. 1989; Durka et al. 1994; Hedin 1994) might even respond to reduced N inputs by, for some time, continuing to "leak" increasing amounts of N to downstream aquatic ecosystems. Such counterintuitive causal links between legislative action and ecosystem response may give decisions makers and the public the false impression that our science can not successfully identify the factors that drive environmental change.

The future condition of aquatic resources - from landscapes to enclosed seas - will emerge from rather complex interactions between population and socioeconomic trends, technological growth, and the inner workings of terrestrial and aquatic ecosystems. Human population is often seen as the ultimate driver of many modern stresses on ecosystems (Schlesinger 1991; Forsberg 1994; Howarth et al. 1996; Viotusek et al. 1997). It is therefore noteworthy that the most recent predictions point to a substantial slowdown in world population growth (Lutz et. al. 1997), with a stable population occurring as early as ca. 2070. The biogeochemical effects of these demographic trends will be modified by trajectories in the use of resources and technology, particularly in developing regions. The next 3 times 25 years therefore present a particularly urgent period for understanding and managing how human populations influence aquatic ecosystems.

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CASES FROM FIVE COASTAL SEA AREAS

A basic aim of the Joint Symposium is to stimulate the interaction of freshwater and marine scientist and managers in order to produce a holistic perspective. Such interaction will be facilitated by focusing on a limited set of cases from different parts of the world, covering differences in climate, socio-economic development, cultural, institutional and political system.

These cases will be highlighted in two main ways:

1. through plenary overviews of the problems being addressed in each of the case areas,
2. through the case-based organization of the poster exhibition.

1 The Baltic Sea
2 The Black Sea
3 The Seto Inland Sea
4 The Chesapeake Bay
5 Lake Victoria

THE BALTIC SEA

Bengt-Owe Jansson, Professor Emeritus in Marine Ecology, Department of Systems Ecology, Stockholm University, S-106 91, Stockholm, Sweden

The biophysical system

The Baltic Sea has an area of roughly 400 000 km^2, a mean depth of 60 m, and a river inflow of ca 500 km^3. The large volume, and narrow and shallow connections to the North Sea give a residence time of water 25 years. Extensive rocky archipelagos make the coastal areas important for the whole Baltic as producers of living matter through solar energy fixation, as collectors of nutrients from land runoff, and as spawning and nursery ground for fish. The basin is filled with brackish water ca 1/5 of the salinity of fully marine waters, forming a stable gradient in the surface water from south to north (Fig.1).

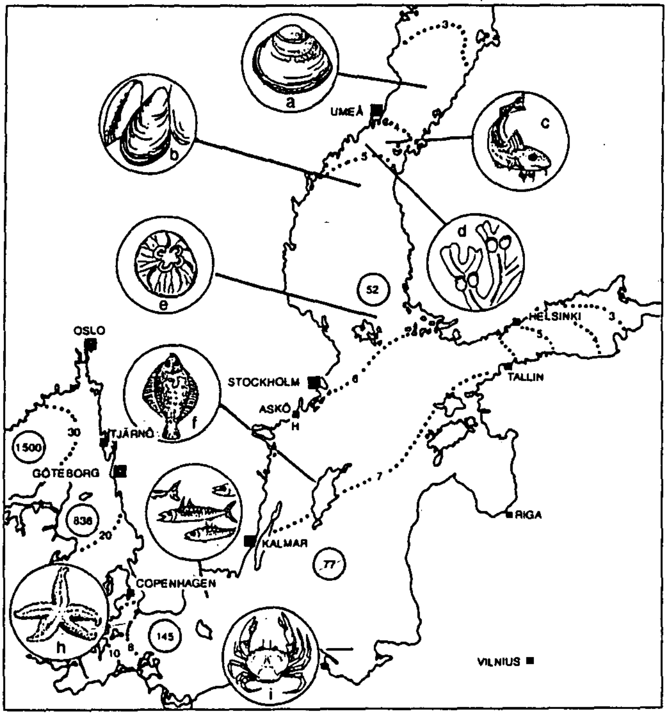

Fig.1. The Baltic Sea. Dotted lines are surface water isohalines, the figures within circles show number of macrofauna species. The circles indicate the distribution limits of some common marine species: (a) Macoma balthica; (b) Mytilus edulis; (c) cod; (d) Fucus vesiculosus; (e) Aurelia aurita; (f) plaice; (g) mackerel; (i) Carcinus maenas; (h) Asterias rubens. (From Jansson, 1972, updated).

This is maintained by the outflow of fresh water from the rivers, moving as a surface current mainly along the Swedish east coast out through the Straits and generating an inward current of the saltier and heavier North Sea water closer to the bottom. This creates a strong vertical stratification of the water column, a primaray halocline, during the whole year, as the Baltic has no tides which can mix the two water masses.The initially higher amounts of oxygen and salt in this bottom water is only slowly mixed with the surface water, mainly through wind and storms. At strong and persistent westerly winds larger packages of North Sea water is pumped into the Baltic. In 1992 around 300 km^3 water of high oxygen and salt content created good water quality in the bottom waters of the Baltic Proper during the following years ter a stagnation period of 16 years. This natural and irregular dynamics of the Baltic water is the weak backbone of the Baltic Sea - long residence time of the water of ca 25 years, stable stratification, irregular inflow of North Sea water, interfoliated by stagnation periods of anoxia in the bottom water (Stigebrandt, 1987).

The organisms in this diluted water: the microscopic algae in the open waters producing ca 150 g C per m ^{2} and year, the seaweeds of rocky bottoms offering food, shelter and oxygen for a rich foodweb and organic matter to the softbottom organisms, consist mostly of marine species (Fig.1). They invaded from the Atlantic during the early history of the Baltic as they can stand the low salinity but has to pay for the stress through slower growth, smaller size, and greater sensitivity to stress. Together with a small number of freshwater species they form a species diversity roughly one third of the number of macroscopic animal species found in the North Sea waters (Fig.1). The low number of species performing the fundamental tasks for a functioning ecosystem such as fixing solar energy, filtering the water, decomposing the accumulating organic material of dead animals and plants, means that such basic functions easily may loose their steady supply of supporting "workers" when the environmental stress increases. This means a low buffering capacity of the Baltic ecosystem (Jansson, 1980).

The fish fauna displays the specific mixture of fresh water and marine species - cod and flounder can be caught in the same gill net as pike and perch. The Baltic fisheries had an optimal period in the middle 1980s, when ca 1 million tons were landed annually (Fig. 2 G). That means an tenfold increase during the last fifty years (Hansson and Rudstam, 1990). This constitutes 1 % of the world catch from a sea with an area 1 part per thousand of the world ocean. The main species are herring, sprat, and cod, the formerly important salmon now close to extinction due to overfishing and diseases. Eel, pike and perch are locally important species. Pen cultures of salmon have been introduced in the archipelagos but play a minor role due to adverse effects on the water quality. Shellfish, such as mussels, cockles, clams and shrimps are too small in the brackish water to be used as human food. The cod stock is rebuilding after the low level during the last stagnation period but is still below the long-time average. Herring and sprat stocks are within safe limits, the latter at its highest, historical level checking the regrowth of the cod population through predation on the cod larvae. There is an urgent need for a better understanding of the resource base of the economic fish species and an working adaptive management of these living resources (Hammer et al, 1993).

The eutrophication process

The drainage area is 4 times as large as the sea area and inhabited by 85 million people from 9 countries: Sweden, Finland, Russia, Estonia, Lathvia, Lithuania, Polen, Germany, and Denmark. Their land use activities emit nutrients to the sea, nitrogen in the order of 1.4 million tons annually, and phosphorus ca 60 000 tons (Table 1). The main sources of nitrogen are agriculture and traffic, and more than 30 % of the total load enter the sea as atmospheric fallout. The distribution pattern indicate the main source over the industrial parts of Northern Europe (Fig.2 B).

The growing loads of nutrients have increased the concentrations of phosphorus and nitrogen in the open Baltic 8 and 4 times, respectively, since year 1900 (Larssson et al., 1985). This have had several clear effects on the ecosystem. The production of living matter by the algae, primary production, has increased by 30-70 %, the animal plankton, food for pelagic fish, have increased by 25 %, and the particle flow of dead animals and plants to the bottoms, sedimentation, have increased by 70-190 % since the turn of the century (Elmgren, 1989). The previous oligotrophic Baltic Sea has been pushed towards the eutrophic side (Fig.2 F).

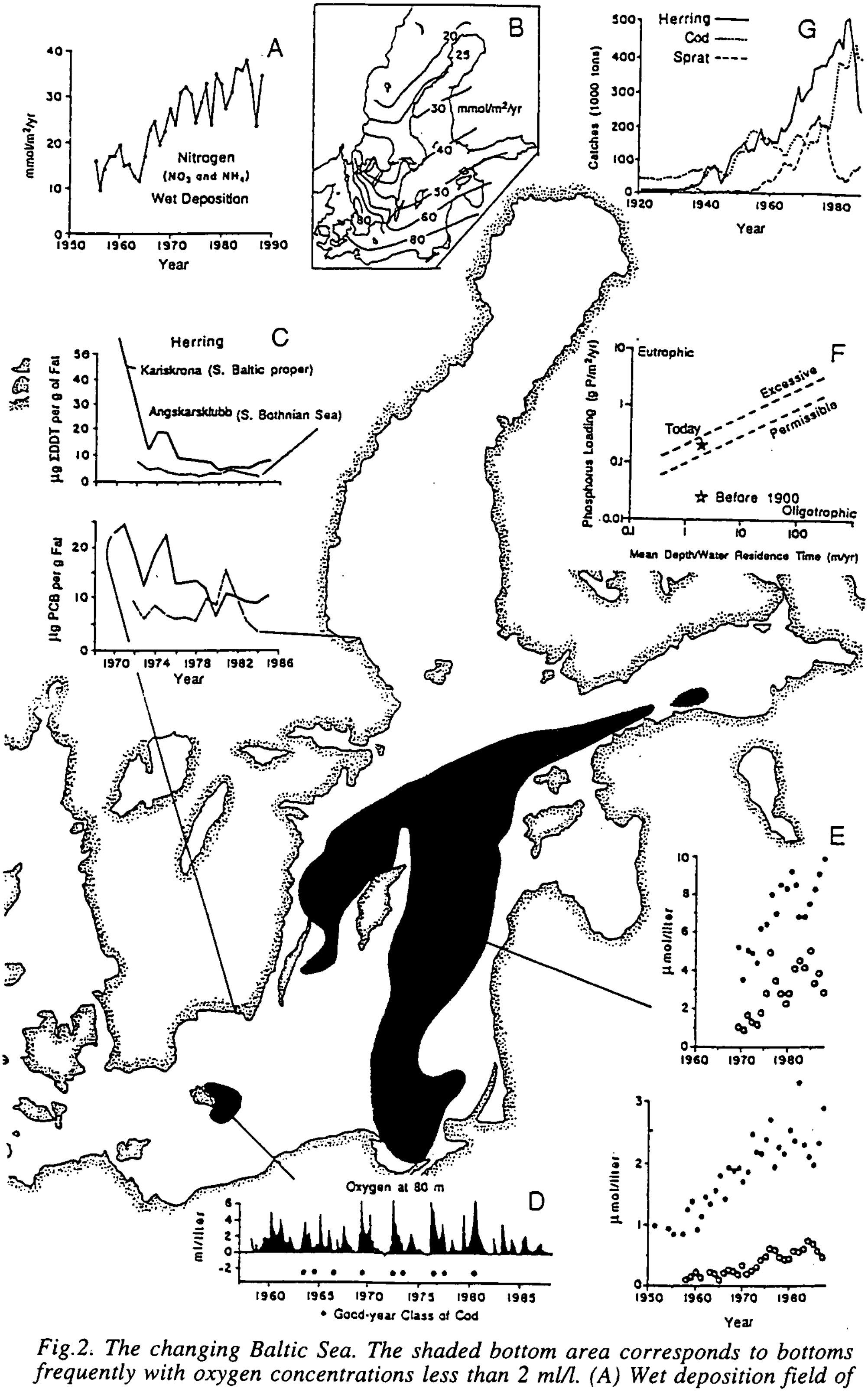

Fig.2. The changing Baltic Sea. The shaded bottom area corresponds to bottoms frequently with oxygen concentrations less than 2 ml/l. (A) Wet deposition field of

inorganic nitrogen compounds (NO_3, NH_4), and (B) wet depositions of same compounds in central Sweden (Stockholm Environmental Institute, 1990). (C) Body burden of DDT and PCB in Baltic herring (Bernes, 1989), (D) Oxygen content in Bornholm Deep and successful spawning of cod (from Bernes, 1989). (E) Trends of phosphorus (upper fig.) and nitrogen (lower fig.) in surface (open circles) and 100-m depth water (filled circles) of the Gotland Sea (Elmgren, 1989). (F) A Vollenweider diagram showing the trophic status in relation to phosphorus input for past and present Baltic (Larssson et al, 1985). (G) Fish catches in the Baltic during 1900s (Bernes, 1988). Figure from Jansson and Velner, 1995.

This has meant more food for the bacteria in the sediment bottoms meaning increasing consumption of oxygen. The Baltic soft bottoms which constitute most of the total bottom area therefore need large increase in oxygen transport, a transport which already before human activities was critical. The result is increase in area and frequency of hydrogen sulphide bottoms (Fig.2). During stagnation periods between strong inflows from the North Sea up to one third of the total bottom area have been devoid of oxygen (Andersin et al. 1978). The low oxygen values in the deeper waters threaten the population of cod as the eggs have to develop floating in the water and so need a salinity of at least 12 per mille (Westin and Nissling, 1991). This is found at depths deeper than 70 m, levels often devoid of oxygen. The only important spawning area nowadays is the Bornholm Basin. This is an exceptionally clear example of coupling between pollution and fisheries, between land use and sea resources.

In the increasing turbid waters of the coastal areas clear-water fish like pike, perch and whitefish, good swimmers and precious game-fish which can collect enough food in clear, poor waters by covering larger areas, give way to roach, bream and other "scrap fish" which do not need to move about in a water, dense with food particles. In ventilated areas - bottoms above the halocline - the food for fish in terms of worms, clams, mussles and snails has increased about four times since the 1920s (Cederwall and Elmgren, 1980). Both cod, herring and sprat have benefitted until overfished or suffering from low oxygen during the 1980s.

Another effect from large-scale, non-point pollution is the decrease of the brown seaweed bladderwrack, *Fucus vesiculosus* . Compared to the early 1940s the depth penetration of the alga has decreased with 3-4 m (Kautsky et al, 1986). The *Fucus* belt is the tropical rainforest of the Baltic and most important as spawning and nursery ground for fish and a loss of this association will have large consequences for the whole system.This is the more serious as the alga spawns only at fullmoon and the sperms and eggs are emitted only at very low water movements (Serrao et al, 1996).The most probable reason for the decline of the bladderwrack is the decreased light penetration due to increased particle concentration in the water. Since 1910 the transparency of the water (Secchi disc readings) have decreased by 2.5 to 3 m (Launiainen et al, 1989). Green and brown filamentous algae benefit from the eutrophication.They are annual, rapidly absorbing nutrients from the water and outcompeting *Fucus*.. Masses of ageing algae accumulate on the bottoms in the archipelagos and contribute to the increase of organic material and the consumption of oxygen at the decomposition process. The free space on the hardbottoms after the algae are gone will probably be invaded by blue mussels. In this way the Baltic Sea is driven deeper into a detritus-based system, probably with a decrease first in species, later in functional diversity.

The dynamics of phosphorus and nitrogen

During summer the pulses of primary producers rapidly change the concentrations through their photosynthetic consumption. The accumulated pools after the decomposition period during winter, however, represent the true conditions for the new production of organic matter during the light season. The nutrient pools are dependent on the freshwater outflow, which increased during the 1980s. There is a clear increase of both nitrate and phosphate in Kattegat, which gives the background for anoxic periods during the 1980s. Also for the other Baltic basins there is an increase of nitrate, stronger for Bothnian Bay, leveling off for the Baltic proper (Wulff et al, 1994).

Algal blooms

The solar energy fixation occurs in pulses, starting with an often intensive spring bloom in March when all of the nitrogen and most of the phosphorus is consumed during a few weeks. Close to 50 % of the phytoplankton biomass settles on the bottoms in absence of larger herbivors, constituting half of the total annual demand of potential energy of the softbottom community (Ankar and Elmgren, 1976). The summer bloom is to a great extent maintained by recycling nutrients, leaving settled organic matter of poor nutrient quality, mostly consisting of zooplankton fecal pellets. In July/August an conspicuous bloom of the cyanobacteria *Nodularia spumigena* occurs. This organism, sometimes slightly toxic, is able of fixing atmospheric nitrogen and draws considerable amounts into the marine system (Table 1). These blooms are known since far back but seem to have increased along with the general increase of offshore phosphorus. An autumn bloom of dinoflagellates and diatoms conclude the productive part of the annual cycle.

Table 1. Major, estimated annual inputs of nitrogen and phosphorus to the Baltic Sea (from Stålnacke, 1996).

Sources	**Period**	**N, tonnes yr $^{-1}$**	**P, tonnes yr^{-1}**
Riverine	1980-1993	830 000	41 000
Coastal point sources	1990	100 000	13 000
Atmospheric deposition	1985-1989	300 000	5 500
Nitrogen fixation	1980	130 000	-
Total		1 360 000	59 500

The ratios between nitrate and phosphate are important for the evaluation of the growth potential of phytoplankton. As they are assimilated in the relation 7:1, lower values indicate limitation of nitrogen, higher a shortage of phosphorus. The low values of the Baltic proper explain the annual blooms of nitrogen fixing algae which are stimulated at ratios below 7 (Niemi, 1979).

The changing N:P ratios has been blamed as one possible reason for the increasing frequency of toxic algal blooms, especially in Kattegat and Skagerrack. Previously present, but outcompeted toxic algae gain advantage and "explode" in blooms, new to the system and to man.

The different cycles of phosphorus and nitrogen

The phosphorus released from the sediment during an anoxic phase is not totally taken up again during an oxygenation process due to chemical processes (Gunnars and Blomqvist, 199?), which is one of the reasons why nitrogen and not phosphorus is usually limiting for primary prooduction in marine waters. The nitrification-denitrification processes are governed by bacteria populations, able to use oxygen for their living both from the water, from nitrate and from sulphate with preferences in that order. The denitrification process is interesting as it transfers inorganic nitrogen to molecular nitrogen which leaves to the atmosphere as one of the greenhouse gases - a way of the system to get rid of excess nitrogen. An important prerequisite is organic carbon usually delivered as leftovers from the plankton system. Following the oxygen distribution there is usually a vertical gradient in the bottom water towards and down in the sediment of nitrification and denitrification. The coupled processes move up and down forced by the oxygen consumption (Enoksson *et al.*, 1990) but being most intensive in energy-rich interfaces like a carbon-rich sediment with a thin oxidized layer (Brettar and Rheinheimer, 1992). Few attempts have been made to quantify the total denitrification of the Baltic proper like Shaffer and Rönner (1984). Dynamic modelling of nutrient models, however, points to the same order of magnitude - 50-60 % of the total nitrogen input (Wulff, Stockholm University, pers.comm.). For phosphorus there is no escape process from the basin, it will successively increase, switching between bottom sediment and bottom water following oxic and anoxic conditions.

Toxic substances
have been a major problem in the Baltic. Before the ban of both PCB and DDT in the middle 1970s populations of seals and fish-eating birds like auks and white tailed sea-eagles, had decreased close to extiction with body burdens 10 times higher than corresponding populations in the North Sea (Jensen et al, 1969). Incidence of leasions, uterine stenosis and occlusions occurred in grey and ringed seals (Bergman and Olsson, 1985). Following the declining toxic levels populations are now recovering, contents in herring and eggs of fish-eating alks are down to low levels (Fig.2 C), and the white-tailed eagle shows good recovery along the Swedish east coast. Cadmium, lead and mercury levels still need urgent attention. Oil input to the sea is in the order of 20, 000 - 70, 000 tons per year, of which 10 % originates at sea, the major part coming from diffuse sources through land runoff. Most harmful are the effects of polycyclic aromatic hydrocarbons (PAHs), generated at burning of oil derivatives, which occur at concentrations 3 times higher than in the North Sea (Broman and Ganning, 1985). New chemicals with unknown effects are continuously found, however.

The socio-economic system
Like the natural system the human system has its pulses, over periods of centuries. At the beginning of the Christian Era waves of different people swept over the Baltic region until a gradual settling based on primitive agriculture gave basis for an early technical development and commerce, using resources like iron, copper, timber, tar, fur, hemp and flax. Urban settlements increased, the Hanseatic League, a cooperation of some, mainly German, port cities grew out of improved navigation and naval progress and dominated the commerce during the centuries following the Viking era (Odén, 1980). Increased capital led to the first overexploitation of natural resources, the following industrial era, triggered by the invention of the steam engine and the introduction of coal as fuel, contains many more. Increasing urbanization paralleled this process, which accelerated at the innovation of the sewage system, based on the myth that the cleaning capacity of water is infinite (Lundgren, 1974).

Baltic Europe today is housing 85 million people, responsible for some 15 % of the global, industrial production (Boczek, 1989) and has an energy use which has increased more than 30 times since 1900. The region contains many medium-sized cities which draw heavily on the natural resources of the area. If the concept of "ecological footprint" (Rees, 1992) - the natural area needed to produce a population's total demands (shelter, food, water, air) - is applied to the 29 largest cities in the basin they would occupy 75-150 % of the total drainage area (Folke et al, 1997). This also incorporates the area necessary to process wastes of the resource use. The agricultural use of land has switched from being a net producer of potential energy to a consumer industry with considerable negative effects on the marine environment.

Institutions
Efforts to regulate the exploitation of the Baltic as a sink of wastes and a source of fisheries, transportation and tourism have not been missing. Being the first of its kind the Convention of the Protection of the Marine Environment of the Baltic Sea was signed in 1974 by seven of the littoral states, and its Commission (HELCOM) has successfully regulated the use of international Baltic waters during the difficult period of the "Cold War", and is now incorporating the drainage area in its rehabilitation schemes, e.g. the Joint Comprehensive Programme, and adopting an Agricultural Annex. The Baltic Fishing Convention was signed in 1973, recommending allowable catches and directing fisheries research. Non Governmental Organizations have played an important role. The Conference of the Baltic Oceanographers and the Baltic Marine Biologists have stimulated research and acted as advisers to, e.g.HELCOM. The Green Movement played an important role in the eastern countries during the Cold War, both for the environment and the stamina of the people. Some 30 NGOs in the Baltic countries have formed the Coalition Clean Baltic (CCB). Organizations such as World Wide Fund, Coalition Clean Baltic and Greenpeace play an important role as observers and pressure groups, especially in the Joint Comprehensive Programme, created by the Prime Ministers in the Baltic countries for the cleaning up of the Baltic Basin.

Towards a sustainable Baltic
Exploitation of the natural resources of Baltic Europe continues. "Vision on Strategies around the Baltic Sea 2010" is a transportation plan, connecting the main urban centers and developing new ones, connecting west with east. A New Hansa is emerging, planning new ferry lines. The Baltic Ring is a network of energy distribution around the Baltic. The present agriculture is under redevelopment within the European Commission. Much of these activities are going on seemingly without connection.

What is badly needed is a total overview, a conceptual model coupling activities and processes between land and water, securing a permanent reources base and necessary feedback processes. This is the practical consequence of a sustainable development, recently adopted by the Baltic prime ministers at their meeting in Visby in spring 1996, when a Baltic Agenda 21 was created.

The significance of open boundaries for an ecologically sustainable development of human societies was stressed by A.M. Jansson (1991). Only by developing feedbacks that secure the life-supporting capacity of regional ecosystems can we maintain an idustrial society. European Community may offer these open boundaries and there are increasing activities of both exploring and realizing this. The EC-project BASYS tackles the basin-wide, biophysical dynamic of the sea, the Baltic Basin Case Study (BBCS) synthesizes current natural and socioeconomic findings in the total drainage basin. Pure economic incentives are also in focus.The Baltic Drainage Basin Project has explored and estimated cost-effective nutrient abatement strategies, recommending a simultaneous reduction of N and P, restoring of wetlands and changing agricultural practices. Zylicz (1994) has reviewed alternative, economic instruments developed for environmental managements, i.a. pollution charges and marketable pollution permits, and how to mobilize the private sector to contribute to a sustainable Baltic Europe.

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THE BLACK SEA: A CONTINUING CAUSE FOR CONCERN

Laurence D. Mee, Coordinator, Black Sea Environmental Programme *BSEP-PCU, Dolmabahçe Sarayi, II Harekat Köskü, 80680 Besiktas, Istanbul, Turkey*

A casual look at a map of Europe will reveal the unique status of the Black Sea, as the world's most isolated seawater body. Indeed, though of similar area to the North Sea or the Baltic and with depths exceeding two kilometers, its entire interchange with the World Ocean is governed by the Bosphorus channel, some sixty kilometers in length and as little as seventy metres depth and seven hundred metres width. Complicating matters more, the Bosphorus winds its way through Istanbul, a mega city of over ten million inhabitants. On the landward side, the careful map reader will note that the catchment area of the Black Sea includes major parts of seventeen countries and covers about one third of continental Europe, from Germany to Georgia. The rivers draining this vast area, inhabited by more than 160 million people, include the Danube, Dnieper and Don, Europe's second, third and fourth rivers. The Black Sea coast itself is currently occupied by six countries, Bulgaria, Romania, Ukraine, Russia, Georgia and Turkey, though holders of maps printed before 1991 will note that Ukraine Russia and Georgia were-Republics within the Soviet Union.

This simple appreciation of the physical and political geography of the Black Sea is the key to understanding its current environmental predicament. A little more environmental history will help to complete the picture: Some eight thousand years ago, the Black Sea was an isolated lake, tens of metres below its current level. Following a global pattern of sea level rise, the waters of the Mediterranean broke through the Bosphorus valley and the Black Sea became a marine system as it was tens of thousands of years earlier. The warm but highly saline Mediterranean waters quickly sank to the bottom of the Sea and the mixture with fresh surface waters resulted in a rather low surface salinity (currently 16 - 20) and a considerable density gradient. The problem is that the replenishment rate of bottom waters was, and remains, very slow, perhaps taking some 800 years for complete exchange. The slow rate of bottom replacement of oxygen and the high oxygen demand from decaying organic matter soon led to permanent anoxia in the waters below 150 metres and the Black Sea is currently the largest anoxic basin in the world. From an ecological standpoint, life in the Black Sea is constrained to the first 150 metres of water and much of this axenic sea has a 'liquid bottom'.

Over the past five millennia, the Black Sea developed unique interlinked ecosystems such as that based upon huge beds of the red algae *Phyllophora* on the extensive north-western shelf of the Sea. The system was not entirely isolated and the seasonal migration of fish and mammals through the Bosphorus connected it with ecosystems in the adjacent Mediterranean. Similarly, anadromous fish, notably sturgeon, depended upon connections with the freshwater ecosystems of the tributary rivers. The Sea included naturally eutrophic and oligotrophic areas and was well able to supply the coastal countries with fish and provide excellent areas for recreation. Indeed, the Black Sea served as the main seaside vacation area for much of the former Soviet Union and a major part of Eastern Europe.

The decline of the Black Sea's ecosystems was recent and precipitous. In their strive to increase standards of living and food production, the Basin countries paid little regard to protecting the environment. The 'green revolution' of the sixties led to a massive increase in nutrient discharge to rivers and this, in mm, caused intense algal blooms in the Black Sea, particularly on its northwestern shelf, the area occupied by *Phyllophora*. The entire ecosystem became destabilized. Deprived of fight, the keystone *Phyllophora* died massively - only a few small patches remain today. The bottom of the NW shelf of the Black Sea is now barren and seasonally anoxic and its important function as a nursery ground to benthic fish stocks has virtually disappeared.

The fate of the NW shelf is only part of the story. The Black Sea coastal zone was already heavily exploited before the coastal countries initiated the process of economic transition in the late 1980s. The early years of transition however, resulted in dramatic short-term changes as public sector infrastructure deteriorated rapidly. There are virtually no fully functioning wastewater treatment plants in the region at this juncture. Furthermore, infrastructure for tourism, transport, human health and environmental protection and conservation has further deteriorated. Bathing water quality is often poor and reports of cholera outbreaks have undermined public confidence in the Black Sea's recreational qualities. Tourism, one of the bases of economic development in the region, has declined considerably. One, less negative, environmental consequence of the current economic crisis has resulted from the decrease in industrial production in the region and the inability for farmers to afford large quantities of agrochemicals. There is some evidence to suggest that the lowered pollutant input to the Sea has resulted in some recovery, albeit limited, of benthic communities in the Sea itself. This offers evidence that the ecological degradation in the Sea can be reversed provided that the adequate measures are taken to prevent pollution when economic growth returns to the agricultural and industrial sectors.

The pressures on the Black Sea environment are also changing. The Black Sea has become a super-highway for the shipment of oil from the huge reserves of the Caspian Basin. This development need not compromise the natural ecosystems or other human users of the Sea but appropriate precautionary measures (contingency plans, investments in reception facilities) are urgently needed. The Black Sea however, has suffered badly from another shipping-related issue. Toward the end of the 1980s, a brackish water ctenophore (a jellyfish-like species) was introduced accidentally during the discharge of ballast water collected along the eastern seaboard of North America. This invasory species predates on zooplankton (including fish larvae) and without natural predators, attained a biomass of 30 million tons in 19 89. This, coupled with heavy overfishing and the loss of nursery areas, had disastrous consequences for commercial fish stocks. Though some species are slowly recovering, Black Sea commercial fisheries are now harvesting some six species compared with 25 or so some three decades ago.

For the Black Sea countries, the process of understanding and change began at the time of *perestroika* in the Soviet Union. As more information became available regarding the state of the Sea and its fisheries, it became obvious that the situation could not be resolved without international consensus and action. The coastal countries (Bulgaria, Georgia, Romania, Russia, Turkey, Ukraine) began a process of negotiation that resulted in the Bucharest Convention for the Protection of the Black Sea Against Pollution, signed in April 1992 and fully ratified by 1994. Recognizing the need for a stronger policy framework for setting joint objectives and milestones, the six Ministers of the Environment met in April 1993 to sign the Odessa Declaration on the Protection of the Black Sea. This Declaration, based upon UNCED Agenda 21 and the concept of common but differentiated responsibilities, set a three year agenda of urgent pragmatic actions for improving environmental management. At the same time, the governments successfully requested the Global Environmental Facility for a three year $ 9.3 million grant in order to establish the Black Sea Environmental Programme (BSEP). Other donors joined the GEF in this venture, notably the European Union, which has contributed some $ 7 million through its Phare and Tacis programmes. 71e primary areas of work of BSEP were in the fields of capacity building, the development of new policy and legislation and the promotion of investments to resolve urgent environmental concerns. The Programme has been successful in assisting the countries of the region to develop a medium/long term Black Sea Strategic Action Plan that was signed by the six Ministers of Environment of the Black Sea countries on 31 October 1996.

The BSEP has proved a nucleus for the development of a strong network of Black Sea institutions and specialists co-ordinated by specialized Activity Centres, one of which is located in each Black Sea country. These cover areas such as emergency response (to oil spills), fisheries and aquaculture, pollution assessment, pollution control, integrated coastal zone management and biological diversity. The entire network is co-ordinated by a Programme Co-ordination Unit, jointly operating in Istanbul with the Secretariat of the Bucharest Convention. Additionally, a strong independent NGO network has developed providing an important tool for environmental advocacy. More than two hundred specialists have been given additional training in order to tackle the new challenges posed by the environmental degradation of the sea and the transition to a market economy. Moreover, the network has proven a powerful instrument for gathering more objective information on the state of the Black Sea and the root causes of the degradation itself. Co-operation has been remarkable. Countries exchanged data assessing all land-based sources of pollution to the Black Sea in 1996. This revealed that nobody is innocent of polluting but that the overwhelming anthropogenic source of nitrogen and phosphorus to the Sea is from international rivers, notably the Danube. The only way to tackle the problem of eutrophication is therefore through the involvement of all seventeen countries within the Black Sea Basin.

Using the BSEP network, a much clearer picture has emerged of the nature of the environmental problems facing the Black Sea and the socio-economic barriers for resolving them. It is clear, for example that the Black Sea is not overwhelmed by chemical pollution. The main proximate causes for decline are eutrophication, sewage and inadequate coastal zone management. The Black Sea Action Plan has taken bold measures to address these issues. It calls for profound fiscal reforms, better transparency and public involvement and places a major emphasis on the conservation of biological diversity. Tourism and aquaculture are selected as areas for development where environmentally friendly techniques can be applied and investments promoted. All these changes require that environmental protection is afforded a high place on the political agenda of the coastal countries and that continued international co-operation is promoted. Eastern European countries are struggling with difficult economic realities. Progress is slow but the Black Sea environment cannot wait much longer.

Figure legends:

Figure 1. The Black Sea Basin covers about one third of the continental land area of Europe.

Figure 2. The transparency of the Sea, as revealed by Secchi disk recordings, illustrates the dramatic increase in eutrophication in the last two decades (Mankovsky and Vladimirov, 1996)

Figure 3. Red algal communities on the NW shelf of the Black Sea in the 1950s (ææææææ), the 1960s (æææ) in the 1970s (-----) and in the 1980s (*ff*) (Zaitsev, 1992)

Figure 4. The assessed inputs of dissolved phosphorus to the Black Sea from all sources in 1995 (BSEP, 1997)

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Zaitsev, Y. (1992) Recent changes in the trophic structure of the Black Sea. Fish. Ocenogr., 1(2) 180-189

Figure 1.

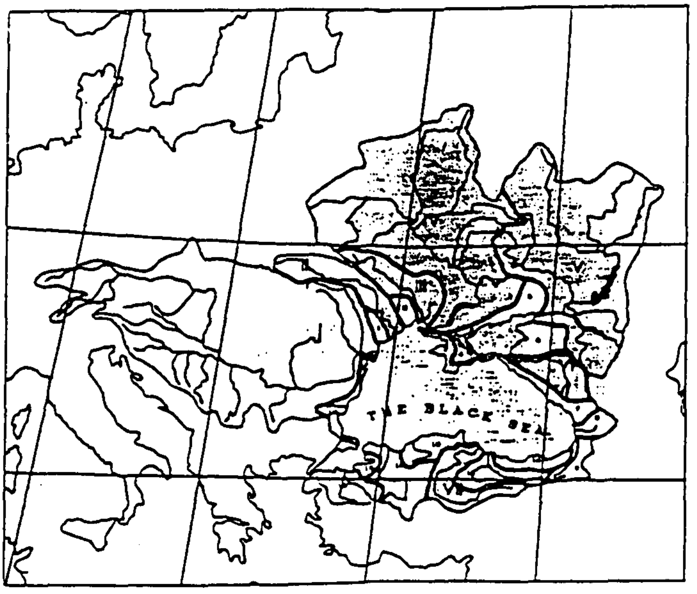


Figure 2.

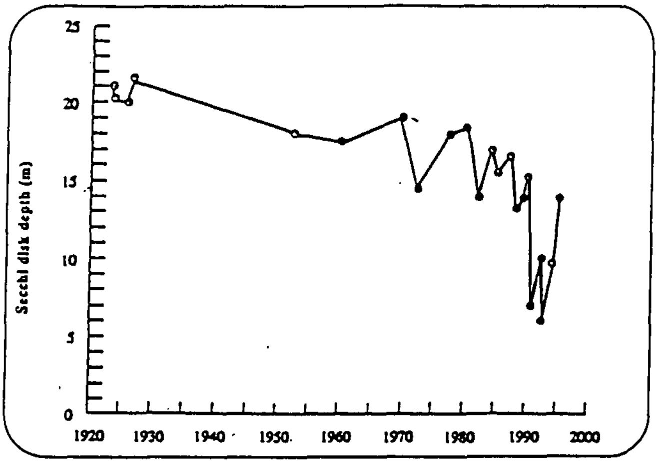


Figure 3.

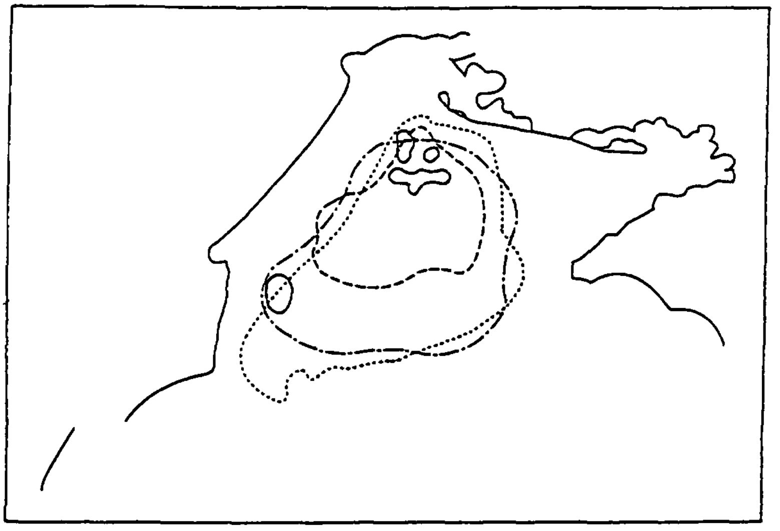
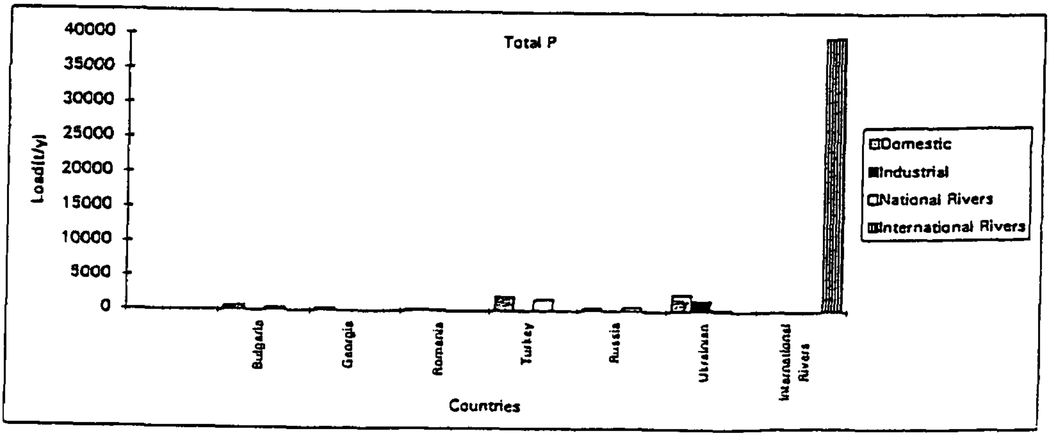


Figure 4.



THE SETO-INLAND SEA:
SUSTAINABLE DEVELOPMENT FROM THE VIEW POINT OF FISHERIES

Tomotoshi Okaichi, Professor of Tokushima Bunri University, Professor Emeritus of Kagawa University, Vice President of Scientific Research Institute of the Seto Inland Sea, 6-8 Kaminocho 3-chome, Takamatsu 761, Japan

General features of the Seta Inland Sea and problems that have occurred

The Seto Inland Sea is situated in the western part of Japan and is famous for its beautiful landscape, which includes as many as 700 islands. It is about 500 km in length and varies from 5 km to 50 km in width. At the same time, the land surrounding the Seto Inland Sea has developed into one of the most industrialized areas in Japan, with a population of about 38 million in 13 surrounding prefectures, accounting for about 28% of Japan's total population of 120 million. The population density is about 500 people/km^2.

The sea has a surface water area of about 22,000 km^2, with a mean water depth of 37 m. It has three mouths; the Kamnon Straits, the Bungo Channel and the Kii Channel. A tidal current is dominant in the Seto Inland Sea. The maximum speed of the tidal current is about 500 cm/sec at the Naruto Straits in the eastern part, and the maximum tidal range about 400 cm in the central part of the Seto Inland Sea. (Fig. 1)

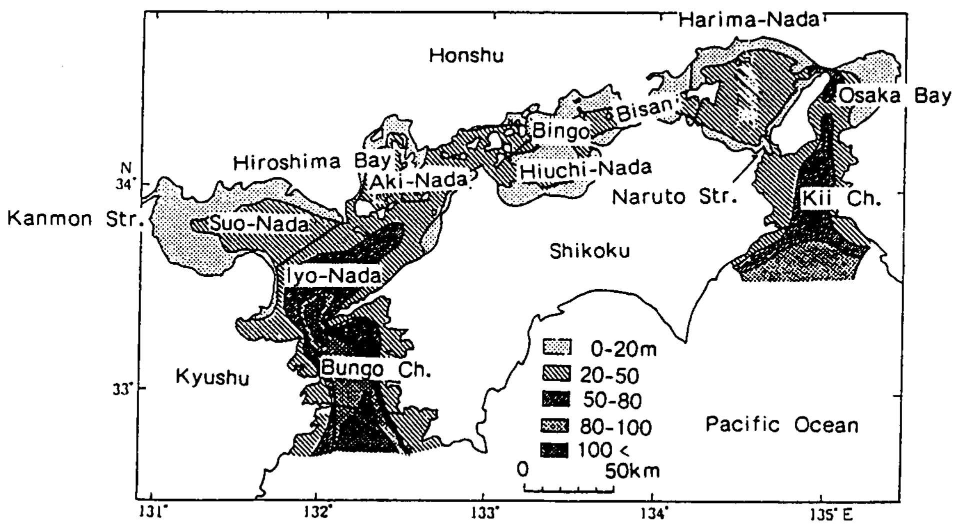


Fig. 1 The Seto Inland Sea, Japan and its topography

Coastal fisheries developed before the industrialization of the area and supplied a considerable amount of marine food to the region. Now Japan is experiencing a smaller fishery output from deep-sea and offshore fishing owing to restrictions introduced by the Marine Law and other factors. The total catch for Japan was 7,500.000 tons in 1996, a decrease of about 60% of the fish catch in 1990. In view of this, the Seto Inland Sea plays an important role in coastal fishing and aquaculture. The fish catch in the Seto Inland Sea accounts for a quarter of the total coastal production. In 1993, the catch in the Seto Inland Sea was 281,000 tons while aquacultural products accounted for 349,000 tons.

Along with fishery and aquaculture, industrial production in the area reached a peak of ¥94,500 billion in 1991, so there is potential for serious artificial contamination of the Sea. Since 1965, red tides, a phenomenon caused by the abnormal blooming of harmful phytoplanktons, have occurred on a large scale almost all over the Seto Inland Sea and have brought about a loss of over ¥25 billion in the past 25 years, especially to aquaculture.

Measures against eutrophication and outbreaks of red tide

Generally speaking, red tide occurs as a result of the eutrophication of water. Measures to control chemical oxygen demand (COD) and to prevent nitrogen and phosphorus from flowing into the sea were terribly inadequate around 1970 and water in the Seto Inland Sea was heavily polluted. To cope with this situation, the Law Concerning Special Measures for the Environmental Conservation of the Seto Hand Sea was enacted in 1973, and a number of administrative steps were taken, such as cutting COD loading from the land in half, reducing phosphorus and nitrogen loads and placing restrictions on reclamation of coastal areas. In the meantime, industrial plants and local governments made every effort to improve their water treatment facilities. Residents living in the coastal area have also become more aware of the need for environmental conservation. Thanks to the efforts of both the government and the private sector, pollution in the Seto Inland Sea has gradually been reduced, and the environment has improved to some extent. As an example of this, red tides occurred 299 times in 1976, but this figure decreased to less than 100 in recent years and aquaculture technology has also progressed, including improvements in fish food. Thus the damage to fishery is being curtailed. (Fig. 2)

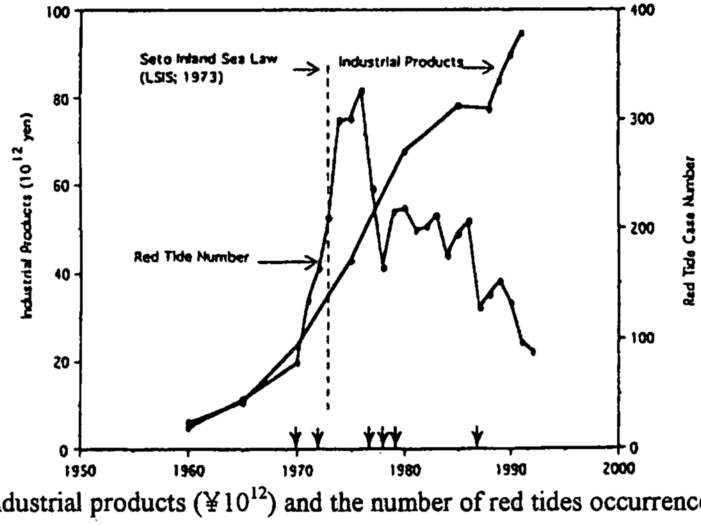


Fig. 2 Industrial products (¥10^{12}) and the number of red tides occurrences1

↓: Fish mass mortality

Interdisciplinary study on the sustainable production of various fish and preservation of the it in the Seto Inland Sea, Japan (1992-1995)

The aim of this interdisciplinary study was to clarify the basic natural, economic social and legal conditions for the preservation of both the fisheries industry while achieving a desirable natural environment in the Seto Inland Sea.

The head of the study team was Dr. Tomotoshi Okaichi, the present author, and the project was carried out from 1993 to 1997 under the sponsorship by the Nippon Life Insurance Foundation.

The study team was composed of six core projects as follows.

1) Quantitative clarification of the rate of primary production in the whole area. (P. 1. Prof. 0. Matsuda, 5 others)

2) Quantitative clarification of the temporal variations in fish catches (P. 1. Drs. Y. Aizawa (1992-1993), S. Hayashi (1993-1994) and Y. Masaki (1994-1995), 6 others)

3) Preservation of fishery grounds and creation of new ones (P. 1. Prof. T. Yanagi, 3 others)

4) Methods for reducing the nutrient load from the land and an assessment of its effect (P. 1. Prof. H. Nakanishi, 5 others)

5) Local economic development and policy decisions (P. I. Prof. S. Komori, 4 others)

6) Legal problems related to fisheries and the marine environment (P. Prof. T. Tuchida, 2 others)

Results and proposals made by the Study

1) The average primary production in the Seto Inland Sea is estimated at 730 mg $C/m^2/day$ while secondary production is estimated at 210 mg $C/m^2/day$, though these vary significantly both seasonally and spatially. The transfer efficiency to secondary production is 26%.

   The tertiary production rate is estimated at 58 Mg $C/m^2/day$ resulting in a transfer efficiency from secondary to tertiary production of 28%. As far as the transfer efficiency from primary production to planktivorous fish production is concerned, we cannot detect any deleterious effect due to excessive eutrophication. (Fig. 3)

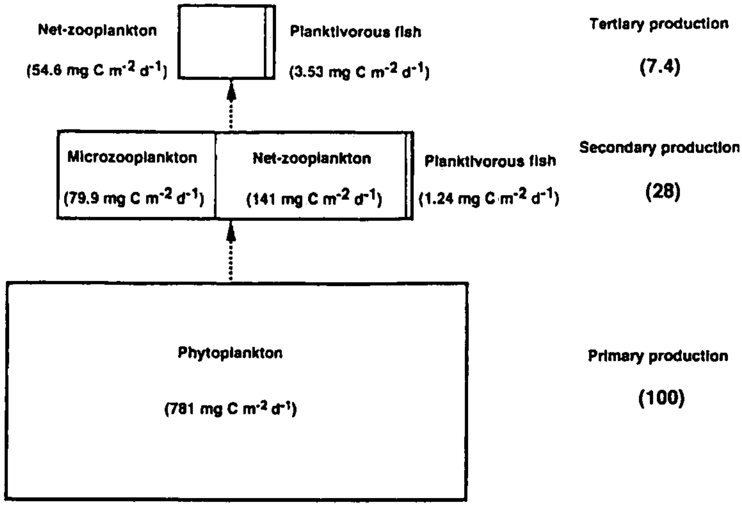
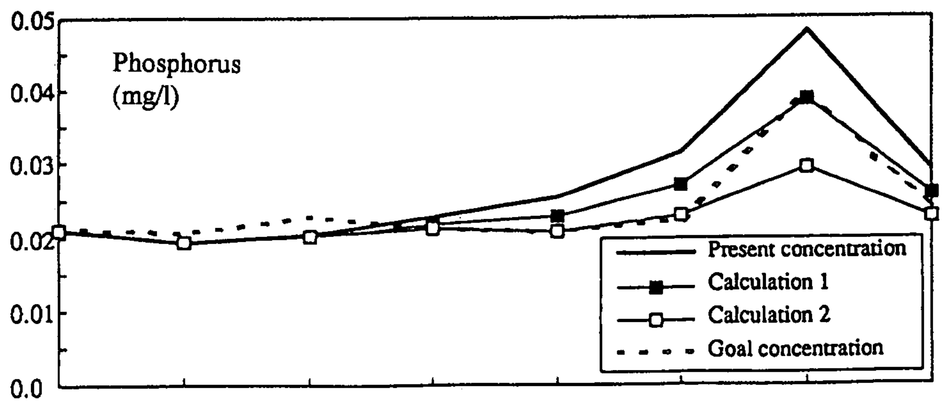


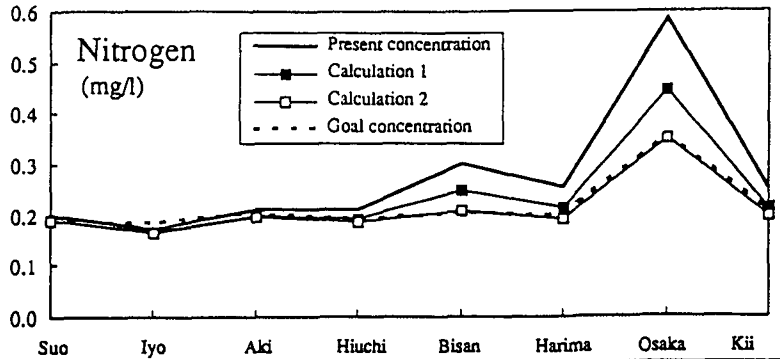
Fig. 3 Simplified trophic structure of the pelagic ecosystem in the Seto Inland Sea. The compartment area of each trophic level represents roughly the relative magnitude of production rate. The transfer efficiencies from primary producers to secondary and tertiary producers are shown on the right.

2) However, conditions at the sea bottom in stagnant areas such as Osaka Bay, Harima Nada and Hiroshima Bay have deteriorated and cause benthic hypoxia or anoxia during the summer. The destruction of environmental conditions at this time of the year lead to a large reduction in benthic animals. Proper environmental measures to reduce nitrogen and phosphorus loads from the land should be taken for conditions at sea bottom to recover. We propose that environmental standards for each region should be adopted for the sustainability of the fisheries. It is essential to reduce the nitrogen and phosphorus loads from land to between 10-80% and 30-65% of their respective loads in the eastern part of the Seto Inland Sea. (Fig. 4)



Subwaters	Suo	Iyo	Aki	Hiuchi	Bisan	Harima	Osaka	Kii
Calculation 1	0.1	0	0	0.3	0.3	0.3	0.3	0.3
Calculation 2	0.1	0	0	0.4	0.6	0.65	0.6	0.3

"Calculation 1" is the case in which the load reduction is limited to a maximum of 30% (= 0.3, in the tables), the maximum that the people in the catchment area can be expected to accomplish. "Calculation 2" is the case in which there is no limit to the reduction effort people can carry out.



Subwaters	Suo	Iyo	Aki	Hiuchi	Bisan	Harima	Osaka	Kii
Calculation 1	0.1	0	0	0.2	0.3	0.3	0.3	0.3
Calculation 2	0.1	0	0	0.1	0.8	0.3	0.55	0.1

Fig. 4 Nutritional load reduction rates required to accomplish the goal concentration

3) The current fish catch in the Seto Inland Sea is 23 tons/km^2 in average. The present rate of fishing activity is estimated at three times above the optimum rate needed to maintain stocks of certain commercially important fish. Suitable fisheries management such as fishing nets with a coarse mesh size, regulation of the fishing season and catchment areas must be adopted. The trend of fish catch from 1922 to 1993 is shown in Fig. 5.

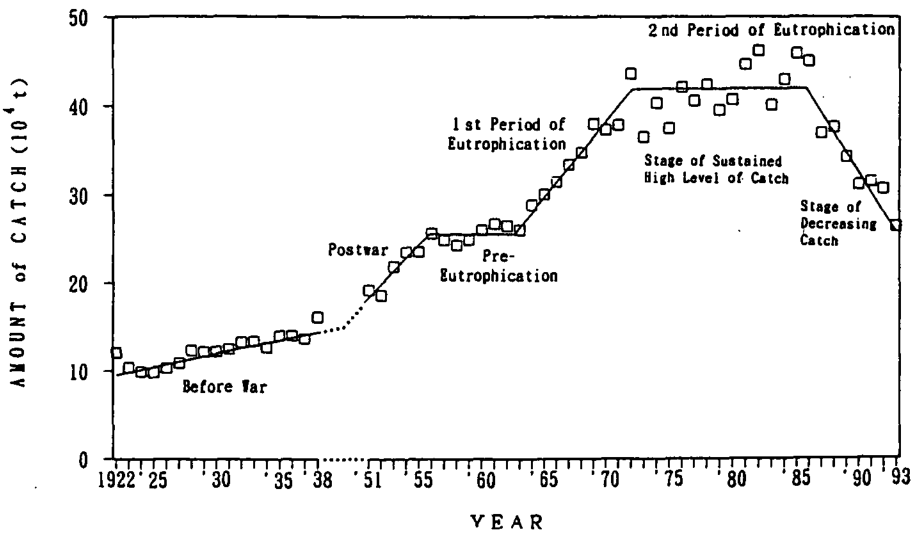


Fig. 5 Changes in the amount of catch in the Seto Inland Sea (modified from Tatara, 1981)

From around 1955 (period of pre-eutrophication) to 1993, trend of fish catch classified by fish price was as follows, 1) total catch of the high price fish is fairly constant, 2) the medium price fish catch increased slowly until the later half of 1970's and stabilized thereafter, 3) the low price fish, such as sardine and sand eel, increased until 1982 and then decreased. 4) the seashell catch decreased after showing a peak in 1972, 5) the seaweed production decreased 1984, and 6) the decrease of the low price fish and the seashell catch has resulted in the recent reduction of the total catch.

4) In 1993, production by aquaculture exceeded the fishery production, as mentioned above. However, the aquaculture grounds are heavily polluted by the continuous load of unconsumed food and fecal pellets. The development of scientific management methods to keep the aquaculture ground clean is required.

5) Man-made structure for inducing upwelling is a very promising technology for increasing primary production in nutrient-poor fishing grounds even in the Seto Inland Sea. The structure (Fig. 6) was set up in the eastern part of Bungo Channel. As shown in Fig. 7, two years later PO_4-P and chlorophyll-a in surface water increased. Creation of a new fisheries ground is expected now.

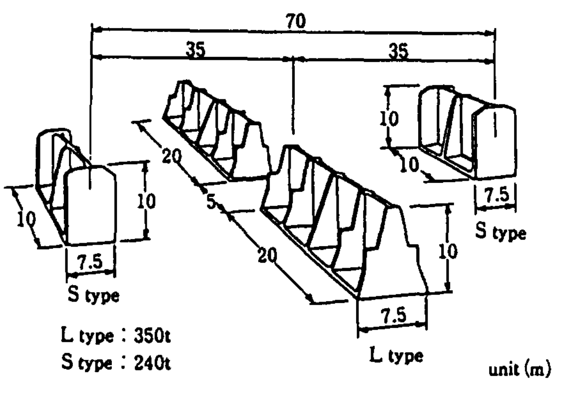


Fig. 6 Man-made structures to induce upwelling

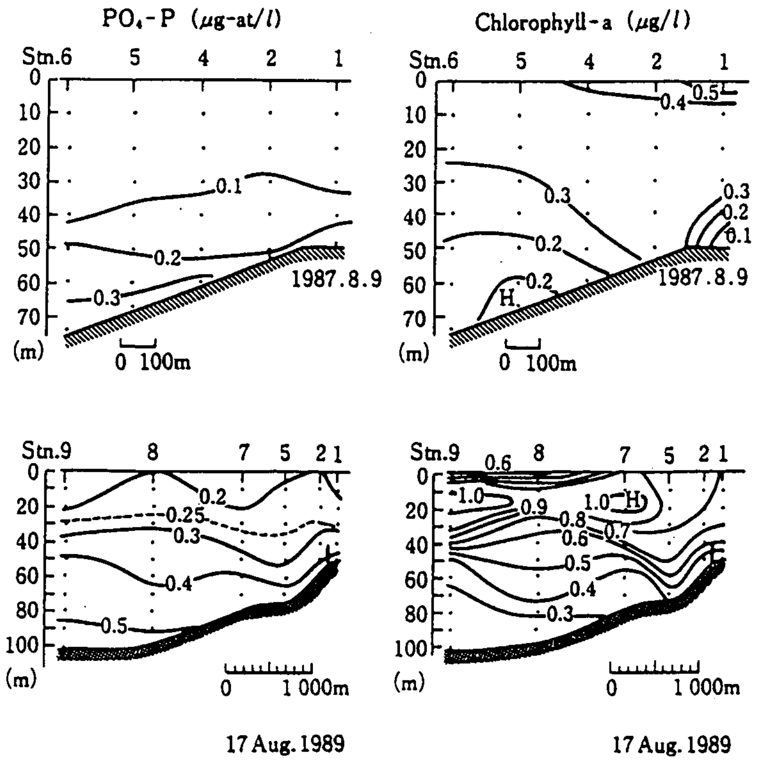


Fig. 7 Changes of vertical distributions of PO_4-P Chl..a before and after setting up man-made structure upwelling

6) The Seto Inland Sea has value not only as a ground for fisheries but also as an industrial area, a recreational area, and a region with historical significance. Harmonization is needed between the various kinds of human activities conducted there. In order to sustain these activities, we have to develop some kind of environmental assessment system that evaluates the total environmental value of the Seto Inland Sea including not only economic use but also recreational use, historical heritage and the symbolic significance of scenery in Japan. The policy decision support system deprived from the study seems to be useful to make up the system for preservation of the environment in general. (Fig. 8)

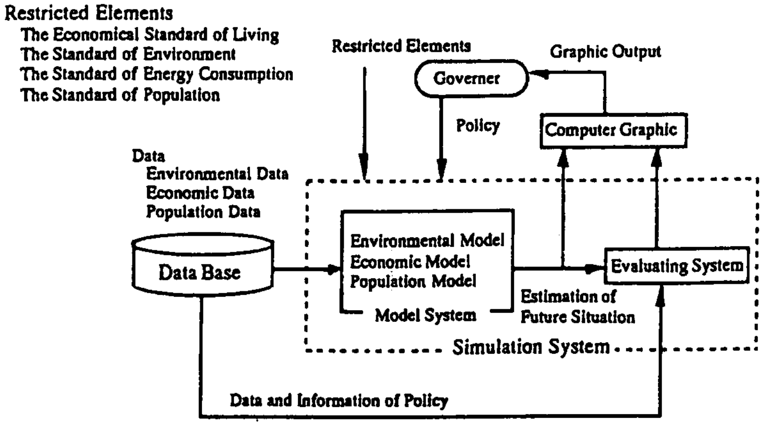


Fig. 8 Policy decision supporting system

7) The examination of japan's legal system concerning environmental preservation and the fisheries industry does indeed provide us with beneficial guidance relating to the governance of coastal management. Assessment of a new legal system in which water use by land-based industries and by the public, who want to use the Seto Inland Sea for various purposes, including water sports and other activities, is co-ordinated with the fisheries industry recognizing that fisheries operators are major players in the protection of the coastal environment.

Acknowledgements

This study was achieved by close co-operation of 30 scientists engaged in 'Interdisciplinary Study on the Sustainable Production of Valuable Fishes and Preservation of Environment in the Seto Inland Sea' under the sponsorship by the Nippon Life Insurance Foundation. The author expresses sincere thanks to those members and the Foundation. My thanks are also extended to the members of the Association for the Environmental Conservation of the Seto Inland Sea and the International Center for the Environmental Management of Enclosed Coastal Seas (EMECS).

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THE CHESAPEAKE BAY: MANAGING AN ECOSYSTEM

Ann Pesiri Swanson, Executive Director, Chesapeake Bay Commission, 60 West Street, Suite 200, Annapolis, MD, 21401, USA

The Chesapeake Bay is the largest and most productive estuary in the United States. It is also among the most productive estuaries in the world. Efforts to restore the Chesapeake Bay are now more than two decades old and there are many lessons we have learned. This paper is intended to highlight some of these lessons and to identify some of the successes experienced in the effort to manage the Bay as a single ecosystem, including all of its waters and the land that defines its watershed.

The Chesapeake Bay restoration effort is designed to work within the highly participatory framework of the American democratic culture. Multiple players are involved at every stage of the restoration process including various levels of government, private citizens, and businesses. The lessons outlined in this paper are put forth with transferability in mind. Some may be directly transferable to similar restoration efforts elsewhere in the world. Others may need to be modified in order to work within the ecological, cultural, or political framework of a given region or country. But, regardless, these lessons will help the reader to better understand the many inner workings of the Chesapeake Bay restoration campaign.

THE CHESAPEAKE BAY

The Chesapeake Bay has often been referred to as the "crown jewel" of the United States' 850 estuaries. Located midway along the east coast of the United States, it extends 180 miles (290 km) from the tidal reaches at the mouth of the Susquehanna River in Maryland to Cape Charles, Virginia, where it meets the Atlantic Ocean. It cuts across virtually the entire north-south length of two states - Maryland and Virginia - helping to define their landscape, their cultures, and their economies.

As an estuarine system, the Chesapeake Bay is highly complex. Within its boundaries exist a range of aquatic environments, from fresh water to nearly full-strength seawater, allowing a broad spectrum of organisms to flourish. It has complicated physical circulation patterns that vary with changes of season, tide, and weather. Outside of its boundaries, adjacent or sometimes remote ecosystems influence the Chesapeake Bay, contributing to its remarkable complexity.

With a width of between four and thirty miles (6 to 50 km), the water surface of the tidal Chesapeake covers 2,500 square miles (6,475 km^2) . The Chesapeake's 64,000 square mile (165,760 $km^{2)}$ watershed encompasses part or all of six states - New York, Pennsylvania, Maryland, Delaware, West Virginia, and Virginia. It includes a number of geologic formations, from the flat coastal plains to the forested mountains of the mid-Atlantic region, with the fertile, largely agricultural piedmont in between. It receives most of its fresh water from about 50 major tributaries and thousands of streams, creeks, and ditches penetrating its sweeping watershed. Eight of these 50 rivers contribute about 90 percent of the freshwater contained in the main stem of the Chesapeake Bay.

But even describing the Bay in the context of a watershed does not fully describe the land's influence on its waters. Chesapeake Bay, compared to other bodies of water, has a huge drainage basin for the amount of water it contains, a ratio of 4,414 square miles of land for every cubic mile of water (2,743 km^2 of land for every 1 km^2 of water). The principle reason is the Chesapeake's extreme shallowness - its average depth is only 22 feet (7 m).

This shallowness contributes to its amazing productivity. It is the home for more than 2,700 species of plants and animals, from tiny creatures wallowing in the marsh mud to giant bald eagles, which have made an awe-inspiring comeback around the Chesapeake region. Some 250 types of fish, crabs, clams, and oysters live in the Bay - many in extraordinary numbers. Together, they have a commercial value of more than one billion dollars annually. Half of the national catch of the Atlantic blue crab is harvested from Bay waters. Based on a catch of 80 million pounds (36 million kg) in a good year, it equates to between 150 and 240 million individual crabs. Of the nation's soft shell crab catch, 90 percent is taken from the Chesapeake.

Still, for all this productivity, the Bay is not without its woes. The Chesapeake acts as a giant catch basin for everything that drains from its massive watershed. Today, much of the Bay's watershed lies in some of the fastest developing regions of the country and is at the southern end of the urban megalopolis, spanning Washington, DC, to New York and the northeastern United States. Two of the country's five major North Atlantic ports Baltimore and Hampton Roads - are on the Chesapeake, and more than 10,000 ocean vessels ply its waters each year.

Close to 13 million people live in the watershed that drains into the Chesapeake, a figure that is expected to reach 14.6 million by the year 2000. Thousands of municipalities, industries of every sort, and farms use water from the Bay and its tributaries to do everything from irrigate crops to cool nuclear reactors. They also use it as a place to dispose of treated waste.

It is estimated that 1.5 billion gallons (5.7 billion liters) of treated sewage flows into the Bay each day from more than 5,000 sources. This does not include the soil, fertilizer, and pesticides running off the farms. By their very nature, pesticides are toxic, while heavy amounts of the nitrogen and phosphorus in fertilizer set off an aquatic chain reaction that ultimately chokes out underwater grasses, the spawning ground for a variety of aquatic life.

At this point, it would be impossible to restore the Chesapeake Bay without addressing these man-induced influences. They permeate the ecosystem and help to define it. They have also inalterably changed it. The current restoration effort attempts to seek a balance whereby the human population can prosper while the native fish and wildlife are provided with the ample habitat, clean water, and harvest restrictions sufficient to sustain their populations.

THE CHESAPEAKE BAY PROGRAM: A RESTORATION PARTNERSHIP

By the mid - 1970's, the impact of the population - of unrestrained harvests and decades of degradation - had sharply impaired the Chesapeake's health and productivity. Under the leadership of several high-level elected officials from the region, the United States Congress in 1976 was persuaded to direct the federal Environmental Protection Agency (EPA) to launch a major study of the Bay's decline. The research was to consider the *entire* Bay system.

Numerous studies existed prior to 1976 that documented negative effects of a specific pollutant or analyzed certain patterns and processes of the natural system. But there was an absence of scientific documentation and analysis for the Bay ecosystem as a whole. Furthermore, while comprehensive, system-wide studies had been conducted elsewhere in the United States, they had never focused on one so large or complex as the Chesapeake Bay.

The 1976 Chesapeake Bay study marked a turning point for estuarine management, nationwide. It demonstrated, for the first time, that ecosystem research and the resultant management programs can apply to geographically large areas that are ecologically, culturally, and politically diverse. It also confirmed that the Bay's waters were inextricably linked to the land use practices of its watershed.

The findings and recommendations from the $27 million Chesapeake Bay research program were released late in 1982. The report laid the foundation for the first Chesapeake Bay Agreement signed in 1983. In that compact, the governments of Pennsylvania, Maryland, Virginia, the Chesapeake Bay Commission (the tri-state legislative agency), the District of Columbia, and the U.S. Environmental Protection Agency agreed to develop and implement coordinated plans "to improve and protect water quality and living resources of the Chesapeake Bay estuarine system." While non-specific in its goals, the 1983 Agreement launched a regional effort to manage the Bay as a whole - as an ecosystem.

That basic declaration of intent was expanded to a series of 31 commitments in a second Chesapeake Bay Agreement signed in December 1987. These commitments spelled out steps to improve the management of fish and wildlife, restore water quality, plan for development, increase public awareness and access, and continue to improve intergovernmental cooperation. The states and federal government were to carry out the agreement, each in their own way, by passing new legislation, creating new initiatives, extending (and better enforcing) existing programs, and backing their commitment with money.

At the core of this unprecedented regional compact was the firm declaration that the "productivity, diversity and abundance" of the estuary's living resource - shellfish, finfish, other aquatic creatures, and vegetation - were "the best ultimate measures of the Chesapeake Bay's condition. " This agreement firmly established the connection among the component parts of the estuary and forced the integration of its management.

With the Chesapeake Bay Agreement as its basic charter, the Chesapeake Bay Program grew to become a unique regional institution, guiding and coordinating Bay-related activities of hundreds of federal, state, local, and inter-state government agencies, and working with dozens of non-governmental business, civic, and environmental organizations as well.

Since 1987, the Chesapeake Bay Agreement has been revised just once, in 1992, with a series of amendments. The basis for these amendments was an analysis called for in the 1987 Agreement. The analysis determined that nutrient reductions in any given river would not have an equal impact on the water quality of the Bay. This finding triggered a fundamental adjustment in the direction of the Bay clean-up effort. While continuing to work toward the 40-percent nutrient reduction goal set for the Bay in the 1987 Agreement, the states also agreed to develop specific strategies to meet nitrogen and phosphorus reduction targets set for each major tributary.

Beyond the nutrient targets, the 1987 Chesapeake Bay Agreement has numerous specific, often deadline-driven goals. The accomplishment and resultant effects of the compact are intended to stretch far into the future. Success in reaching the goals requires a substantial investment of time and money of every citizen in the watershed. It means providing incentives to promote proper environmental management practices. It means preventing nitrogen influx by upgrading waste containment and treatment. It means using less fertilizer on farm fields and building ponds, pits, and other protections against nutrient runoff. It means developing our landscape in more environmentally-sensitive patterns. It means levying heavy fines against scofflaws who continue to pollute. Basically, it means we need to change how we do things in the Chesapeake Bay region.

THE RESTORATION CAMPAIGN IS NOW TWO DECADES OLD

Two decades have passed since FPA began its research on the Chesapeake Bay and the multi-jurisdictional management effort was launched. Much has been accomplished, yet many more challenges lie ahead. What follows is a summary of the 12 key lessons learned by the leaders of the Bay clean-up effort. They are presented in the belief that some or all of these lessons may be transferable to the restoration efforts of other large-scale environmental management efforts.

1. Begin with comprehensive scientific studies that combine theory, detailed knowledge, monitoring, and modeling

The EPA Bay Program study presented the public and political leadership of the region with a solid, scientific foundation for decision-making. The information was comprehensive and multi-disciplinary. It identified clear linkages between land, water, and living resources. Since the release of the EPA report in 1983, highly sophisticated monitoring, modeling, and targeted research have continued to play a central role in the formulation of policy in the region. Admittedly, policy decisions are not always based on science. But, if made available in an easily-understandable format, the chances are greatly improved that science will be integrated into the policy decision-making process. On-going monitoring helps policy-makers to measure their progress while modeling offers a useful tool to test the monitoring findings into the future.

Transferability: Comprehensive coastal management programs must be based on the best available science and technology. This normally is found at research laboratories that are components of universities within the region. Our experience is that facilitated and meaningful exchange of information between the academic research and management communities is highly desirable. As we move toward whole-ecosystem programs at the cutting edge of science and policy, it is *absolutely* essential.

2. Involve the highest levels of leadership possible

There is strength in strong leadership and accountability. High-level and diverse leadership is key. The chairman of the Chesapeake Bay Commission, the governors of three states, the mayor of our nation's capital, and the administrator of the U.S. EPA provide prominent leadership as members of the "Chesapeake Executive Council." The Council meets annually to adopt new policies and revitalize the public commitment to the clean-up. Since the elected terms of these leaders vary, the Program is never without continuity as elected officials take and leave office. Long-term stability is provided by the infrastructure of the Program - the agreements, the staffs of the agencies involved, and the universities of the region.

Transferability: Jurisdictions vary, and coastal ecosystems embrace many of them both within and between nations. High-ranking officials in each jurisdiction should be visibly involved in a coastal management program. Only these officials have the authority to endorse and implement policies developed by the program infrastructure.

3. Embrace clear, strong, specific, comprehensive, and measurable goals

The Bay Agreements, and the high-level leaders who have signed them, provide an outstanding and enduring commitment to the restoration of the Bay ecosystem. A set of highly specific goals, many with deadlines, have been adopted that are unmatched nationwide. These goals cover a comprehensive array of issues including water quality, living resources, growth management, public information and education, research and monitoring, and public access. They include such specific goals as achieving a 40 percent reduction in nitrogen and phosphorus reaching the Bay by the year 2000 and eliminating fish blockages throughout the Bay's tributaries. Goals that are quantifiable make progress measurable and keep leaders accountable. The goals also last beyond the terms of the elected leaders and provide for continuity in the face of political change.

Transferability: The specific goals of the Chesapeake Bay Agreement may not necessarily be the best models for other coastal systems. However, regardless of the restoration challenge, the process of setting mutually agreed upon goals is important. The commitments should be realistic, but they should also challenge the programs to implement significant change. In addition, they should form the basis for periodic re-evaluation of progress (lesson 11).

4. Encourage the participation of a broad spectrum of participants

Ecosystems like the Chesapeake's are extraordinarily complex. A framework to manage it has had to involve a complex array of players representing all levels of government, the private sector, scientists, and citizens. Three governors, 40 members of Congress, hundreds of state legislators and local elected officials, 13 federal agencies, four interstate agencies, more than 700 citizen groups, and hundreds of businesses all play a role in our restoration effort. Together, these players bring immense political leadership and financial support to the Program.

The Bay Program has established more than 50 subcommittees and workgroups to ensure that all of these interests are represented and that the goals of the Program are ultimately achieved. Government employees work side-by-side with representatives of industry, local government, business, and the public at large. Strong communication strategies, frequent meetings, and an inclusive process have become the signature of the Chesapeake Bay Program.

Transferability: Strong communication links can enable many to participate at minimal expense. No matter how desirable broad-based involvement may be, a coastal program should not outgrow the ability of its participants to communicate. Advances in electronic mail capabilities and access to the Internet now make this a lesson many more can learn.

5. Provide incentives and methods for institutional cooperation

In the Bay region, the principle incentives are both money and public pressure. The active, financial involvement of EPA and other federal agencies has leveraged hundreds of millions of state and local dollars. Cost share and technical assistance programs have been established to address a range of management issues and have allowed for much of the restoration effort to be voluntary in nature. These incentives have been complemented by regulatory programs that ensure protection of key resources. An informed and active public has continued to provide positive pressures on elected officials to adopt strong policies and to maintain the federal and state funding for Bay clean-up initiatives.

Transferability: Over two-thirds of the world's population live close to a coastal sea or great lake. Behavioral change, such as the implementation of a phosphate detergent ban in the Chesapeake region, can have a huge multiplier effect. Effective coastal management cannot reside solely with governmental agencies and non-governmental organizations. In addition to formal announcements and newsletters, nations can take advantage of their education infrastructure to teach ecological principles and environmental stewardship to the next generation of citizens.

6. Inform and involve the public

The citizenry of the Bay region is remarkably knowledgeable. While there is a naturally high public sentiment toward saving the Bay, some of the credit should go to the Bay leaders' extensive educational and technical assistance efforts. Survey after survey reveals overwhelming public support for the restoration efforts and a growing understanding of concepts such as "watersheds" and "ecosystems." Citizens are concerned and speak their minds about what they are willing to do to restore the Chesapeake Bay. As in all situations, there is a wide diversity of opinion, but in the end most are supportive, at least at the base-line level. The management of the Bay involves complex political decisions. Special interests add pressure to these decisions. But in the end, an informed and vocal public has proven to be the policy-makers' greatest ally.

Transferability: A balanced approach can be a consequence of strong involvement at the level of the local jurisdiction. This is the basis of the new Tributary Strategies for the

Chesapeake Bay. In some cases, it may be possible to take advantage of strong local activities by integrating them into a larger coastal management program. In others, as for the Chesapeake, the larger program came first and is now forming the context for local program development.

7. Develop a balanced set of management tools

In a program that spans the gamut from land use policy to fisheries management to recreational boating to airborne toxics, a diversity of implementation tools has proven critical. We have found that when managing an ecosystem, no one approach works best in all ecological, political, and economic situations. The Bay Program involves three states and more than one thousand empowered local governments of markedly different orientations. As a result, management tools range from legislative mandates to voluntary efforts. Strong laws and regulations ensure effective pollution control and resource stewardship in the region while broad public education and technical assistance programs provide incentives. For the restoration of the Bay to work, the approaches have had to vary greatly within the watershed.

Transferability: No coastal management program will be successful if it exceeds available financial resources. When choices must be made, combating known sources of pollution must be the immediate goal. Most programs begin with point sources: improving wastewater treatment or regulating toxic discharges. However, the phosphate detergent ban taught us that changing peoples' behaviour has great amplification potential. Progress in pollution control will engender support of more difficult and costly activities such as habitat restoration and wetland mitigation.

8. Choose pollution prevention before restoration or mitigation

Despite significant public and private investments in control technologies and management practices to reduce pollution from discharge pipes and land runoff, the Chesapeake Bay continues to have nutrient and toxic problems. Once the pollution has entered the waterway or the habitat has been destroyed, it becomes technologically-complex and expensive to restore. In the Bay region, the prevention of pollution at its source has repeatedly proven to be the preferred approach. A ban on phosphate-containing laundry soaps instituted in the 1980s throughout the Bay watershed, for example, has resulted in nearly a 40 percent reduction in phosphorus entering the Chesapeake Bay from point sources. This represents one of the largest single reduction of nutrients achieved since the Bay Program's inception. Importantly, it was achieved at no cost to government and little, if any, cost to the consumer. The Bay waters are cleaner and clothes continue to be bright and stain-free.

Transferability: Unquestionably, the degradation and pollution of our environment has reached global scale. Regardless of the location, the full restoration of an ecosystem, once it is degraded, has proven complex, costly, and usually impossible. We must do more, and develop ways to stop or to at least reduce pollution at its source. Businesses, universities, governments, and citizens must join forces to identify new methods of preventing pollution. Once they are identified, they must be shared regionally and globally.

9. Test scientific theories and management approaches on a small scale

For the past two decades, a number of scientific theories and pollution control technologies were comprehensively studied in smaller watersheds within the Bay ecosystem. The effectiveness of various point and nonpoint source controls and approaches to public involvement were evaluated. In the Bay region, testing research methodologies and pollution control strategies on a smaller scale, using demonstration or pilot projects, has led to increased success when these techniques have been applied more broadly. These demonstration projects have helped to develop public confidence, attract supportive dollars, and build the confidence of political leaders.

Transferability: In many cases, small scale project testing can be melded with local jurisdiction program development. This provides for the development of partnerships and encourages more participants to become vested in the demonstration project.

10. Focus on integration of government agencies

Despite the existence of theory, practice, and tools that support the implementation of watershed-wide management, there remain practical obstacles to implementing the concept. In the United States, the state natural resources agencies are often separate from the planning, budget, or water management departments. This dissection of responsibility often leads to difficulties in integrating management efforts that cross agency lines. As our knowledge of the inter-relationships and connectedness of land, water, and living resources grows, we periodically attempt to restructure our government agencies to better integrate the component parts.

Achieving proper integration has proved problematic. It challenges the boundaries of traditional resource management. It requires the cooperation of diverse players whose educational, philosophical, and professional orientations are often worlds apart. It involves the constant communication and collaboration of multiple agencies at numerous levels of government. It often crosses traditional areas of management, for example, forcing fisheries scientists to work with land planners, sewage treatment plant operators to coordinate with farmers, and so on.

Transferability: Our lesson in integration is equivalent to "harmonization" being practised by many coastal programs, including those of the North Sea, Baltic Sea, and Inland Sea of Japan. Harmonization across agencies depends on the nature of governmental structure. And, if we could broaden this lesson, we strongly recommend that a coastal program provide for the integration of management, science, and citizen stewardship as a critical first step.

11. Conduct regular reassessments of goals and progress

A cornerstone of the Chesapeake Bay Program has been a constant commitment to reassess our goals, monitor the trends, and measure our progress. The health and vitality of the living resources serve as an important indicator of our success. In addition, routine water quality monitoring and futuristic modeling helps us to track progress in achieving our goals and plot the course for the future. Periodically, these efforts reveal new information that, in turn, leads to improved ways of controlling pollution, managing fisheries, and restoring habitat. Sometimes this means a shifting of the course - a change in how we do things. Politically, these changes are never easy. We may have already informed the public that a problem was the result of a certain pesticide, only to later discover that it is caused by a nutrient instead. We have found that, regardless of the commitments that have been made in the past or the information that has been released, it is always better to be straight-forward with the findings. The public has generally demonstrated an ability to alter course if new knowledge dictates a revised approach. This dynamic approach to management has contributed to the integrity of the Program.

Transferability: Periodic assessments should be undertaken in the context of program goals, and they should engage the participation of the full range of stakeholders. It is equally important to maintain program flexibility which allows for, as a result of advances in research, changes in goals or the establishment of new ones.

12. Demonstrate and communicate results

The Bay Program was officially launched in 1983. Since that time, its efforts have held the line on nitrogen and have achieved a 20 percent reduction in phosphorus in the Chesapeake Bay. The outlook remains optimistic. We are, at the very least, stabilizing our pollution loads, and are beginning to see significant improvements in many of our rivers. We have seen demonstrable gains in the way we manage land, provide fish passage, restore sea grasses, manage fisheries across state lines, and ban the use of toxic chemicals known to have an impact on our ecosystem.

Measuring progress and publicizing results has proven key to sustaining leadership commitment and public support. Honesty, even when the findings are disheartening, is critical. The frequent and open sharing of information - whether good or bad - has been essential to maintaining the trust and commitment of the stakeholders involved.

Transferability: While it is easy to view any environmental clean-up project pessimistically, in the Chesapeake, we have made progress. Some of that progress is witnessed by declining nutrient loads in spite of a growing population in the watershed. Some is in the restoration of commercially-important resources like the striped bass. And some is in the increased environmental awareness on the part of our citizenry that many visitors to our region quickly observe. Many coastal programs were instituted in response to a crisis: toxics in marine mammals, red tides, oil spills, crashes in a fishery, to name a few. Continuing citizen stewardship depends on making progress in the absence of crisis.

CONCLUSION

For the past two decades, the Bay Program has gone through its own evolution. What began as a water quality-oriented program designed to address the decline of the Bay's living resources has grown to involve integrated management of land, air, water, and living resources including man. Management mechanisms employed by the Program factor in ecological, socio-economic, and cultural considerations as well.

This evolution from water to watershed has required all of us to constantly reassess how we manage the Program. As our concepts and knowledge evolve, so must our governance. We must constantly look for new and creative approaches to managing our resources, integrating and financing our programs, structuring our agencies, and soliciting our citizens' support.

The twelve lessons described above collectively constitute a framework for ecosystem management. While it is highly unlikely that the Chesapeake Bay model can be wholly transferred to another system, one central lesson stands out. In order to truly succeed, management strategies must be as comprehensive, interactive, and responsive as the ecosystem they are created to restore.

LAKE VICTORIA IN EAST AFRICA

Christopher Mbote Nyirabu, Executive Secretary, Lake Victoria Environment Management Project Secretariat, Tanzania

INTRODUCTION

Lake Victoria is a wide subject and has many issues some of which are of a general nature and others highly specific. For this reason my presentation will be an overview of major issues on Lake Victoria: Physical Description, biological and environmental issues, water pollution, fisheries, land use and wetland management, water hyacinth infestation, socio-economic and scientific benefits, management issues (laws and regulations governing the management of the Lake resources, and their enforcement), and measures being taken by the three riparian countries of Kenya, Tanzania and Uganda to rehabilitate the Lake and save it from further degradation, under the Lake Victoria Environment Management Project.

PHYSICAL DESCRIPTION OF THE LAKE

Lake Victoria is an international fresh water body and an important resource shared between Kenya, with 6%, Tanzania 51%, and Uganda 43% of the Lake's total surface area. The Lake has a total surface area of about 69,000 km^2 making it the second largest body of fresh water in the world, second only to Lake Superior in U.S.A. It has a shore line of about 3,460 km. It stretches for about 412 km from North to South between 0'30'N and 3°12S and 355 km from West to East between longitudes 31°37' and 34°53'. The Lake is relatively shallow with a maximum depth of 84 m and a mean depth of 40 m.

Origin of the Lake: The origin of the Lake is still a subject of scientific dispute. It seems, however, that the Lake is much more recent than the other Lakes of Tanganyika and Nyasa. It has been suggested that most likely, the Lake could have formed about 25,000 to 35,000 years ago. Recent evidence suggests that the Lake may have dried up completely between 10,000 and 14,000 years ago, and that many of the rivers which now flow east into it including Kagera are said to have flowed west, at least in the Miocene, Pliocene, and part of the Pleistocene eras (2 million years ago). It is further suggested that a more recent upthrust of the western side of the basin is said to have reversed these rivers, and caused the Lake to form and the rivers to flow eastward, into it.

The Lake Victoria Basin: The Lake Victoria Basin has an estimated area of 1 90,000 km^2, which is about 3 times larger than the surface area of the Lake itself. The Basin drains five countries, which include Kenya, Tanzania, Uganda, Burundi and Rwanda. However, Kenya, Tanzania and Uganda, are the largest owners of the Lake Basin in terms of land surface, with 154,850 km^2 (81.5%) of total Basin area, each with the following area: Tanzania 44%, Kenya 21.5%, Uganda 15.9%, Rwanda 11.4% and Burundi 7.2%.

Volume of Water: Due to the Lake's shallowness, it is estimated that it holds about $2,750^3$ billion cubic metres of water (Bootsma and Hecky, 1993) and Talling (1966) and Hecky and Bugenyi (1992) both of whom estimate the volume of the Lake Victoria waters to be about 2752 m^4. It is interesting to note that the volume of water in Lake

Victoria is only equal to 15 per cent of the volume of water of Lake Tanganyika even though the latter has less than half the surface area of Lake Victoria. Data available show that gross annual water impact into Lake Victoria is 148,000[5] MCM. Out of this, 125,000 MCM (85%) is direct rainfall into the Lake, while 23,000 MCM (15%) comes from 19 different river systems, flowing into the Lake.

BIOLOGICAL AND ENVIRONMENTAL ISSUES

Lake Victoria is facing very serious threats to its existence. The Lake ecosystem has undergone drastic changes in the past three or so decades. Massive blooms of algae dominated by the potentially toxic blue green type have developed. The distance at which a white disc is visible from the surface has declined from 5 metres in the 1930s to 1 metre or less in the 1990s. There is over fishing and oxygen depletion at lower depths of the Lake which threaten the artisanal fisheries and biodiversity. Water hyacinth has began, to choke important water ways and landings especially in Uganda. Scientists advance two main hypothesis for these changes. The first is that of the introduction in the Lake, of the Nile Perch as an exotic species, about 30 or so years ago. Secondly, nutrient inputs from nearby catchment. These problems which are threatening the existence of the Lake are caused by human activities. According to Forsberg C. "A large and growing population will result in increased nutrient transportation from the land to the Lake due to erosion, increased pollution from rural as well as urban non-point sources."

Table 1: Proportion of the country and Population of each country in the Lake Basin

Country	% of Country in the Lake Basin	Population of each Country in the Lake Basin	% of Population
Tanzania	8	5,368,942	25
Kenya	7	11,313,262	39
Uganda	12	6,445,320	40
Burundi	50	-	75
Rwanda	80	-	75

Water Quality

The Lake water is increasingly deteriorating in quality the causes of which are not adequately established and quantified. Some examples of manifestations of water quality deterioration are: an increase in algal productivity dominated by the blue green type and a two - to three fold decrease in transparency; oxygen deficiency which affects up to 50% of the Lake's bottom, high concentration of phosphorus in excess to that required to support algal growth, and concentration of nitrogen on the shallow water. There also no established water quality criteria, data collection network is inadequate, lack of information on the accumulation of micro-pollutants in the lake sediments and lack of information on the levels of residual agrochemicals from diffuse sources, pollutants from urban surface run-off.

The Lake water is faced with two types of pollution sources, point and non-point sources. The point sources of pollution are caused by different industries, settlements and urban centres. On the other hand non-point sources of pollution stem from population activities such as agriculture, livestock keeping, deforestation, biomass burning and others. Due to these and other nutrients, massive blooms of algae, dominated by toxic blue green variety, have developed in the Lake causing deoxygenation of the waters, increased sickness to people, animals and other living organisms using the Lake waters.

Industrial Pollution

Industrial wastes is one of the point sources of pollution of Lake Victoria waters, and consists of liquid wastes of agro-chemicals from industries used in the production of goods. Common polluting industries include breweries, fish processing, tanning, paper and soap making, sugar and coffee to name but only some.

Most of these industries have no treatment plants. Some, if not all, of these industries, use very old technology which have no waste treatment facilities. As a result of lack of adequate treatment facilities by industries in urban centres close to Lake Victoria, most of the agro-chemical wastes end up in the Lake in a raw form polluting the water.

Municipal/Domestic Waste

Domestic waste is a flux of nutrients from urban centres to a given body of water like Lake Victoria waters produced by urban and rural populations. The large population residing in the urban centres, in the shore of Lake Victoria which include Bukoba, Kisumu, Entebbe, Jinja, Mwanza, Musoma, Nansio and other minor settlements, produce a lot of liquid and solid wastes such as urine, faeces and all sorts of solid wastes. As most of these centres are located close to Lake Victoria shore, and because most of these centres lack or have inadequate sewerage and sanitation facilities, most of the domestic liquid wastes from these urban centres end up in Lake Victoria.

Agricultural Pollution

The kind of agriculture practised in the Lake Victoria Basin is another source of pollution of the Lake. There are two sources of agricultural pollution of the Lake, namely: (a) the Agro-chemical which include pesticides, herbicides and fungicides mostly used for crop protection and in small amounts, as disinfectants for weevils. (b) Organic and artificial fertilizers used on land is one cause of eutrophication of Lake Victoria through leaching of nutrients.

Agrochemicals in the Kenya and Tanzania Basin is mainly used on large scale estates such as coffee, tea, maize, and tobacco. The amount of agromechanicals and fertilizers used Kenya in the Lake Basin area show that in 1997, 16,300 tonnes, 1978 , 15,800 tonnes, fertilizers were used and in the same years 206 and 347 of persticides were used. In Tanzania, the use of agrochemicals and fertilizers within the Basin vary from year to year. However, a wide range of agrochemicals are used, which include ammonium phosphate, calcium Ammonia Nitrate, Triple super Phosphate and Urea. The amount used in tonnage are: 1984 (2,485),1985 (3,494), 1986 (4,967),1987 (2,249),1988 (3,867), 1989 (2,004), 1990 (3,863).

Table 2: Urban Centres in the Lake Victoria Basin, inhabitants and Nutrient flux to Lake Victoria from Domestic waste

Country/ Town	Total Pop. in the Lake Basin 1996	Urban Population 1996	Annual N. load (tonnes)	Annual P. load (tonnes)	Total Annual Pop. Growth (%)	Urban Annual Pop. Growth (%)
	23,127,524	1,923,061	7,693	1,923	3.5	5.9

Pollution by Livestock

Due to cultural, social and economic dimensions of livestock keeping in the three riparian countries, the number of livestock in the Lake Basin is very large. No figures were available from Kenya and Uganda of the number of livestock in the Lake Basin. However, in Tanzania data from the 1988 and 1994 Livestock Census show that there were 3,042,600 and 3,231,600, livestock units respectively in the Lake Basin alone. The increase in the number of livestock, has increased pressure on land required for grazing. Livestock keepers encroach on the forests and woodlands by felling down trees and clearing forests thereby making the land bare and therefore susceptible to soil erosion.

Deforestation

Again the large and growing population in the Lake Basin is responsible for deforestation. Pressure on forest resources has then increased as a result of increased population, due to the need for more agricultural land to grow crops, for grazing, poles and timber (for various uses e.g. construction, furniture), charcoal and fuel wood for domestic uses, and wood for curing tobacco and smoking fish. The problem is further compounded by wild fires and maninduced fires causing a decrease in forests and woodlands. It is estimated that wood supplies about 95 percent of the domestic energy requirement in Tanzania. The figure may not be very different in Uganda and Kenya. Furthermore, population pressure on land leads to communities moving into forests, game reserves, national parks, conservation areas and near the Lake beaches.

Biomass Burning

The burning of the biomass in the Lake Victoria Basin during the dry season, also affects the tropic state of the Lake. The burning of biomass which is quite common in the basin, is used by the communities for clearing of forests, savanna and wood lands to convert them into agricultural and pastoral lands. Many livestock keepers also use fire to stimulate rejuvenation of grass pastures and to clear grasslands from dry and unwanted vegetation. There are also man induced fires as well as wild fires. It is estimated that about 95 percent of the domestic energy requirements in Tanzania supplied by fuel wood, charcoal, agricultural residues and to some extent animal dung. It can be also be assumed that the same applies to Kenya and Uganda. As such emission produced during the burning of biomass is transported in the atmosphere and eventually reach the aquatic ecosystem of the Lake Victoria by wet or dry deposition.

Table 3: Showing Annual Nutrient Emission from burning of fuel wood in the Lake Victoria Basin Tanzania

Region	Population in 1996	Average Fuel wood consumption per capita (m^1)	Total Fuel wood consumption in (tonnes)	Emission of Nitrogen (tonnes)	Emission of phosphorus (tonnes)
Kagera	1,651,795	2.0	2,353,808	8,389,±2,574	553±210
Mara	1,229,714	0.8	700,937	2,498± 767	164± 63
Mwanza	2,487,433	1.3	2,303,985	8,212±2,519	452±205
TOTAL	5,368,942	1.4	5,385,730	19,099±5,860	1,259±478

Wetlands in the Lake Basin

According to Swedish International Development Agency Report (1 9 82) and the Lake Zone Regional Physical Plan (1982) the total area covered by wetlands in the Lake Basin of Tanzania is about 500 km^2. About 70% of this wetland area could be classified as seasonally flooded grassland marshes. In Kenya, it is estimated that there are about 470 km^2 of permanent wetlands and 650 km^2 of seasonal head water wetlands in principal rivers. There were no figures for Uganda, but there are many wetlands in Uganda such as that of River Nabajuzi, Kansanga, Nakayiba, Nakivubo, Kachindo wetlands and others.

Wetlands perform very useful functions not only in respect to the Lake Victoria basin, but to other areas of the riparian countries as well. Many lacustrine wetlands can and do intercept overland run off and therefore influence water quality by moderating the amount of nutrients, pollutants and sediment that enter the Lake. Traditionally, wetlands provide useful purposes such as fishing, hunting, salt making, ceramics and grazing, agriculture such as rice and sugar, vegetables, maize, sorghum, bananas and beans farming. In spite of the useful functions performed by wetlands, human activities pose a threat to the integrity of the wetland particularly in the Lake Basin.

Wetlands are polluted by domestic and industrial wastes and agrochemicals from industries and municipal wastes within the Lake Basin. There is also encroachment by people due to the shortage of land and by people who want virgin lands. Some wetlands have been affected by the introduction of illegally or otherwise, of alien species in them such as water hyacinth and nile perch.

Tanzania and Kenya like Uganda should formulate comprehensive policy on wetlands. Currently, some of the existing policies are conflicting as regards to wetlands management. For example in Tanzania the agricultural policy on irrigation favours wetland drainage while the water and the draft environment policy favours wise use of wetlands. These policies should be followed by the enactment of harmonized laws for the management and conservation/protection of wetlands by compelling compliance to these laws. On the other hand, Uganda has formulated a National Wetlands Policy based on the principles of: "no drainage, sustainable use, environmentally sound management, diversification of use of wetlands which is dependent upon Environment Impact Assessment."

Fishery in Lake Victoria

Most of the fish fauna of Lake Victoria, apart from those introduced recently, lived in the pre-Pleistocene west flowing rivers which flooded to form Lake Victoria. Recently, there has been a very rapid increase in fish species of over 500 in the Lake particularly among the cichlid haplochromine species flock which has been estimated to consist of over 300 endemic haplochromine species. This species diversity has made Lake Victoria a renowned world heritage spot of tremendous biological importance. Other major species are the tilapiines, Barbus, protopterus, morinyrus, Labeo, Gnathonemus, Rastrineobola, Symontis, Clarias and others, mostly non-cichlids.

Although Lake Victoria had a rich and multi species of fishery before 1960s, this composition has now greatly changed. The abundant haplochromine flock is in danger of disappearing. It is said that only pockets of some species can be seen in protected bays and inlets. The near disappearance or extinction of important fish species from Lake Victoria is due to the introduction of new species in the Lake in the 1950s, the Nile Perch in particular.

Until 1980s, the Nile Perch remained a very small proportion of the commercial catch, in fact, less than 5 percent. By 1990s the commercial catch of the Lake was now dominated by the Nile Perch, estimated to account for 60 percent. The remaining 40 percent was the Omena. The Haplochromines and other species have almost disappeared from the commercial catch. Apart from the introduction of new fish species into Lake Victoria, there has also been irrational or illegal use of destructive fishing methods, which include, among others, trawl nets, gillets with mesh size of less than 127 mm; beach seines; dagaa nets with less than 10 mm. mesh size as well as the use dynamite and insectsides like thiodine. There has also been over fishing in the Lake Victoria due to commercialisation of the fishing which has been made possible by the introduction of gill nets, trawl nets, beach seines and other methods.

Fish provides high value protein food, employment and income to many people. It is estimated that over 2,600 full time fishermen are engaged in the fishing activities using both traditional and modem methods. It is also estimated that about 500,000 people are formally or informally employed in fisheries related activities, and that about 25 million people within the Lake Victoria Basin benefit in one way or another from fishery. On the whole, Lake Victoria fish catches are estimated to be between 400,000 and 500,000 metric tonnes with

Tanzania landing about 40, Kenya 35 and Uganda 25 percent. The landed value for this catch is estimated to be between US $ 300 and US $ 400 million annually. Fish fillet export is also a major source of foreign exchange earning to the three riparian countries. Fish from Lake Victoria is now exported to the European Union, U.S.A., Japan and Israel.

The Invasion of Water Hyacinth

Lake Victoria has also been infested with Water Hyacinth (Eichhornia Crassipes), a flowering plant, which increases and spreads very rapidly. The weed is said to originate from the Amazonia in Brazil. In the riparian countries of Kenya, Tanzania and Uganda, it is said that the water hyacinth was being grown in some places as an ornamental plant since 1957. It appeared in Lake Naivasha between 1982 and 1983. In 1992, it was sighted on the Kenyan side of the Lake Victoria. In Tanzania it was first sighted in 1990 and in Uganda it was reported in 1988. The weed has spread rapidly in many parts of the Lake, although there is no data to show the actual area covered by the weed. Estimates of the area covered by the weed depends on who makes the estimates. The percentage sighted frequently is one percent (1%) of the Lake's surface area.

The weed increases through production of stolons, bearing daughter plants. In addition large quantities of long-lived seeds are produced. The weed quantity is known to double between 5 to 15 days under optimum temperatures of between 25 to 27.5C and is said to cease to grow at temperatures below 10°C or above 40°C. The weed flourishes well in rich waters with nutrients especially nitrogen and phosphorus, along shoreline, near urban centres/settlement along the Lake especially in rivers estuaries.

The weed is now chocking/blocking important water ways, ports such as Jinja, Kisumu and landing beaches. In addition, the large floating mats of the water hyacinth now interfere with commercial transportation services for people and goods, and blocks access to water supply. The weed also kills fish through deoxygenation of water and by reducing nutrients in sheltered bays which are breeding and nursery grounds for fish.

The Water Hyacinth can be and controlled by using several methods. The most known methods are the biological, mechanical, chemical and physical. The three riparian countries' governments have decided that three methods be used in controlling the weed by using harvesters; biological, using two types of weevil species for long term, and physical methods by using people to remove the weed where harvesters can not be used. However, the use of chemicals has not been ruled out. But, chemicals can only be used after a thorough and environmental impact assessment has been done proving that the chemicals used do not affect any living organism in the Lake.

SOCIO-ECONOMICS AND SCIENTIFIC BENEFITS OF THE LAKE

In recent years, the socio-economic aspects of the fisheries of the Lake have become very important. Fish provides high value protein food to many people within and without the Lake Basin. It also provides employment to an estimated number of fishermen totalling 2,600 who are using both modem and traditional methods. It is also estimated that about 500,000 people are formally or informally employed in fisheries related activities such as working in the fish processing industries, fishing, selling fish etc, and that about 25 million people within and without the basin benefit in one way or another from fishery related activities as well as from the many economic activities taking place within the Lake. The Lake fish catches are estimated to be between 400,000 and 500,000 metric tonnes with Tanzania, Kenya and Uganda estimated to land about 40, 35 and 25 respectively. The total landed estimated value for this catch is estimated to be between US $300 and $400 million annually. It is also estimated that the gross domestic product of the Lake catchment is in the order of US $3-4 billion annually.

MANAGEMENT ISSUES OF LAKE VICTORIA

Apart from the environmental problems facing Lake Victoria, there are also problems concerning management of the Lake which include inadequate finances for funding management activities of research, extension, monitoring and enforcement of laws and regulations. The current laws and regulations are inadequate, and the institutions responsible for enforcement are weak, there is lack of inadequate data and information collection among other things.

Financing the Lake's Management Activities

The environmental problems facing the Lake are also due to insufficient funding for the various activities which are important for environment and fisheries development and management. The sources of funding for these activities in the three riparian countries are mainly from budgetary allocations by the Ministries of Finance and occasionally grants from international donor agencies. These funds are, in most cases, are inadequate for financing the activities of the Lake due to the economic conditions facing the three riparian countries. Lake Victoria funding has to compete with other development, recurrent , social and political activities. When it comes to which activities should get low priority Lake Victoria management is likely to be the victim.

Laws and Regulations Governing the Lake

In each of the three riparian countries, there are laws/acts which regulate the management of waters, fisheries and other resources generally. There are no specific laws governing the management of Lake Victoria per see. In Tanzania for example there are several laws/acts of Parliament which prohibit the discharge of certain substances into sewers e.g. the Public Health (Sewage and Drainage) Ordinance. Recently prohibitions of water pollution have been included in several acts such as the National Urban Water Authority, the Central Water Board and the National Radiation Commission. The Water Utilization and Control Act establishes standards for water quality and effluent emissions. These acts are general and are not specific to Lake Victoria. Apart from being general, existing legislations are sectoral, outdated and not harmonized.

These sectoral laws/acts should be reviewed, updated harmonized and strengthened to concerns of conserving Lake Victoria resources. What is now required is, for the three riparian countries, to have a common policy which can be translated into law in each country and be enforced at national levels. Perhaps it is high time the three riparian countries considered establishing an institutional mechanism for the management of the Lake Victoria resources per se.

In addition, management of the Lake Victoria's resources has institutional weaknesses. Institutions which are responsible for its management are sectoral and with little co-ordination. There is no single central co-ordinating system for better and efficient management of the Lake resources, in all the three riparian countries.

Such uncoordinated institutional arrangement does not facilitate inter disciplinary approach which is necessary for the proper management of the Lake, since it leads to a lot of waste and duplication of efforts.

One other hand weakness in the management of the Lake is lack of involving and making the community to participate in the environmental conservation of the Lake. There is no evidence to show that the community in the Lake Basin has been involved in conserving the lake's environment. Under such circumstances it is difficult to implement successfully environmental conservation and management policies and programmes on the Lake without involving those who are responsible, for degrading it, in mitigating against the problems they have caused.

In the extension services there is lack of co-ordination between the extension services and research institutions in the natural resources sector, in the individual countries and in the region as a whole. Furthermore, extension services lack adequate and essential equipments to facilitate carrying out their work. In Kenya and Tanzania extension officers also act as law enforcement, while in Uganda there is a separate division which is responsible for law enforcement, separating the two roles. These enforcement officers have powers to arrest, confiscate equipment and appliances used to commit an act against, say fishing. However, due to the outdated nature of most laws concerning the management of natural resources including those of Lake Victoria, the penalties provided for under these acts are too light to act as effective deterrents.

LAKE VICTORIA ENVIRONMENT MANAGEMENT PROJECT

Rehabilitation of Lake Victoria

By 1994 the Governments of the three riparian countries had realised the extent of degradation of the Lake environment through increased agricultural and urban run-offs, discharge of domestic and industrial waste, and the present level of exploitation of the fisheries resources, etc. decided that some action must be taken, and taken urgently. As a result, in August 1994 the three riparian countries initiated what is now popularly known as the Lake Victoria Environment Management Project with the aim of rehabilitating the Lake ecosystem for the benefit of the populations of the riparian countries and the international communities. This is a five (5) year project which has the following major objectives: (a) to maximize the sustainable benefits to riparian communities by using the resources within the basin to generate food, employment and income, supply of safe water, and sustain a disease free environment. (b) To conserve biodiversity and genetic resources for the benefit of the riparian communities and the global community. (c) To harmonize national programs in order to achieve maximum extent, the reversal of increasing environmental degradation.

The LVEMP, which is the first phase of a longer term program is being funded by the World Bank through the International Development Association, and the Global Environment Facility. The first phase, will mainly be used for data/information collection in order to improve the management of the Lake Victoria ecosystem.

The project consists of two broad sets of activities. One set, designed to address specific environmental threats to Lake, will be carried out in a series of 14 selected pilot zones. These pilot zones will deal with the development of ground water resources, reduction of sediments and nutrient flow, especially, phosphorus, reduction of faecal coliform and municipal nutrient output into the Lake; regulating industrial effluent; defining current contamination of fish; stabilization of the catch of Nile Perch as well as increasing the catch of the indigenous species; increase incomes of local fisher fold; and reduce and control water hyacinth. Another set, intended to improve information on the Lake and build capacity for effective management, is to be carried out on a lake-wide basis. The lake-wide activities will assess and measure sources of nutrients causing eutrophication; fisheries-trophic state integrations; model and monitor lake circulation; define and measure the contaminant threat; harmonize regulations and legislations; monitor recovery and impact; as well as build institutional capacity.

Fisheries Management

Fisheries management is intended to improve fisheries extension services in order to enforce the various fisheries Acts in the three riparian countries effectively, train fisheries officers and fisher folk. Enforcement will include prohibition of illegal fishing gear, prevention of gear theft, and illegal entry into fishing. Extension services would be strengthened to allow the project staff to introduce new fishing techniques, small scale aquaculture, promote micro projects and assist in overall monitoring of fisheries in the Lake. It will also help to introduce post-harvest loses by improving handling and processing and finally data collection will be strengthened and harmonized. As part of this initiative, extension officers will be given equipments and facilities.

Fish Levy Trust

A Fisheries Levy Trust will be created. The aim of the Levy is to establish a system of collecting taxes/levies from fishing activities to support the Lake's fisheries development and ecosystem management. Under aquaculture, the project will deal with domestication of indigenous fish species of high nutritional value including restoration of the several endangered fish species. The focus will be on the 12 high prized indigenous spacious species including Oreochromis esculents. Socio-economic studies will also be undertaken on small scale, fishing and fish commodity systems as well as provide information on current fishery distribution patterns, community involvement from harvesting to marketing. Community activities which contribute to environmental degradation will be documented. The study will also show the contribution of fishery to the national economies of each of the riparian country.

Management and control of Water Hyacinth

The aim of this program is to establish a sustainable long-term capacity for sustaining control of the water hyacinth. There are several methods of controlling the weed; namely, mechanical, physical, biological and chemical. The program will rely on mechanical biological and physical methods. The mechanical method is the use of a harvester. It has been used in Uganda for the last two or so years and seems to be successful. The biological method will make use of two weevil species which have been used and found to be very effective world wide. They have already been imported by the three riparian countries, and are now being reared and multiplied. These weevil species are chevroned water hyacinth weevil (enochetina bruchii Hystache) and the water hyacinth weevil (Neochetina eichorniae Warner).

The Water Quality and Ecosystem Management component will provide information on the characteristics of the waters of the Lake such as changes in limnology, model as well as predict their short and long term changes, quantitative information on nutrient loading and recycling, sources and mechanics of eutrophication and pollution and their effect on Lake productivity, phytoplankton communities and their composition, algal blooms and their dynamics, lake zooplankton, microbes, benethic flora and fauna, lake flies and their roles, trophic inter-relationship, and lake palae limnology.

There is also management of eutrophication. Two studies will be involved - sedimentation and hydraulic conditions in Lake Victoria as well as construction of a model of water circulation and quality in the Lake.

The Industrial and Municipal Waste Management

The program aims at improving the management of industrial and municipal effluent, and assessing the contribution of urban run off to lake pollution in order to design appropriate alleviation measures. An inventory and classifications of all factories and industries in the Basin will be determined. Treatment of effluent before discharge would be assessed and its dilution and dispersion levels in the receiving water bodies, quantify pollution and nutrient flows from urban run off, identify and characterize pollution hot sports, formulate effluent discharge standard guidelines, carry out a public awareness campaign as well as initiate pilot treatment, projects in selected municipalities and industries. The pilot industrial effluent treatment would create wetlands to test tertiary treatment through filtration of industrial waste from various industries in the three countries implementing this program.

Land Use and Wetland Management

This program consists of two components, namely Management of Pollution Loading, and Buffering capacity of wetlands with four pilot projects: These pilot projects are: Assessment of the Role of Agrochemicals in Pollution, integrated soil and water conservation, sustainable use of Wetlands Products, and Afforestation. The pollution loading project will establish a water quality monitoring network throughout the Basin, assess the effects of changes in land use planning on pollution loads in Lake and develop policies and programs to control non-point source pollution. The second project will study the buffering processes and capacity of Lake Victoria Wetlands and devise a proper strategy of managing them.

CONCLUSION

Lake Victoria is a critical resource not only to the communities of the three riparian countries but also to the international community in general, economically, biologically as well as scientifically. The Lake supports a large community within the basin. It is home to many living organisms. It provides opportunities for various biological and scientific studies to scientists in fisheries, limnology, eutrophication, pollution and others.

The three riparian countries with the assistance of the World Bank/IDA and the Global Environment Facility have initiated a rehabilitation program for the Lake. However, taking into account the state of the Lake's level of degradation, I am tempted to assume that the three riparian countries cannot afford to rehabilitate the Lake and bring it to a condition in which it were 30 - 40 years ago.

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EUTROPHICATION, HABITAT DYNAMICS AND TROPHIC FEEDBACKS: UNDERSTANDING AND MANAGING COASTAL ECOSYSTEMS

W. M. Kemp, Professor[1] *& W. R. Boynton, Professor*[2],
University of Maryland Center for Environmental Sciences,
[1] *Horn Point Laboratory, P.O. Box 775, Cambridge, Maryland 21613, USA*
[2] *Chesapeake Biological Lab, P.O. Box 38, Solomons, Maryland 20688, USA*

Background and Introduction

As a consequence of natural hydrologic, meteorological and oceanographic processes, ecosystems at the land-sea interface tend to be focal points for delivery of water, sediments, nutrients, and organic matter derived from adjacent environments. This natural fertilization provides the life-blood which makes estuaries and other coastal ecosystems among the world's most highly productive biomes (Costanza et al. 1995). Inputs of these materials from watershed, atmosphere and ocean to coastal environments vary significantly across a wide spectrum of scales (days-to-decades), with fundamentally different variance spectra depending on the source. Coastal ecosystems are among the most heavily fertilized environments in the biosphere (LMER Coord. Comm.), and their associated populations and processes are highly responsive to variations in inputs and forces (Boynton and Kemp 1997). Overlain on the background variations of nutrient inputs to estuaries are global-scale eutrophication trends of increasing fertilization (Nixon 1995), arising in part from the demographic trends whereby human populations continue to be concentrated in coastal regions. Many detrimental ecological effects of eutrophication have been well documented; however, responses to over-fertilization often involve complex non-linear interactions, which are not well understood.

Chesapeake Bay Ecosystem. Here, we discuss the responses of coastal ecosystems to eutrophication in terms of changes in extent and structure of habitats and mitigating effects of ecological feedback processes. We draw largely from our experience in the study of Chesapeake Bay, which is a large estuarine ecosystem on the Atlantic coast of North America. This partially stratified estuary is approximately 300 km long and 3-30 km wide, with a drainage basin of 19,000 km^2 and a ratio of watershed-to-estuary areas of 17. Although the maximum depth of the estuary is some 60 m, its mean depth is only 9 m, with some 65% of its area less than that the mean. The Bay has numerous tributary estuaries, which have a range of differing sizes, shapes and circulation patterns. Chesapeake Bay is extremely productive, with annual mean rates of primary production between 400 and 600 g C m^{-2} y^{-1}, and total fish harvest of 2 g fw m^{-2} y^{-1}. In fact, compared with other coastal ecosystems worldwide, this estuary and its tributaries have among the highest rates of primary production per unit nutrient loading (Fig. 1a) and the highest fish yield per unit primary production (Fig. 1b). On the other hand, detrimental effects of eutrophication have been evident for the last two decades in Chesapeake Bay and its tributary ecosystems despite the fact that nutrient loading rates in these ecosystems are modest compared to other estuaries. Hence, the mechanisms which contribute to the Bay's high productivity may also be responsible for its relative sensitivity to eutrophication effects.

Nutrient Dynamics in Chesapeake Bay. Nutrients enter estuaries such as Chesapeake Bay through a variety of pathways, including diffuse (rivers, streams, groundwater) and point (sewage and industrial effluents) sources, and atmospheric deposition. Diffuse sources constitute 60 % of the total nitrogen (N) and phosphorus (P) loadings to the Bay, with the Susquehanna River delivering almost two-thirds of the total diffuse nutrient loading (Boynton et al. 1995). Interannual variations in river flow and associated nutrient and organic carbon (C) loading are relatively large, although secular trends of increasing N and decreasing C have been evident over the last fifteen years. Point sources deliver one-third or less of the N and P inputs to the Bay. Atmospheric deposition is another major source of N inputs to the Bay accounting for some 12-20% of the loading to the estuary's water surface (Boynton et al. 1995), with rainwater pH declining by 1.5 units in the decade of the 1970's (Ford and Correll, 1982). The major sinks for N are sediment burial (35%), transport to the ocean (30%) and denitrification (26%), with fisheries yield resulting in another 9% of the total removal of N from the Bay; in contrast, sediment burial accounts for the vast majority of all P losses (Boynton et al. 1995). It is remarkable that such a large fraction of the N entering the estuary is removed via trophic pathways to fish harvest.

Results and Discussions

Scaling Ecological Processes to Estuary Dimensions. In recent years ecologists have become acutely aware that measurements in natural and experimental systems vary with the temporal and spatial scales of observation, and that the behaviour of organisms and the structures of communities and ecosystems appear to vary also with scale. To an unquantified extent, the characteristics which we attribute to ecosystems are a function of the physical dimensions of the system and the scales of our observations. We are interested developing scaling principles for comparing observations among systems and subsystems to deepen our understanding of fundamental estuarine processes and to facilitate application of practical lessons learned from one scientific investigations in one system to address similar problems (e.g., eutrophication) in other coastal ecosystems.

Here we illustrate the importance of considering residence time and water depth as a key temporal and spatial scales for analysis of coastal ecosystems. Water residence time (T_r), provides a scaling variable which can be related to time-scales biological processes, fixed by physiological constraints. Phytoplankton biomass accumulation is directly related to nutrient delivery rate for many different estuaries with relatively long residence time. However, when T_r is short (relative to algal growth), phytoplankton biomass can be inversely related to river flow (Hagy 1996). Rates of benthic N recycling are directly related (with a seasonal time-lag) to N loading rates. However, there are slightly different relations for each of five estuarine tributaries of the Bay, with the ratio of N recycling per unit N loading varying from 1 to 3 and the ratio inversely related to water depth. A similar relation appears for data from different experimental ecosystems; however, the depth effect was more acute because of additional effects on light attenuation by mesocosm walls. It is critical that scaling relationships such as these be considered when extrapolating results obtained from experimental ecosystems to conditions in the natural environment. For example, recent experiments from mesocosms of differing depth (Fig. 2) revealed that volumetric rates of photosynthesis (PS) scaled inversely with depth in spring due to the prevalence of light limitation, while areal rates scaled directly with depth during summer when rates were limited by nutrient availability (Petersen et al. 1997). In spring, other ecological processes including nutrient uptake rates and zooplankton growth and abundance appear to follow these patterns of PS scaling (Fig. 2). Although it appears that for all four data sets a single relation could be fit to observations from mesocosms and natural environment, attempts to extrapolate from mesocosm data provide poor predictions for natural estuaries.

Coastal Eutrophication and Habitat Loss. As a consequences of coastal eutrophication habitat for demersal and benthic is lost through two important mechanisms: oxygen depletion from bottom waters; declining seagrass populations. These eutrophication effects, which represent shifts from one toward another stable state (e.g., Scheffer 1989) are global in their scope.

Reports of seasonal depletion of oxygen (O_2) from bottom waters of Chesapeake Bay go back to the early 1930's. Each year natural processes contribute to springtime strengthening of density stratification (which isolated the bottom waters from potential atmospheric replenishment of O_2) and deposition of the vernal algal bloom (Kemp et al. 1992). However, despite considerable interannual variation in bottom water O_2 conditions, it appears that there has been a secular increase in the spatial and temporal extent of hypoxic ($O_2 < 2$ mg/l) waters since the 1950's (Officer et al. 1984). Year to year variations in river flow lead to changes in two critical factors contributing to O_2 depletion: 1) buoyancy (associated with freshwater), which increases the strength of stratification, separating bottom waters from atmospheric sources of replenishment; 2) nutrients, which support algal growth, sinking and decay (and microbial O_2 consumption). In the mid 1980's the relation between volume of summer-time hypoxic water and river flow appears to have undergone a dramatic shift (Boicourt 1992). This shift is possibly related to a threshold at which hypoxic water starts to creep onto vast shoal areas of the Bay, affecting a range of biogeochemical processes, such as nitrification-denitrification, which have provided a feedback control on eutrophication (Kemp et al. 1990). It appears that small changes in nutrient delivery from year to year can lead to significant changes (3-5 weeks) in the timing of incipient hypoxic condition, which may have serious detrimental consequences for biogeochemical processes as well as for growth and survival of benthic animals.

The seagrass populations of Chesapeake Bay underwent a dramatic decline in abundance starting in the early 1960's, coincident with major increases in nutrient loading and algal biomass and decreases in water clarity (Orth and Moore 1983). Although the decline of seagrasses was a bay wide phenomenon, it started in the more eutrophic regions (e.g., the upper Bay and western tributaries) and spread over the next decade to other areas of the estuary (Kemp et al. 1983). Ecosystem simulation models have been used to support and analyze inferences from field and laboratory studies--that nutrient enrichment was the primary cause (among others including increased suspended sediments and runoff of agricultural herbicides) of the seagrass losses (Kemp et al. 1995, Madden and Kemp 1996). Seagrass communities in this and other coastal systems provide important habitat for fish, invertebrates and waterfowl. Field observations indicate significantly higher abundance and diversity of fish and invertebrates in vegetated versus unvegetated shoal habitats (Lubbers et al. 1992), and fluctuations in valuable waterfowl populations are highly correlated with changes in seagrass abundance over the last several decades (Kemp et al. 1984). Based on statistical analyses of data from current and former seagrass sites, indices were established to monitor the quality of environmental conditions for plant growth and survival (Dennison et al. 1993). Simulation models have been used to improve these indices and to develop effective strategies for restoration of seagrass habitats in relation to nutrient reduction and transplanting efforts (Madden and Kemp 1996).

Organic Carbon Balance & Net Ecosystem Metabolism. As indicated above, inputs of inorganic nutrients are necessary to sustain fisheries harvest in coastal ecosystems. Inorganic nutrients are transformed into fish biomass through coupled primary and secondary production, with some nutrients being recycled, via respiration and other pathways of metabolic decomposition, back to inorganic forms. The net production of organic matter, over and above respiratory losses back to inorganic compounds, depends on nutrient inputs from external sources and sets constraints on the combined fluxes of export, burial and fish removal (Kemp et al. 1997). When density stratification is strong, photosynthesis and respiration are largely separated into upper and lower water layers, respectively. Hence, inputs of inorganic nutrients can lead to conditions of bottom O_2 depletion. Differences among adjacent regions in ecosystem structure, habitat quality and fisheries production may be directly related to de-coupling of photosynthesis (PS) and respiration (R). We argue that the partitioning and net balance for metabolic processes (NEM = PS - R) provide useful indices of the health and productivity of coastal ecosystems (Kemp et al. 1997). The integrated NEM of coastal ecosystems appears to be directly related to the ratio of inorganic: organic nutrient inputs, suggesting that eutrophication trends are driving coastal ecosystems toward higher NEM (Fig. 3). In systems where PS and R are not separated significantly in time or space, such increases in NEM could be channeled into increased fish production. The opposite trend appears to be occurring in Chesapeake Bay where stratification and regionalization lead to separation of PS and R.

Ecological Feedback Processes. There are many examples of non-linear, ecological feedback-processes lead to unexpected system responses to perturbations. The natural microbial process of denitrification (DN) removes approximately 25% of the N inputs to Chesapeake Bay under present conditions (Boynton et al. 1995). DN transforms the plant nutrient, nitrate, into nitrogen gas, which is unavailable for plant uptake. This value is low compared to the trend reported for other (non-stratified) estuaries, where denitrification removed some 50% of input N (Seitzinger 1988). In many estuaries, DN occurs primarily in sediments, directly coupled to nitrification, which is a process requiring O_2 to transform ammonium into nitrate. Hence, with eutrophication, the absence of O_2 inhibits nitrification, which in turn inhibits DN, which in turn allows concentrations of ammonium (a favored plant nutrient, typically limiting algal growth) to accumulate and support more growth and decomposition of algae which further reduces O_2 concentrations. The good news is that there is a similar self-enhancing effect when the process is reversed and eutrophication trends are mitigated. Prior to settlement by Europeans, the waters of Chesapeake Bay were filled with oyster populations which acquire food by filtering algae and other organic matter from the overlying water. When oysters and other benthic suspension-feeders are abundant, they may be capable of controlling algal biomass and reduce effects of eutrophication. As a result of human harvest and other factors, biomass of oysters has decreased 100-fold since the middle of the nineteenth century, and it has been speculated that a restored oyster population would retard negative effects of eutrophication (Newell 1988). Ecosystem simulations suggest a more complex situation, because oyster feeding also enhances nutrient recycling. If oysters were placed in raft cultures above relatively deep (>8 m) waters, increased suspension-feeding results in greater hypoxic conditions. However, model experiments (Fig. 4) indicate that a 10-fold increase in oyster biomass concentrated in shoals would effect similar improvements in bottom water O_2 conditions as would a major reduction (40%) in nutrient loading to the Bay (Kemp and Bartleson 1991).

Conclusions

It is concluded that coastal eutrophication is a widespread problem of global proportions, arising from effects of humans. In estuaries like Chesapeake Bay, diffuse watershed and atmospheric sources of nutrients dominate, while the surprising importance of fisheries harvest as a N sink emphasizes the relation between nutrient loading, net production and trophic interactions leading to fish. A key consequence of eutrophication is loss of animal habitat in shallow and deep regions through declines in seagrasses and bottom oxygen, respectively. Ecosystem experiments and comparative analyses of data from different estuaries and different regions in a single system offer robust approaches to deepen our understanding of ecological processes and relations to human perturbations and to transfer lesson learned in one system to problems in another. Such analyses, however, require careful consideration of how differences in scale affect extrapolation. Effective strategies for restoring habitats destroyed by eutrophication can enhancing natural feedback processes, which produce large improvements with small modifications.

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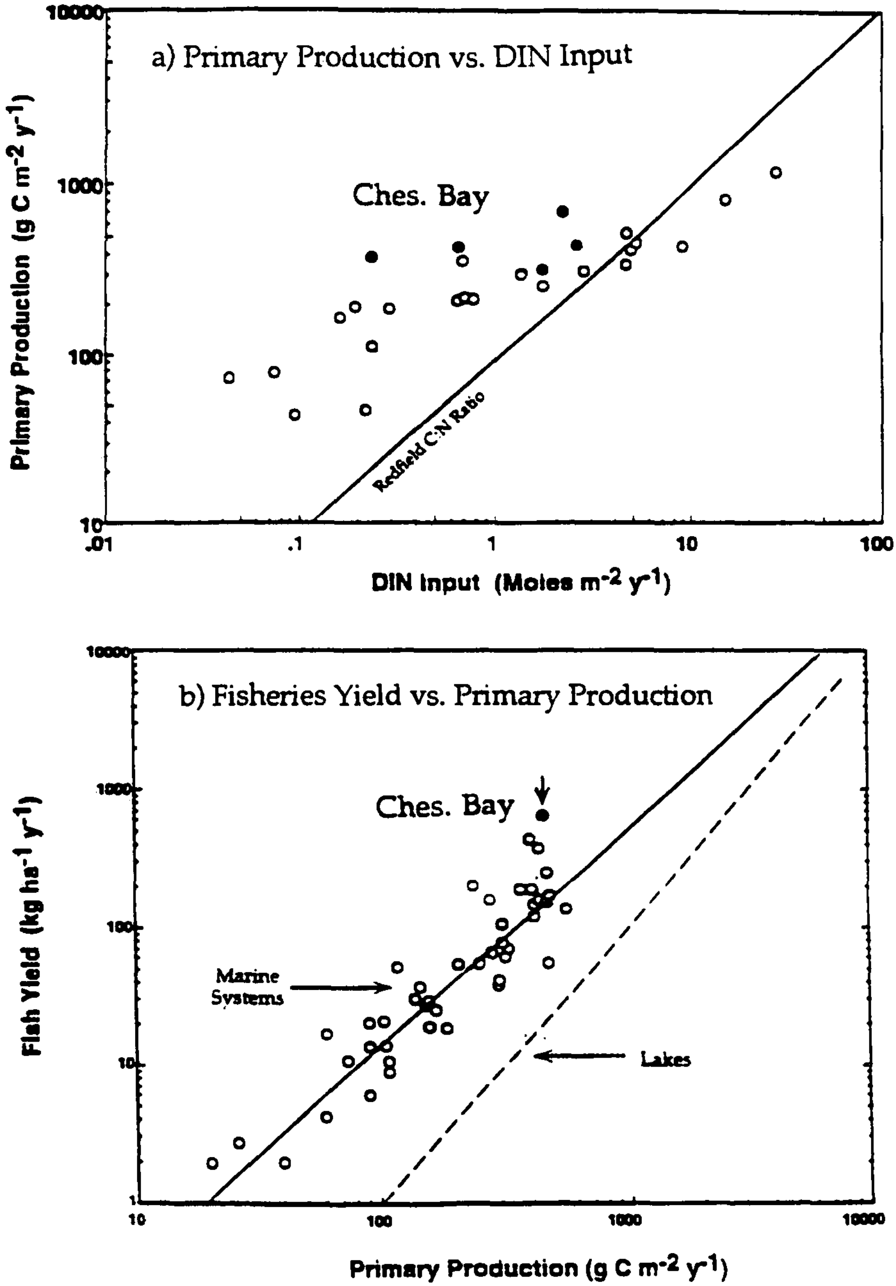


Fig. 1. Comparative analysis among coastal ecosystems relating (a) annual mean primary production (PP) to variations in nitrogen (DIN) loading & (b) annual mean fisheries yield to variations in PP. Redrawn from (a) Nixon (1992) and (b) Nixon (1988); filled circles for Cheapeake Bay values.

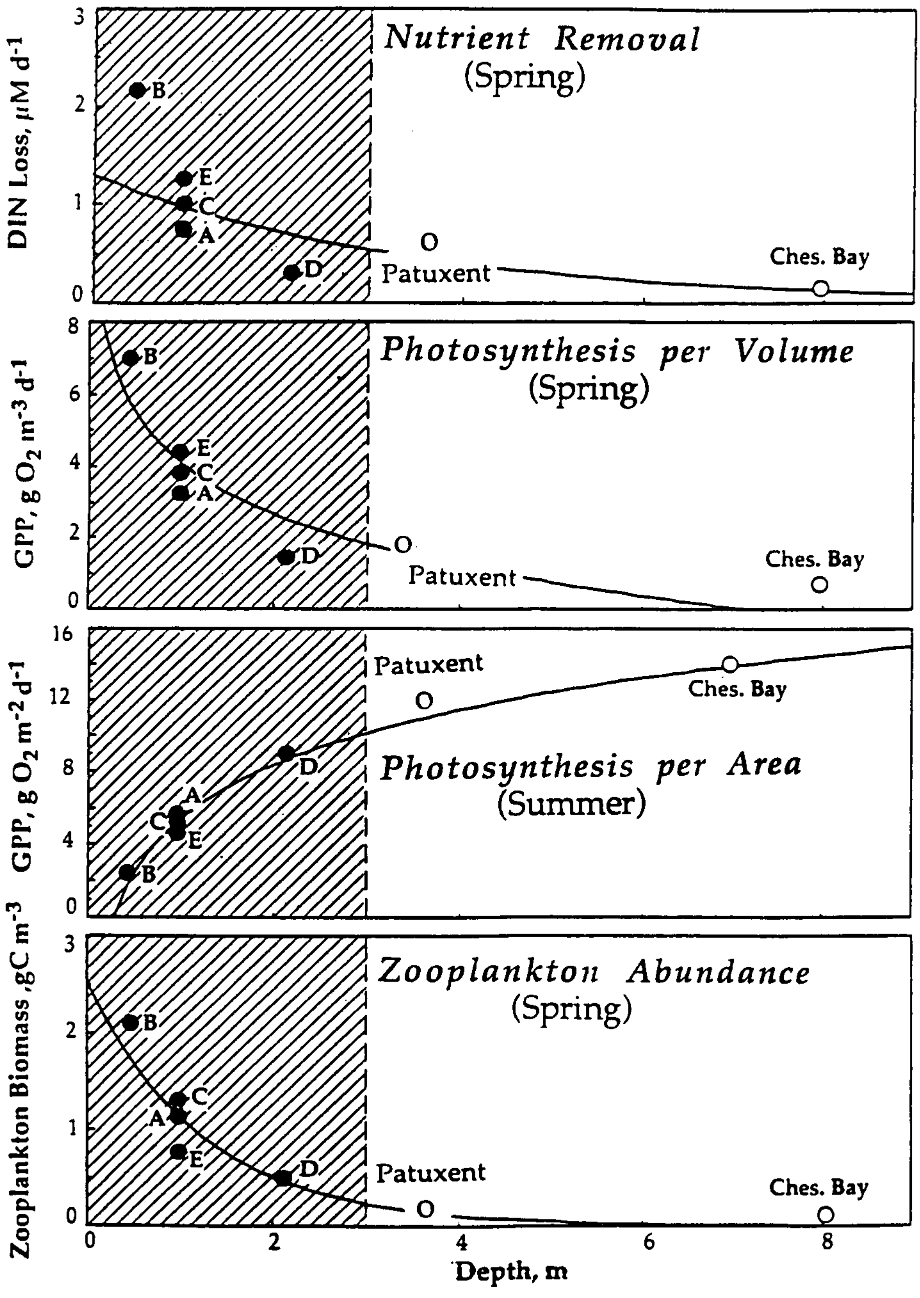


Fig. 2. Scaling properties & processes in experimental (filled circles) and natural (open circles) ecosystems versus water depth for: (a) nitrogen (DIN) uptake in spring; (b) photosynthesis (PS) per water volume in spring; (c) PS per area in summer; (d) zooplankton abundance in spring.

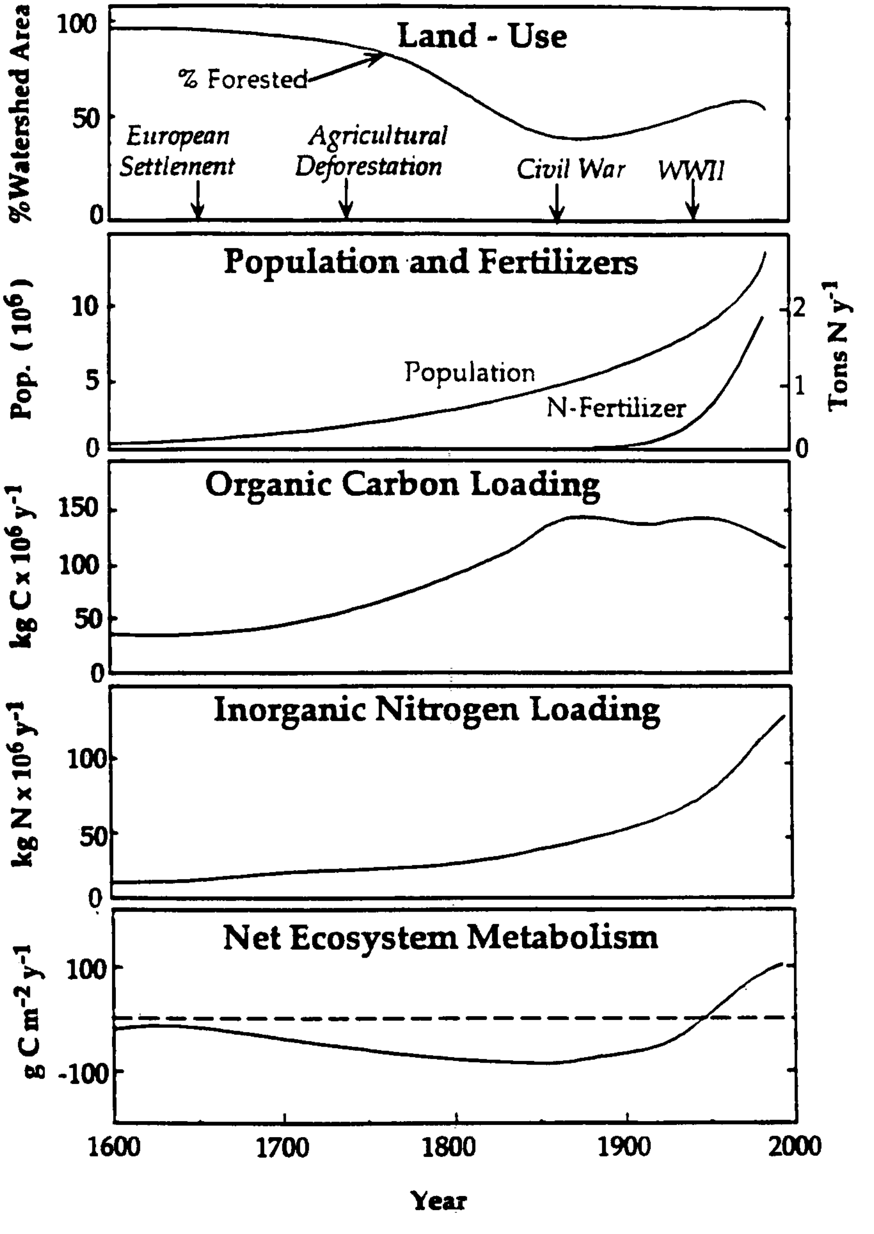


Fig. 3. Reconstructed history of: (a) land-use plus (b) human population and nitrogen fertilizer use in Chesapeake Bay watershed; (c, d) inputs of organic carbon and inorganic nitrogen to the estuary; and (e) net ecosystem metabolism (photosynthesis - respiration) of estuarine ecosystem.

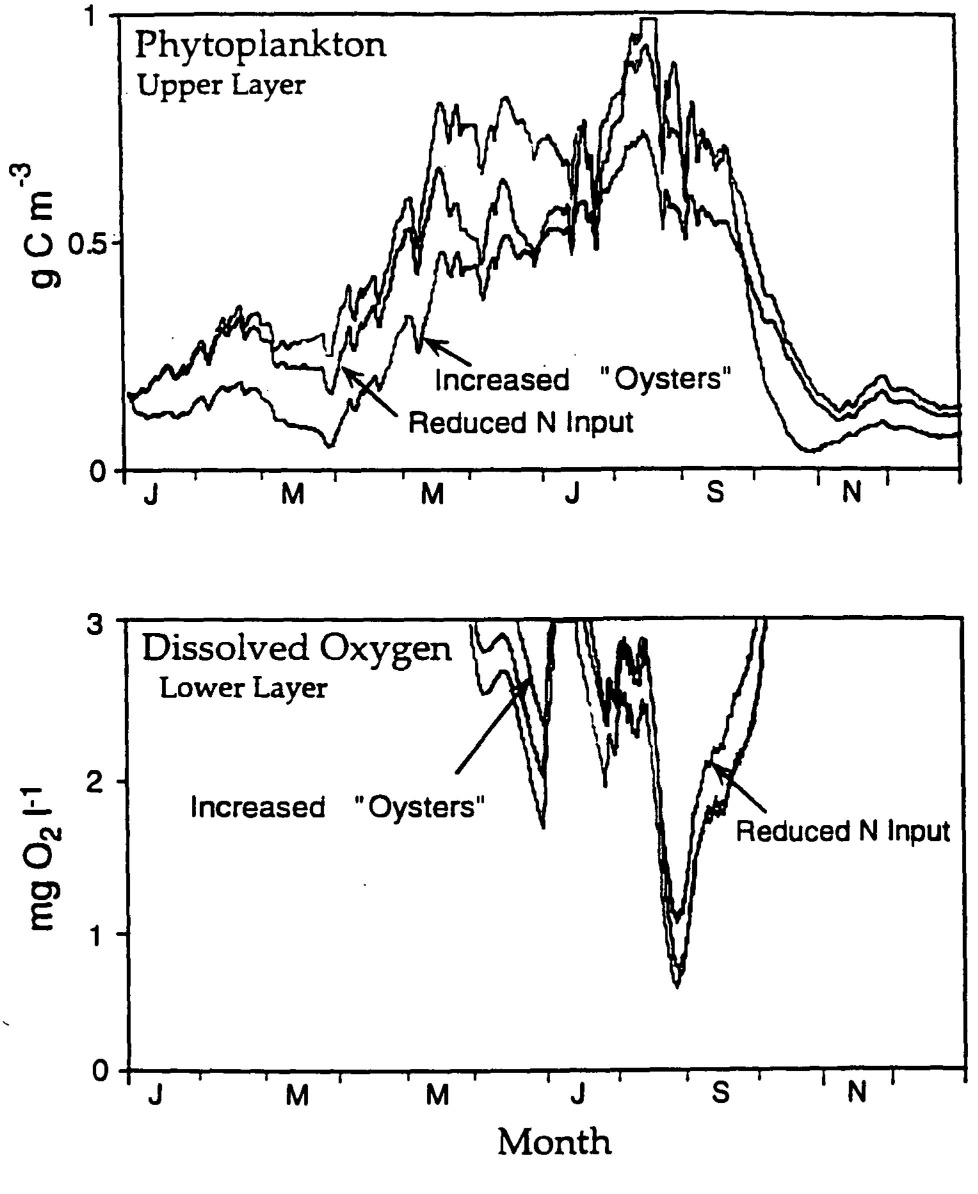


Fig. 4. Model simulations comparing effects of reducing nutrient loading to Chesapeake Bay by 40 % of present values versus restoring biomass of suspension-feeding oysters to former levels; ecosystem responses measured in terms of (a) phytoplankont abundance and (b) bottom layer dissolved oxygen.

MINIMIZING POLLUTANTS FROM LAND-BASED SOURCES

Ms Terttu Melvasalo, Director, Water Branch, UNEP, Kenya

1. Introduction

Two months ago, five years after the Rio Summit of the Earth, the United Nations General Assembly held a Special Session, Earth Summit + 5, to review the status of implementation of Agenda 21. The session concluded that there are issues which, In spite of some progress, still require urgent concrete action to achieve sustainable development called for in Agenda 21. Among the identified sectors of high priority, two deal with water: one freshwater and the other one oceans and seas. Freshwater problems were considered by the governments the highest priority, the most critical issue.

The message is clear. Mankind is facing some kind serious water problems in all regions of the world, and urgent action is needed. I believe these problems can be addressed by strengthening existing co-operation mechanisms on all levels. Governments, intergovernmental organizations, local authorities, industry, private sector, non-governmental organizations (NGOs) and the general public, must find a common vision on how to best protect and conserve for future generations the biggest, and ultimately most important, natural resource we have on the Planet Earth , water.

According to the work plan of the Secretary General of the United Nations, the Commission on Sustainable Development will meet in 1998 to discuss a common strategy on freshwater problems, and in 1999 on issues related to oceans and seas. This Stockholm Water Symposium is an important link as a strong means to create public awareness before these high-level debates. The Stockholm Water Prizes also are drawing the attention of the general public to water issues, and to the urgent need to protect water resources in all over the world.

2. Where are the problems?

In developing countries, with a dramatic increase of population and urban expansion, especially on coastal zones, freshwater issues should be a priority for action by governments. In fact, the efficient management of water resources should be a priority concern in West Asia, Africa, Asia and the Pacific. Protection of water resources from nutrients, organic pollutants, heavy metals, radioactive substances, acidification and contamination is also high on the agenda in Europe and North America.

More than 60% of the world's population lives within 100 kilometres of a coastline, and nearly all people live in a riverbasin. More than 3 billion people rely on coastal and marine habitats for food, building sites, transportation, recreation and waste disposal. Further more than 1.5 billion people depend on ground water to drink and more than 1 billion people still lack safe drinking water. There is concern about the intrusion of saltwater into freshwater supplies, about the equitable distribution of the benefits of water, the sources (it's fair share), and about the use of water among countries sharing water courses.

Region-based assessments of the state of coastal waters exist, or are being developed or updated, for many regional seas that serve as recipients of the discharges from big rivers, megacities, industries and other land-use activities, including agriculture. On the other hand, only a few of the internationally shared river basins have been assessed to the extent needed for establishment of realistic action plans and legally binding instruments for the rivers and their drainage areas, in order to protect the waters from land-based pollution and human misuse.

One good example of the needed holistic approach is UNEP's recently finalized and published Mekong River Basin Diagnostic Study. it deals not only with freshwater, but also with other environmental issues, including biodiversity, fisheries and human health, as well as with socio-economic, institutional and legal aspects of the issue. It is intended to facilitate preparation of the next step; that is, a Transboundary Diagnostic Analysis, proposed to be funded by the Global Environment Facility (GEF). Furthermore, a global assessment of existing international river basin agreements also is currently being undertaken by UNEP in order to analyze the success and weaknesses of the agreements.

The major pollutants in coastal waters that are discharged directly or indirectly via rivers or airborne are nutrients, chemicals, radioactive substances, oil etc. Each region has specific problems; thus, strategies to minimize pollution cannot be identical for all regions.

3. Is the integrated water management a solution?

Freshwater and sea water issues are linked together in terms of their environmental protection, including both quality and quantity aspects. Thus integrated management plans should consider the water resources within a single water management continuum from freshwater sources to the coastal waters and oceans. Effective practical solutions to water problems can only be recommended, if all relevant aspects are taken into account, including environmental, waste management, land-use, scientific, technical, institutional, legal, social, economic and political factors. This approach for dealing with water management comprises integrated watershed and river basin management, together with relevant coastal zone management.

In the regions comprising both river basins and marine areas, an integrated approach would work to reduce pollution from land-based activities, treating the whole catchment area as a one management continuum. Sometimes this, however, means a risk of conflict , if the basin and its associated coastal and sea areas are shared by two or more nations. Consequently there is a need for riparian countries of shared waters to reach agreement for the equitable sharing of the water-related benefits of such internationally shared water resources.

In addition to a number of shared regional seas, however, there are more than three hundred international river basins and numerous groundwater aquifers being shared by two or more nations. Nevertheless, very few international conventions and agreements are directed to the sustainable management and use of these freshwater resources.

In marine areas, regional seas and sub-regional sea areas, there are some examples of success stories. Through intergovernmental co-operation riparian countries have achieved effective implementation through agreements on how to protect their coastal and marine areas by performing pollution reduction measures within the catchment area. In some cases, even land-locked countries and airborne pollution have been included in the action programmes, an example being the Baltic Sea region.

4. What was agreed on global level in Washington 1995 - The Global Programme of Action, (GPA)

Delegates from 109 countries met in Washington D.C. in October - November 1 995 in an International Conference, organized by UNEP and hosted by the USA. They adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) and welcomed an offer from UNEP to co-ordinate and facilitate its implementation as the GPA secretariat. The Programme of Action, therefore, is designed to be a source of conceptual and practical guidance for national and/or regional authorities to devise and implement sustained actions to prevent, reduce, control and/or eliminate marine degradation from land-based activities. Effective implementation of this Programme of Action is a crucial step forward in the protection of the marine environment and its associated river basins and coastal watersheds, and also will promote the objectives and goals of sustainable development. Implementation of the programme is of the highest priorities and a big challenge for this and the next decades.

The task of UNEP, as GPA Secretariat, is to promote and facilitate the implementation of the Programme at a national, sub-regional, regional and global level. UNEP is also assisting the regions to get a realistic picture of the pollution loads from land-based activities, and to identify the need for priority actions to address problems.

While recognizing that states have a primary role in the implementation of this programme, and in close partnership with other UN, intergovernmental and regional organizations, UNEP is assisting regions to prepare reviews of land-based sources and activities, and their impacts, on the quality and uses of marine, coastal and associated freshwater environments. On the basis of these reviews, an assessment of the impacts of land-based activities on a global level will be completed by 1999.

The goal of these assessments is to assist countries and regions to identify and prioritize their main problems, and to agree on their programmes of action.

5. How to approach implementation of the GPA and who should take action ?

The effective implementation of the Programme of Action to reduce marine and freshwater pollution from land-based activities is possible only in close co-operation and partnership with relevant UN Agencies, international, governmental and nongovernmental organizations, environmental institutions, national and local governments, the academic sector, funding agencies and the private sector. One of the cornerstones of its implementation is strengthening national capabilities for protection

of the aquatic environment as a whole, and promotion of regional and sub-regional co-operation in the implementation of the Programme of Action.
Because the problems are different in different regions, it is crucial that elements of the regional strategies will be identified by the concerned governments, with special reference to recommended approaches by pollutant source categories. These categories include domestic wastewaters, industrial pollutants, agricultural pollutants , urban drainage, atmospheric fallout etc. In the effective implementation of the Programme of Action, both sectorwise and substancewise approaches are needed, especially with regard to preparation and implementation of agreements, laws and regulations to control production, discharges, and emissions of polluting substances and activities.

The General Assembly of the United Nations adopted Resolution 181/159 in December 1996 on the institutional arrangements for implementation of the Programme, GPA. This Resolution requests States to take action in the governing bodies of relevant Intergovernmental organizations and programmes to ensure their active role in implementation of the GPA.

In January 1997 the 19th UNEP Governing Council adopted a decision inviting the Sub-Committee on Oceans and Coastal Areas of the Advisory Committee on Co-ordination (ACC) to perform the function of a steering committee on technical co-operation and assistance for the Programme of Action. This Sub-Committee will work in close collaboration with the Sub-Committee on Water Resources and facilitate the regular review on the status of implementation of the Programme of Action.

6. Regional approach - proposal for practical solution

In practical terms the GPA is effectively implemented through the regional seas programmes. This means co-operation between UN Organizations, regional intergovernmental organizations, global and regional development banks, scientific institutions, industry, governments and local governments, NGOs, etc. Integrated coastal management is possible only through integrated water management, including consideration of rivers originating from land-locked countries.

In many regions the basis for action-oriented joint strategies to implement the joint programme, is existing conventions, protocols and action plans agreed within the framework of UNEP's Regional Seas Programme or other regional mechanisms, such as the ones for the Baltic Sea (HELCOM) and North-Atlantic (OSPAR). On a practical level, there are different options, such as broadening the mandate of the regional conventions to cover all uses of the concerned regional sea and its drainage area, including associated freshwater basins. Adoption of specific protocols and establishment of regional systems for clean technology co-operation are also possible tools. The Law of the Sea Convention offers a framework for many innovative and advanced concepts for implementation of the GPA on a regional level. An other new instrument is the Convention on the Law of the Non-Navigational Uses of International Watercourses, adopted in May 1997.

Transfer of advanced or clean technology, including sewage treatment, especially in megacities, and identification of new sources of funding are examples of requirements for effective regional implementation of the Programme of Action. Relevant linkages

between local, national and regional decision making also should be established including national and regional laws, regulations and management plans.
Because of differences between regions with regard to their natural resources, social, economic and cultural development, it is not possible to find a single model for the implementation of pollution reduction programmes. Thus different regions should adopt different strategies and institutional arrangements in order to achieve results leading to improvement of their water environment.

Examples of successful process will be discussed in detail during this symposium . Another good example is, how the riparian countries of the Mediterranean Sea succeeded last year through their Barcelona Convention mechanism to up-date the protocol on land-based pollution and action plan, to include the requirements of the Global Programme of Action. A similar process is under consideration in some other regional seas.

7. Information of Information - Clearing House of the GPA

The Global Programme of Action called for development of a Clearing-House mechanism. It should provide a referral system , through which decision makers at the national and regional level can be provided with access to current sources of information, practical experience and scientific and technical expertise, relevant for them in developing and implementing strategies to deal with the impacts of landbased activities.

The Clearing-House of the Programme consists of several basic elements:

a) Data directory - with components organized by source category. It contains information on current sources of information, practical experience and technical expertise.
b) Information delivery mechanisms - It allows decisionmakers to have ready access to the data directory and
c) Infrastructure - the institutional process for developing, organizing and maintaining the directory and delivery mechanisms.

The Clearing-House, which is currently under preparation, will be based on an effective network of international organizations, such as UNEP, FAO, WHO, IAEA, IOC, IMO, etc. Links to the private sector, industry and financing institutions are crucial for this information network. In the World Wide Web, access to the present information is available under UNEP's homepage.

The GPA identifies nine main source categories, including sewage, persistent organic pollutants, radioactive substances, heavy metals, oil, litter and nutrients.

UNGA resolution 181/159 on institutional arrangements for implementation of the GPA called on States to take action in the governing bodies of relevant intergovernmental organizations and programmes, so as to ensure these organizations and programmes take the lead in co-ordinating the development of the Clearing-House mechanism with respect to the following source categories.

	Source category	Responsibility
a)	Sewage	WHO
b)	Persistent organic pollutants	IPSMC, IPCS, IFCS
c)	Heavy metals	UNEP, IPSMC
d)	Radioactive substances	IAEA
e)	Nutrients	FAO
	Sediment mobilization	FAO
g)	Oils (hydrocarbons)	IMO
h)	Litter	IMO
i)	Physical alterations, including habitat modification and destruction of areas of concern	UNEP

Agricultural activities, aquaculture and sediment mobilization, and even tourism, are sectors considered in the framework of the GPA. Physical alterations and destruction of habitats also should be considered as a consequence of the increase of populations and economic activities in river basins and coastal areas. Some UN agencies have already considered the proposed responsibility of the organization and decided on action (e.g. WHO and IOC of UNESCO).

8. Final remarks

The oceans form a reservoir of water. The capacity of nature to distil] water as vapour into clouds is amazing. The rain is then spread over all the continents, providing a fantastic water purification megamechanism. Thus rain water, wherever it fails, is originally clean water. As we now know, anthropogenic activities can contaminate and pollute the rainwater even before it fails. Fortunately for us , the Nature has patience in cleaning the water polluted by us, and in keeping this huge megacleaning system functioning properly. Unfortunately for us we continue to pollute it.

In 1 972 twenty five years ago, 1 participated here in Stockholm in the forum of nongovernmental organizations and individuals, worried about the future of our Planet. In an open forum, we talked about global pollution problems, and even such sensitive questions as how to stop the increasing over population of the world. We also collected names for a new group called "Friends of the Earth". At the same time here in Stockholm, in the high level intergovernmental conference, the United Nations Environment Programme, UNEP, was established. Thus UNEP's Regional Seas Programme and its present Integrated Water Programme are children of those high level and, 1 must say, visionary decisions. In addition to establishment of UNEP in the Stockholm Conference in 1 972, the seven riparian countries of the Baltic Sea highlighted a need to establish their own joint regional strategy to protect their common sea area. They accepted the offer of the Finland to draft a convention, which the countries signed in 1974. The UNEP's Regional Seas Programme, and the Baltic Sea co-operation provide good examples of how countries with different ecological and political background can work together to find a solid solution to the minimization of land-based pollution.

The joint effort, Global Programme of Action, GPA, is an essential step forward in minimizing the pollution of the marine environment and its associated river basins and coastal watersheds. Implementation of the Programme of Action, should be our highest priorities and it is big challenge for this and the next decades, far to the next millennium.

POLICIES FOR OVERCOMING BARRIERS IN GOVERNANCE AND CITIZEN INVOLVEMENT

Nobuo Kumamoto, Professor of Law, Faculty of Law, Hokkaigakuen University, Sapporo, Japan

1. Water Pollution from Land-Based Activities

It is my pleasure to make this presentation as one of the plenary speeches at this joint conference. The topic which I am going to discuss is "Policies for Overcoming Barriers in Governance and Citizen Involvement", which covers a broad variety of aspects.

Water pollution from land-based activities is largely associated with urbanization, industrialization, agricultural practice, mining operations, construction works and so forth. Furthermore, major sources of pollution from various land-based activities include domestic sewage, etc. These land-based activities pollute the river and lake waters and eventually the sea, especially near coastal or enclosed sea areas.

2. Major Sources of Sea Water Pollution

On the other hand, major sources of sea water pollution today are observed in the release of oil, accidental chemical spills, the construction of bridges, airports, etc. Additional pollution sources include the land reclamation, the reclamation by drainage, the construction of flood control facilities, and fish hatcheries. Thus the sea water is easily polluted not only by land-based activities but also by marine-related activities as well. Sea water pollution from these types of activities have been seriously evident throughout the world. In particular, serious sea water pollution can be observed along the coastal zones or enclosed sea areas such as the Inland Sea of Japan, the Baltic Sea, the Chesapeake Bay, the Mediterranean Sea and the Black Sea. As most of you are aware, these are just a mere sampling of areas that have experienced this problem.

3. Integration of Policies

a. Integration of Policies through Legal Measures

Considering these causes of water pollution, we are clearly required to adopt appropriate policies to control the sources of water pollution. This can be achieved through legislation, regulations, or ordinances with penalties. Another alternative is through incentive measures such as subsidization, and tax exemptions. It can also be dealt with through education; that is providing information or techniques for preventive measures. These aforementioned efforts have become common in many countries.

b. Integration of Regulations and Incentive Measures.

The most important point for the policies of these preventive measures is to integrate different types of regulative and incentive policies, which, in turn, require us to integrate all possible elements relating to water pollution problems within a single legislation. This makes it possible to consider these elements in their natural state of coexistence.

c. Imposing Regulations and Providing Benefits

The point that I want to suggest here is that such legislation or ordinances should provide financial assistance to potential effected parties, whether they be citizens' groups or private sector businesses. This assistance would be offered in order to make it possible for them to adopt the technical measures enforced by laws and ordinances. Such a financial assistance can be illustrated in the form of low interest loans, subsidization, tax deductions or exemptions and other appropriate incentive measures. Similarly, the technical assistance can be introduced here to provide information on potential preventative measures that can be taken. This may include environmental education at various levels, or information on necessary facilities or mechanical devices. Integration in this sense means a general combination of all possible elements concerned for preventive or incentive measures.

d. Integration of Geographically Related Projects

Another example of the integration policies can be examined from a geographic perspective. Let's take a look at an example concerning the land-use planning along rivers and coastal zone protection planning in neighboring geographic areas. Land-use planning programs include the control or regulation of land-use for farming, preserving forest areas, and constructing industrial zones, which are located along rivers. On the other hand, coastal zone protection planning covers programs including various regulations for keeping the coastal sea water clean. These policies may cover an area where each directly relates to the land-use policies along the river and coastal sea. Thus, these policies should be effectively combined and enforced as one integrated policy.

4. Integration of Concerned Organizations

a. Cooperation on a Domestic Level

Another point related to integration is the cooperation among administrative authorities and other concerned groups such as fishery and labor unions, farmers' associations, fish hatchery and nursery unions, fish farms or other business associations. This is a key element in the governance of integrated management of sea and river water. Policies relating to water pollution in these organizations should aim toward a common goal, enforce common regulations and adopt appropriate incentives for achieving the goal. Cases of the Chesapeake Bay in the United States and the Inland Sea of Japan are two examples where the cooperation among concerned organizations is taking place.

b. Cooperation on an International Level

Cooperation is also strongly desired among these types of organizations on an international level as well. We have seen various examples of international cooperation in areas such as the Baltic Sea or the Black Sea. Although the integration of concerned policies on an international level can play an important role, we must also recognize that such efforts are not sufficient in some instances,

5. Integration of Contradicting Demands

a. Awareness of Members in Concerned Groups

Now let me describe the integration of contradicting demands among these organizations. The interests of the fishery unions may easily contradict the interests of the industry unions. The industry unions may sometimes refrain from taking part in the anti-reclaiming movement organized by citizens' groups because of their loyalty to the companies over the citizens' groups. The problem between these groups is often quite delicate. The cooperation between these groups, therefore depends on the awareness of the members of the union towards our environment. If their environmental awareness is strong and high, cooperation can be expected. Unfortunately, however, if this ideal solution can not be attained, compromise instead of cooperation must be used to settle conflicts among the groups.

b. Role of Environmental Education

Considering such situations, environmental education plays quite an important role in influencing the attitudes of these concerned organizations .

c. Integration Between Contradicting Demands

Another example of contradicting demands between two organizations can be seen in the relationships between the fishing unions and industry. The unions, needless to say, want to keep unpolluted sea water. Industry, on the other hand, requires land along the coast for the construction of factories or other facilities for manufacturing. This, of course, can create serious problems in the area. In this situation, the contradicting demands by the unions and industry should be appropriately integrated with one another according to designated legal procedures.

d. Introduction of the Due Process

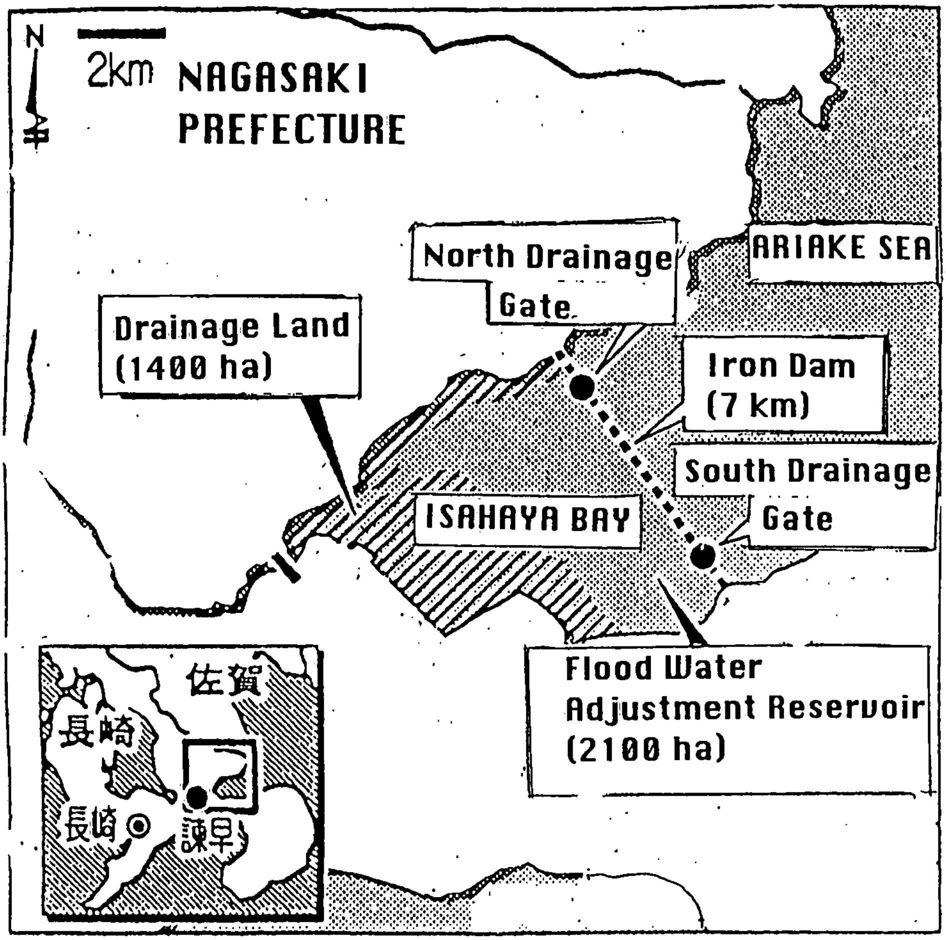
Due process, as a legal principle, should be involved in the standard procedures. In other words, this requires us to search and work towards the most appropriate means to resolve these contradicting demands according to certain legal processes. In this case, we must keep in mind that the interests of the unions or the industry should be reviewed carefully.

e. Contradiction Between Demands by Citizens' Groups

We may even find similar contradicting demands between different citizens' groups. This potential complexity of diverse interests can create a serious burden. For example, one citizens' group may insist on protecting the seashore while another citizens' group may plan to reclaim the seashore, in order to build houses on the reclaimed land. We can see similar cases in all parts of the world, I believe.

f. Isahaya Bay Reclamation by Drainage

Let's take for instance a recent Japanese reclamation case through drainage of the Isahaya Bay in Nagasaki Prefecture, Kyushu Island. The original drainage reclamation



(from Hokkaido Newspaper, 1997)

project was planned in 1952. This was created to enlarge the rice growing farmland to help cope with the food shortages experienced for a period after the second World War. This original project was , however, abolished because of an anti-reclamation movement organized by a fishermen's group. In 1985, it reappeared, though on a smaller scale. This time it was presented for the purpose of preventing a large scale flood in the area. As the picture indicates, the bay was cut off by an iron-made 7 km dam located in the Ariake Sea. As a result of the dam construction, 1400 ha of land was reclaimed from the sea. This land was converted for farming, while another 2100 ha of land will be used in case of emergency as a flood water adjustment reservoir. In this case a citizens' group started an anti-reclamation movement to protect the natural seashore of the bay. This movement was also supported by quite a large number of other citizens' groups. However, this was in opposition to a project promoted by the prefectural government. After the construction was completed last April, the effected area became completely cut off from the sea. In addition to the opposition by the anti-reclamation movement, another citizens' group, consisting of local farmers and other effected residents, formed. This group supported the national project and declared opposition against the outside involvement of citizens' groups supporting the anti-reclamation movement. This resulted in a conflict between pro-reclamation citizens' groups and the anti-reclamation citizens' groups.

g. Problems Before Us

Now, what is the best way to settle the conflict between the two groups and how can we integrate these contradicted interests within one·policy ?

6. Environmental Impact Assessment and Time Lapse Reassessment

a. Environmental Impact Assessment

Environmental impact assessment is, needless to say, one of the most effective measures which can address these opposing demands before a project commences. Thus a compromise of interests is appropriately expected. Naturally the compromise in this situation, however, does not mean a mere dividing of the interests by the groups. Instead, it means a possible integration for the overall protection of the environment. Thus, environmental impact assessment requires various standards for evaluating all aspects of the project. Such standards, however, should be reviewed not only from a short term perspective, but also in the long term as well. This is because the circumstances surrounding a project may change over time. Furthermore, it means that the program should be reassessed after a certain period in order to determine whether revisions are required. From this perspective the concept of a time lapse reassessment should be introduced for the purpose of reevaluating a development project.

b. Time Lapse Reassessment

The concept of a time lapse reassessment was quite recently introduced by the Hokkaido Prefectural Government in Japan through an enforcement standard, which states its purpose as follows:

- past projects or plans must be subject to reevaluation after a designated period of time. This should include a reassessment of the original intent and effect of the project.

The enforcement standard requires concerned officers to assess the project or plan by the following points:

- necessity, appropriateness, priority, effect, citizen awareness and other alternatives.

BALTIC MARINE ENVIRONMENT PROTECTION COMMISSION - HELSINKI COMMISSION

Dr. Tapani Kohonen, Executive Secretary of the Helsinki Commission, Katajanokanlaituri 6 B, FIN-00160 Helsinki, Finland

Introduction

The vulnerable marine environment is strongly threatened by human activities in the Baltic Sea and its drainage area. The threats originate from all the countries in the area but the most acute ones are those from the states on eastern, southeastern and southern side of the sea which are now in transition. Of the 80 million people living in the drainage area 30 million are lacking proper waste water treatment. Municipalities and industries are discharging their untreated waste waters directly to watercourses and coastal waters. The inadequate or total lack of municipal treatment is combined with lacking pre-treatment of industrial waste waters, which are discharged to the municipal sewage systems. Agricultural practices, including intensive livestock husbandry, are a major contributor to the high nutrient load. This is also true as regards nitrogen emissions by traffic. According to the second pollution load compilation by HELCOM, based on data from 1990, the approximate annual waterborne load into the Baltic Sea was 662,000 tons of nitrogen and 45,800 tons of phosphorus (1). The respective figures for 1995 are 846,200 tons of nitrogen and 43,400 tons of phosphorus. It might be that the mentioned values, however, are too low due to uncertainties in the reported figures. About 10-30 percent of the total load of nitrogen emanates from atmospheric deposition. The mentioned load levels are estimated to represent about three times those of the 1950s.

The inputs of large amounts of phosphorous and nitrogen compounds result in eutrophication and excessive growth of biomass. This is especially observed in the Gulf of Finland, the Gulf of Riga and in the coastal areas of the eastern, southern and southwestern Baltic Sea area. Intense algal blooms appear not only in local or regional coastal areas but also in the open sea. In some areas, even toxic algae appear, causing additional problems. The decay of this vast biomass depletes oxygen and the general decrease of oxygen in the deeper water of the Baltic Sea is considered to be one of the reasons for the severely weakened cod catch. Significant increases in the prevalence of several fish diseases in the entrance areas are related to decreasing oxygen conditions.

Although concentrations of heavy metals in fish and shellfish have not changed significantly since the early 1980s, the concentrations are still higher than the background values. Enrichment of the most toxic metals, cadmium, mercury and lead, is about the same in both the Baltic and the North Sea fish, and well below hazardous levels for human consumption, according to WHO standards. In the southern Baltic, a downward trend in lead concentrations, probably due to the elimination of lead in car petrol, has been observed. The ban of the use of certain persistent toxic organic compounds, such as DDT and PCBs, has led to their significant decrease in the biota since 1974. Due to remedial action, the concentrations of toxic substances in biota have decreased distinctly in some parts of the Baltic Sea (2).

The effects of toxic substances on the biological system of the Baltic Sea are very serious. Since long, populations of birds and seals in the Baltic Sea, e.g., have been threatened by pollutants, such as heavy metals and organochlorines. The white-tailed eagle, e.g., was close to extinction. Due to decrease in discharges and other action, these populations are now recovering. Concerning seals, it can be mentioned that the rapidly growing seal populations in some areas now cause strong conflicts with fishermen and their organizations.

Fish with severe injuries were earlier found locally outside pulp and paper industry but have disappeared in pace with remedial action at the plants. For the moment, the stocks of wild salmon are close to extinction, not only due to overfishing but also due to a disease known as M-74 phenomenon, suggested to be related to the combined effects of pollutants.

The heavy pollution load from agriculture and industry in the countries in economic transition has decreased considerably during the last years. One reason for this is the reform of ownership within agriculture as well as disappearance of former markets resulting in disintegration of former collective and state farms into cooperatives and private farms. This has led to a reduction in the consumption of fertilizers and pesticides as well as in the number of cattle and other animals on the farms. In Estonia, e.g., the number of cattle is estimated to have been reduced to almost a half between 1988 and 1994 from 820,000 to 460,000 and the number of poultry to almost a fourth from 6.8 to 1.8 million. The use of nitrogen fertilizers has, during the same time period, gone down from 110,000 tons to 30,000 tons, phosphorous fertilizers from 60,000 tons to 10,000 tons and pesticides from 1,850 tons to 240 tons. The situation is similar in the other countries in transition. As to the industrial sector, the production has also decreased considerably, due to the transition into market economy. Many enterprises and plants have been closed and others have reduced their production because of losing the eastern market for which the production was mainly oriented and also due to incapacity to compete on the western market. Reductions in the pollution discharges from municipal waste water treatment plants have also been achieved. A new third compilation of the pollution load on the Baltic Sea based on measurements and estimates during 1995 is now under preparation. It is planned to be published in 1997.

The Helsinki Conventions

The Convention on the Protection of the Marine Environment of the Baltic Sea Area - Helsinki Convention, was signed in 1974 by the then seven Baltic Sea riparian States (Denmark, Finland, German Democratic Republic, Federal Republic of Germany, Poland, Sweden and the USSR). The Convention entered into force in 1980, when it was ratified by all the mentioned states. It covers the whole sea area out to the border between Kattegatt and Skagerrak but excludes the internal waters (3).

The objective of the Helsinki Convention is to protect the Baltic marine environment against all forms of pollution. In 1992, a revised Convention based on the many years of experience with the 1974 Convention was signed. The new Convention covers also the internal waters of the Contracting Parties and takes into account nature conservation. It also reflects developments in the international environmental policy and the environmental law (3).

The 1992 Convention tightens and specifies measures to combat pollution from land-based sources. A precise objective is to prevent and eliminate pollution in order to ensure the ecological restoration of the Baltic Sea, self-regeneration of its environment and preservation of its ecological balance. Best Environmental Practice and Best Available Technology are to be used for this purpose and the Polluter Pays Principle is to be applied.

The new Convention presupposes that preventive measures must be taken in the whole drainage area of the Baltic Sea. Furthermore, the Signatories shall individually and jointly take all appropriate measures to conserve natural habitats and biological diversity.

So far, the 1992 Helsinki Convention has been ratified by Denmark, Estonia, the European Community, Finland, Latvia, Lithuania, Germany and Sweden. Most probably the Convention will enter into force next year after ratification by Poland and the Russian Federation.

The decision-making body of the Helsinki Convention is the Baltic Marine Environment Protection Commission, the Helsinki Commission (HELCOM), an intergovernmental organization with a permanent international secretariat in Helsinki. The HELCOM Recommendations on measures relating to the purposes of the Convention have to be implemented through national laws, policies, standards, etc. They are not legally binding but have quite a binding political and moral force since they are taken unanimously.

The organization of the Helsinki Commission comprises at present the Commission, four permanent Committees and the HELCOM Programme Implementation Task Force (working at committee level with expanded participation). They have several working and expert groups, and the work is further supported by informal meetings, workshops, seminars and symposia for specific topics.

The Environment Committee works on joint monitoring programmes covering different sectors of the marine environment, the open sea, coastal waters, and airborne pollution. The data are compiled into joint databases and evaluated at regular intervals by experts from the Contracting Parties in order to assess the environmental conditions. The third assessment of the status of the marine environment is just published.

The Technological Committee works on restriction of discharges into waters and emissions to the atmosphere from urban areas, municipalities and industry, and diffuse sources, including agriculture and traffic. Recommendations are prepared on banning or decreasing the use of certain substances or on reducing discharges and emissions. Also, it makes at regular intervals compilations on the pollution load to the Baltic Sea.

The Maritime Committee takes measures against all kinds of operational pollution from ships and offshore platforms and deals with facilities in ports to dispose of ships' wastes. It also coordinates the activities of the Contracting Parties in matters concerning the protection of the Baltic Sea from pollution by ships. At present, one of the main concerns is how to reduce the illegal discharges into the Baltic Sea and how to develop a Baltic Manual on national legal systems concerning violations of anti-pollution regulations.

The Combatting Committee elaborates the rules and guidelines for cooperation in combatting spillages of oil and other harmful substances. It also coordinates airborne surveillance with remote sensing techniques to find and record oil discharges.

The HELCOM Programme Implementation Task Force plans and coordinates the implementation of the Baltic Sea Joint Comprehensive Environmental Action Programme.

The starting point of cooperation of the Baltic Sea States in the implementation of the Helsinki Convention was an assessment of the state of the environment of the Convention Area. Thus, a joint monitoring programme for the open Baltic Sea is being coordinated by the Helsinki Commission since 1979. The open sea monitoring was later extended to cover also monitoring of airborne pollution and radioactive substances. National monitoring programmes for coastal areas supplement the joint programme and harmonized system of monitoring of these areas is under development. During the past years, a lot of efforts have been made to improve the reliability of the collected data by arranging several intercalibration and intercomparison exercises and training courses for personnel involved in the practical work.

Another important instrument to monitor the implementation of the Convention is a continuous project dealing with periodic evaluation of waterborne point and nonpoint pollution load entering the marine environment with direct and via rivers. The project started in 1985 and is proceeding in stages according to a unified methodology. A similar project has been also established for periodic evaluation of pollution load from atmospheric deposition.

It is worth mentioning that the 1992 Helsinki Convention requires the Contracting Parties to report regularly to the Commission and to provide information to the public. Reports shall be given on the legal and other measures taken to implement the Convention's provisions and the recommendations adopted thereunder. At the request of a Contracting Party or the Commission, the Contracting Parties shall provide information on discharge permits, emission data or data on environmental quality. With this regulation, reporting is made far more concrete and is made binding under international law. In this way, the Commission now has a valuable instrument at its disposal with which it can confirm the implementation of the Convention and its decisions - admittedly not through powers of inspection, but by evaluating the information submitted to it.

The Baltic Sea Joint Comprehensive Environmental Action Programme

During the late 1980s - and even more clearly after the collapse of the socialist regimes in Eastern Europe in the early 1990s - it was evident that the Helsinki Convention had not been the leading star for all the governments around the Baltic Sea with respect to action taken to protect the environment. Many of the decisions/recommendations by the Helsinki Commission had, unfortunately, not been implemented in practice. This was especially true in the present countries in transition, where there were regions with partly destroyed environment. Industry operated with outdated technology and emitted harmful substances, with great amounts of harmful and toxic wastes stored in landfills without control or protection against leakage. Municipalities discharged their waste waters without any treatment. Agriculture did not take environmental conditions into account.

For taking action against this very serious situation, the environmental ministers from the Baltic Sea States committed themselves at a meeting in 1988 to cut down the discharges entering the Baltic Sea of some harmful substances and nutrients by 50 % by 1995. As the next step, a conference at prime ministerial level was held in Ronneby, Sweden in 1990. The prime ministers decided to set up an ad hoc High Level Task Force to elaborate a programme to restore the Baltic Sea to a sound ecological balance.

Within the Task Force, four international financial institutions, viz. the European Investment Bank, the European Bank for Reconstruction and Development, the Nordic Investment Bank and the World Bank, acted as Executing Agencies, coordinating prefeasibility studies in eight areas in Russia, Estonia, Latvia, Lithuania, Poland, eastern Germany and the former Czech and Slovak Federal Republic.

In addition, topical studies were carried out within the Task Force dealing with airborne pollution, agriculture and wetland areas. The national plans submitted to the HELCOM ad hoc High Level Task Force as background material were used in the preparation of the Action Programme, as well.

The resulting Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) was approved as regards principles and strategies at a Diplomatic Conference in Helsinki in 1992 and a Programme Implementation Task Force, HELCOM PITF, was established within the framework of the Helsinki Commission.

The Programme consists of six major elements:

1. Policies, Laws and Regulations
2. Institutional Strengthening and Human Resources Development
3. Investment Activities
4. Management Programmes for Coastal Lagoons and Wetlands
5. Applied Research
6. Public Awareness and Environmental Education

As to the investments in point and non-point source control, the Programme focuses on 132 "hot spots", all land-based pollution sources. From these 47 were classified as the priority hot spots, two third of which are located in the countries in transition and are equal to 75% from the total investment costs. The Programme shall be implemented within a twenty-year period, 1993-2012; the financial resources needed have been estimated to be 18 billion ECU.

All the countries with territory within the Baltic Sea drainage area (the Contracting Parties to the Helsinki Convention, Belarus, Czech Republic, Norway, Slovak Republic and the Ukraine), the European Community and five international financial institutions (the four earlier mentioned and the Nordic Environment Finance Corporation, NEFCO), as well as the Baltic Sea Fishery Commission (IBSFC) are the members of the HELCOM PITF.

A High Level Conference on Resource Mobilization was held in March 1993 in Gdansk, Poland. In this conference the concerned Ministers of the Environment committed their countries to make all efforts to mobilize local, national, bilateral or multilateral financial and other resources for the implementation of the Programme.

Implementation of the various elements of the Programme started in 1993. Some of the countries involved have taken the responsibility as a lead party for a whole element or a substantial part of an element. Furthermore, the non-governmental organization World Wide Fund for Nature (WWF) has taken the lead for programme element number 4 "Management Programmes for Coastal Lagoons and Wetlands". Other NGOs, such as the International Council for Local Environmental Initiatives (ICLEI), the Union of the Baltic Cities (UBC) and the International Network for Environmental Management (INEM) also contribute actively on practical level to the implementation work supporting the elements "Policies, Laws and Regulations" and "Institutional Strengthening and Human Resources Development".

As to "Investment Activities for Point Source Pollution", the international financial institutions involved are active here, as well as a number of donor countries acting bi- and multilaterally. Finland and Sweden have taken a lead party for this element.

For "Non-Point Source Pollution", Poland and Germany share the responsibility, acting within the sectors of agriculture and traffic, respectively.

Finland with the support of Coalition Clean Baltic (CCB) is the Lead Party for the programme element "Publics Awareness and Environmental Education".

Results achieved within the Action Programme

For programme elements 1 and 2, "Policies, Laws and Regulations" and "Institutional Strengthening and Human Resources Development", advice has been rendered and a variety of seminars and training have been arranged for experts on all levels from the countries in transition. The implementation of requisite laws, policies and regulations is going on well. Estonia, Latvia, Lithuania and Poland have brought their legislation towards conformity with EU legislation in conjunction with their approximation process. Most of the countries in transition have also improved their use of economic instruments to gather resources mainly for waste water treatment and of protective measures for the environment, in general.

In spite of many seminars and training courses, available national experts are, however, still very scarce in relation to the actual need. This holds true for both the central and regional and local levels. The countries in transition need multiple assistance in terms of financing and transfer of know-how for the establishment of public infrastructures as well as for training of experts.

Within the programme element "Management Programmes for Coastal Lagoons and Wetlands" key target areas have been specified and so-called Area Task Teams have been set up to develop management plans in a decentralized manner. For time being 13 joint projects have been identified within the element "Public Awareness and Environmental Education" which will call for immediate financial support.

As to "Investment Activities for Point Source Pollution", of the 132 hot spots identified 15 have been removed from the list, so far. They are five pulp and paper industry plants in Finland, four in Sweden and one in Estonia as well as one industrial land fill site, two municipal waste water treatment plants in Germany. In a number of other hot spots, the pollution load reduction has started and is proceeding step-wise. A few projects are almost finalized, many are under construction or advanced planning but a great number still remain to be taken care of.

It can be noted that the countries in transition themselves are firmly committed to tackle their hot spots to the extent possible with their own resources. Poland has currently more than 1,000 waste water treatment plants under construction, and about 300 are completed annually. More than 95 % of the costs for environmental actions are covered nationally. Lithuania has allocated 5 % of its national budget for waste water treatment. Similar commitments can be found in Estonia and Latvia, as well. Regarding major hot spots, co-financing has become instrumental to get major projects under way. Good examples are the Lithuanian projects in Vilnius, Klaipeda, Kaunas, the Latvian project in Liepaja, as well as the Estonian projects in Tallinn and Haapsalu/Matsalu. In these activities, besides requisite national resources, the World Bank, NEFCO, EBRD, Denmark, Finland, Sweden, the EU-LIFE and PHARE Programmes, the European Union for Coastal Conservation (EUCC) and WWF have been as co-financiers.

As to the non-point pollution, a plan for balanced fertilization in agriculture is under development as well as a strategy for the reduction of emissions from traffic.

As there is the 20 years' time span for implementing the JCP, the total sum of allocated or reserved resources looks promising due to the good availability of external funding. In future more and more internal financial resources are needed together with external financing from the EU and Nordic funds as well as from bilateral sources. From the estimated total costs for investments for the point source hot spots about 27% have been allocated or reserved. The distribution of investments between municipal and industrial projects show that the industrial sector is progressing very slowly. The main part of the allocated or reserved funds is related to municipal waste water treatment and only about 25 % to industry.

Experiences

Of great importance to the development of the cooperation on the protection of the marine environment of the Baltic Sea and elaboration of the Helsinki Convention was the understanding by all the governments of the Baltic Sea States that it is a joint interest and commitment to have a living Baltic Sea. The not legally binding HELCOM recommendations have, therefore, also been implemented in national legislation and policy in all Contracting Parties. However, many recommendations have not been implemented in practice, due to insufficient enforcement mechanism, especially in the countries now being in transition. The follow-up work done by the Helsinki Commission has during the past years not had such a form that implementation shortcomings concerning the Convention and the political decisions could be clearly demonstrated. For future use, a well-developed and harmonized follow-up system must be agreed upon and introduced. The system is for the moment under elaboration, in conjunction with preparing the reporting on the implementation of ministerial decisions taken in 1988, in which the Baltic Sea countries committed themselves to the 50 % reduction of pollution inputs to the marine environment by the year 1995. The overall percentages seems to below the target and some countries have even bigger gaps.

The positive results achieved during the first years of implementing the JCP have several reasons. First of all, the initiative to the action programme was taken at the highest possible level, by the Prime Ministers. That guaranteed necessary resources and political pressure while elaborating the programme as well as the commitments later on by the countries involved to implement the adopted programme.

Of primary importance is also the involvement of the International Financial Institutions, IFIs, from the very beginning in the elaboration of the programme. They conducted pre-feasibility studies and have since developed a thorough knowledge of needs and conditions in the areas concerned. The continued participation of the IFIs in the implementation, the continuously intensive bilateral assistance rendered particularly by HELCOM PITF countries as well as by HELCOM observer organizations have facilitated mobilization of financial resources. The IFIs are the major managers regarding project preparation, wrapping-up of financing from various sources and control of the implementation of the specific projects. Assistance for implementing the JCP has also been given by a variety of other countries and organizations. Especially, the support by cities in the west to their counterparts in the countries in transition has turned out to be very valuable. As to major investment projects, co-financing has become instrumental with contributions from IFIs, donor countries, the EU funds and different organizations, besides the national contribution.

The philosophy to use step-wise approaches - not necessarily Best Available Technology at once - and cost-effective methods increases substantially the efficiency of pollution load reductions. In order to make it financially possible to work not only with major waste water treatment plants, a number of small and medium-size municipalities have been gathered into joint projects to create an extensive enough financial package to be of interest to the financial institutions.

Furthermore, the involvement of the non-governmental organizations has been of great importance in increasing public awareness and getting public support for the efforts to restore the environment.

In some regions, however, the progress is rather slow. This is not due to lacking financial resources, which the IFIs claim exist. Instead, the reason is that the mostly still very unstable legal and institutional framework create a reluctance to invest. This causes particularly implementation problems regarding polluting industrial plants whose legal status is mostly unclear, as are their environmental liabilities for damages caused earlier. This is why the important contribution of private investments is missing. In the municipal waste water treatment and clean water supply area, tariffs may be set but often remain largely unpaid. The security of refinancing investments is, therefore, undercut.

Some donors restrict the use of the grants made available to equipment and enterprises representing their own country. This often means that the amount of work carried out and the transfer of know-how will be less than would be the case when using staff and companies from the recipient country.

The flow of information on planned and ongoing activities from all parties involved is also rather poor. It looks like donors as well as recipient countries are competing, for different reasons. There is a risk that this causes duplication and hinders optimal use of existing resources. Sensible coordination of information at all levels could promote the process of implementation.

Unfortunately, some lead parties have not allocated sufficient resources for fulfilling the task. This might cause a hinder for other donors and slow down the implementation process for the element in question.

One of the most important issues for the implementation process is to keep the political interest and pressure high through many consecutive years even when other acute political questions are coming up. The present poor financial situation in many donor countries makes this, of course, difficult for HELCOM.

Newest political decisions

The Swedish Prime Minister called for a new conference on prime ministerial level in May 1996, with environmental cooperation as one of the main items to be discussed. This so called Visby Summit gave extra impetus to the ongoing HELCOM activities to restore the Baltic Sea to a sound ecological balance, as set as the goal for the JCP. The Presidency Declaration given in Visby and the Kalmar Communique given by the foreign ministers in July 1996 address three different but at the same time interlinked actions for the Helsinki Commission.

Firstly, the development of an Agenda 21 for the Baltic Sea Region should be and have been initiated by the Ministers for environment protection in the ministerial meeting in Saltsjöbaden, Sweden in October 1996. The Action Programmes adopted by the Council of the Baltic Sea States in Kalmar must be implemented. As a part of the Third Action Programme, the JCP must be updated and strengthened. The JCP will become an important element in the elaboration of that Baltic Agenda 21. Other actions addressed by the Kalmar Action Programmes to HELCOM were i.a.

- the continuous reduction of discharges, emissions and losses of hazardous substances thereby moving towards the target of their cessation within one generation (25 years),

- the expeditious implementation of the HELCOM Srategy for Port Reception Facilities and the HELCOM assessment of future environment risks of increased handling and transportation of oil in the Baltic Sea Region,

- the strengthening of actions to further limit emissions and leakages of nutrients from agriculture and the development of an annex to the Helsinki Convention on agriculture,

- the development of a coherent policy for sustainable fishing in the Baltic Sea based on a comprehensive plan to be elaborated by the International Baltic Sea

Fishery Commission in consultation with HELCOM and ICES,

- the protection of biodiversity and nature conservation, including the further development of integrated coastal zone management, and

- the development of action programmes for transboundary water courses.

The emphasis of an Agenda 21 for the BSR must be on regional cooperation, meaning that priorities and structures must emenate from the common sharing of environmental priorities and development needs. The regional problems of the area should ne the driving forces. A regional Agenda 21 must not duplicate or upscale national or local Agendas 21, nor can it follow the structure of the original Agenda 21. It must therefore find its own logical structure and bring added value to the process. An Agenda 21 for the Baltic Sea Region should emphasize environmental, including health, and spatial planning aspects of sustainable development in the region.

In the development of an Agenda 21 for the Baltic Sea Region it is necessary to build on the work already carried out within international fora in the region such as the HELCOM, the International Baltic Sea Fishery Commission and the International Council for the Exploration of the Sea (ICES). The HELCOM JCP should continue to be a basis for joint action as well as being an important element in the elaboration of an Agenda 21 for BSR. Furthermore, VASAB 2010 which aims at incorporating environmental factors fully into a concept of flexible and dynamic planning, should be integrated into the development process and form a part of a future Agenda 21 for the Baltic Sea Region. The work should also take fully into consideration interregional cooperation, for example within the Barents Euro-Arctic Region and the North Sea cooperation, as well as subregional cooperation, including local authorities.

The economic sectors of crucial importance for sustainable development in the region for which integration of environmental concerns seems particularly necessary are agriculture, energy, fishery, forestry, industry, tourism and transport.
Attention should also be paid to municipalities and urban systems, coastal zones, the open sea and valuable natural and cultural areas.

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THE ROLE OF INDUSTRY IN THE SUSTAINABLE MANAGEMENT OF FRESHWATER RESOURCES

Mr Björn Stigson, President of the World Business Council for Sustainable Development, Switzerland

Only a few weeks ago our American friends at NASA landed an unmanned spacecraft on the **'red" planet.** We all marvelled at the colour photographs sent back to earth by this craft and its rover. The landscape appears to have been sculpted by massive water flows millions of years ago. But where is the water now? 1 could not avoid contrasting those stark Martian images with images from space of our own **"blue" planet.**

It is our water and our thin atmospheric layer which sustains life on Earth. We are here in Stockholm surrounded by fresh and sea water to rededicate ourselves to protecting the water resources that are so vital to us all.

Protecting means wise use. To paraphrase Gro Harland Brundtland, it means managing our fresh water systems to meet our present needs without compromising the ability of future generations to meet their own needs. For many years now industry has been conscientiously addressing water quality issues. Only recently has industry become increasingly aware of fresh water supply as an issue of concern.

1. What is WBCSD?

Permit me to begin by taking a few moments to introduce you to the WBCSD, the organization that I represent. The World Business Council for Sustainable Development (WBCSD) is a coalition of more than 120 leading international companies that share a commitment to the environment and to the principles of economic growth and sustainable development. We have members in 36 countries representing more than 20 major industrial sectors, and we are a powerful business voice on sustainable development issues - and plays an important role in developing closer co-operation between business, government and others, and in encouraging high standards of environmental management in business itself.

1.2 Objectives

The objectives of **WBCSD's** work can be defined with four key phrases:

* Business Leadership
* Policy Development
* Best Practice
* Global Outreach

a) Business Leadership

We focus on international and cross-sectoral issues and this is also evident when you look at our membership. Besides the members in the World Business Council, we have a network of national and regional BCSDs in developing countries and countries in transition. In those organizations we have approximately 700 leading local businessmen as members.

We stress that we are a business advocate, not a lobbying organization. We speak on behalf of business on the different issues related to sustainable development.

b) **Policy Development**

In our Policy Development work, we focus on sustainable development subsystems and the framework conditions for business to contribute to sustainable development. We actively seek partnerships and co-operate with other organizations that share our views and objectives.

c) **Best Practice**

We demonstrate through case studies **Best Practice** among our members and other companies. We encourage our members to inform others about their achievements and help others avoid errors that might have been made..

d) **Global Outreach**

Part of our credibility comes from being a truly global organization. Our network of national and regional BCSDs is a very important element of our structure. We are advocates of technology co-operation; we wish to make sure that industry gets it right the first time; there is no need for rapidly industrializing nations to repeat mistakes that were made during early industrialization in Europe and North America.

2. Sustainable Development from an Industry Perspective

Sustainable development from an industry perspective can be illustrated with this chart. It is built on three pillars, economic growth, ecological balance and social progress. Industry's contribution to sustainable development comes through eco-efficient leadership.

The industry contribution can be more or less effective depending upon the framework conditions under which we operate. There is also a very important element of uncertainty when it comes to sustainable development. We know fairly little about the carrying capacity of ecosystems.

Eco-efficiency is a management approach developed by the WBCSD. Narrowly defined, it is about producing more with less resources and less pollution. But it goes further and encourages business to become more competitive, more innovative, and more environmentally responsible.

It is designed to help companies support sustainable development. It has been taken up by many corporations and business schools, and is one of defining principles in a new investment fund.

The concept of eco-efficiency makes seven main demands on companies:

* Reduce the material intensity of goods and services
* Reduce the energy intensity of goods and services
* Reduce toxic dispersion
* Enhance material recyclability
* Maximize sustainable use of renewable resources
* Extend product durability
* Increase the service intensity of goods and services.

The WBCSD Water Project

The WBCSD recognizes that the organization has an important opportunity to contribute to the sustainable use of the world's finite fresh water resources and has established a working group to review the key debates about water and the policy options for industry. The project has as its goal to develop a role for industry in the management of fresh water resources. The working group has identified a few key areas to concentrate its activities, including:

* development of a benchmark publication on water management for the end of 1997, in conjunction with UNEP, and incorporating up-to-date examples of water management from WBCSD members,

* participation in the development of sustainable water policy. This includes economic water pricing, recycle and reuse, moving towards the goal of eco-efficient water use like zero pollution from industrial discharges into water bodies,

* dissemination of best industry practice in water management.

Competing Sectors:

Fresh water is a renewable but locally finite resource. The growing demands for water by all sectors fuelled by rapidly growing populations, cannot be sustained indefinitely into the future. Moreover, the significant levels of pollution in many water supplies all over the world further reduces the amount of water available for use. There are water shortages in many and areas now and there could be shortages in areas with normally abundant water resources in the future.

Historically industry has not been overly concerned with water. With few exceptions, water is a minor cost of the finished goods and services produced by business. Business was always prepared to pay higher prices and bid water away from other users. The business community is increasingly aware that when future water shortages occur, the political process may give absolute priority to individuals and agriculture while industry might be prevented from simply paying higher prices. Industry recognizes that it must find ways to establish partnerships with governments, farmers, NG0s, and others concerned with general water management.

As part of the early activities of the working group, a review of key water issues has been made and I will highlight some of the findings.

Increasing demands for water are occurring from 4 key areas which in aggregate are exerting unsustainable pressures both in developed and developing countries,

* human needs for safe drinking water and proper sanitation

* agriculture requirements for expanded production to meet population growth,

* environmental needs to protect endangered species, biodiversity and unique areas of special interest, and

* industrial needs to provide more goods and services for a growing population.

Human needs: The major factor influencing the demand for fresh water is the world's rapidly growing population and continued urbanization. The world's population is expected to increase from 5.3 billion in 1990, to 10 billion people in 2050, with 90 % of future population growth occurring in the developing countries.

The WBCSD working group has identified a number of areas where industry has an active role, including the research and development of efficient new infrastructure for urban water supply and new technology for the re-use of urban waste water.

Agriculture: Agriculture is the largest water user sector, accounting for approximately two thirds of current global fresh water use. Agriculture is also the largest polluter of water in both developed and developing countries as a result of pollution from poor land management practices including unwise use of pesticides and fertilizers, inefficiencies in irrigation, unrealistically low subsidized water costs which encourage wasteful practices. In the agricultural sector the issue is often one of non-point sources where it is difficult to identify the source and exact discharge points of the pollution. This is an area the working group considers to be key for the evolution of new government water policy.

The WBCSD working group will promote best practice in environmental management and product stewardship, including fertilizer and pesticide management. In addition, industry research and development in the area of better irrigation technology is strongly supported. However, the issue of economic pricing of water, in the agricultural sector, is recognized as a key area for priority government attention.

Environmental needs: The allocation of water for environmental needs is a growing area of investigation and policy development. The environment requires water of sufficient quality and quantity to maintain a diverse array of ecosystems and biodiversity. Moreover, it is becoming increasingly obvious that the environment is not just a sectoral user of water, but provides a fundamental role in maintaining the quality and supply of the world's water resource for use by other sectors. One classic example is forested watershed protection. Poorly planned clear-cutting of forests on steep slopes has led to disastrous soil erosion and flooding. The short term economic gains have led to dramatic social and disaster relief costs far outweighing the benefits.

Possible roles for industry, include the support of catchment management networks amongst stakeholders in a watershed to promote effective environmental management of water and land resources. This is of particular interest to those companies in the natural resource sectors of mining, forest products, paper, and oil and gas extraction. The chemical and fertilizer sectors also have an important role to play in protecting environmental amenities and life supporting ecosystems. Additionally, the continued education of industry in water management practices is recommanded.

Industry: Currently, industrial use of water accounts for approximately 20 to 30% of global fresh water consumption. But, industrial demand for water particularly in rapidly industrializing countries is growing quickly.

Significant progress has been made by many companies primarily in OECD countries in the area of water conservation. This trend will continue to grow and, in the face of increasing demand from downstream users for a greater share of water, industry must continue to adjust and develop its water management strategies.

Industry has a much larger role to play than just protecting its access to water. Industry also brings the technological capability to move water, treat water and manage water supplies. The development of water technology and strategies for providing clean drinking water and removing wastes is one area where industry is intimately connected to improving the living conditions of populations in developing countries. Industry has an opportunity to participate in providing sustainable solutions for water management, not only for itself but for its neighbours, local farmers and ecosystems as well.

The most sensitive water issue for many industry sectors is water quality. While the limitations of the future supply of water for industry is a growing concern, industry is often perceived by the public as the worst polluter of water. Although there are many serious examples of point source industrial pollution in the world, pollution control regulations and water charges have generally ensured the trend towards industry compliance with ever stringent limitations on discharges to public waters.

By contrast with public perception, the WBCSD working group regards pollution from agriculture and urban waste water as by far the larger problems - in terms of absolute levels of pollution, the geographical extent of the pollution problem and in the relative difficulty of controlling these non-industrial sources of pollution.

A Role for Industry:

Six main areas have been identified by the WBCSD working group where industry has the greatest opportunity to contribute positively both to the debate and to the remedial actions. These are listed below.

* improving water management practices and technology within companies, such as water conservation and "zero emission" technology,

* the option of re-use of urban water for industrial

* the option of re-use of urban water for industrial purposes,

* possible relocation of industry to areas where water access is guaranteed,

* improving the communication of best practice water management to other catchment water users to generate trust and commercial opportunities, in particular in the developing world,

* participating in the development of responsible water policy - such as economic water pricing. this will facilitate sustainable water use for all sectors, and develop industry incentives for improved water management,

* research into water management practice and technologies not only for business application but or use in the urban agricultural and environmental sectors as well.

However, let me use one example to stress the importance of industry-government partnerships. During World War 11, few paid any attention to water quality in the Rhine. As Europe underwent its post-war economic recovery, the Rhine became one of the most polluted rivers in the world. By the time the alpine water left Switzerland at Basel, the water was no longer drinkable. Untreated human waste and chemical wastes from the plants in Switzerland, France and Germany poured into the river.

In the early 1980's government officials from all three jurisdictions in Basel sat down with the four leading chemical companies (Ciba-Geigy, Hofmann-LaRoche, Lonza, and Sandoz) operating in the Basel area. The engineering departments of the chemical companies, in co-operation with government agencies, designed a state of the art wastewater treatment facility. All biodegradable waste was processed in one section and all chemical wastes requiring special treatment were processed in an adjoining facility. Industry operates and maintains the entire facility under government supervision. The net result has been a dramatic recovery of water quality in the Basel area which contributed its part in the cleaning up of the Rhine River.

Conclusions:

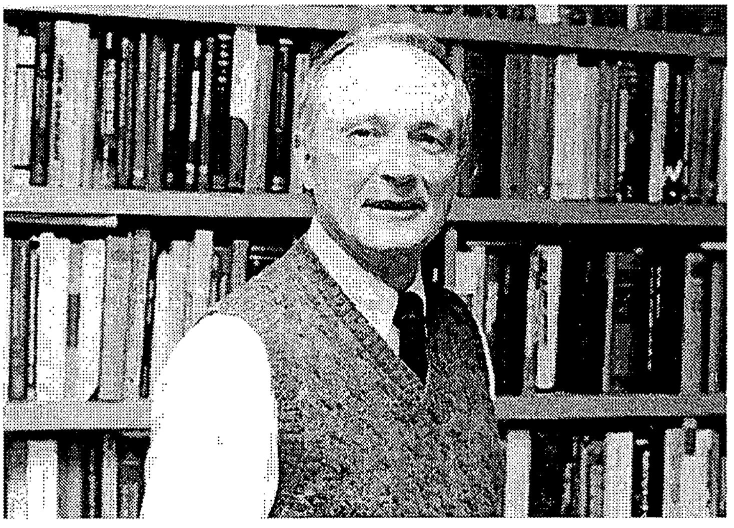
To conclude, industry is starting to realize the importance of water issues for its future operations. And, we are prepared to play our role to find solutions. However, we realize that business cannot solve these challenges alone.

We need partnerships and co-operation with other stakeholders.

We welcome the efforts by the Stockholm Water Institute to bring us all together here at this conference as one step in the process to attain more sustainable water management.

The 1997 Water Prize Laureate

Professor Peter S Eagleson,
Department of Civil and Environmental Engineering,
Massachusetts Institute of Technology,
Cambridge, MA, USA



GEOPHYSICS, NATURAL SELECTION, AND HYDROLOGICAL FORECASTING

Peter S. Eagleson, Professor Emeritus, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, U.S.A.

Introduction

Over the last 30 years hydrology has evolved from a field focused on engineering problems of rainfall-runoff and irrigation scheduling at the scale of the small watershed to a field struggling with global-scale issues which demand a geophysical perspective. This shift of viewpoint, emphasizing the geosciences, is essential both to achieving an understanding of the environmental consequences of climate change, and to developing the practical tools for long-range forecasting of water availability.

Earth Surface-Atmosphere Feedback

The fundamental difference between the hydrologic system at small geographic scale and that at large geographic scale lies in the relative sensitivity of the precipitation to the feedback of moisture and heat from the surface to the atmosphere. Figure 1 is a 'clinical' diagram of this feedback for water within a column of atmosphere in which:

Q_{in} , Q_{out} = rates of inflow and outflow of atmospheric moisture
R = net total rate of surface and groundwater runoff of water from the land
W = stored atmospheric moisture
S = stored soil moisture
E = rate of evapotranspiration
P = total rate of precipitation = $P_m + P_a$
P_m = rate of precipitation of 'recycled'(i.e. evaporated within the column) moisture
P_a = rate of precipitation of moisture convected atmospherically into the column.

We will call the average horizontal displacement of a recycled water molecule from "E" to "P", the "*hydrologic scale*" ; it changes with climate. The horizontal dimension of the column in Fig. 1 is that of the problem of interest (i.e. watershed, river basin, continent, etc) and we call it the "*geographic scale*". P may be assumed independent of E whenever the hydrologic scale exceeds the geographic scale. Such is the case for small watersheds except perhaps in the tropics where horizontal atmospheric motion is weak. This independent precipitation, in which the urface is decoupled from the atmosphere, is the dynamic situation corresponding to the classical hydrologic model in universal use through the middle of this century. It is represented by the simple linear cascade illustrated in Figure 2.

At the large geographic scales necessary to consider issues such as global change, the feedback fluxes are important determinants of the precipitation, so the atmosphere and surface must be considered as a coupled (often highly non-linear) system. This is the modern model of the hydrologic system and is illustrated here in Figure 3.

Hydrologic Teleconnections

The complex dynamics of Earth's coupled fluids, oceans-atmosphere-soil moisture, contain a wide spectrum of periodic components. The higher, multi-year periods (i.e.low frequencies) originate in the response of the large ocean masses to their forcing by solar heating and planetary motions while constrained by the size and shape of the ocean basins. The lower periods (i.e. high frequencies) are characteristic of the low density, low heat capacity, thermodynamically active atmosphere. The response characteristics of these very different fluids are most closely matched in the tropics due to the sharp ocean stratification and deep atmospheric convection there. It is there that their primary dynamic coupling occurs. Being the principal moisture and solar energy reservoirs for the hydrologic cycle, the tropical oceans force hydrologic responses at corresponding periods in the tropical atmosphere. The atmosphere then transfers energy and water mass down a cascade of thermodynamically-induced internal motions of ever-diminishing scale and period, as it transports energy and water mass rapidly over great distances and into higher latitudes. In contrast, the land surfaces constitute relatively immobile energy and moisture reservoirs whose dynamics are "overdamped" in that they have negligible natural oscillations of their own. As such they respond and feedback to the local atmosphere with a decreasing intensity as the excitation period shortens. The dynamic connection of ocean forcing atmosphere followed by atmosphere forcing distant landsurface is called a hydrologic 'teleconnection' after the pioneering observations of Namais (1962), and it has obvious potential for long-range forecasts having great economic value. The allied teleconnection arising from land surface forcing atmosphere at point "A" followed by atmosphere forcing landsurface at pont "B" also has forecasting utility. However, in comparison with the former, it is: 1) shorter in temporal and spatial range due to the absence of oceanic involvement; and 2) weaker due to the dispersal of energy and water mass across a spectrum of forcing frequencies. The variable dependence of the local land surface precipitation upon the local land surface moisture state raises the interesting possibility of dynamically-generated persistence in the climate of land surfaces (Rodríguez-Iturbe et al., 1991).

Several hydrologic teleconnections have been empirically recognized for some time. Regional- and global- scale numerical models of the coupled land surface, atmosphere, and ocean are now providing the geophysical justification necessary for confident use of these teleconnections for forecasting purposes.

Ocean-Atmosphere Coupling

Principal among the recognized oceanic teleconnections is "El Niño", the quasi-periodic appearance of anomalously warm surface water in the Eastern tropical Pacific Ocean due to ocean-atmosphere coupling. ssociated with El Niño through atmospheric teleconnections are anomalous moisture and temperature conditions at distant locations as is shown in Figure 4 (Kerr, 1992). One of these teleconnections, which illustrates the practical importance of large-scale hydrologic understanding, is the El Niño-induced area of dry conditions in Eastern Brazil containing the headwaters of the Trombetas River. Figure 5 (WMO-UNEP, 1992) shows the strong correlation between the normalized monthly flow in the Trombetas River (vertical lines) and the Southern Oscillation Index, SOI (continuous line), which is the normalized difference in surface atmospheric pressure between Tahiti and Darwin. Large negative values of the SOI indicate the presence of El Niño. In addition to the approximately six-month lag time between the SOI and the streamflow apparent in Fig. 5, numerical models of the El Niño mechanism can forecast its appearance by nearly two years (Cane and Zebiak, 1985). There is thus the potential for 2-year forecasts of monthly streamflow in the Trombetas which could have great utility in engineering activities such as reservoir management.

In a similar fashion Eltahir (1996) has shown a high negative correlation between the average annual flow in the Nile River and the SOI as is shown in Fig. 6.

Land Surface-Atmosphere Coupling

Strong observational evidence exists of land surface teleconnections driven by regional snow cover (Namais, 1978; Dey and Branu Kumar, 1983). As an example, the Indian summer monsoon rainfall and the Himalayan snow cover of the previous winter are compared in Fig. 7.

The theoretical explanation for this and other observed land surface teleconnections is not obvious and will be found only with the aid of large-scale numerical models of the coupled land surface and atmosphere. In these models, the hydrologic states and fluxes at the land surface are necessary boundary conditions to the fluid and thermodynamic equations governing the atmospheric physics. At vegetated land surfaces these boundary conditions involve biological states and fluxes which are not determined by the familiar conservation equations of fluid dynamics, and the geometrical structure of the plant canopy modulates the biophysical interaction of the atmosphere-plant-soil system. Our research suggests that we can formulate in physical terms the natural selection processes that determine the canopy configuration and that fix the average vegetal fluxes under equilibrium conditions. These additional equations should facilitate writing an approximate dynamic landsurface boundary condition in which the canopy structure is not pre-specified but is instead determined by the climate and soil in a truly interactive process. Such capability is needed in order to deal realistically with climate change.

Biophysical Boundary Conditions at the Land Surface

We describe the average rate of transpiration of the plant community in terms of its two primary state variables: 1) the fractional coverage or "canopy density", M, and 2) the species-dependent transpiration efficiency, k_v, which is the ratio of transpiration to bare soil potential evaporation, E_p. These take their place in the expression of long-term average (i.e. climatic) water balance as

$$P = (1 - M)\,\beta(S)\,E_p + M\,k_v E_p + R(S) \tag{1}$$

in which β is the bare soil evaporation efficiency. How does nature select the values of M and k_v for a given climate and soil?

If we choose a particular vegetation type k_V is fixed, and with a given climate and soil Eq. 1 gives a single soil moisture state, S, and a single evapotranspiration, P - R(S), for each value of M as is shown in Fig. 8. The intermediate M at which S is a maximum is a condition of maximum security for the canopy since it implies minimum water-demand stress and hence high resistance to disease. The different, intermediate M at which E is a maximum is a condition of maximum biological productivity since the latter is directly proportional to canopy water use (Rosenzweig, 1968). Accordingly, it seems reasonable to assume that natural selection will fix the canopy equilibrium value of M for a given species at a value within the 'operating range' given by these two maxima; in seeking to maximize reproductivity, the plant will maximize biological productivity to the extent that prooves compatible with its own security given the local variability of climate. Limited observations support this hypothesis (Salvucci and Eagleson, 1992) which we call the *external conditions* of optimality.

For a given canopy density, our research suggests that the transpiration efficiency, k_V, is selected by an *internal condition* of canopy structure which maximizes the transfer of both moisture and light between canopy and atmosphere; this too assures the maximization of biomass production.

Finally, natural selection will satisfy both the internal and external conditions simultaneously thereby fixing both M and k_V as is illustrated in the sketch of Fig. 9.

Summary

Exploiting the natural determinism of climate can reduce the uncertainty in long- range hydrological forecasting. This is possible through global-scale numerical models that capture the essential couplings of the land surface and atmosphere as well as those of the oceans and atmosphere. Vegetation plays a key role in the land surface-atmosphere interaction, but its 'equation of state', which is a boundary condition for the equations governing the atmospheric motion, is unknown. Ongoing research determines the canopy equilibrium state from natural selection hypotheses.

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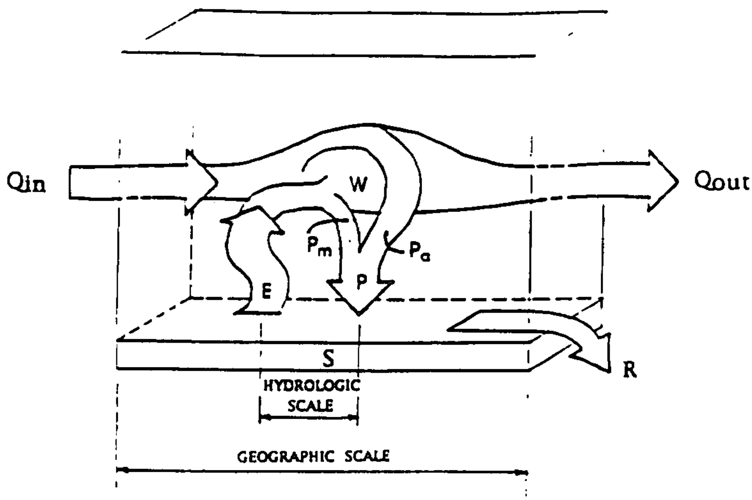


Figure 1 The Flow Paths of Atmospheric Moisture (After Brubaker et al., 1993)

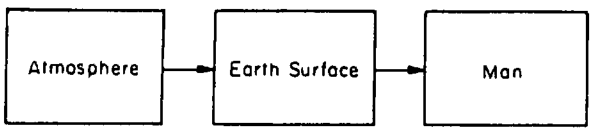


Figure 2 Classical Concept of the Hydrologic System (NRC, 1982)

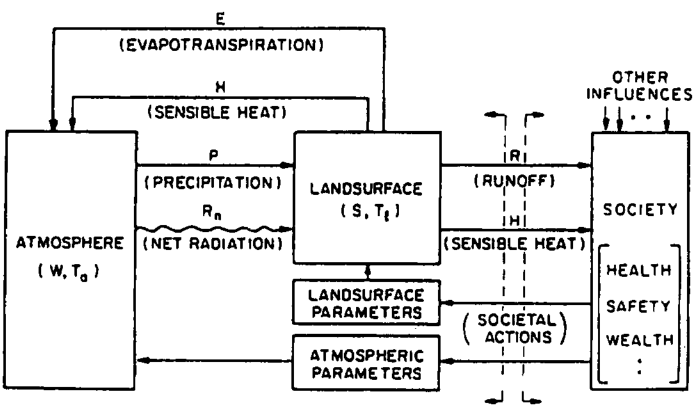


Figure 3 Modern Concept of the Hydrologic System (Eagleson, 1994)

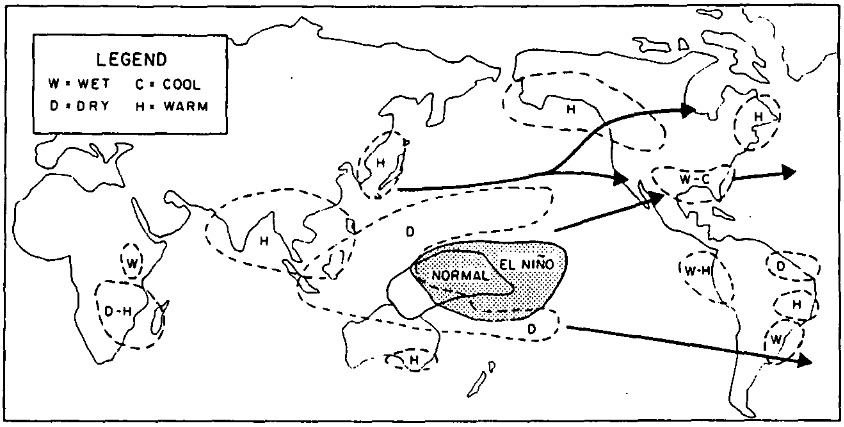


Figure 4 The Long Reach of El Niño (Kerr, 1992)

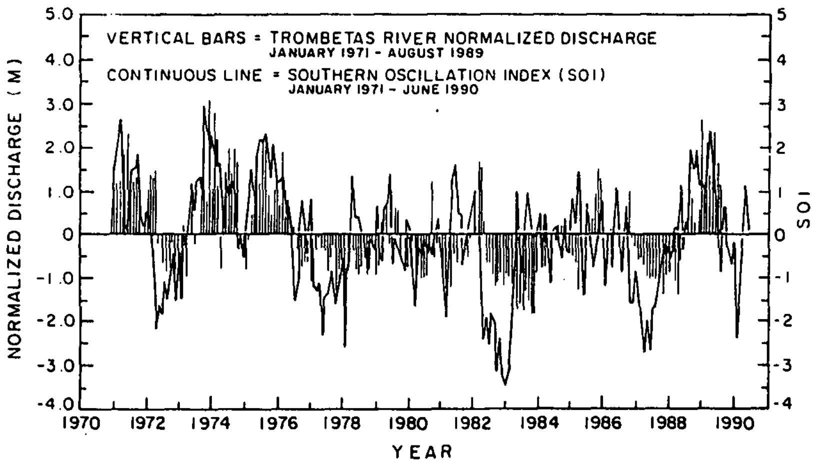


Figure 5 Correlation of Trombetas River Flow and the SOI (WMO-UNEP, 1992)

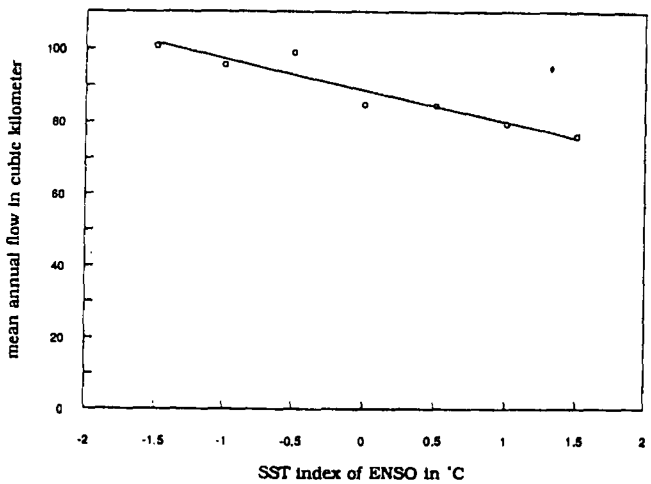


Figure 6 Correlation of Nile River Flow and the SOI (Eltahir, 1996)

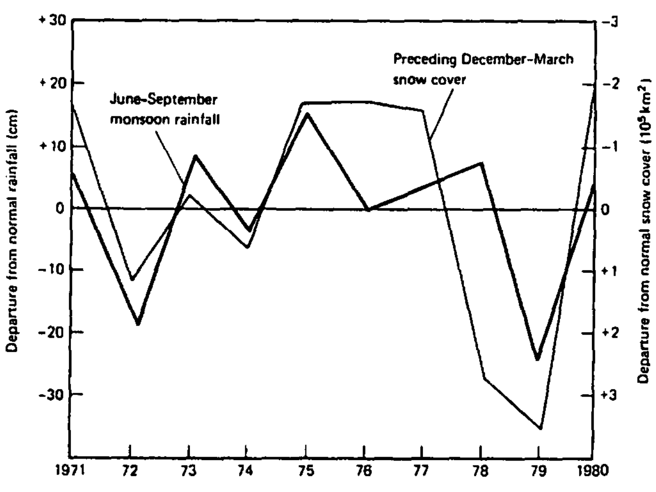


Figure 7 Correlation of Indian Summer Monsoon Rainfall and Himalayan Snowcover of Preceeding Winter (Walsh, 1984 after Dey and Branu Kumar, 1983)

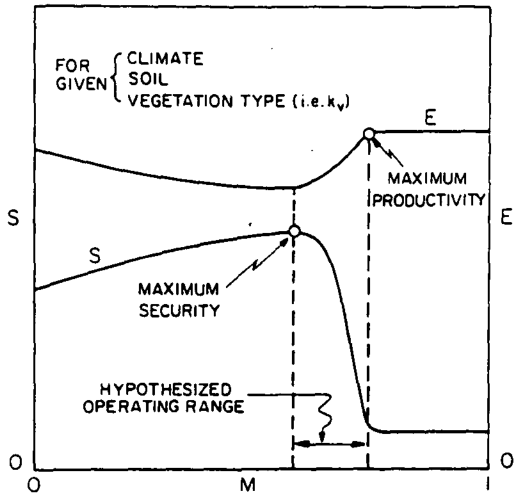


Figure 8 Solutions of the Climatic Water Balance Equation in Water-Limited Case (Salvucci & Eagleson, 1992)

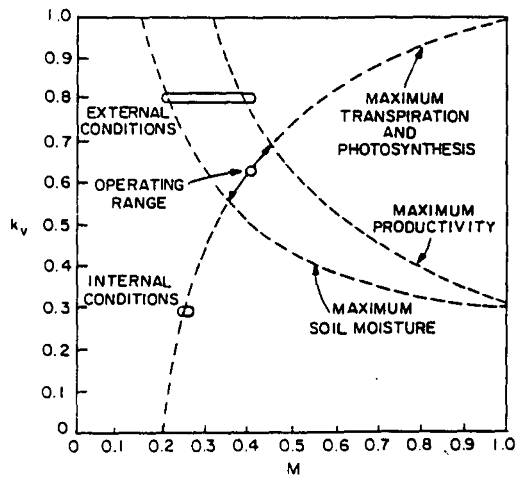


Figure 9 Canopy State Variables as Determined by Natural Selection (Fixed climate, soil, and vegetal species)

PART 2

WORKSHOPS AND POSTERS

WORKSHOP 1:

AN ECOSYSTEM APPROACH: DRAINAGE BASIN AND COASTAL SEA AS A WHOLE SYSTEM

Dr Donald F Boesch, USA (Chairman),
Professor Bengt Owe Jansson, Sweden (Rapporteur)

Presentations were made in this workshop by experts from 13 nations on a wide variety of enclosed coastal seas. Nonetheless, they demonstrated that an ecosystem approach to both science and management is not only helpful but essential in order to assess and manage the complex interactions of humans and the environment which characterize coastal seas.

From the broadest perspective, the large marine ecosystems encompassing the world's coastal seas were shown to be dominated either by land-based pollution, particularly over-enrichment by nutrients, the unintended effects of fishery harvests, or climatic variation. Such a broadly regional approach provides a framework for addressing common problems and solutions and the interactions of ecosystems (e.g. estuaries and bays with the coastal ocean) within these large areas.

In addition to these regional similarities, there are many interregional similarities and lessons which can be useful in environmental management which were exemplified by the presentations and discussions in the workshop. The first of these concerns the importance of human activities often far-removed from the coast on the delivery of materials, including fresh water, sediments, nutrients, and potentially toxic contaminants to coastal waters. This importance is accentuated in semi-enclosed bays, gulfs, and seas which have restricted interaction with the open ocean. Nutrients and contaminants are delivered not only via rivers and direct discharges, but also via the atmosphere and even groundwater. Knowledge of the pathways and amounts of delivery is critical for effective control and management. This requires linkage of coastal waters with their watersheds and "airsheds." Such an allencompassing ecosystem approach is difficult even for the most technically advanced and environmentally aware nations and provides immense challenges to developing nations. Transfer of knowledge and technical assistance are critically needed.

Another important lesson is that environmental improvements have been achieved through treatment of wastes discharged into coastal waters and managing harvests of fisheries to achieve more sustainable yields. However, we have discovered that this is usually not enough. At the time of reductions of point sources, loadings from diffuse sources, particularly those resulting from agriculture, have grown in both developed and developing nations. Eutrophication of coastal waters around the world grew dramatically from 1970, often with disastrous results. Also, we have seen many unanticipated effects of fishery harvests on food chains and the ecosystem. These observations point to the need to understand and manage human impacts on water quality and the productivity of living resources within a common framework. Utilization of one species may have impacts on others and on water quality. Similarly, determining the carrying capacity of ecosystems with regard to nutrient loadings is needed to avoid adverse impacts on more sensitive fisheries, for example those that depend on oxygenated conditions near the seabed.

A third important lesson is the need to appreciate both the scale of ecosystem processes and the scale of the influence of management actions. An example presented in the workshop showed managing small scale phenomena around riparian zones within a watershed could have repercussions well downstream in coastal waters. On the other hand, water impoundments in large watersheds have effects not only on the habitat quality in the river below but also on estuary on the distal end of the river. In addition, it is important to understand the time scales of both natural variability and the responses to management actions.

Although most of the presentations during the workshop were based in natural science, discussions clearly underscored the fourth important lesson, the need to involve and integrate social and economic perspectives in the ecosystem approach. Economic requirements, population growth and distribution, demand for food and materials, cultural preferences, social priorities, and political arrangements all affect ecosystems of the drainage basin and the coastal sea. They also determine what is achievable in terms of effective ecosystem management and restoration. Conversely, these ecosystems have major effects on these human dimensions. Greater harmonization is required in order to achieve sustainable development.

LARGE MARINE ECOSYSTEMS: ASSESSMENT AND MANAGEMENT FROM DRAINAGE BASIN TO OCEAN

KENNETH SHERMAN, *National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center, Narragansett Laboratory, 28 Tarzwell Drive, Narragansett, RI 02882*

1. INTRODUCTION

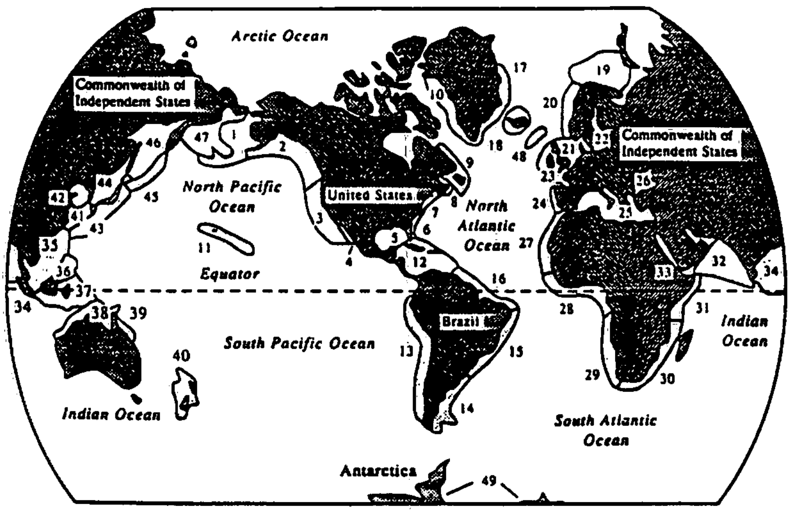
The long term sustainability of coastal ecosystems as a resource for healthy economies in coastal nations appears to be diminishing. A growing awareness that the quality of the coastal ecosystems is being adversely impacted by multiple driving forces has accelerated efforts by scientists and program managers to assess, monitor, and mitigate coastal stressors from an ecosystem perspective. The Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) is encouraging coastal nations to establish national programs for assessing and monitoring coastal ecosystems so as to enhance the ability of national and regional management organizations to develop and implement effective remedial programs for improving the quality of degraded ecosystems. This encouragement follows from the significant milestone achieved in June, 1992, with the adoption by a majority of coastal countries of follow-on actions to the UNCED declarations on the ocean for the nations of the globe to: *(1) prevent, reduce, and control degradation of the marine environment so as to maintain and improve its life-support and productive capacities; (2) develop and increase the potential of marine living resources to meet human nutritional needs, as well as social, economic, and development goals; and (3) promote the integrated management and sustainable development of coastal areas and the marine environment.*

2. COASTAL ECOSYSTEM STRESS

Post-UNCED concern has been expressed over the deteriorating condition of the world's coastal ecosystems that produce most of the world's living marine resources. Within the nearshore areas and extending seaward around the margins of the global land masses, coastal ecosystems are being subjected to increased stress from toxic effluents, habitat degradation, excessive nutrient loadings, harmful algal blooms, emergent diseases, fallout from aerosol contaminants, and episodic losses of living marine resources from pollution effects and over-exploitation. Coastal pollution, changes in biodiversity, the degraded states of fish stocks, and the loss of coastal habitat generally are limiting achievement of the full economic potential of coastal ecosystems. Present efforts to address these problems by local, regional, national, and international institutions responsible for resource stewardship has been less than successful. Informed decisions for ensuring the long term development and sustainability of coastal marine resources can best be made when based on sound scientifically-derived options. For most coastal ecosystems, existing environmental data pertinent to studies of perturbations to habitats and populations at the species, population, community, and ecosystem level is difficult to synthesize because of spatially and temporally fragmented character, lack of comparability, and inaccessibility. To overcome these shortcomings, there is a need for a more coherent and integrative assessment of the changing states of coastal ecosystems from drainage basins to the adjacent marine ecosystems that is directly linked to institutions responsible for the governance of the ecosystems. An essential component of an ecosystem management regime is the inclusion of a scientifically-based strategy to monitor and assess the changing states and health of the ecosystem by tracking key biological and environmental parameters. From this perspective, marine ecosystem assessment and monitoring is defined as a component of a management system that includes: (1) regulatory, (2) institutional, and (3) decision-making aspects relating to marine ecosystems. The system would include, therefore, a range of activities to provide management information about ecosystem conditions, contaminants, and resources at risk within the geographic extent of the ecosystem.

3. THE LARGE MARINE ECOSYSTEM ASSESSMENT STRATEGY

An ecological framework that can serve as a basis for achieving the UNCED objectives is the large marine ecosystem (LME) concept. LMEs are increasingly being subjected to stress from growing exploitation of fish and other renewable resources, coastal zone damage, habitat losses, river basin runoff, dumping of urban wastes, and fallout from aerosol contaminants. These are regions of ocean space encompassing coastal areas from river drainage basins and estuaries on out to the seaward boundary of continental shelves and the seaward margins of coastal current systems. LMEs are relatively large regions on the order of 200,000 km^2 or larger, characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations. The theory, measurement, and modeling relevant to monitoring the changing states of LME's are imbedded in published reports on ecosystems with multiple steady states, and on the pattern formation and spatial diffusion within ecosystems (AAAS 1986, 1989, 1990, 1991, 1993). Based on examination of the bathymetry, hydrography, productivity, and trophic linkages of marine populations, the spatial extent of 49 distinct LMEs have been described from around the margins of the Atlantic, Pacific, and Indian Oceans (Fig. 1).



1. Eastern Bering Sea
2. Gulf of Alaska
3. California Current
4. Gulf of California
5. Gulf of Mexico
6. Southeast U.S. Continental Shelf
7. Notheast U.S. Continental Shelf
8. Scotian Shelf
9. Newfoundland Shelf
10. West Greenland Shelf
11. Insular Pacific-Hawaiian
12. Caribbean Sea
13. Humboldt Current
14. Patagonian Shelf
15. Brazil Current
16. Northeast Brazil Shelf
17. East Greenland Shelf
18. Iceland Shelf
19. Barents Sea
20. Norwegian Shelf
21. North Sea
22. Baltic Sea
23. Celtic-Biscay Shelf
24. Iberian Coastal
25. Mediterranean Sea
26. Black Sea
27. Canary Current
28. Guinea Current
29. Benguela Current
30. Agulhas Current
31. Somali Coastal Current
32. Arabian Sea
33. Red Sea
34. Bay of Bengal
35. South China Sea
36. Sulu-Celebes Seas
37. Indonesian Seas
38. Northern Australian Shelf
39. Great Barrier Reef
40. New Zealand Shelf
41. East China Sea
42. Yellow Sea
43. Kuroshio Current
44. Sea of Japan
45. Oyashio Current
46. Sea of Okhotsk
47. West Bering Sea
48. Faroe Plateau
49. Antarctic

Fig. 1. Boundaries of 49 large marine ecosystems.

These LME's produce 95 percent of the annual global fisheries biomass yields; reports on the changing states of biomass yields and health have been published for 29 of the LMEs (Sherman 1994). The assessments of the changing states of LMEs are based on information obtained from five operational modules that link science-based information to socioeconomic benefits for countries bordering on LMEs. The modules are focused on ecosystem (1) productivity, (2) fish and fisheries, (3) pollution and health (4) socioeconomic conditions, and (5) governance protocols.

Productivity Module

Productivity can be related to the carrying capacity of the ecosystem for supporting fish resources (Pauly and Christensen 1995). Recently it has been reported that the maximum global level of primary productivity for supporting the average annual world catch of fisheries has been reached, and further large-scale 'unmanaged' increases in fisheries yields from marine ecosystems are likely to be at trophic levels below fish in the marine food chain (Beddington 1995). Evidence of this effect appears to be corroborated by the recent changes in the species composition of the catches of fisheries from the East China Sea LME (Chen and Shen 1995). Measurement of ecosystem productivity can also serve as a useful indication of the growing problem of coastal eutrophication (NSQSR 1993). In several LMEs, excessive nutrient loadings of coastal waters have been related to algal blooms that have been implicated in mass mortalities of living resources, emergence of pathogens (e.g. cholera, vibrios, red tides, paralytic shellfish toxins) and explosive growth of non-indigenous species (Epstein 1993).

The ecosystem parameters measured in the productivity module are zooplankton biodiversity and information on species composition, zooplankton biomass, water column structure, photosynthetically active radiation (PAR), transparency, chlorophyll-*a*, NO_2, NO_3, and primary production. The plankton of LMEs can be measured by deploying Continuous Plankton Recorder (CPR) systems from commercial vessels of opportunity (Glover 1967). The advanced plankton recorders can be fitted with sensors for temperature, salinity,chlorophyll, nitrate/nitrite, petroleum, hydrocarbons, light, bioluminescence, and primary productivity (Aiken 1981; Aiken and Bellan 1990; Williams and Aiken 1990; UNESCO 1992; Williams 1993), providing the means to monitor changes in phytoplankton, zooplankton, primary productivity, species composition and dominance, and long-term changes in the physical and nutrient characteristics of the LME, as well as longer term changes relating to the biofeedback of the plankton to the stress of environmental change (Colebrook 1986; Dickson 1988; Williams 1993).

The fish and fisheries module

Changes in biodiversity among the dominant species within the fish communities of LMEs have resulted from excessive exploitation (Sissenwine and Cohen 1991), naturally occurring environmental shifts in climate regime (Bakun 1993) or coastal pollution (Mee 1992; Bombace 1993). Changes in the biodiversity of the fish community can generate cascading effects up the food chain to apex predators and down the food chain to plankton components of the ecosystem (Overholtz and Nicolas 1979; Payne et al.1990). These three sources of variability in fisheries yield are operable in most LMEs. However, they can be described as primary, secondary, and tertiary driving forces in fisheries yields, contingent on the ecosystem under investigation. For example, in the Humboldt Current, Benguela Current, and California Current LMEs, the primary driving force influencing variability in fisheries yield is the influence of changes in upwelling strength (Bakun 1995,1993, MacCall 1986, Crawford 1989; Alheit and Bernal 1993) fishing and pollution effects are secondary and tertiary effects on fisheries yields. In continental Shelf LMEs including the Yellow Sea and Northeast US Shelf, excessive fisheries effort has been the cause of large-scale declines in catch and changes in the biodiversity and dominance in the fish community (Tang 1993; Sissenwine 1986). In these ecosystems, pollution and environmental perturbation are of secondary and tertiary influence. In contrast, significant coastal pollution and eutrophication have been the principal factors driving the changes in fisheries yields of the Northwest Adriatic (Bombace 1993), the Black Sea (Mee 1992), and the near coastal areas of the Baltic Sea (Kullenberg 1986). Overexploitation and natural environmental changes are of secondary and tertiary importance. Consideration of the driving forces of change in biomass yield is important when developing options for management of living marine resources for long-term sustainability.

The Fish and Fisheries module includes fisheries-independent bottom trawl surveys and acoustic surveys for pelagic species to obtain time-series information on changes in biodiversity and abundance levels of the fish community. Standardized sampling procedures, when deployed from small calibrated trawlers, can provide important information on diverse changes in fish species. The fish catch provides biological samples for stock assessments, stomach analyses, age, growth, fecundity, and size comparisons (ICES C.M. 1991), data for clarifying and quantifying multispecies trophic relationships, and the collection of samples to monitor coastal pollution. Samples of trawl-caught fish can be used to monitor pathological conditions that may be associated with coastal pollution. The trawlers can also be used as platforms for obtaining water, sediment, and benthic samples for monitoring harmful algal blooms, virus vectors of disease, eutrophication, anoxia, and changes in benthic communities.

Pollution and ecosystem health module

In several LMEs, pollution has been a principal driving force in changes of biomass yields. Assessing the changing status of pollution and health of the entire LME is scientifically challenging. Ecosystem 'health' is a concept of wide interest for which a single precise scientific definition is problematical. Methods to assess the health of LMEs are being developed from modifications to a series of indicators and indices described by several investigators (Costanza 1992; Rapport 1992; Norton 1992; Karr 1992). The over-riding objective is to monitor changes in health from an ecosystem perspective as a measure of the overall performance of a complex system (Costanza 1992). The health paradigm is based on the multiple-state comparisons of ecosystem resilience and stability (Holling 1986; Pimm 1984; Costanza 1992) and is an evolving concept.

Following the definition of Costanza 1992 to be healthy and sustainable, an ecosystem must maintain its metabolic activity level, its internal structure and organization, and must be resistant to external stress over time and space scales relevant to the ecosystem. These concepts were discussed by panels of experts at 2 workshops convened in 1992 by NOAA (NOAA 1993). Among the indices discussed by the participants were five that are being considered as experimental measures of changing ecosystem states and health: (1) biodiversity; (2) stability; (3) yields; (4) productivity; and (5) resilience. The data from which to derive the experimental indices are obtained from time-series monitoring of key ecosystem parameters. An effort to validate the utility of the indices is under development by NOAA at the Northeast Fisheries Science Center. The ecosystem sampling strategy is focused on parameters relating to the resources at risk from overexploitation, species protected by legislative authority (marine mammals), and other key biological and physical components at the lower end of the food chain (plankton, nutrients, hydrography). The parameters of interest are described in Sherman (1994) and include zooplankton composition, zooplankton biomass, water column structure, photosynthetically active radiation (PAR), transparency, chlorophyll-*a*, NO_2, NO_3, primary production, pollution, marine mammal biomass, marine mammal composition, runoff, wind stress, seabird community structure, seabird counts, finfish composition, finfish, biomass, domoic acid, saxitoxin, and paralytic shellfish poisoning (PSP). The experimental parameters selected incorporate the behavior of individuals, the resultant responses of populations and communities, as well as their interactions with the physical and chemical environment. The selected parameters provide a basis for comparing changing health status among ecosystems.

Fish, benthic invertebrates and other biological indicator species are used in the Pollution and Ecosystem Health module to measure pollution effects on the ecosystem including the bivalve monitoring strategy of 'Mussel-Watch', the pathobiological examination of fish (Goldberg 1976; Farrington et al. 1983; ICES 1988; O'Connor et al. 1991; White and Robertson 1996) and the estuarine and nearshore monitoring of contaminants in the water column, substrate, and selected groups of organisms. An important component of the associated research to support the assessment is the definition of routes of exposure to toxic contaminants of selected finfish and shellfish and the assessment exposure to toxic chemicals by several life history stages. The routes of bioaccumulation and trophic transfer of contaminants is assessed, and critical life history stages and selected food-chain organisms are examined for a variety of parameters that indicate exposure to, and effects of, contaminants. Contaminant-related effects measured include diseases, impaired reproductive capacity, and impaired growth. Many of these effects can be caused by direct exposure to contaminants, or by indirect effects, such as those resulting from alterations in prey organisms. The assessment of chemical contaminant exposure and effects on fisheries resources and food-chain organisms consists of a suite of parameters, including biochemical responses that are clearly linked to contaminant exposure coupled with measurements of organ disease and reproductive status that have been used in previous studies to establish links between exposure and effects. The specific suite of parameters measured will cover the same general responses and thus allow for comparable assessment of the physiological status of each species sampled as it relates to chemical contaminant exposure and effects at the individual species and population level. The implementation of protocols for assessing the frequency and effect of harmful algal blooms (Smayda 1991) and emergent diseases (Epstein 1993) are included in the pollution module.

The socioeconomic module

This module is characterized by its emphasis on practical applications of its scientific findings in managing the LME and on the explicit integration of economic analysis with the science-based assessments to assure that prospective management measures are cost-effective. Economists and policy analysts will need to work closely with ecologists and other scientists to identify and evaluate management options that are both scientifically credible and economically practical.

The economic and management research will be closely integrated with the science throughout, and is designed intentionally to respond adaptively to enhanced scientific information. This component of the LME approach to marine resources management was developed by the late James Broadus, former Director of the Marine Policy Center, Woods Hole Oceanographic institution. It consists of six interrelated elements:

(1) **Human forcing functions**

The natural starting point is a generalized characterization of the ways in which human activities affect the natural marine system and the expected 'sensitivity' of these forcing functions to various types and levels of human activity. Population dynamics, coastal development, and land-use practices in the system's drainage basin are clear examples. Work integrating the efforts of natural and social scientists should concentrate further on resolving apparent effects (such as eutrophication-associated red tide events or changing fish population structures) that are confounded by cycles or complex dynamics in the natural system itself. Progress is possible, too, in achieving better characterizations of the way in which human forcing is mediated by alternate management options. Emphasis should be on isolating and quantifying those forcing activities (sewage discharge, agricultural runoff, fishing effort) likely to be expressed most prominently in effects on the natural system.

(2) **Assessing Impacts**

Another natural element in the systemic approach is to estimate and even predict the economic impacts of unmanaged degradation in the natural system and, obversely, the expected benefits of management measures. Such assessment is a form of standard benefit-cost analysis, but it requires scientific information to describe the effects of human forcing so they may be quantified in economic terms. Initial analysis should focus on the social and economic sectors likely to experience the largest impacts: fishing, aquaculture, public health, recreation, and tourism.

(3) **Feedbacks**

Collaborative effort should also be devoted to identifying and estimating the feedbacks of economic impacts into the human forcing function. Extensive coastal eutrophication, for example, associated with coastal development and runoff, might reduce the suitability of coastal areas for aquaculture production and increase its exposure to red tide damage, thereby putting a premium on capture fishery and increasing pressure on wild stocks. Similar feedbacks, both negative and positive, should be addressed and expressed in economic terms for all the major sectors.

(4) **Ecosystem Service/The Value of Biodiversity**
Special consideration should be given to improved knowledge of how the natural system generates economic values. Many valuable services provided by natural systems are not traded in markets or included in planning evaluations, so extra care must be made to assure that they are not sacrificed through ignorance. The services provided by coastal wetlands as nurseries for fisheries, natural pollution filters, and storm buffers are well-known examples that have particular relevance to coastal reclamation activities. Other examples are more subtle, including the importance of predator-prey relationships and the possibility of losing unrecognized 'keystone' species in a valuable ecosystem. Experience indicates that growing economic values on aesthetic and recreational/tourism amenities are to be expected in the LMEs. A variety of sources of economic value arising from the natural diversity of the LME should be identified and assessed in regard to existing uses and potential management innovations.

(5) **Environmental Economics**
Many of the elements described in this section comprise topics in Environmental Economics. Specialists in that field attempt to estimate the economic values (both use and non-use) associated with environmental resources and to identify the conditions associated with their optimal management (to derive the greatest net benefits for society). An important element is the collaboration between scholars from developing nations and those from the developed countries to transfer and adapt to the needs and techniques of Environmental Economics.

(6) **Integrated Assessment**
The ultimate objective is the integration of all the results achieved above, with scientific characterizations of the LME, into a comprehensive analytic framework (decision support environment) that will permit integrated assessment of human practices, effects, and management options in the region. Such work is at the forefront of recent research on the human dimensions of global environmental change as well as research on human interactions with natural marine systems.

Governance module

The Governance module is evolving based on case studies now underway among ecosystems to be managed from a more holistic perspective in projects supported by the Global Environmental Facility (GEF), including the Yellow Sea Ecosystem, where the principal effort is underway by the Peoples Republic of China (Tang 1989) and South Korea (Zhang and Kim 1997), and also for the Gulf of Guinea LME by Ivory Coast, Ghana, Nigeria, Benin and Cameroon (UNIDO 1997), and by the governments of South Africa, Namibia and Angola to conduct joint assessments of the resources of the Benguela LME to guide the development of the shared resources of the ecosystem to ensure their long-term sustainability, particularly with regard to food security. The Great Barrier Reef Ecosystem is also being managed from an holistic ecosystems perspective (Bradbury and Mundy 1989; Kelleher 1993) along with the Northwest Australian Continental Shelf Ecosystem (Sainsbury 1988) under management by the state and federal governments of Australia; and the Antarctic marine ecosystem under the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and its 21 nation membership (Scully et al. 1986; Sherman and Ryan 1988). Movement toward ecosystems management is emerging for the North Sea (NSQSR 1993), the Barents Sea (Eikeland 1992), and the Black Sea (Hey and Mee 1993).

4. FAST TRACK LME AND INTEGRATED COASTAL MANAGEMENT (FTICM-LME) PROJECTS

A framework for linking science-based assessments of the changing states of coastal ecosystems also guiding environmentally sound economic development of ecosystem resources and management practices is now emerging from a series of regional efforts aimed at cross-sectoral integration of assessments of coastal productivity, fish and fisheries, and pollution and ecosystem health, with socioeconomics and governance modules. The application of the modules is being supported, in part, by grants from the GEF in collaboration with national governments of countries bordering large marine ecosystems in Asia, Africa, Central and South America, and eastern Europe.

The GEF Operational Strategy calls for the development and implementation of projects in the International Waters Program that can achieve global benefits through the implementation by countries of more comprehensive approaches for restoring and protecting the "International Waters" (IW) environment. The goal of the IW program *"is to assist countries in making changes in the ways that human activities are conducted in different sectors so that the particular water body and its multi-country drainage basin can sustainably support human activities."* The GEF has placed priority on *changing sectoral policies and activities responsible for the most serious root causes of transboundary environmental concerns* and *determining the expected baseline and additional actions needed to resolve each priority concern. Based on the countries' commitments to change sectoral policies or activities and to find baseline investments, the GEF may fund the agreed incremental cost of additional measures* (GEF 1997). One of the focal areas for funding by the GEF is to mitigate stressors on Large Marine Ecosystems, and promote priority actions for improving environmental quality and the sustainable development of resources within LMEs important to the economic growth and food security of developing countries in Asia, Africa, Central and South America and eastern Europe.

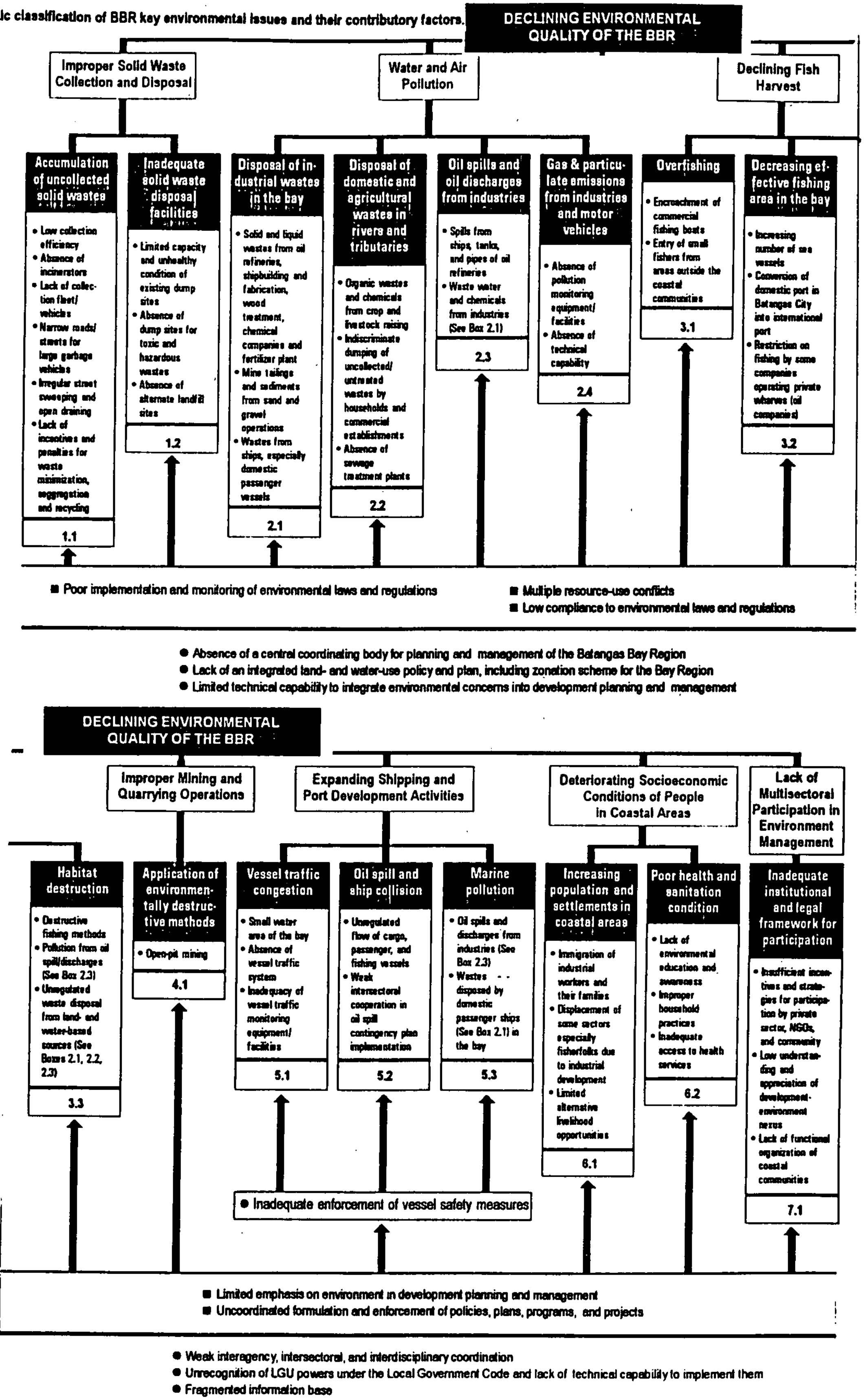
It is important to strengthen the linkages between science and management for the drainage basins and near coastal and geographic extent of the LMEs, and also to improve on the methodologies for ensuring that near coastal and drainage basin effects on the LME proper are included in the overarching strategy for a systems approach to a management strategy that includes: (1) drainage basin, (2) near coastal, and (3) offshore coastal components of the LME.

Two model systems can be used to fill this pressing need for improved assessment strategies: the Batangas Bay model in the Philippines and the Xiamen Municipality model in China. Both were developed as demonstration projects in Integrated Coastal Management (ICM). The projects are part of the Global Environmental Facility/UNDP/International Maritime Organization's Regional Programs for the Prevention and Management of Marine Pollution in the East Asian Seas (Environment and Natural Resources Office of the Provincial Government of Batangas, 1996). The approach provides a framework for management of the coast of the Batangas Bay region of the Province of Batangas in the Philippines. It includes guidelines for the implementation of a core program of: (1) integrated waste management, (2) water pollution abatement, (3) conservation of stressed mangrove and coral reef areas, (4) coastal tourism development, and (5) improvements of the municipal fisheries. Special support programs addressing interests of the stakeholders of the region have been developed and are being implemented for: (1) development of legal and institutional mechanisms for ICM, (2) strengthening of provincial integrated planning and resource management, (3) improvement of policy support systems, (4) upgrading of monitoring and enforcement capabilities, (5) capacity building in technology transfer and coastal management, (6) community outreach, (7) establishment of a multisectoral information, education, and communication system, (8) expansion of research and extension activities, (9) establishment of a management information system, and (10) development of sustainable financing mechanisms. A list of the key environmental management issues that are the root cause of the declining environmental quality of the region is given in Table 1.

Table 1. Key environmental management issues in Batangas Bay Region.		
AREA OF CONCERN	ISSUES	CONTRIBUTORY FACTORS
Solid Waste Generation, Collection, and Disposal	Accumulation of uncollected solid waste Lecheate pollution Indiscriminate mixing of solid waste and toxic and hazardous wastes	Inadequate dump sites Low collection efficiency Random dumping of uncollected waste Indiscriminate dumping from domestic passenger ships Absence of incinerators Lack of collection fleet/vehicles Narrow roads/streets for large garbage vehicles Irregular street sweeping and open-drain cleaning Lack of incentives and penalties for waste minimization, segregation, and recycling
Water and Air Pollution	Increased threats of oil discharges from industries and oil spill from heavy vessel traffic Disposal of untreated agricultural (poultry, piggery and farmland) and industrial wastes into tributaries and coastal waters Disposal of untreated sewage into coastal waters Habitat destruction/loss, especially the coral reefs	Oil spill from ships, tanks, and pipes of oil refineries Oily wastes from oil refineries, shipyard, and marine construction industries Gas and particulate emissions from industrial and power-generating plants and motor vehicles Organic wastes and chemicals from crop and livestock raising Mine tailings and sediments from mining and quarrying operations Destructive fishing methods Indiscriminate dumping of households and commercial establishments Absence of sewage treatment plants Poor enforcement and monitoring of environmental laws and regulations
Municipal Fishing	Declining fish harvest Decreasing effective fishing area in the Bay Reduced income	Inappropriate fishing methods Overfishing Pollution from oil spill Encroachment of commercial fishing Unregulated waste disposal from land- and water-based sources Conversion of Batangas port to international port
Mining and Quarrying	Unregulated environmentally destructive practices	Application of open-pit mining method Lack of enforcement of environmental laws
Shipping and Port Development	Vessel traffic congestion Oil spill and ship collision Marine pollution	Small water area of the bay Incompatibility with some land and water uses of the bay Unregulated flow of cargo, passenger and fishing vessels Poor enforcement of vessel safety measures Absence of vessel traffic system Inadequacy of vessel traffic monitoring equipment Weak intersectoral cooperation in oil-spill contingency plan execution
Human Settlements and Population Growth, Especially in Coastal Areas	Increasing settlements along coastal areas Poor health and sanitary conditions	In-migration of industrial workers and their families Limited alternative livelihood opportunities Improper household practices Inadequate health facilities and services
Participation of Private Sector and Nongovernment Organizations in Environmental Management	Lack of effective and sustained participation	Inadequate institutional and legal framework for participation and empowerment Insufficient incentive mechanisms for participation Lack of functional organization of coastal communities Low understanding and appreciation of development-environment nexus
Integrated Policies, Plans, Programs, and Institutional Support	Limited emphasis on environment in development planning and management Uncoordinated formulation and enforcement of policies, plans, programs, and projects Occurrence of resource-use conflicts Low compliance to environmental laws and regulations	Absence of a central coordinating body for planning and development of the Batangas Bay Region Lack of an integrated land- and water-use policy and plan, including zonation scheme for the bay region Limited technical capability to integrate environmental concerns into development planning and management Most local planners have no formal training on environmental management Weak interagency, intersectoral and interdisciplinary coordination Unrecognition of LGU powers under the Local Government Code and lack of technical ability to implement them Fragmented information base Poor law enforcement and monitoring of its compliance.

* Table 1 excerpted from PG-ENRO 1996 (as cited under References)

e 2. Systematic classification of BBR key environmental issues and their contributory factors.



* Figure 2 excerpted from PG-ENRO 1996 (as cited under References)

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A CASE STUDY OF A SPECIFIC TOOL TO FOLLOW PARTICULATE MATTER AND POLLUTION CARRIED BY PARTICLES FROM THE RHONE RIVER TO THE NW MEDITERRANEAN SEA

Mary-Hélène NOËL, Post-Doctoral researcher,
presentation of results from the Ph.D. work carried out in France at CNRS-URA 386.
Present address: National Institute for Environmental Studies, Water and Soil Division, 16-2 Onogawa, Tsukuba, IBARAKI, 305 JAPAN, E-mail: noel@nies.go.jp

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I. Introduction and description of the problem:

The surface area of the coastal seas is limited, with only 7% of the ocean surface. Although, the coastal seas are central to processes such as up-welling, primary production, sedimentation, biological activity and play a key role in the cycling of elements between the land and open sea systems. Coastal seas are highly exposed to human activity and use, with the introduction of domestic and industrial waste, agriculture derived products (e.g. fertilisers, pesticides). The fishery activities, aqua-culture, marine transportation and leisure activities have the potential to induce ecosystem disequilibrium of the coastal seas and be sources of pollution.

Coastal seas receive supplies from:

⇒ rivers (freshwater as a carrier of natural compounds and pollutants),
⇒ marine circulation (marine water mass as a carrier of land derived, atmospheric derived and biological derived compounds),
⇒ direct atmospheric fallout on the sea surface,
⇒ biological products derived inside the water column and sediments.

The complexity of this ecosystem results from of the interaction between hydrodynamic, biological, physical and chemical conditions and behaviour. To understand the coastal seas responses to different uses and purposes, in the short and long term, we need to adopt a qualitative, quantitative and integrated approach. The main difficulty is specifying the source of the pollutant after its introduction into the environment as well as the long-term time scale.

Developing a methodology as specific as possible which allows the course of river pollutants to be traced into coastal seas is critical for environmental policy decisions in the future.

II. The Rhone River and the Gulf of Lions presented as a case study:

The Mediterranean Sea is a half-enclosed system, which is particularly sensitive to contamination (high population density and concentration of industries along the shore). At present, the Rhone River (France), is the most important freshwater supply into the Mediterranean Sea. For the period from 1960-1993 its water discharge was 5.34×10^{10} m^3/y (1) and the solid discharge was 3.6×10^6 t/y with a range between 0.7×10^6 to 12×10^6 t/y (2). The Rhone River can be considered as the major source of anthropogenic pollutants because of the high concentration of industrial facilities located in its watershed. Many dams, derivations and hydroelectric plants have been build along the Rhone River, essentially before the 1960's. Considering the river as a carrier of pollutants and particulate matter transportation once the main constructions were build, it is becoming important to understand its significance in terms of modern supply quantity and distribution into the Gulf of Lions (Figure 1). Moreover, the sea-bed bottom morphology and hydrodynamic conditions of this Gulf provides the opportunity for a case study of particulate matter dispersion from the river to the sea. The methodology proposed is to use a specific tracer of the particulate matter source, which gives an indirect way of tracing the particulate matter and its associated pollutants.

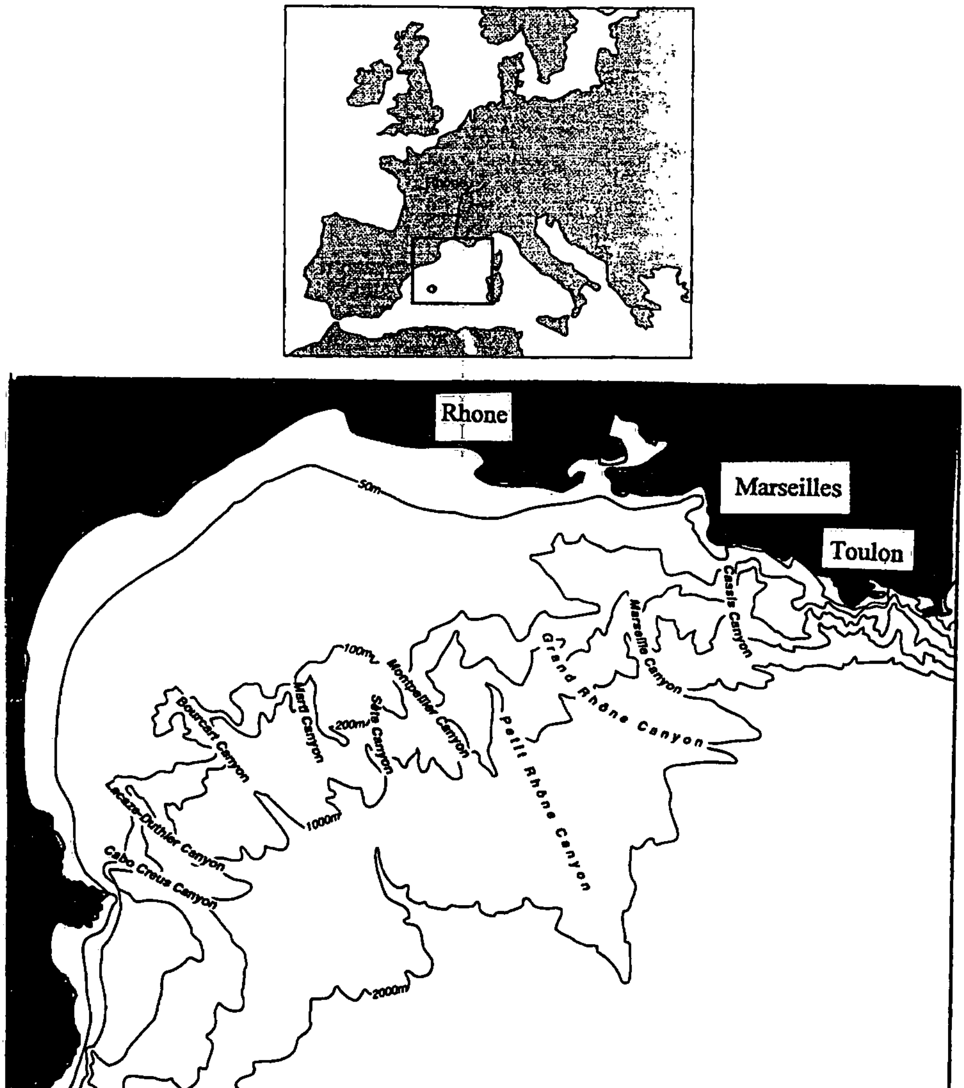

Figure 1: Gulf of Lions with isobathymetric contours and the location of canyons

The ^{238}Pu isotope carried by the Rhone River fulfils the conditions for tracing its particulate matter to the sea, mainly by using the ratio of $^{238}Pu/^{239,240}Pu$.

The characteristics of the plutonium isotopes which are relevant for the tracer are as follows:

a) high particulate matter affinity (partition coefficient between dissolved and particulate phase, $K_d > 10^5$) (2)(3);
b) specific isotopic ratio $^{238}Pu/^{239,240}Pu$ of the Rhone River supply (0.20 ± 0.02) in comparison with the global fallout ratio (0.032 ± 0.01, (2)(4)). This in particular is due to the industrial effluent discharge compositions (mainly ^{238}Pu, 1954-1990 integrated ratio of 0.24 ± 0.02, close to 0.3 (5)(6)(7)) from the nuclear reprocessing plant located at Marcoule (210 km from the mouth);
c) starting point of the introduction of the industrial effluents in 1958 and 1954 for the global fallout, which are synchronous with the achievement of the main modification of its watershed;
d) insignificant reactivity of plutonium isotopes in the freshwater/seawater mixing zone, as well as post-sediment incorporation (8)(9)(10)(11)(12)(13)(14)(15);
e) a long enough half-life period (24 360 years for $^{239,240}Pu$ and 86.4 years for ^{238}Pu);
f) high sensitivity of detection by using alpha-emitter characteristics of the plutonium isotopes (less than 10^{-15} g/g).

The feasibility of this very specific tracer has been tested. Data required was obtained from calculations, estimations and measurements since there are only few publications of direct data available (16). The integrated plutonium flux from the different sources to the Gulf of Lions has been determined for the total tracing period i.e. 1954-1990 (Table 1). The global fallout over the study area is reconstructed on the basis of British monitoring data. A watershed model of the plutonium accumulated in soils which is transferred into the river is made and calibrated with sampling measurement data. The industrial plutonium of the Rhone River, supplied by the Marcoule nuclear reprocessing plant, was calculated by using available dissimilar data and the plutonium/caesium ratio of the effluents.

Origin of plutonium source to the Gulf of Lions	Integrated flux in GBq		Ratio
	^{238}Pu	$^{239,240}Pu$	$^{238}Pu/^{239,240}Pu$
Atmospheric Pu recycled by the watersheds, (Rhone upstream of the reprocessing plant and the Languedoc-Roussillon rivers)	3 ± 1	97 ± 29	0.032 ± 0.01
Industrial Pu from Marcoule reprocessing plant effluents discharged into the Rhone River	105 ± 9	435 ± 9	0.24 ± 0.02
Direct atmospheric fallout, deposition on the Gulf of Lions' seawater surface	32 ± 10	948 ± 284	0.032 ± 0.01

Table 1: 1954-1990 integrated plutonium flux to the Gulf of Lions

The total integrated telluric supply of plutonium to the Gulf of Lions from 1954 to 1990 is calculated to be **140 ± 10 GBq** in **^{238}Pu** and of **1480 ± 300 GBq** in **$^{239,240}Pu$**. It will be used to compare the marine sediment plutonium flux accumulation with the sources.

III. Distribution of the modern particulate matter from the Rhone River into the Gulf of Lions (1954-1990):

Plutonium content inventories of marine sediments were obtained from suitable sediment sampling and analysis. According to the plutonium sources and sediment content characteristics, the Rhone River's contribution has been calculated. The relations used for the calculations are based on the plutonium isotopes ratios (provide information on the origin of the source) and the integrated plutonium concentrations. The plutonium tracer gives the possibility to calculate specifically the Rhone's particulate matter accumulated in the marine sediment during the period from 1954 to 1990.

At least 50 % of the total Rhone's particulate matter supply into the Gulf remains in the vicinity of the river mouth. Nearly 30 % is distributed over the continental shelf after mixing. The plutonium content characteristics of two marine sediment cores led to the conclusion of a poor mixing of the Rhone River material supply with the other particulate matter sources (Figure 2). Thus, a 'direct connection' with the river material supply accumulation is shown. Two places in particular has been found although it is possible that more sites exist but were not sampled. Further investigations are necessary since such a pattern has been revealed. The first anomaly in the accumulation pattern is located on the continental shelf, 150 km from the mouth along the 100 m depth isobath and is close to a gyre current system. A sediment core located 20 km from the river mouth on the same isobath shows a similar plutonium fingerprint.

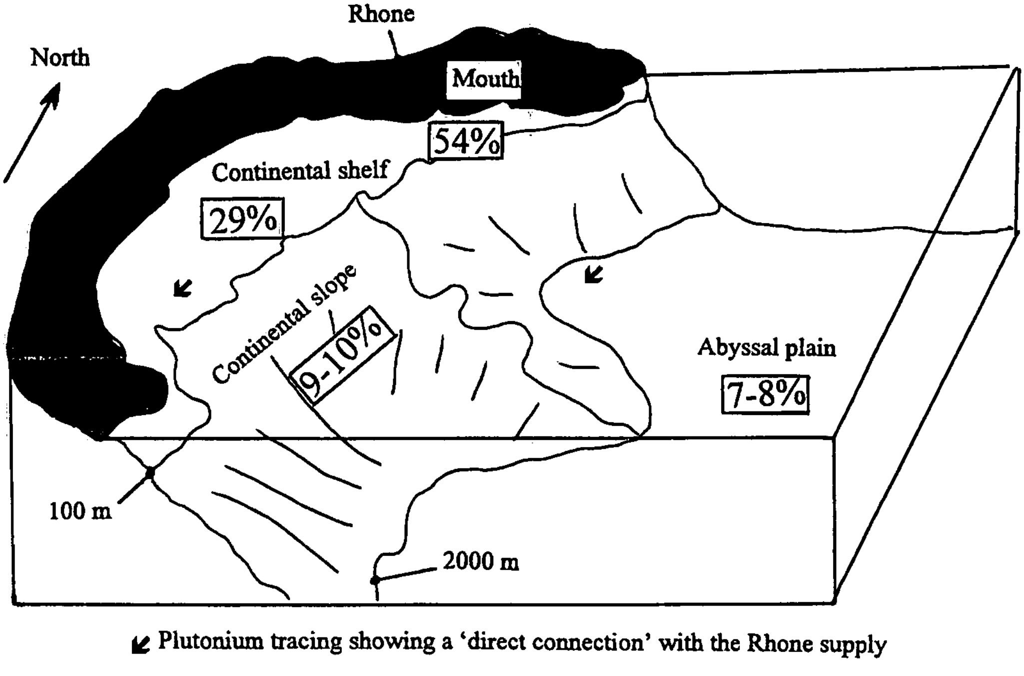

Figure 2: Rhone's particulate matter accumulation in the Gulf of Lions

A sediment pathway along the 100 m depth isobath, supported by the water column marine currents hydrodynamics drawn for certain conditions (17) is thus suspected. The plutonium tracing is an integration of 40 years sediment accumulation. This particulate matter transportation and accumulation near an anticyclonic current system can be the sum of temporal but significant processes. The second place showing a 'direct connection' to the Rhone River supply is located far from the river mouth, in the abyssal plain at a depth of 2230 m. This spot could be connected with the lay-out of a canyon from the sea-bed bottom morphology. Thus, the distance from the source does not seem to be the main criteria for such transportation. This result highlights the role of geomorphology of the sea-floor (canyons) and hydrodynamic conditions (main direction of currents, gyres...) in particulate matter accumulation processes over a time scale of 40 years. Without the high specificity of this tracing method, this 'direct connection' would not have been revealed.

IV. The plutonium as a case of a pollutant budget in a continental margin:

Plutonium isotopes used as a tracer in this study are first of all anthropogenic pollutants. The plutonium flux accumulated in the continental margin sediments of the Gulf of Lions is calculated from the corresponding sediments cores plutonium content and their surface of deposition. The total surface of this margin is 22000 km^2 and the plutonium flux budget is based on 12 sediment cores. According to the Rhone's sediment distribution, the prodelta has an important contribution to the total particulate matter accumulation budget. But the surface delimitation of this area needs more intensive sampling as the heterogeneity is high. And in addition, deeper cores are required since 12 m depth core is not sufficient to reach a depth without plutonium isotopes. Therefore, the prodelta area has been disregarded from the plutonium flux budget of the margin to avoid any over-estimation. Thus, the budget calculated here is minimal; the total plutonium flux accumulated up to 1990 is 196 GBq in ^{238}Pu and 2925 GBq in ^{239,240}Pu.

Plutonium supply and accumulation in the continental margin sediments	Plutonium flux in GBq	
	^{238}Pu	^{239,240}Pu
Σ watersheds, direct fallout to the Gulf of Lions	140	1480
Margin sediment accumulation (without prodelta)	> 196	> 2925
Margin sediment excess of Pu accumulation	**55**	**1445**
^{238}Pu/^{239,240}Pu ratio of the excess	**^{238}Pu/^{239,240} Pu 0.038**	

Table 2: Flux budget of plutonium supplies and accumulation by the marine sediments of the continental margin of the Gulf of Lions, excluding the prodelta of the Rhone River

The plutonium flux accumulated by the continental margin sediments exhibits an excess when compared with the continental supplies (sum of the watershed atmospheric plutonium recycling, industrial discharges and direct atmospheric fallout), even though this budget is minimal as the prodelta has been discarded from the calculation (Table 2). Different hypotheses to explain this excess has been tested (2). The 'fingerprint' obtained from the plutonium isotopic ratio (0.038) lead to the conclusion of an atmospheric derived supply. This is the case of the ratio ^{238}Pu/^{239,240}Pu of the Mediterranean seawater (i.e. 0.04) which therefore can be the supplier of the additional plutonium accumulated by the marine sediments. The Gulf of Lions has a strong marine current which runs alongside the continental slope (called the Liguro-Provencal current). At the depth of contact between this marine current vein and the continental slope, the plutonium profiles exhibit an inverse pattern compared with all of the other sampling locations (shelf, top and bottom of the slope, abyssal plain) (Figure 3).

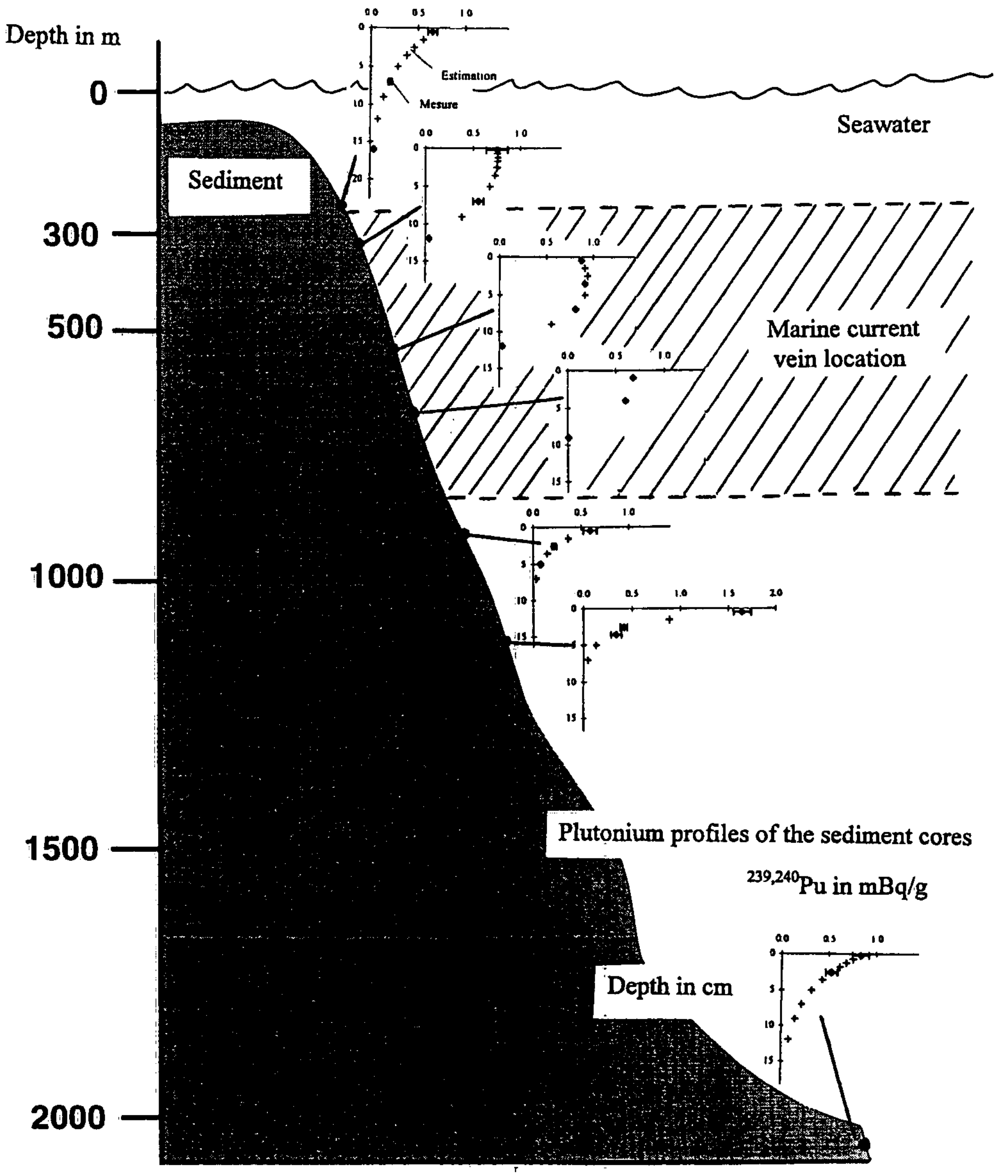

Figure 3: Plutonium profiles differentiation at the depth of the marine current contact

The mechanism which leads to the development of such profiles within the sediment cores is not yet explained. But as they are only located at the depth of contact with the marine current vein, the latter seems to play an active role in the continental margin particulate matter accumulation processes. From the available plutonium concentration data of the Mediterranean seawater and the velocity of this current, 1.8×10^6 m^3/s (18), the corresponding potential supply of dissolved plutonium to the Gulf of Lions is estimated at 2840 GBq in ^{238}Pu and 67440 GBq of ^{239,240} Pu for the tracing duration. Such a flux is important because of the high velocity of the current (1000 fold of the Rhone water discharge and equivalent to the velocity of the Strait of Gibraltar). The biological activity which take place in the water column (19)(20)(21), the colloids (13) and the particulate matter in sedimentation (22) are able to realise the dissolved/particulate transfer of the plutonium content from this current water mass to the bottom. The intrusion of this marine current inside the Gulf of Lions is not systematic and occurs under special hydrodynamic and wind conditions. Consequently, it is difficult to obtain a direct estimate of the real contribution of this marine source to the continental margin. Less than 2 % scavenging of the estimated dissolved plutonium content of the marine current with accumulation inside the continental margin sediments equilibrates the plutonium budget and produces the correct $^{238}Pu/^{239,240}Pu$ ratio. 2 % of transfer is a realistic estimation with regard to the processes involved and the intrusion probability of the current inside the continental margin area. Such a transfer is in agreement with the high sedimentation rate of biogenic particulate matter recorded near the Corsica coast with 19 to 57 $m.d^{-1}$ (23) and with the lateral advection hypothesis inside the Lacaze-Duthiers canyon (24). Therefore, the scavenging does not seem to be limited to one canyon but is significant over the entire continental margin. Thus, the marine current as a potential supplier inside the balance of the sediment accumulation of the continental margin over 40 years is highlighted.

V. Conclusion with generalisations to the global coastal sea environment:

Particulate matter discharged from the river is distributed mainly in the coastal areas where human activities and numerous natural processes occur (e.g. up-welling zones, primary production). The environmental quality of coastal areas is consequently not only dependent on the particulate discharge of rivers. With the plutonium budget, this is the first time that a quantitative approach has been made which shows that the Gulf of Lions can be considered as a sink for the plutonium rather than a source to the open sea. Such behaviour is in agreement with the plutonium sediment accumulation of other marginal areas in the United States (25)(12)(26). Moreover, the balance budget of the plutonium accumulated inside the continental margin has enhanced the marine source. Therefore, this result tends to lower the contribution of the continental supplies. Consequently, the pollutant accumulation found inside the continental margin sediments can be provided either by local sources (river discharges) or global sources (atmospheric fallout, marine recycling). Dissolved pollutant supplies from river discharges and global atmospheric fallout (in the open sea) supplied by the marine current water masses can be trapped inside continental margin sediments, most likely through scavenging processes. In global ocean margins, such behaviour has been stressed for dissolved trace metals (Cd, Cu, Ni and Zn)(27). The scavenging highlighted by the plutonium budget should also occur for other contaminants with high particulate affinity. Continental margin areas have therefore to be considered as an active link between the continent and the open sea. Results of particulate matter tracing by plutonium isotopes from the Rhone into the Gulf of Lions can be considered as a case study of the continental margin pollutant transfer processes which emphasise marine recycling.
Policies of waste treatment, watershed management, air pollution control, and even the depository location of pollutant containers in the deep-sea must take into account the marine coastal resources and the health of the ecosystem. It is important to be aware of local discharges, but also global contamination which can both be accumulated in the continental margins. Pathways and time scales are different but have to be included in long term management policy to gain efficient results.

In addition, to be able to obtain the budget balance between the different sources, a data-base of basic measurements is required (e.g. freshwater and particulate matter flux, rain precipitation over the sea, directions and strength of currents). The accuracy of the budget, balance and predictions are dependent on the quality of such a data-base and the time span. The response of the coastal seas could be rapid or not depending on the changes which have occurred (water or particulate content quality and quantity). Therefore, data-bases collected over as long a time period as possible and at regular intervals is required.

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WORKSHOP 2:

MODELS AS TOOLS FOR ECOSYSTEM UNDERSTANDING, COMMUNICATION, MANAGEMENT, AND RESTORATION

Dr Lars Hedin, USA (Chairman)
Mr Lars Rahm, Sweden (Rapporteur)

INTRODUCTION

There is no question that models are becoming one of the most important and widespread scientific tools in environmental sciences. And yet, there are great dangers associated with the uncritical application of models to environmental and ecological problems. Our work group entertained a general discussion of both prospects and limitations of models, and we discussed a series of case-studies presented by each workshop participant. Overall, we concluded that conferences such as the Stockholm Water Symposium and EMIECS can in the future play an important role by enhancing discussion of model applications and by building critically needed bridges between modelers and managers or empirical scientists.

Individual workshop presentations focused primarily on rivers, estuaries, and enclosed coastal ecosystems. There was emphasis on three coastal regions: the Baltic Sea, the Black Sea, and Japanese estuarine areas including the Seto Inland Sea. The presented models ranged broadly from hydrodynamic transport models, to more complex coupled hydrodynamic-ecological models, and also included a few efforts to explicitly include economic parameters in cost-benefit analyses. Models from regions with intensive aquaculture and fisheries, such as Japan and Malaysia, mainly focused on understanding the formation and movement of anoxic water masses. In contrast, understanding of eutrophication and the movement of limiting nutrients were the most common themes for studies in the Baltic and the Black Seas, and for studies of nutrient sources within large river basins.

PROSPECTS AND LIMITS OF MODELS

Individual research presentations in our workshop reflected the wide range of applications that models can serve: to formalize and test scientific understanding, to integrate the various components and processes that make up whole ecosystems, to communicate findings between scientists and policy makers or the public, to explore "hypothetical experiments" of different future scenarios, and to integrate ecology and socio-economic systems.

But many modelling efforts still remain in their infancy. And it is unfortunately all too easy to misuse models and, in the process, cause harm or confusion rather than solve environmental problems. In this document we summarize several items that our group believes can enhance modelling as a field, and promote a broader acceptance of models as scientific and educational tools. We also recommend that several "bridges" be built between modelers and other communities of scientists and decision makers:

1) Transparency: The idea of transparency is important for the acceptance of models as credible scientific tools. Decision-makers, the general public, and other scientists are more likely to accept models that can be relatively easily understood - that is, models that are transparent. And yet, models are often exceedingly complex and difficult to understand. How can we avoid the natural human tendency (perhaps borne out of our curiosity) to create ever-increasing complexities in our efforts to find better ways to mimic nature? We believe that the key issue is how to keep models transparent enough so that they remain comprehensible to decision makers and to the general scientific community. What are the minimum set of parameters needed for a given model - or in scientifically broader terminology, what are the "minimum set of fundamental processes" that are needed to reach the stated goal of a given model?

   There also are inherent potentials for conflicts. For example, very complex models can become "expert systems" that leaves only the top specialists in the field to interpret the model output. Many regions of the world need more accessible and broadbased models that can serve to educate decision-makers as well as local communities. Yet, relevant and efficient tools for visualization of model results are often lacking, making dissemination of results to non-specialists cumbersome.

2) Uncertainty, Sensitivity, and Verification: There are inherent limits to all models since they, by definition, represent idealizations of the real world. For example functional relationships employed in models are often not exact, but associated with varying degrees of uncertainty, non-linearity, stochastic behaviour, and can depend on multiple variables in manners that are not accurately captured by the modelling effort. It will become increasingly important to pay attention to the limitations imposed by such uncertainties, and to develop ways in which models can explicitly display the overall uncertainty caused by aggregated uncertainties of internal components. We saw in our workshop attempts to probe the sensitivity of models by varying single parameters (i.e., one form of "sensitivity analysis"). For example, one presentation used the exclusion of parameters as a way of examining whether a given parameter behaved as a "key driving process" in the model. However, our general impression was that there is much room for improvement in how to address uncertainties, how to analyze the sensitivity of models, and how to use empirical data sets to evaluate the predictive ability of a model. Attention to these three areas is needed for models to be better accepted by decision-makers and scientists in general.

   Our workshop revealed that while funds may be available for the construction of models, there are in most cases a paucity of empirical data that are needed for validation of how well a given model works. Without clear and strong links to verification based on real empirical data, there is a danger that modelling efforts become a theoretical exercise within the confines of a computer. One important recommendation is for the modelling community to more proactively build partnerships with empirical research groups. Such partnerships ought to be mutually beneficial, strengthening empirical research efforts as well as modelling efforts.

3) Omission of key driving processes: Our group noted that some of the most relevant processes may at times be entirely omitted from models, either by accident or because the processes are too complex to deal with in a simplified manner. A case in point was the general lack of inclusion of benthic processes in the models that were presented from coastal areas and estuaries. While benthic processes are very difficult to model (in part due to difficulties of describing movements of water and nutrients across sediment-water interfaces) they may nevertheless be central for our understanding of how these systems respond over time to eutrophication. Fortunately several examples were presented where river catchments and coastal regions were coupled - something that will be crucial for future management of coastal zones.

BRIDGES TO OTHER COMMUNITIES

Perhaps most importantly, our workshop recommended that several "bridges" be built between the community of modelers and other communities. These are very practical recommendations that can be directly acted upon by the Stockholm Water Symposium and by EMECS, and that can be incorporated in future meetings. Our workshop participants were asked the question "What kind of interactions will, in future workshops and conferences, produce the most progressive development of modelling as a scientific and educational tool." Three types of interactions - or "bridges" - were proposed:

1) Bridge to managers and policy makers: There is an urgent need to promote a dialog between scientists and the decision-makers that act upon scientific information and models. This urgency was felt particularly strongly by participants in our workshop. We therefore propose that experienced managers and policy makers be invited to the next meeting and, in a direct dialogue with experienced modelers, jointly address several key questions: 1) What do managers and policy makers need from modelers? (and conversely, what do modelers need from managers and policy makers?); 2) Why are decision-makers not listening more to modelers right now?; 3) What levels of uncertainty are acceptable to managers and policy makers? and 4) Are pilot projects and demonstration models a good way to enhance the credibility of models?

2) Bridge to economists and social sciences: Models hold the prospect of joining ecological systems to economical and social decisions. We saw in our workshop an example of how a model could be used to evaluate the cost of alternative schemes for mitigating eutrophication. This and similar kinds of "optimality models" hold great promise, but also demand that modelers work more closely with economists and social scientists.

3) Bridge between physical and biological processes: Our workshop clearly illustrated that modelling of physical properties (such as water flow) has a longer tradition and is more standardized in its application than modelling of biological processes. The lack of progress and standardization of biological and ecological models, or sub-models, may be due to inherent differences caused by the evolutionary nature of biological communities. But even if biological models are inherently more difficult they still often remain key for understanding how ecosystem respond to human

stresses. The workshop participants identified a key question that currently limits our progress: How can we better develop more robust and more generally applicable biological models or sub-models?

CONCLUSIONS

In summary, the application of models can be characterized as a balance between great prospects and great dangers or limitations. The Stockholm Water Symposium and EMECS can play a direct role in encouraging the growth of modelling as a field, the careful application of models to solve real environmental problems, and the use of models as tools to educate fellow scientists, managers, policy makers, and the general public.

MODELS AND MANAGEMENT OF THE BALTIC SEA

Fredrik Wulff, Professor in marine systems ecology, Department of Systems Ecology, University of Stockholm, 106 91 Stockholm, Sweden

Marine pollution has, until the last decades, been considered only as a local or regional problem, primarily due to the dilution effect of the vast oceans. The Baltic Sea was the first case where antrophogenic effects on an entire marine ecosystem were documented. The virtual elimination of top predators like eagles and seals, the development of anoxia in deep basins and toxic blooms are example of large-scale effects, caused by toxic substances and eutrophication in the Baltic.

It is however not surprising that the Baltic is particularly sensitive to pollution, considering that it is surrounded by 85 million people with intensive agriculture and industry in a drainage basin four times larger than the sea. The special physical properties of this enclosed shallow brackish water sea further enhance the effects of the large inputs of polluting substances. Originally an oligotrophic system, an increase of nitrogen and phosphorus inputs by four and eight times during this century, has increased productivity and dramatically changed the species composition and food webs. New species have been established as important components of the communities.

The effects of pollution the Baltic ecosystem are now well described in many scientific studies and has been followed by extensive monitoring programs. International agreements on the ban of various toxic substances have resulted in improved conditions. Endangered species of birds and marine mammals are now recovering. For nutrient loads and eutrophication no major improvements have occurred. In contrast to toxic substances, nutrients are natural and essential components of any ecosystem and should only be reduced to levels where the negative effect are eliminated. Recent estimates on the cost to reduce these loads indicate that major reductions are not possible to obtain by using only 'clean end-of-pipe technology'; major reduction from agriculture, traffic and energy sectors are needed. This will involve not only massive international funding but also difficult political decisions directly affecting living standards. This is particularly difficult in a region with large differences in economies and living standards between countries, i.e. between the western societies and the former east-bloc countries.

In addition, most of the causal relationships behind eutrophication are only understood qualitatively. The complex interplay between physical and biogeochemical processes, nutrient inputs and climatic variations, can only be understood by using models. Such models are also necessary in order to develop a management strategy on how, there and how much the nutrient inputs should be reduced.

Two different modeling approaches have been used i.e. 'empirical' and 'mechanistic' models. Empirical models are developed by using the large data sets from this region to develop nutrient budgets. These are then used to develop descriptions how changes in nutrient inputs will affect concentrations of both nitrogen, phosphorus and silica. These models demonstrate principal differences in the behavior of these nutrients and between the different sub-basins of the Baltic Sea. The results suggest that the Baltic has changed from an oligotrophic, phosphorus limited system to an mesotrophic system where primary production is nitrogen limited. These changes is to a large extent depending on the varying efficiency of the internal sinks (and sources) of phosphorus compared to nitrogen, at different levels of eutrophication.

Mechanistic models describe various physical and blogeochemical processes controlling nutrient levels and productivity of the sea. These models have been useful tools to test various hypotheses about the relative importance of different processes. Earlier versions are now expanded from dealing with only nitrogen to also include phosphorus. Although it is generally recognized that nitrogen is currently limiting productivity in the Baltic proper, phosphorus is limiting in the northern Bothnian Bay and in many coastal regions. However, this does not necessarily mean that a nitrogen reduction to the Baltic proper would lower organic production with the high concentrations of phosphorus that are now prevailing. Model simulations suggest that a reduction of nitrogen input could be compensated by enhanced fixation of atmospheric nitrogen by cyanobacteria. On the other hand, empirical evidence suggest that in those coastal archipelago regions where a drastic reduction of phosphorus input has been implemented, further reduction of production could only be initiated by a nitrogen reduction. Model simulations suggest that the optimal nutrient reduction strategy may be different if seen from a local, regional or large-scale perspective.

NESTED SCALES OF LIFE SUPPORTING PROCESSES AND HUMAN JUSTICE

Thomas Gumbricht, Dr, Royal Institute of Technology,
Division of Land and Water Resources, S-100 44 Stockholm

Introduction

Present environmental models largely fail to explain system behaviour. This is attributed the hard stuck paradigm of simplified cause-effect behaviour of small number systems. At present notoriously applied to arbitrary discretised scales where it can be formulated as elaborate mathematical relations. Such relations are then analytically or numerically solved; uncertainties are introduced as random elements following the law of large numbers (which breaks down in the presence of living processes). The models thus lack a necessary transparency for improving decision making. This seduces managers, planners and policy makers into using reductionistic conclusions based on average conditions which do not, and can not, reflect the duality of the site specific, hierarchical and highly organised communication of the living system.

The role of science for policy and management of social and economic perspectives have been put on the agenda by Sokal, with his hoax article in the journal *Social Text*. This has also raised the question about natural science as a cultural construct. This clearly demonstrates that science is part of society, and that any science that formalises itself to a language (whether mathematical or linguistic) cut off from society is meaningless. Such formalistic language cannot ultimately achieve pure description and at the same time be rich enough to guide behaviour. The gaps between the complexity of for instance sustainability and models, represented as mathematical tools or legal systems, are approaching a level where they no longer communicate with society.

Time and complexity in natural science

In natural science complexity was introduced with thermodynamics - time was no longer irreversible (Prigogine and Stengers, 1984). Instead time lead to development. The increase in disorder over time is a necessity for life to exists as a structure far from thermodynamic equilibrium. Life nourishes from sucking order from its environment, enclosing a higher internal order at the cost of an outer increase in disorder. This is accomplished via a continuos hierarchy, ranging from a sub-cellular level to a global scale. Yet still arguments can be heard from leading scientists that LaPlace demon really could exist - everything can be forecasted by deterministic models. In water sciences this is reflected in the use of for instance Darcy's law for modelling ground water flow, and by the application of Navier-Stokes equation for solving turbulent flow problems in different media. Basic assumptions underlying these equations are seldom questioned. But it is now clear that for instance interactions between different phases (e.g. liquid-solid, liquid-gaseous) lead to chaotic behaviour at different scales. God is playing dice, at least at this scale.

Ideas of nature and societal organisation

Throughout Western history there has been a tendency to organise society according to mainstream ideas of what is a 'natural' system. Plato, in a Greek tradition of a decaying world, *mundus senescens*, wanted to organise society as a hierarchy led by enlightened philosophers. The aim being preventing the further decay. The forbidden seeking of knowledge should be privileged only for those capable of the correct interpretation. The prevailing thought was that of nature's being deducing moral constraints; rationality should rule the world. And nature was interpreted as a 'a great chain of being' (Lovejoy, 1936). That Christianity inherited these ideas is recognised by the resemblance of the myths of Prometheus and the garden of Eden - seeking knowledge is punished. The influence of these ideas reached all the way, at least, to T. More's Utopia (1516). With Romanticism comes a change - Kant formulates an alternative view on moral constraints as freed from the interpretations of nature. Another view on society, as organised after knowledge and science spread throughout, was advocated already by F. Bacon in his *New Atlantis* (posthumously published 1627). The scientific revolution led to the creation of the tools for technical support of a new 'industrial' development, mentally prepared by these changes. Instead of being the steward of a divine creation, man became the ruler of Earth and her lower beings. In the myth of Faust, the seeker of knowledge is forgiven by the divine.

New principles of justice and politics were constructed based on the Kantian ideal and the political philosophies of notably Bentham, Locke and Rousseau. Combined with the (Epicurean) idea of natural rights - leading to capitalism, and on the (platonic) idea of individual inequality and the paradox of freedom - leading to patriarchalism and communism. With the capitalistic system having evolved to a leading position, it is still clear that it can not constrain itself to live within ecological frameworks. Despite the efforts in Rio 1992, the environmental problems are still escalating, and are principally unsolved for a growing population. There is a need for new theories of social, economical and technical interactions under ecological constraints. With what has been said above, what are the potential routes to follow?

<u>Nesting scales and justice - a solution?</u>

In natural science many studies seek solutions either in nesting reductionistic models of different scales, or try to use holistic approaches based on first principles and heuristic pattern recognition for evaluation. The former is most commonly done nesting global circulation models (GCMs) with finer scaled models of for instance hydrology and ecology. The problem is that most GCMs are based on the same basic (cause-effect) assumptions of climate forcing; results are deterministic scenarios that still do not match climate observation data very well. Heuristic pattern recognition demands a very dense observation of the phenomena in time and space, where the observation must be adjusted to natural frequencies and architectures. The best example probably comes from medicine, where patterns of electrocardiograms (ECGs) now can reveal much about hart functions.

Justice and its distribution unquestionably influences sustainable development. In social science new theories on distributed justice have been formulated challenging the paradigm of utilitarianism set forth by Bentham, notably by Rawls (1972) and subsequent developers of his theory (see Viking, 1995). Rawls' theory rests on the idea of a social contract, in Rawls' case signed under a veil of ignorance - that is under conditions where individuals do not know their position in society. This holds a key for maximising the minimum. Strong advocates of animal rights have extended Rawls' ideas of a distributive justice to also include non-human beings (cf vegans). Both utilitarianism and Rawls' theory are based on a Kantian ideal, decoupled from any natural science foundation.

Norton (1996) proposes an approach for constraining human activity in harmony with natural 'quanta' as suggested by Holling (1992). An individual scale with locally developed values that express the preference of individuals, given the established limits and rules - physical laws, governmental laws, and market conditions. A community scale where society's dialogue with nature will be defined by policy and management on one hand and natural ecological and hydrological processes, *inter alia,* on the other. Norton (1996) recognises this as the most important scale for sustainable development at present. The discrepancy between the community and individual scale is manifold. Many of these problems have been investigated with game theoretical approaches, highlighting both the problem of scale like in the Hardin's (1968) tragedy in the commons, and in conflicting interests on the same scale, like in the prisoners dilemma. The importance of communicating systems between community and individuals for sustainable development, especially for securing the disadvantaged has been shown by Viking (1995). Norton (1996) also suggests a global scale. However, no organisation principle for accomplishing this has been shown to exist. It is interesting to note that Norton's suggestions in a sense is returning to the Greek idea of nature's being defining moral constraints.

Conclusion

Natural systems have a tendency to absorb small changes until they become brittle, reaching thresholds, where small changes can lead to bifurcations and chaotic fluctuations. Traditional cause-effect models of natural phenomena fail to forecast such events; societal organisation at different scales fail to constrain and distribute sustainable levels of environmental explorations. This advocates 'adaptive management' and medical approaches using robust pattern recognition as guiding principles. Using more transparent 'pattern' based models, including thematic maps, also promote the active participation of decision and policy makers. To secure sustainability, distributive aspects recognising scale dependency in both value and model formulation must be emphasised. Constraining society to ecological levels of total resource exploitations demands a natural science foundation; to justly distribute the resources is equally important for sustainable development, demanding a procedural justice decoupled from nature's being.

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WORKSHOP 3:

MONITORING: A BASIS FOR TRACKING AND UNDERSTANDING FRESH-WATER AND COASTAL RESPONSES

Professor Henry Regier, Canada (Chairman)
Ms Ingrid Jansson, Sweden (Rapporteur)

INTRODUCTION

This workshop focused on how interdisciplinary monitoring programmes should be developed, how the data collected might be assessed and used both to understand the dynamics of coastal waters and enclosed seas, and to demonstrate the effects of actions taken within the drainage area. Long-term environmental monitoring provides necessary data on the relative, ecosystemic status of a regional water system to be compared with quantitative and qualitative goals to be achieved. The design of the monitoring programmes is crucial, since it determines how well effects of measures taken can be tracked and analyzed. Unexpected episodic results or trends may indicate the presence of factors not considered in the original monitoring design.

The workshop included all together 1 essay and 7 regional papers. Monitoring programmes from different parts of the world (the Guanabara Bay in Brazil, the Chesapeake Bay in USA, the Turkish part of the Mediterranean Sea, the Seto Inland Sea in Japan, the Gulf of Finland, and the Jordan freshwater system) showed examples of on-going or suggested solutions to ecosystemic degradation.

In Brazil, the problems of the coastal area was shown by the studies performed in the heavily polluted Guanabara Bay, surrounded by a large metropolitan and industrialized area including the city of Rio de Janeiro. The clean-up project in Guanabara Bay, internationally funded by IRDP and OCFE, is aiming to recover the water quality within the bay. Plants for primary treatment of the sewage water are planned. Preliminary data are available from the period 1980-1990, but the ecosystem functions are still poorly understood. According to the speaker the findings reinforce the importance of tidal cycles on water quality variability and monitoring programmes must be continued and be improved to allow more profound analysis based on uniform data set.

The design of long-term monitoring programmes in the Cheasapeak Bay Programme was presented as well as approaches taken and lessons learned. The overall approach to the design of this programme, the reevaluation and the refinement were discussed as well as sophisticated techniques to separate the impacts of natural factors from anthropogenic effects on long term trends. As monitoring progresses over time, statistical analyses can show how the design can be modified to produce more or better information within the same margin of expenditure. The assessments indicated that an optimal regime could be approached without additional resources by reallocating half the seasonal fixed-station sampling effort to the randomized design, providing that the collections were made during spring and summer, the seasons shown to be most sensitive both for trend detection and for biological discrimination between stressed and nonstressed conditions of environmental quality. Recent analyses of status and trends in the benthic communities in the Cheasapeak Bay were also shown and the significance of the results to management actions were discussed.

A project relating coastal zone development to living marine resources and their habitats in the Chesapeake Bay performed by NOAA, National Marine Fisheries Service was presented. The Coastal Change, Analysis Program(C-CAP) at NOAA will monitor the coastal region of the U.S. to develop a digital data base of land cover and habitat change. By using this and other GIS data combined with transport and process models a holistic view of the coastal region, beyond just coastal wetlands, will be developed. It is suggested that greater consideration should be given to preservation, restoration and maintenance of forested land in the headwater areas of tributary streams.

A long-term pollution study (1982-1996) in the Turkish part of the North-eastern Mediterranean was presented. This work includes the implementation on the trends against time and the impacts of pollutants on the marine life. Eutrophication is only a local problem in the bays outside the biggest cities (Iskenderun and Mersin), since Mediterranean waters normally are oligotrophic, but sharp increases of PAHs from industrial point sources (incl oil pollution) have been recorded during the last 15 years. The riverine loads of TSS (total suspended solids) did not change much in quantity, while there is a significant increase of TSS loads in domestic and industrial discharges. An increasing trend of industrial wastes measured as COD (chemical oxygen demand) was also shown, when the domestic effluents had almost constant concentration of COD. Examples of recent actions on the prevention of pollution were shown.

In Jordan studies of the use of monitoring programmes concerning options and strategies for managing fresh water resources has been performed. A presentation was made of the project Water Quality Improvement and Conservation (WQIC), which has been supported by USAID since 1992. The surface water monitoring, however, has been implemented since 1988 by the Water quality control group (WAJ). The generated data will be used by the operation at the purification treatment plant and for quality control.

A study in the semi-enclosed Hiroshima Bay, The Seto Inland Sea, Japan was reported, where temporal shifts in the limiting nutrient from nitrogen towards phosphorus were shown to occur in response to the degree of rainfall intensity in the fresh water inflow (Ohta river). A programme to monitor phytoplankton production, as a function of concentrations of nutrients, must take such episodic meteorologic connections into account.

In the Gulf of Finland a Finnish joint operational environmental monitoring and forecast system for blue-green algal blooms was suggested. By combining information from field data from buoy stations, coastal stations and ships with satellite imagery, aerial surveys and a mathematic modelling programme was suggested to be constructed as an operational forecast system.

OUTCOMES OF THE WORKSHOP

Workshop participants strongly stressed the need for close links between integrative research, monitoring and other kinds of information services to yield high quality data over long periods. Monitoring provides tools for understanding and assessing environmental stresses and disturbances (eutrophication, sedimentation, pollution etc.) and produces scientific information for management broadly defined. Scientific collaboration in an interdisciplinary way helps to produce relevant and cost-effective environmental information. Low cost techniques do exist, which can produce robust scientific data, easily and quickly processed through multivariate analysis, for example

There is a need of intercomparisons, especially concerning appropriate methodologies, to collate data from various geographical regions and to adopt an integrated and multi-scale approach. In an on-going monitoring programme the importance of re-evaluation and refinement of methods and alternative ways of carrying through the programmes were discussed, as well as techniques to separate the impacts of natural factors from anthropogenic effects on long term trends.

Agricultural and urban areas generate stresses for coastal wetlands and enclosed seas, but forests generally have beneficial effects. The preservation, restoration and maintenance of forested land even in the up-lands are important to the ecological integrity of living marine resources and their habitat.

Much that is good has happened since the 1972 Stockholm Conference on the Human Environment. Information from long-term monitoring shows a mixed record, some advances and some retreats. With respect to information services useful for ecosystemic rehabilitation, Monitoring contributes its part together with Mapping, Modelling- and Management case studies. Each of the four Ms relates both to the natural- and cultural features of an ecosystem. To emphasize one of these four Ms over the others would be self-serving by the relevant specialists. Monitoring can contribute effectively if it is organized and periodically re-organized as part of the emerging four M system of ecosystem information services.

CONCLUSIONS AND RECOMMENDATIONS

The participants in workshop 3 reviewed the purpose, scope, dim and strategy of the 7th SWS/3rd EMECS Conference and the charge of the workshop. The conceptual and practical approach taken by the SWS/EMECS organizers was strongly endorsed.

In numerous global and regional agreements, nations have made formal commitments to long-term monitoring of environment and resources. Some of these commitments relate to enclosed seas. It is not known whether the existing set of international commitments are sufficient, e.g. with respect to the expected climate change. Current national programmes should be compared to those in international agreements to assess the adequacy of both the national and international commitments to the integrated information services and specifically to long-term monitoring.

The profession of experts in monitoring enclosed seas is contributing to the understanding of aquatic ecosystems, but much greater efforts are needed to improve the understanding of instabilities of the systems, especially with respect to major episodic events and teleconnections. Examples include storms, floods, droughts, oil spills, chemical accidents, toxic algal blooms and oceanic oscillations, especially as these all interact systemically and reciprocally with changes in the coastal zone and enclosed seas, that are due to inappropriate urbanization and unsustainable development as a result of mass migrations of humans towards the coast. Scientific and technical capabilities with respect to discontinuous phenomena are improving rapidly, and such new expertise needs comparatively more support. Countries should put in place quick-response capabilities to map and monitor such episodes immediately when they occur. Researchers should then, quickly attempt to explain what happened. Improved forecasting of such events should be expected from the monitoring experts.

MONITORING COASTAL AND ESTUARINE SYSTEMS: THE NEED FOR AN INTEGRATED APPROACH

Bernard Sylvand, Docteur ès-Sciences, Centre National de la Recherche Scientifique ER 109, Groupe d'Etude des Milieux Estuariens et Littoraux, 54 rue du Dr. Charcot, BP 2, 14530 Luc-sur-Mer, France.

Jean-Paul Ducrotoy, Docteur en Biologie, Director of Centre for Environmental Research into Coastal Issues, University College, Filey Road, Scarborough YO11 3AZ, United Kingdom.

Abstract

Scientific information on coastal systems is needed because they are heavily impacted by human activities; throughout the world, loss of habitats and contamination from rivers put these systems at risk. Interdisciplinary monitoring programmes on estuaries along the French coast of the English Channel have been carried out since 25 years by a research team named GEMEL (Groupe d'Etude des Milieux Estuariens et Littoraux). The same methodology has recently been applied to the North-East coast of England by CERCI (a Centre for Environmental Research into Coastal Issues).

In the first part of the paper, we will review the reasons why it is so important to monitor enclosed and coastal ecosystems. Then, we will consider three topics linked to monitoring: interdisciplinarity, the necessity for a multi-scale approach, and the need for intercomparisons and international co-operation. Examples are drawn from the North Sea Task Force (Oslo and Paris Commissions, International Council for the Exploration of the Sea) and COST (Co-opération Scientifique et Technique) 647, a European research programme. Before the conclusion, we will consider the methodologies which are involved for the study of estuarine and coastal sites, in relation to the need for networking and international collaboration.

Monitoring enclosed and coastal ecosystems

Coastal and estuarine ecosystems have been heavily influenced by the human species through pollution and habitat loss throughout the world. The natural and anthropogenic systems in operation across the coastal zone are highly complex and their inherent high levels of variability make difficult the elucidation of their dynamics and ecological role. Examples of environmental issues include the enrichment of enclosed waters with organic matter leading to eutrophication (Desprez *et al.*, 1992), pollution by chemicals such as oil (Dauvin & Ibanez, 1986; Nihoul & Ducrotoy, 1994) and sedimentation due to land-based activities or sea-level rise (Sylvand & Savini, 1991). The joint Group of Experts on the Scientific Aspects of Marine environmental Protection (GESAMP) recently reviewed the use of bio-indicators in the measurement of the condition of the marine environment and suggested and stressed the need to assess scientifically and understand the impact of human activities on the marine environment. Their definition of monitoring has been adopted in this paper as it summarises clearly and concisely the aims and objectives of the scientific approach to the understanding of environmental changes. According to GESAMP, monitoring is the "observation of a variable over space and/or time in order to determine the conditions and state of an ecosystem" (GESAMP, 1995). The definitions of the various types of monitoring which they have identified can be summarised as follows:

- Baseline surveys are highly valuable to environmental managers and should describe a situation at time-zero.
- Surveillance Monitoring is carried out to detect wide ranging or subtle impacts. It aims at predicting changes.
- Compliance monitoring deals with the detection and quantification of the impact(s) of an anticipated disturbance. Usually, it compares the observed situation to pre-existing standards.
- Feed-back monitoring helps to check the effects of measures taken to improve a disturbed environment.

From the above definitions, it can be seen that monitoring provides a tool for understanding and assessing natural and human-induced disturbances and produces scientific information for environmental management, as well as protection and conservation. It requires the collection of quantitative data over more or less long periods of time. Thus, monitoring implies measurements using validated methods and selected stations, distributed throughout the ecosystem, and has to be repeated through time (Ducrotoy *et al.*, 1989). During the past 25 years, GEMEL (Groupe d'Etude des Milieux Estuariens et Littoraux) has developed an original interdisciplinary monitoring methodology based on its work on estuaries along the French coast of the English Channel. GEMEL, in collaboration with the Centre National de la Recherche Scientifique (CNRS) and the Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) have carried out a multi-scale monitoring programme for several years in the Baie des Veys, the Seine estuary and the Baie de Somme based on long-term monitoring of water quality, sediments and zoobenthos.

Adopting a similar approach and recognising the need for the co-ordination of activities relating to coastal management and efficient policy, CERCI (a Centre for European Research into Coastal Issues) at University College Scarborough (UK) was recently inaugurated. The philosophy of CERCI is that in coastal research, the study of the marine components of the system, and the adjacent terrestrial component, cannot be treated as being separate. Rather, it is essential that the focus of coastal research is a holistic one taking into account both of these system components and the interface which exists between them. For this reason, the CERCI definition of coastal is a wide one, encompassing the watershed areas of the rivers and streams feeding into the sea, the built environments and agricultural systems immediately behind the coastal fringe, the inter tidal area itself, and, the open sea adjacent to the shore.
CERCI has already established a range of research programmes related to coastal issues. The location of the centre, on a stretch of the UK coastline which includes a number of regional, national and European designated sites (SSSIs, SACs, SPAs...), the industrial/urban centres of the Tees and Humber estuaries, rich fish grounds, and oil, gas and gravel resources, places it in an ideal setting for an experimental approach to coastal monitoring with the scope to put local research into an international context.

Interdisciplinarity

An interdisciplinary approach is essential to effective monitoring. Studies by GEMEL and CERCI take a bio-sedimentary approach and monitor the macrobenthos and environmental parameters to assess the quality of the environment. Such studies which provide a typology of communities, allowed a better understanding of changes and trends in time and space.

Indicators should be selected from the biological sciences (fauna, flora, microbiology, productivity, recruitment, mortality, diversity, genetics, biochemistry), physics (substratum, sediments, hydrodynamics, hydraulics, climatology, geography) and chemistry (water quality, sediments, inter-face exchanges, contamination). In order to understand mechanisms and processes, monitoring requires as good an understanding of biological systems as possible but in relation to others disciplines (figure 1). For instance, the nature of the substratum and hydrodynamic conditions are known to influence the quality of the living communities; climatic conditions, in turn, will influence the hydrodynamics and, consequently, the productivity (Sylvand & Savini, 1991).

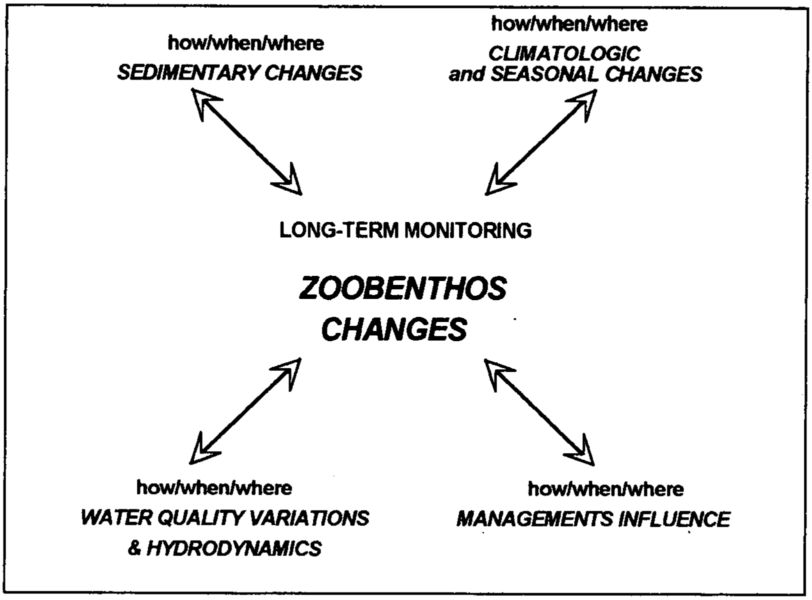


Figure 1 An example of monitoring based on the survey of zoobenthos. Interdisciplinarity is the consequence of questions from the original monitoring and of the responses in feed-back from complementary studies.

It should be understood that there are no physical boundaries between ecosystems, but continuity on different spatial scales. Therefore, what happens in the water-shed needs to be considered. This is demonstrated in figure 2 which shows the GEMEL strategy for measuring environmental parameters relating to estuaries. Knowledge of the bio-sedimentary facies (associating sediment profiles and benthic species assemblages) and of the topography of the ecosystem enabled the selection of sampling sites for assessing the water quality. A tidal-gauge and a weather station were used to understand oceanographic and climatic variations in liaison with an estimate of fresh-water flows into the estuary. Estuarine water from the inner estuary was sampled with poles and bottles equipped with siphons which allowed to sample water at various stages of the incoming tide. Pore water was also taken in relation to the distribution of bio-sedimentary facies. Freshwater inputs were sampled with automated samplers and a survey boat. The open marine waters were sampled at the mouth of the estuary from a research vessel. Data products included quality charts, conservation diagrams and vertical profiles for the parameters as shown in the caption of figure 2.

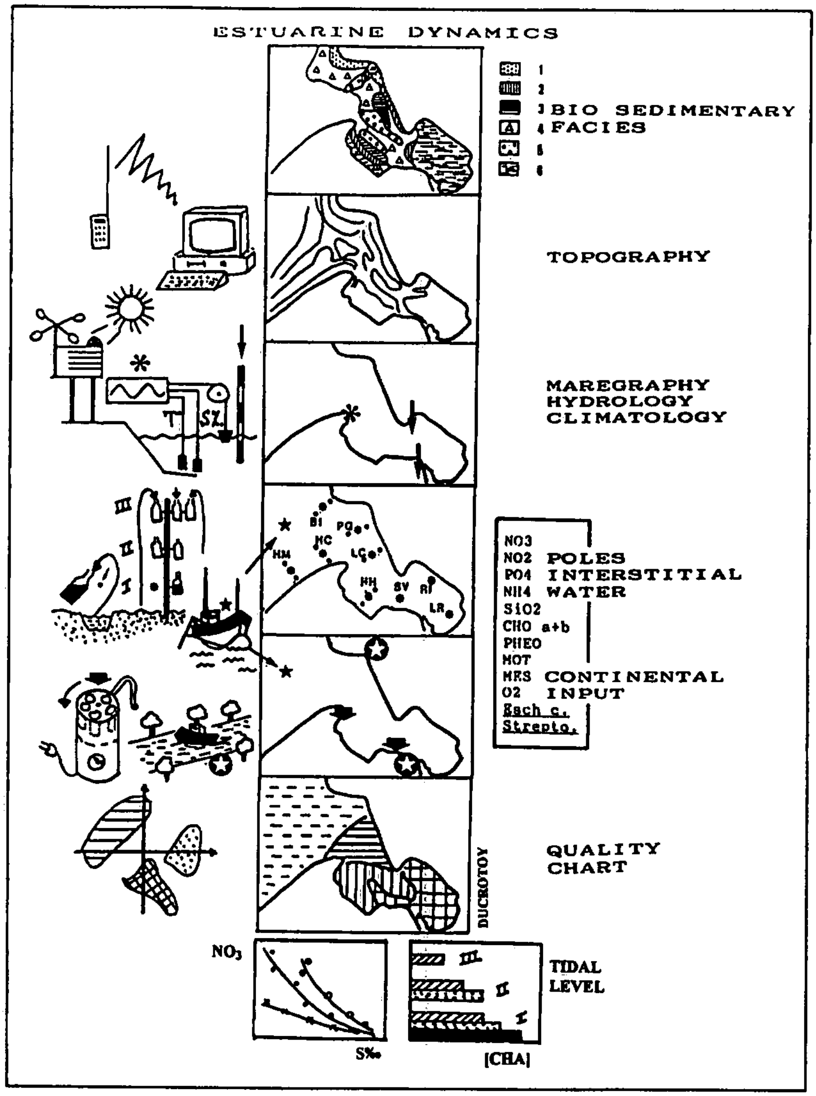
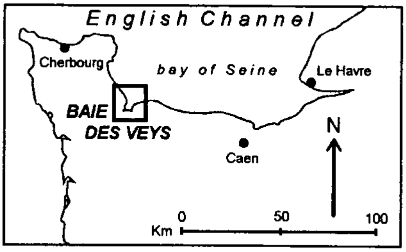


Figure 2 The EXELSOM programme in the Baie de Somme in 1990-1995. The left column shows the equipment used in monitoring the water and sediment quality. The middle column illustrates the geographical distribution of features and sampling stations. The right column displays outcomes and types of data products

NO_3: nitrate; NO_2: nitrite; PO_4: phosphate; NH_4: ammonium; SiO_2: silicon; CHO_{a+b}: chlorophyle a and b; PHEO: pheopigments;MOT: total organic matter; MES: suspended matter; O_2: oxygen concentration; <u>Esch c.</u>: Escherichia coli; <u>Strepto</u>: Streptococci

One example illustrating the above approach will now be drawn from the Baie des Veys, in North Western France where long-term monitoring has been carried out over twenty years. Figure 3 shows the Baie des Veys before 1986 : it was then 6 km wide, 6 km large, and included two separate tidal channels corresponding to two small rivers. Oyster and mussel aquaculture was and still is an important activity together with cockle fisheries on the tidal flat. Changes in the position of the channels are a threat to aquaculture but were predicted well before 1986 through the understanding of the structure and dynamics of the sediment cover and the estuarine fauna. The result of these changes at the beginning of the next century have been predicted through the use of long-term monitoring (Sylvand, 1986) and a scenario for future changes in the Baie des Veys up to the year 2000 was proposed by Sylvand & Savini (1991) and, more recently, refined by Sylvand (1995, 1996).



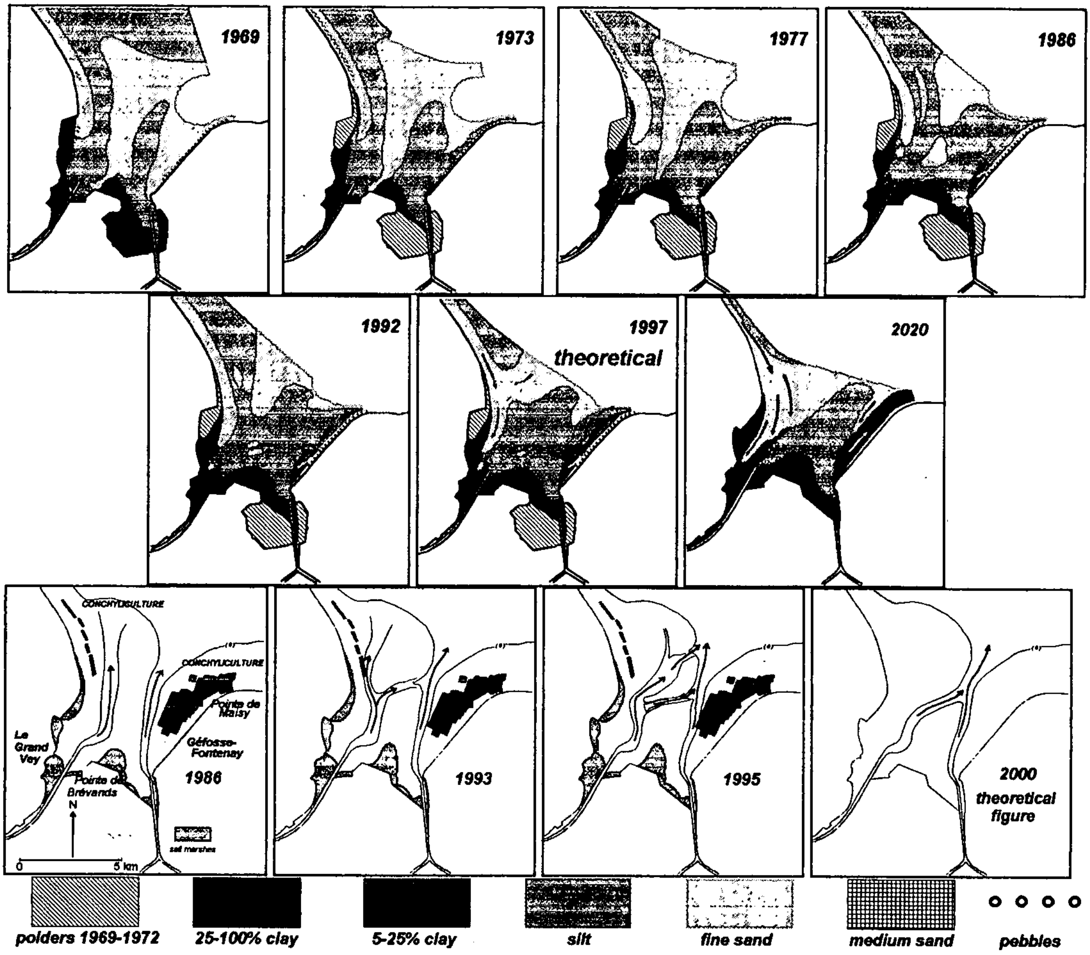
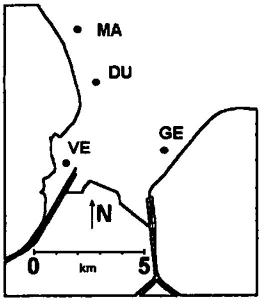


Figure 3 Results of a long-term monitoring on sediments and tidal channels morphology in the Baie des Veys (French Coast of the Eastern English Channel : Sylvand, 1995); the study of changes of grain size distribution helped to construct predictive

sedimentary maps (theoretical figures) useful for information about future managements. The last row of maps show the correlative changes in the tidal channels morphology as a threat to the mussels and oyster cultures (black pixeled pattern).



Multivariate methods for the processing of ecological data was described by Souprayen *et al.* (1991) in the framework of the European Programme COST (CO-opération Scientifique et Technique) 647. An example of the use of multivariate analysis to process medium-and short-term monitoring data has also been drawn from the work carried out in the Baie des Veys. Four stations named La Madeleine (MA), La Petite Dune (DU), Le Grand Vey (VE) and Géfosse (GE) were selected for this review. Benthic animals were sampled every month over fifteen months (months are shown by numbers). Figure 4 shows how the sedimentary conditions influence the stability of benthic assemblages (stable at GE), the different regimes in winter and summer (at DU and MA) and the impact of storms (at VE).

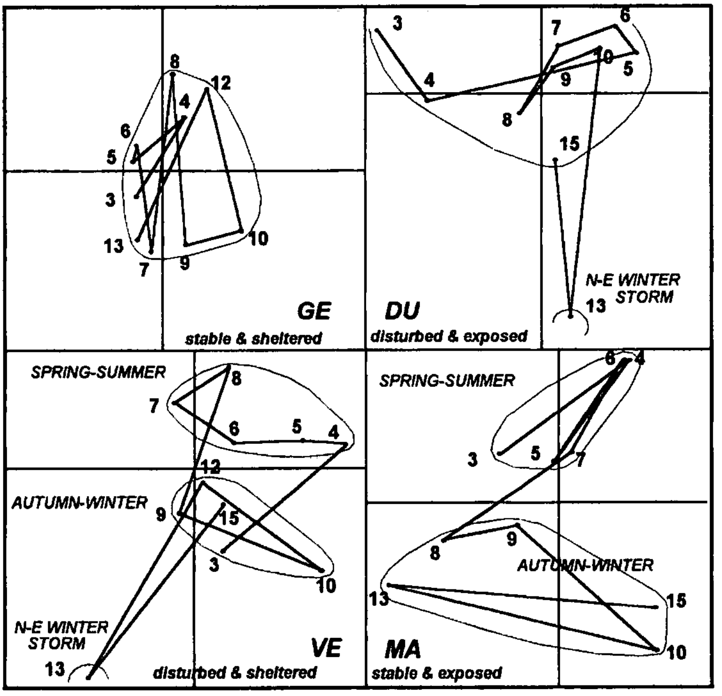


Figure 4 Short-term monitoring on 4 selected stations in the Baie des Veys (Sylvand, 1986, 1995), sampled each month during one year : the results of a multivariate analysis on macrozoobenthic quantitative data discriminate different environmental conditions explaining sedimentary data from the long-term and medium-term sedimentary monitoring.

Sediments from two sites, located in the VE area, were considered as populations of grain size and the data was processed similarly to biological data. Samples were taken four times a year and grain-size parameters were computed (Sylvand, 1996). Both stations (VE1 and VE2) characteristics were different at the start of the survey, but. after 11 years, these stations acquired similar features as shown at the top of the figure by the two main arrows. The estuarine area was under the pressure of expanding polders and mud flats increased in space. The result was that estuarine sediments became more and more homogeneous as shown on figure 5.

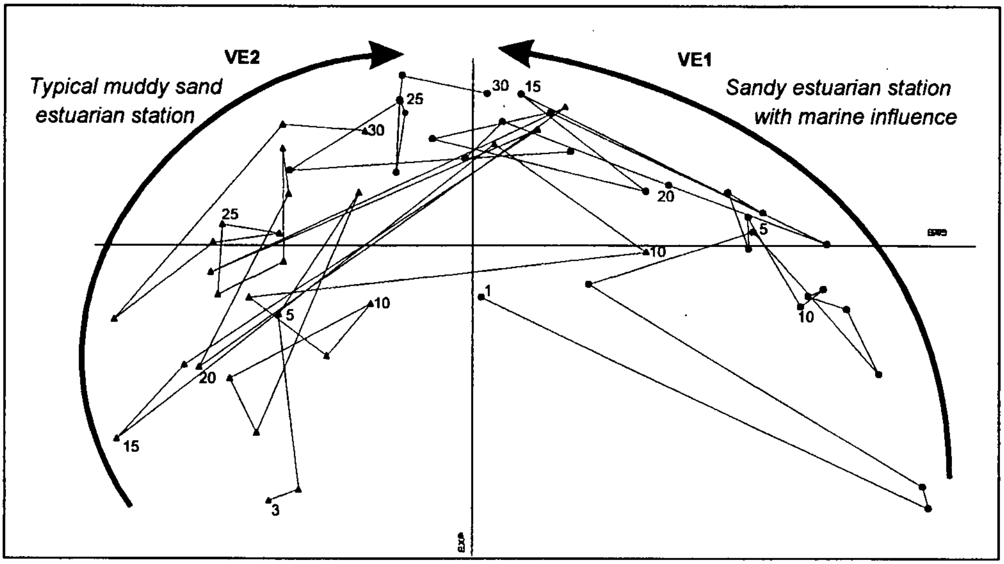


Figure 5 Example of medium-term monitoring in the estuarine part of the Baie des Veys, on 2 different estuarine stations (Sylvand, 1995). Samples were carried out four times a year during ten years. This multivariate analysis shows the homogenisation of the 2 different stations toward a similarity of grain size parameters.

A multi-scale approach

A central issue in community ecology is to determine the various factors underlying spatial and temporal variations in community structure and to place this knowledge into a predictive framework. But, changes in ecosystems take place at various levels : from individual cells to organs, individuals, populations, communities, ecosystems biomes or globally.

A hierarchical set of indicators (figure 6) is, therefore, needed in order to :

- identify environmental problems, in relation to global ecological changes and resulting economic changes,
- define and characterise these problems through studies in sedimentology, ecology, etc., and
- feed decision-making and management and, also, future studies.

Bio-indicators can be used to monitor the quality of coastal ecosystems:

- **Bio-assays** to assessing mortality and sub-lethal effects,
- **Bio-markers** from molecules to species assemblages.

There are biological responses that can be linked to the presence of chemicals (chemically induced stress in biota):

- **Histo-pathology**
- **Physiology**
  - whole organisms
  - metabolic rates
  - growth
  - reproductive behaviour
- **Ecology**
  - univariate = a single measurable variable responds to environmental factors,
  - multivariate = loss of species / biological diversity

Figure 6 Types of bio-indicators used in estuarine and coastal monitoring

Along those lines, GEMEL and CERCI have developed a methodology involving interactive studies from laboratory investigations (biochemistry, physiology, etc.) to large area studies (environmental parameters, including physical and chemical characteristics). Modelling and fieldwork have suggested that, on a local scale, biotic factors interact with environmental factors to produce community patterns. But, on a regional and global scale, ecosystems are also under the influence of climatic and oceanographic influences. This is why predictive models need also to be hierarchical, with the simpler local-scale models nested within more complex larger scale models (Figure 7).

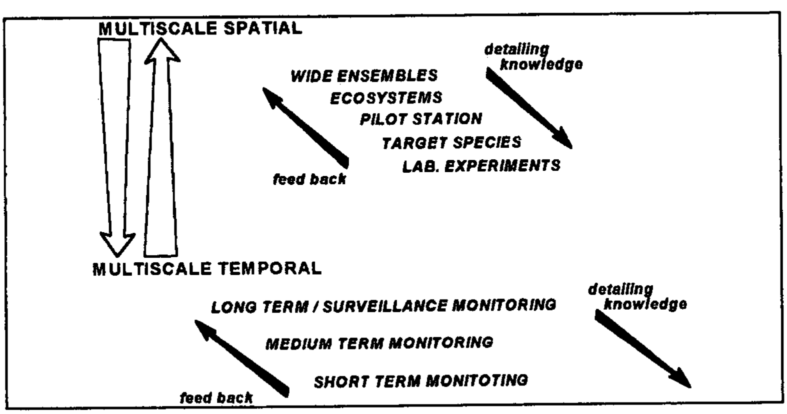


Figure 7

Monitoring through a multi-scale approach.

This multi-scale approach was summarised by Ducrotoy in 1997b. It implies the study of ecological patterns generated at different scales by different processes and was applied to estuaries in North Western France. Changes in benthic populations from the estuaries were recorded at pilot-stations.

Pilot-stations were defined as representative sites of specific communities in order to:

- quantify the temporal variability of populations,
- detect any consequences of disturbances, and

- identify species whose biological cycles appeared to be explained because of their role in the ecosystem (notion of key-species)

The survey of pilot-stations produced data on abundance, richness and biomass on zoo- and phyto-benthic species. Studies of key-species yielded data on size, age, population structure, sexual maturation and chemical analysis of their tissues, in particular glycogen (Hawkins *et al.*, 1997).

Benthic population mapping was based on stratified random-sampling of environmental characteristics and incorporated the notion of bio-facies, deriving from the interaction between the substrate and the organisms. An example of a multi-tier sampling strategy was developed by Lemoine *et al.* (1988) and fully presented in Ducrotoy and Elkaim (1992). The sampling methodology involved establishing a sampling grid based on 20 main transects, secondary transects (with a total of several hundreds main and secondary sampling sites along the transects) and six pilot-stations (figure 8). Impacts may be local, regional or global. Hydrodynamics may extend local effects. It is why human impacts should be understood in terms of their magnitude, frequency, and reversibility. Therefore, the only features to be included are those which are measurable or which might stand up in legal proceedings (Ducrotoy & Elliott, 1997). This refers to compliance monitoring which deals with the detection and quantification of the impact(s) of an anticipated disturbance. But, it should also been considered that changes occur in a spatio-temporal context. Usually, this enables scientists to compare the observed situation to the pre-existing

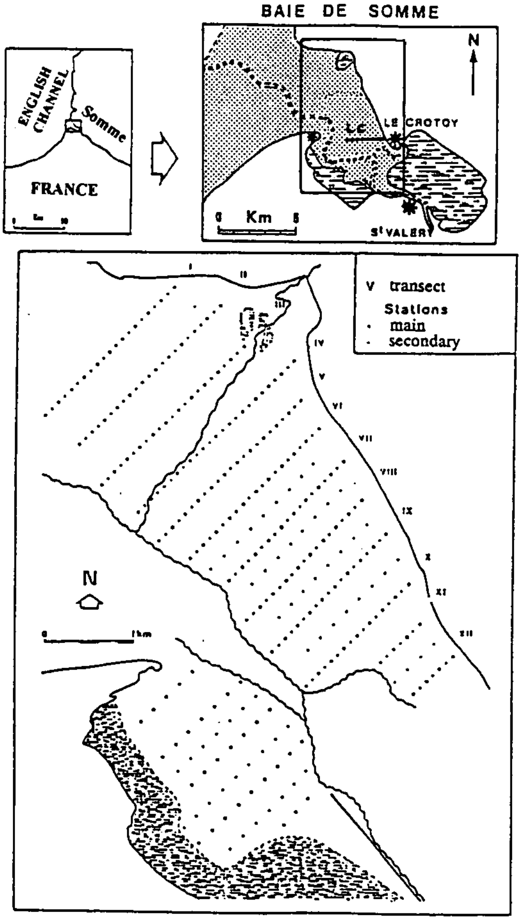


Figure 8 Location of the Baie de Somme and monitoring sampling grid used in the framework of the programme EXELSOM in 1990-1995

standards but it should never be separated from an ecosystemic approach including an understanding of food-webs. The ecosystemic approach puts the emphasis on the links between inputs and concentrations of contaminants and their effects on biological systems. It dictates the need for compliance monitoring and surveillance monitoring and where possible leads to the derivation of ecological standards and objectives. As Ducrotoy and Elliott (1997) recently emphasised, it also treats the environment as a resource to be managed, and recognises its assimilative capacity. In the long-term, surveillance monitoring has to be carried out to detect wide ranging or subtle impacts. It aims at predicting changes through a multi-dynamical holistic view. Areas of interest include: plant and animal communities, sedimentary aspects, inputs of contaminants/pollutants, general hydrodynamics and environmental management (Desprez *et al.*, 1986, Sylvand & Savini, 1991). In the medium- and short-term, there might be a need for defining some aspects of changes taking place in specific areas which demonstrate a typical pattern of change and to target organisms which would then be considered as bio-indicators.

The next example deals with the survey of macro-algal communities on the Yorkshire coast of England by CERCI. Macro-algae are important in intertidal ecosystems having a key role as primary producers and as an important link in the food chain. A result of stresses (such as the eutrophication of estuarine and inshore waters) macroalgal communities might be disrupted; species may disappear, successions be modified and biomass productivity altered. By considering the biological diversity, abundance and productivity of macro-algal communities in relation to natural and anthropogenic factors it may be possible to assess the status of coastal areas and predict the impact of changes within the environment (Tobin *et al.*, 1996). Although a number of inventories of macroalgal diversity, biomass and productivity exist for parts of the coastline of the British Isles, comprehensive studies of their distribution coupled with an attempt to inter-relate biological diversity, productivity and environmental factors are rare. This is why a landscape scale analysis approach was adopted by CERCI to monitor regional coastal intertidal areas in order to assess the shore status and to predict the impact of changes. In order to carry out an effective study of the vegetation distribution with respect to environmental factors, a number of points must be considered. In particular, seaweed distribution will be influenced by both natural and anthropogenic factors. Study sites were selected in areas which are known to be influenced by some/all of the factors given in Table 1. Six sites were selected along the Yorkshire coast of England and the composition of the algal communities compared to control areas, e.g. areas not affected by anthropogenic stresses. This was important for the database if assessment of shore quality or predictions of changes were to be made.

NATURAL	ANTHROPOGENIC
Broad-scale biogeographic influences	Organic input
Substrate type	Non-sewage organic input
Exposure / shelter	Inorganic input
Sediment load	
Freshwater influence	Proximity to harbour, resort...
Seasonality	Type of sewage treatment used
Competition	Recreation
Plant-animal interaction	Industry
Succession	Trampling

Table 1 Factors influencing distribution and abundance of intertidal macro-algae.

A single survey of any given site, however, would only provide a 'snap-shot' of the vegetation distribution. A series of eight transects were located at a workshop-site were specific local disturbances could be investigated. Each transect comprised of rectangular boxes located at different heights on the shore. Within each of the 22 boxes, 5 random quadrats were sampled each month. A digitised imagery system is currently being developed with a view to monitor changes in algal and zoobentos coverage at selected sites through the use of an image measurement software.

Intercomparisons and international co-operation

Any knowledge acquired on a specific coastal area may potentially be needed to improve the understanding of others habitats. Comparing data sets from selected geographical areas enables scientists to determine whether observed changes are due to local conditions or are part of a broad scale natural pattern. Ducrotoy & Sylvand (1991 and in prep.) described and compared changes in the bio-sedimentary characteristics of the Baie des Veys and the Baie de Somme. Despite their differing geographical positions on the French coast of the English Channel, the two sites showed similar morphological, sedimentary and faunal characteristic, e.g. the presence of a tidal deltaic area, high hydrodynamics and a low species diversity with high biomass.

Anthropogenic influences were also similar, e.g. land reclamation, the canalisation of rivers, pollution and nutrient enrichment. The macrobenthic assemblages reflected local environmental conditions and the typical estuarine communities were deemed to be at risk due to human activities and, possibly, climatic changes. One consequence was the loss of the productive muddy areas which are of more benefit to waders and fish than the poorer sandy areas and unused salt-marshes. Eutrophication was shown increase the productivity of estuarine communities but the attendant oxygen depletion could kill invertebrates in specific areas (Desprez *et al.*, 1992).

In Europe, from 1979-1994, the COST 647 (now defunct for lack of funding) demonstrated the need to discriminate between oceanic / climatic induced changes from local / regional / global human disturbances (Desprez *et al.*, 1986). Latitudinal trends in the reproduction of invertebrates , recruitment and population characteristics were collected and compared over long-periods of time (Ducrotoy, 1997b). The COST 647 programme resulted in the exchange of information between several research teams located at various sites on the coasts of Europe, in a strategy of medium-term surveillance monitoring including studies on specific target as zoological marine species. Comparing systems allowed an experimental approach which would be impossible to practice at full scale on whole ecosystems. This dictated the need for fora to discuss appropriate methodologies, to collate data from various geographical origins and to adopt an interdisciplinary approach (Wilson *et al.*, 1987, Ducrotoy *et al.*, 1989, Sylvand *et al.*, 1989). As emphasised recently by Lewis (1996), much international interest and expertise should now be devoted to revive a similar approach in order to monitor global warming.

As there are no physical boundaries between ecosystems but continuity on different spatial scales, only "well-focused international programmes will be able to pull together long-term data series that, alas, conflict with the short-termism of politicians and desk-bound academics" as emphasised by Lewis (1996).

Another successful story to be reported is the North Sea Task Force (NSTF) and its Monitoring Master Plan (MMP) for the North Sea. One of the main responsibilities of the North Sea Task Force was to prepare an update of the 1987 and 1990 Quality Status Reports of the North Sea (QSR) by 1994 (NSTF, 1994). In order to strengthen the scientific basis on which the updated assessment would rest, the North Sea Task Force established a comprehensive monitoring programme and initiated intensive collaboration with the scientific community in each of its member countries.

	MANDATORY LIST	VOLUNTARY LIST
heavy metals	cadmium, copper, mercury, lead, zinc	arsenic, chromium, nickel
organics	PCBs (on an individual CB basis), alpha- and gamma-HCH, HCB	(atrazine and simazine), toxaphene, chlordanes
nutrients and nutrient related parameters	Total P, Ortho-P, total N, NH_4-N, NO_2-N, NO_3-N, silicate and interpretation parameters: salinity, suspended solids, temperature, dissolved oxygen and Secchi depth.	algal composition (species, their abundance and distribution) production parameters abundance of macrophytes

Table 2 Mandatory and voluntary determinands monitored in water, sediments and biota under the Monitoring Master Plan of the North Sea Task Force in 1991-1993. Most interestingly, the MMP put the emphasis on biological parameters but was not over ambitious regarding the chemistry.

On the basis of the natural hydrographic variations found in the North Sea, 13 sub-regions were identified by the North Sea Task Force. For each of these a lead country, usually in association with one or two co-operating countries, was responsible for preparing a sub-regional quality status report. The sub-regional reports formed the basis of the holistic North Sea Quality Status Report published in early 1994 (NSTF, 1994). In order to provide information on the geographical distribution of chemical contaminants and biological effects the NSTF launched the MMP in 1990. The monitoring programme was simple and incorporated eutrophication interpretation parameters. Another strong point in the MMP was the inclusion of the survey of biological effects. The MMP was developed in order to expand that part of the Joint Monitoring Programme (JMP) of the Oslo and Paris Commissions which is concerned with the spatial distribution of contaminants, particularly in sediments, and to add the monitoring of the biological effects of contaminants (Ducrotoy, 1994).

The MMP:

- covered all the areas of the North Sea including the English Channel;
- included several offshore North Sea monitoring stations in all areas;
- had sufficient breadth of coverage to provide a 'snapshot' picture of the spatial distribution of contaminants across the whole of the area;
- included the contaminants of interest in the context of a baseline survey; and
- aimed to co-ordinate biological and chemical monitoring over the whole North Sea.

The MMP was simple enough to allow all contracting parties to fulfil their commitment but, in a few instances, reporting failed in a way that some quantitative data was not submitted on time or at all for inclusion in the QSR (Ducrotoy, 1994 and 1997a). Nevertheless, the North Sea Task Force was successful in establishing an efficient system for keeping policy-makers and administrators informed about important scientific developments. These three elements: monitoring, a strong scientific basis, and an effective transfer of information are part of a new dynamic approach to assessing the quality of the marine environment of the North Sea. The 1993 Quality Status Report of the North Sea emphasised the need for a clear understanding of diversity, for the protection of both species and habitats: and strongly recommended the initiation of diversity monitoring programmes, especially in coastal areas, these being, perhaps, the most sensitive to anthropogenic stresses.

Methodologies and conviviality

The need for interdisciplinarity and intercomparisons requires the development of the exchange of scientific information within a convivial framework of collegiality. The scientific community should reject the protectionism unfortunately displayed by some research teams. GEMEL has widely demonstrated its commitment to the promotion of rewarding human relationships which was reflected in the methodology they used, i.e. large areas to be sampled by large teams, involving several specialisms co-ordinated through integrated programmes (Desprez *et al.*, 1990). Unfortunately, in the Western world, the technological response to sampling difficulties has often been strongly focused on the development of automated sampling apparatus and remote sensing techniques. As a consequence, field sampling was disregarded and cheap labour replaced by costly equipment. Field work is not necessarily better than satellite data but complementarity should be the leading concept.

In this way, within a spirit of international collaboration, the introduction of new technologies should not prevent developing countries from establishing their own scientific research. Low cost techniques do exist and produce robust scientific data easily processed through multivariate analysis (Souprayen *et al.*, 1991). Fore example, a surveillance monitoring programme has been carried out in the Baie des Veys (France) over 25 years at a minimal cost of $5,000 a year, plus a basic equipment of $4,000 which simply needed maintenance over the years (Sylvand, 1995). It is true that coastal and estuarine areas have an important role to play in modern economics and this might explain the renewed interest from both politicians and the public for their quality status, but, in 1991, Ducrotoy & Elliott emphasised that despite this, the scientific community is often under pressure to obtain the data using meagre resources. Cheap field work should not pre-empt the use of Information Technology and, for instance, the establishment of an Environmental Information System (EIS) by CERCI for monitoring the Yorkshire coast has proved to be a useful tool with respect to the continuing quality assessment of the area. The information held in the database allows identification of areas of high biodiversity, potentially polluted sites, or areas of scarce/threatened species. The information is also useful in predicting change in distribution due to natural and anthropogenic factors. In this way it is hoped that the use of geographical information systems will soon become an integral part of all coastal management schemes.

The planning of monitoring in relation to research needs to be elaborated carefully and extended in the long-term because most ecosystems do not react quickly and need to be monitored over time (Ducrotoy & Sylvand, 1991). The fact that monitoring and research are interwoven requires co-ordination, in order that the relevant and cost-effective information is produced. It necessitates feed-back from managers in view of producing integrated programmes, devoted to produce periodic assessments. Such integrated programmes need to rely upon suitable methodologies (Quality Assurance) and should allow routine applications. Nevertheless, all studies are useful on ecosystems. In turn, quality assessment should identify gaps in knowledge in order to improve our understanding of coastal ecosystems in terms of the function and role of the various elements of the system and in terms of their response to disturbance.

Finally, conviviality should also exist between scientists, citizens and policy-makers. This was emphasised recently by Gray (1996) who put into light the need for feed-back monitoring.

Conclusions

The location of sampling sites should be selected objectively and frequencies of sampling should be optimal and in harmony with biological cycles (seasonal and annual). The survey should be applied to a specific ecological unit such as an estuary, a bay, a stretch of coast, a channel, a strait or an enclosed sea. The site should be chosen according to its environmental characteristics and/or according to the type of human activities which might impact on the environmental quality of the ecosystem. Monitoring should rely upon high quality data and should therefore be supported by a robust quality assurance programme. Consideration should be given to the need for future assessment and objectives should be agreed before starting, but various components may be included in the methodology in order to avoid pre-emption on future conclusions. This is why monitoring has to be carried out in a research context to explain the causes and variability of parameters in time and space. All research is applicable, if not applied, and there should be no division between pure research and applied research. If a study is deemed to be purely applied and strongly focused, the risk is that the methodology might ignore important areas for scientific study for economic reasons and opportunities may be missed for interdisciplinary studies and comparisons with others sites. Scientists should collaborate in order to produce relevant and cost-effective environmental information. This will necessitate an input from managers in order to producing integrated programmes, devoted to producing periodic assessments. Therefore, the future of monitoring resides in a renewed conviviality between scientists and between scientists and managers, as was demonstrated in the North Sea Task Force venture. Interdisciplinarity and multi-methodologies should contribute to the development of an ecosystemic approach to management.

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WATER POLLUTION TRENDS IN GUANABARA BAY, BRAZIL

Rodolfo Paranhos, *Department of Marine Biology, UFRJ,*
✉ *prédio do CCS, Bloco A, Cidade Universitária, Rio de Janeiro, CEP 21944-970, Brasil.* 🖳 *rodpar@ibccf.biof.ufrj.br*

Concern on eutrophication and its consequences to human health are increasing worldwide, because human made pollution has been considered the major cause of productivity degradation in coastal regions (Vollenweider, 1992).

Among those coastal regions, Guanabara Bay is located in a humid sub-tropical region, surrounded by the second largest metropolitan and industrialized area in Brazil (Fig 1). As several other coastal regions in the world, this bay is under great environmental pressure. It has a 4,000 km^2 drainage basin that is northern limited by a 2,000 m high mountain range. Most of that height is composed by step slopes, meaning torrential runoff during rainy events. The bay receives around 25 $m^3 s^{-1}$ from rivers, diluted in it's 381 km^2 area. A population in excess of 10 million people discharges daily 470 tons of BOD, plus 5.5 tons of garbage. All domestic sewage is disposed virtually untreated into watershed and then into the bay. Industrial activities produce a 150 ton per day sewage input.

Potential uses of this water system mainly include navigation, fishing and leisure. However, unordered occupation and waste (domestic and industrial) dilution has been prevailing. Human interference has caused serious damage both in ecological and social-economical senses. Consequently the bay, its drainage basin, and few remaining mangrove areas are suffering from serious environmental problems (FEEMA, 1980 and 1990; Hagler and Hagler, 1981; Pfeiffer *et al.*, 1982; Mayr *et al.*, 1989), which are similar to the ones found in other densely urbanized areas in the world. In this way a recognized environmental degradation scenario is predominant. Despite this common knowledge, Guanabara Bay has several inlets and areas with different water quality standards (Contador and Paranhos, 1996).

Guanabara Bay is considered one of the most eutrophicated among coastal ecosystems in the world, but still has a surprisingly living resources potential (Mayr *et al.*, 1989). An internationally funded clean-up project (U$$ 750 million from IRDB and OCFE) is in course aiming to recover the water quality of Guanabara Bay.

Aiming to draw the trends of water quality, available data from different sources during the 1980-1990 period were used, plus some data up to 1995. Much of the data was obtained from the Environmental State Agency (FEEMA), consisting of monthly measurements between 1980 and 1990. Eight to thirteen sampling stations were distributed around the bay area, and APHA (1980) methods were used to analyze water samples. Complementary data was obtained from UFRJ diel sampling from 1986 to 1995. Strategic sampling sites were selected, based on a pollution gradient and different circulation patterns. Sampling and analytical methods followed the usual Oceanography standards (Grasshoff *et al.*, 1983; Parsons *et al.*, 1984), and triplicate numbers of samples were analyzed in the laboratory.

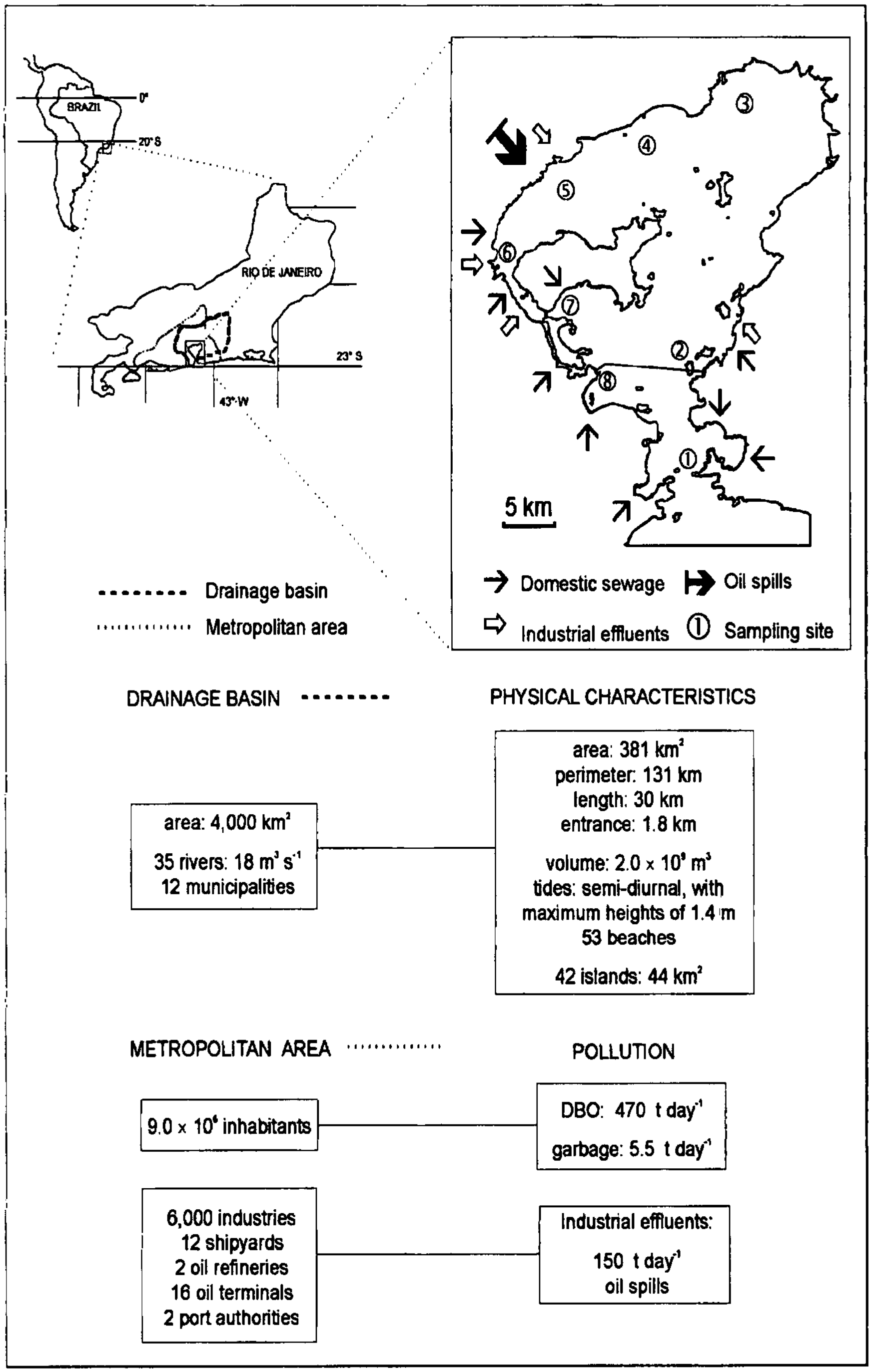

Figure 1. Location of Guanabara Bay, its drainadge basin, metropolitan area of Rio de Janeiro, and the sampling sites. Figure modified from Paranhos *et al.* (1997a).

Available data were organized in chronological order of sampling, and linear regression analyses using the least-squares method of time on variables were performed (Drapper and Smith, 1981). The significance of the regression coefficients was tested by ANOVA, and the results presented are in the 95% confidence level (Zar, 1984).

Rainy season lasts from October to April, with high temperatures and highest salinity range due to precipitation (up to 250 mm per month) on the watershed, leading to a highly stratified water column (Mayr *et al.*, 1989; Villac, 1990). Dry season (less than 150 mm per month) occurs from May to September, with lowest rainfall from July to August (less than 80 mm per month). Lowest water temperatures and high salinities are also observed in winter (Paranhos and Mayr, 1993).

Pronounced short-term variability in hydrobiological features (nutrients and phytoplankton) has been observed in Guanabara Bay, and most of that variability is tidal induced (Mayr *et al.*, 1989; Paranhos *et al.*, 1997a). A Central Channel region is crucial for circulation patterns within the bay. Water renewal promoted by tidal cycles is associated to bathymetric profiles and thus pollution loads undergo a different degree of dilution. The wide range of data also indicates that the bay works as a self-cleaning system even during ebb tides and in the inner channels. Our findings clearly reinforce the importance of tidal cycles on water quality variability. The short and long term trends must be certainly known and critically considered in any modeling attempt in estuarine systems such as Guanabara Bay.

The population of the Rio de Janeiro metropolitan area increased 9% between 1980 and 1990, without any increment in sewage treatment. Hence the increase in organic matter input and the consequent decrease in water quality standards were expected results.

During this period (from 1980 to 1990), the mean water temperatures were 25.2°C (surface) and 23.7°C (bottom waters), and no trends were discernible (Paranhos *et al.*, 1993). A decreasing salinity trend was found for the whole Guanabara Bay, and a significant decrease was characterized (-0.145 S $year^{-1}$, or -4,9% between 1980 and 1990). Although differences among the yearly rates of change were observed, all sampling sites on the bottom layer had a significant salinity decrease. The salinity reduction ranged from 0.17 S $year^{-1}$ at the Central Channel region (site 2, see Fig 1) to 0.60 S $year^{-1}$ at the Northwestern region (site 6, see Fig 1). Decreasing dissolved oxygen levels were found as well, with an average loss of 5% within the whole bay, and up to 50% decrease at the Northwestern area (Lavrado *et al.*, 1991). Eutrophication is exemplified by increasing Total Phosphorus (average 99% within the whole bay, and up to 177% at the Northwest area) and Total Nitrogen levels (average 31% within the whole bay). Water pollution microbial indicators represented by fecal and total coliforms, presented an increase from 1,3 to 2,9% per year. The actual levels were around 10^3 up to 10^8 coliforms per liter (Paranhos *et al.*, 1995).

Limited sampling frequency and irregularity of sampling introduced discontinuities in the data set during this 11 year period. It was not possible to remove seasonal and tidal components from this data set. Therefore, the long-term trend figures presented here should not be interpreted as absolute numbers, but as the best possible assessment with the available data. However they are useful to access the evolution of eutrophication within Guanabara Bay.

The importance of mixing between polluted fresh waters and coastal saline waters is indicated by significant inverse linear correlation between salinity and ortophosphate (Paranhos *et al.*, 1997). Ortophosphate is introduced in the bay by rivers and sewage discharges, and showed a non-conservative mixing behavior. During the estuarine mixture, another probable source of orthophosphate can be attributed to nutrient remobilization from sediments (Rebello *et al.*, 1988) and internal cycling within the bay. Both total and fecal coliforms exhibited a non-conservative mixing behavior along the sampling sites, with coliform levels decreasing with salinity. Significant positive correlation between salinity and nitrate indicates that nitrification has been occurring due to the inflow of oxygenated coastal waters (Paranhos *et al.*, 1997). This hypothesis was corroborated by a significant positive correlation between salinity and dissolved oxygen. Dissolved oxygen and nitrate were positively correlated as well, further supporting the nitrification pathway. Nitrate was only detected when oxygen became available to support the nitrification process. Nitrate and ortophosphate also showed an inverse linear relationship, indicating different cycling pathways for these nutrients. Organic matter mineralization was found in a similar gradient to organic pollution. However, highest nitrate levels were only found associated to regions where the water quality was better.

Total and fecal coliforms were found in high levels at sampling sites subjected to contaminated freshwater loads, usually at the Northwestern region (sites 5, 6 and 7, see Fig 1). The values were at least two orders of magnitude (usually up to 4) higher than values found at the Central Channel (site 2). At this region, coliform values found indicated acceptable bathing levels accordingly to the Brazilian sanitary water quality standards (CONAMA, 1992 - less than 1,000 coliforms per 100 mL). However, coliform values at the Northwestern region ($\approx 10^4$ per 100 mL, and from 10^5 to up to 10^8 per 100 mL) were always much higher than these standards. The sampling site between Fundão and Governador Islands (site 7) was the most polluted one concerning both total and fecal coliforms, with levels' characteristic of sewage. Surprisingly, at that site one can observe a daily queue of leisure fishermen, a clear indication of productivity despite the pollution.

Low oxygen levels, high nutrients (both phosphorus and nitrogen), chlorophyll a, and coliform levels characterized the Northwestern region as the most impacted area. In contrast, the Central Channel and bay entrance regions can exhibit values as low as coastal waters, and oxygen saturated waters.

The spatial and temporal trends found reflect the population increase without the respective improvement on sewage treatment. Other causes of the above mentioned trends are related to the unordered occupation on shore (landfills), destruction of slopes due to deforestation and consequent sediment transport, and river rectification. High sedimentation rates (up to 2.0 cm $year^{-1}$) associated with landfills have resulted in severe restriction of water circulation and increasing water turnover time (Amador, 1980), with further reduction of depths and obstruction of channels between the islands. Since the beginning of this century the circulation in the bay has been continuously restricted as a result of land reclamation (Oliveira, 1958). The whole Guanabara Bay has become shallower interfering with coastal water inflow. That has been causing salinities to decrease within the bay (Paranhos *et al.*, 1993). Differences found in water quality among the sampling sites and all tidal regimes support our observations. All the above mentioned factors are known to cause severe circulation restriction (Amador, 1980), with consequent decrease in dilution of pollution loads and water quality (Mayr *et al.*, 1989; Villac, 1990; Lavrado *et al.*, 1991).

Guanabara Bay is able to receive high nutrient loads without showing extreme environmental degradation in its totality (Mayr *et al.*, 1989). This can be attributed to physical and geomorphologic conditions, which explains the influence of the tidal currents observed. Depths are not uniform along the bay: a narrow and deeper channel exists along its major axis (20 m deep on average). The areas near the margins are less than 1 m deep during ebb tides. The poorest water quality area is confined to a small portion in the west zone (Lavrado *et al.*, 1991; Paranhos *et al.*, 1993). Guanabara Bay has a high degree of spatial variability in physical (water depths, vertical mixing rates, suspended sediment concentration) and chemical (waste dumping, continental and marine contributions) properties that affect biological processes. Despite huge load input, Guanabara Bay has been able to regenerate itself. Nutrients are recycled up to simple chemical forms (dissolved and inorganic) and are exported or used to increase primary production. Most nutrients (up to 75%) are exported within the dissolved phase, and inorganic forms of nitrogen and phosphorus accounts for most of that nutrient exportation (Paranhos *et al.*, 1977b).

Variability of hydrobiology in Guanabara Bay is determined mostly by the pollution gradient observed, that is the balance between coastal and watershed influence. The watershed and Northwest and West bay areas are heavily occupied, containing most of the industrial and population pollution sources. As in San Francisco Bay (Powell *et al.*, 1989), Guanabara Bay's Central Channel is of fundamental importance to its water renewal. This water exchange is crucial for the balance between continental inputs delivered to the coastal region and coastal water inflow. This spatial variability is attributed to variations in concentrations in riverine and marine end-members, and the transfer of nutrients between dissolved and particulate phases in the water column (Tappin *et al.*, 1993).

Ranking second in importance, seasonal variability distinguishes a rainy summer (October to March) from a less rainy winter (April to September). There is a seasonal pattern on water column stratification, due to smaller surface salinities on summer. This regulates distribution of most chemical and biological variables.

Spatial distribution and seasonal variability are then the driven forces on annual scale variability (Mayr *et al.*, 1989; Villac, 1990; Paranhos and Mayr, 1993). On short time scales, tidal influence is the most important factor on data variability (Paranhos *et al.*, 1997).

In conclusion, the main reasons of the degradation of Guanabara Bay water quality could be attributed to the increasing pollution input plus the restriction on water circulation (caused by landfills and shallowing). Monitoring programs for Guanabara Bay must be continued and should be improved, to allow for more detailed analysis based on uniform data set. From the panorama presented here, an obvious reduction on pollution loads is of high priority. It must be followed by actions aiming to avoid more restrictions to water circulation (regulation on shore modifications, deforestation on slopes and drainage basin).

Considering official clean-up program and its master plan (JICA, 1994), the initial actions on course are centered on building a sewage network, plus the maintenance of the existing one. Sewage primary treatment plants are planned, however, depending on foreign funding. Planned as well are submarine pipelines into the bay. However, this program has conceptual and technical drawbacks due to its more political than scientific nature, and several controversial decisions have been made. It prevents realistic previsions and could lead to misleading decisions on Guanabara Bay ecosystem recovery.

Only a consistent sampling program could access the clean-up project effectiveness, and frequent data acquisition is of high priority. To attend this challenging goal, a compatible sampling strategy was designed (Villac *et al.*, 1991), which is now incorporated on official monitoring of the clean-up program in course. Environmental State Agency institutional sampling is based on every two month sampling on eight sites distributed around the bay.

Among University research centers, UFRJ is sampling weekly at two strategic sites and mooring automated data acquisition is about to begin. This strategy is designed based on GOOS (Global Ocean Observing System) philosophy, an Operational Oceanography approach.

Despite its great socio-economical importance, this bay is relatively unstudied and the ecosystem functions are poorly understood. Coupled to a high frequency sampling and a serious pollution loads evaluation on the watershed, further studies are necessary to describe and quantify sources and sinks of nutrients as well as organic matter cycling within Guanabara Bay. On that scope, productive potential studies, and food web assessment are of high priority to understand Guanabara Bay dynamics. Once the above mentioned targets are achieved, there will be a significant input in modeling its aquatic biogeochemistry. Consequently, prediction of living and exploitable resources will be more accurate, improving their management in the next millenium.

Acknowledgments
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WORKSHOP 4:

UNDERSTANDING LONG TERM CHANGES IN DRAINAGE BASINS AND COASTAL SEAS

Dr Masataka Watanabe, Japan (Chairman)
Dr Sten Bergström and Ms Iréne Johansson, Sweden (Rapporteurs)

The meeting was held on Tuesday August 12, 1997, in Stockholm. Altogether 10 presentations were given, with examples from many regions (Baltic basin, Osaka Bay in Japan, Bay of Haifa in Israel, Avacha Bay in Russia, Gulf of Riga in Latvia). Some 40 people who participated vividly in the discussions attended the workshop.

Prof. Anders Grimvall gave a keynote address on time scales of nutrient losses from land to the Baltic Sea and Dr Stålnacke, representing young scientists, followed up with a presentation of river transports in the same area.

EXPERIENCES

The problems of pollution of semi-enclosed seas have accelerated greatly after the Second World War. In the 1970s the focus was on pollution from point sources while in recent years the effects of non-point sources have become a major concern. One effect is more widespread and more frequent outbursts of algae blooms and red tides in coastal areas and semi-enclosed seas. In the Baltic Sea, for example, algae bloom sometimes gives dramatic effects like in July the warm summer of 1997.

The experiences from different studies in the world reveal mixed success with restoration programmes. In Sweden the goal of a 50% reduction of the input of nutrients to the Baltic Sea has not been achieved. The concentration of phosphorus can generally be reduced relatively rapidly from high to moderate levels, whereas a further reduction is much more difficult. The reduction of non-point nitrogen pollution remains a major problem.

The inertia in some of the systems in the Baltic basin is probably the cause of the limited response to drastic changes in fertilisation in the Eastern European countries. As the economic system is changing in these areas the nutrient retention capacity may be reduced as new agricultural practice is introduced.

Interesting results from a study in the Riga Bay shows that the loads of heavy metals have dropped substantially since 1989. Direct success, as concerns COD, is reported from mitigation programmes in the Osaka Bay in Japan, although the internal production due to nitrogen and phosphate remains an unsolved problem.

Data consistency was identified as a key issue. This is particular critical for long term analysis of water quality. One conclusion is also that methods have to be developed further to help distinguish natural variabilities in environmental conditions from effects of human impact.

GAPS AND METHODOLOGY

The meeting identified the understanding of non-point nitrogen pollution as one of the most urgent topics for future research. This includes the turnover of nitrogen in the soil, effects of land use and agricultural practice, lakes and wetlands. It was also noted that not only fertilisers should be in focus, but also its proportion in relation to other chemicals, such as silicate and iron can be of significance for primary production and eutrofication.

The application of tracers to fertilisers was proposed as a means to investigate the mechanism and fate of non-point source pollution compounds. There is still a substantial uncertainty regarding the role of different sources in the present nutrient loads.

Models and other analysis tools, which take proper consideration of time lags, buffering and inertia of the system, have to be developed to handle non-stationary conditions. These are caused, for example, by changing land use, soil degradation, reservoir development and operation.

COMMON EFFORTS

A general conclusion is that legal processes, determination, firm decisions and long term commitments are required for successful restoration programmes. It is also of utmost importance with a sound scientific background, engagement and realistic and quantifiable goals. An open dialogue must be developed between scientists and responsible bodies for water restoration programmes. This means that successes and failures must be exposed and analysed continuously and openly.

Interdisciplinary approaches are necessary for the understanding of long term changes in drainage basins and coastal seas. Several speakers exemplified this. This embraces meteorology, hydrology, biology, ecology and oceanography among other natural sciences, but social sciences must not be forgotten. Full use should be made of monitoring programmes, biogeochemical archives, analysis and mathematical models.

International methodological co-operation should be developed between areas with environmental problems in semi-enclosed seas and their catchments. As this is a problem that many countries have in common their will be a significant benefit from joint efforts.

TIMESCALES OF NUTRIENT LOSSES FROM LAND TO SEA - A EUROPEAN PERSPECTIVE

Anders Grimvall[1], *Per Stålnacke*[2] *and Andrzej Tonderski*[3]

1) Department of Statistics, P.O. Box 7013, Swedish University of Agricultural Sciences, SE-75007 Uppsala, Sweden
2) Jordforsk - Centre for Soil and Environmental Research, N-1432 Ås, Norway
3) Department of Water and Environmental Studies, Linköping University, SE-58183 Linköping, Sweden

Abstract

Empirical data regarding the timescales of nutrient losses from soil to water and land to sea were reviewed. The appearance of strongly elevated concentrations of nitrogen and phosphorus in major European rivers was found to be primarily a post-war phenomenon. However, the relatively rapid water quality response to increased point source emissions and intensified agriculture does not imply that the reaction to decreased emissions will be equally rapid. Long-term fertilisation experiments have shown that important processes in the large-scale turnover of nitrogen operate on a timescale of decades up to at least a century, and in several major Eastern European rivers there is a remarkable lack of response to the dramatic decrease in the use of commericial fertilisers that started in the late 1980s. In Western Europe, studies of decreased phosphorus emissions have shown that riverine loads of this element can be rapidly reduced from high to moderate levels, whereas a further reduction, if achieved at all, may take decades. Together, the reviewed studies showed that the inertia of the systems that control the loss of nutrients from land to sea was underestimated when the present goal of a 50% reduction of the input of nutrients to the Baltic Sea and the North Sea was adopted.

Introduction

Losses of nutrients from land to sea have caused considerable concern in large parts of Europe. In the late 1980s, a goal of a 50% reduction of the nitrogen and phosphorus export to the North Sea and the Baltic Sea was adopted by HELCOM (Helsinki Commission) and OSPARCOM (Oslo-Paris Commission), and action programmes were initiated to achieve this goal by 1995. Now that data for the first half of the 1990s have become available, it is obvious that the reduction actually achieved is much smaller (Bonde, 1994; Stålnacke *et al.*, 1997a). Most of the interannual variation in the export of nutrients to the sea seems to be related to natural fluctuations in runoff, and the export of nitrogen has been particularly difficult to reduce. Slow implementation of proposed measures may be one important reason the goals have not been realised. However, it is also important to consider the inertia of the aquatic and terrestrial systems that control the export of nutrients from land to sea.

In the present article, we discuss various types of empirical data that may elucidate the timescales of large-scale nutrient losses to the sea. In particular, we examine how major changes in land-based activities have influenced riverine loads of nutrients. The dramatic change in agricultural practices that was caused by the economic decline in the Soviet Union and Eastern Europe has created unique opportunities to study the impact of land use and agricultural practices on water quality (Oláh & Oláh, 1996; Löfgren *et al.*, 1997; Tonderski *et al.*, 1997b). Furthermore, large point emissions of phosphorus to lakes and rivers have been removed, which has enabled river-basin-scale studies of processes in the aquatic environment. Long-term fertilisation experiments on agricultural and forested land provide additional information about the timescales of various processes in soil (Jenkinson, 1991; Tamm *et al.*, 1995).

Past increases in riverine loads of nutrients

To widen the perspective on the failure to halve the export of nutrients to the North Sea and the Baltic Sea, we first consider the question of how long it took to reach the present situation. Direct measurements of water quality primarily cover the past few decades, and before that time there is mainly indirect information regarding the state of the environment. Moreover, it is not known whether the very first measurements of nutrient concentrations in surface waters (e.g. Balló, 1876) were accurate or not. Nevertheless, it is indisputable that significant increases in the riverine export of nutrients from land to lakes and seas did occur in the 19th century. During that period in history, sewage emissions mounted due to urbanisation and a general growth in population, and increased draining and tilling of agricultural soils favoured erosion and leaching processes. Studies of lake sediments have confirmed that the loss of phosphorus from agricultural land increased long before commercial fertilisers were used (Dearing *et al.*, 1987), and the classical experiments at Rothamsted show that older agricultural practices also resulted in substantial export of nitrogen to water (Lawes *et al.*, 1881). However, the fact that environmental changes did take place long ago does not negate the exceptionally high rate of change during the latter half of the 20th century. In fact, regular water quality measurements provide clear evidence that strongly elevated nutrient concentrations in major European rivers represent what is primarily a post-war phenomenon. In Western Europe, the 1950s and 1960s seem to be the most critical decades (e.g. José, 1989; Behrendt & Böhme, 1993), whereas in Eastern Europe substantial increases also occurred in the 1970s and early 1980s (Tsirkunov *et al.*, 1992; Oláh & Oláh, 1996).

The graphs in Figure 1 show annual flow-weighted mean values of nitrate and phosphate at Lobith on the Rhine River, near the border between Germany and the Netherlands. As can be seen, the nitrate concentration approximately tripled from the early 1950s to 1980. The phosphate concentration at the same site increased about fivefold from the late 1950s to 1980, when a massive action programme curbed the upward trend and turned it into a decrease. The graphs in Figure 2 illustrate nitrate trends in the Tisza River at sampling sites in Hungary, and it can be seen that the interannual variation there is more irregular than in the Rhine. However, Figures 1 and 2 both show that a substantial increase in the riverine loads of nutrients can be realised within one to two decades.

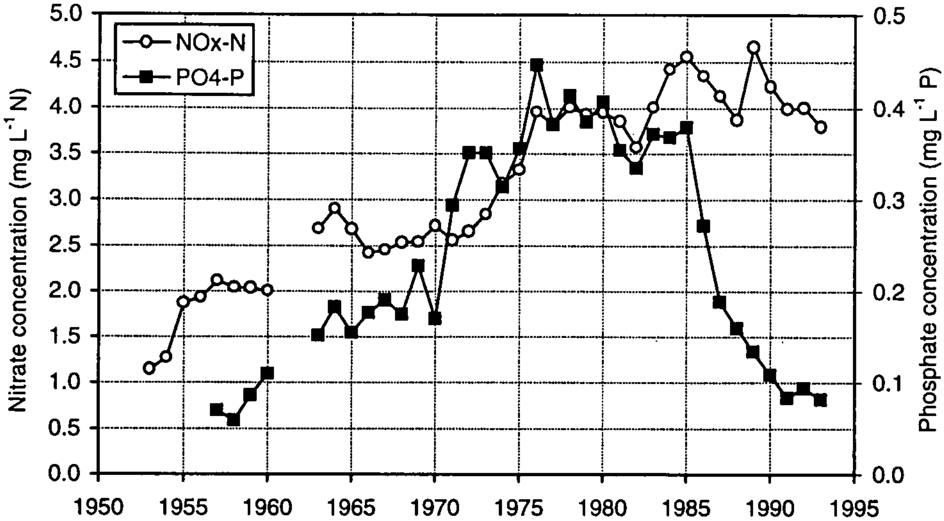

Figure 1. Annual flow-weighted mean concentrations of NO_3-N and PO_4-P at Lobith on the Rhine. Sources: van Dijk *et al.* (1996) and Netherlands Institute for Inland Water Management and Wastewater Treatment (RIZA).

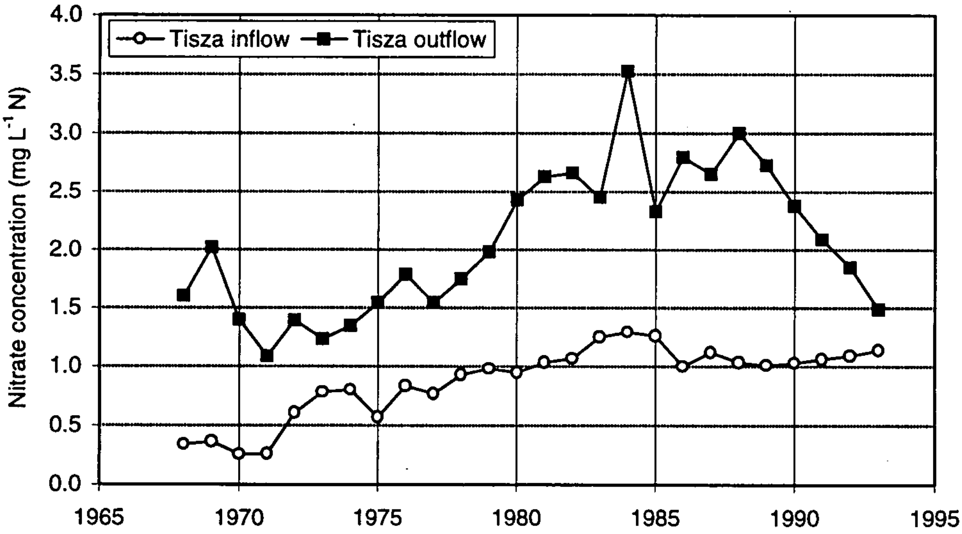

Figure 2. Annual mean concentrations of NO_3-N in the Tisza River in Hungary. Source: Oláh & Oláh (1996).

Water quality response to reduced point emissions

The measures thus far invoked to reduce point emissions of nutrients to water have mainly focused on phosphorus. There are two main reasons for this: first, it has long been known that phosphorus plays a key role in the eutrophication of inland waters (Vollenweider, 1968); second, removal of phosphorus can easily be introduced in existing systems for wastewater treatment.

The time series of phosphate data from the Rhine River (Figure 1) shows a very dramatic decrease in the mid 1980s, when several major point emissions of phosphorus were practically eliminated and phosphorus-containing detergents were phased out. Over less than a decade, the phosphate concentration in the river dropped from a very high level to the values that had prevailed in the 1950s (Behrendt & Böhme, 1993; van Dijk *et al.*, 1996). However, experience from the Rhine is not applicable to all river basins. This can be illustrated by observations in the lake-rich Motala River Basin in Sweden (Figure 3). In the mid 1970s, tertiary treatment was introduced at all major wastewater treatment plants in this basin, and the total point emissions of phosphorus in the study area dropped by almost 200 tonnes yr^{-1} to less than 10% of the previous level (Karlsson, 1989). In spite of that, the flow-normalised transport of phosphorus at the river mouth has remained at a level of about 100 tonnes yr^{-1}.

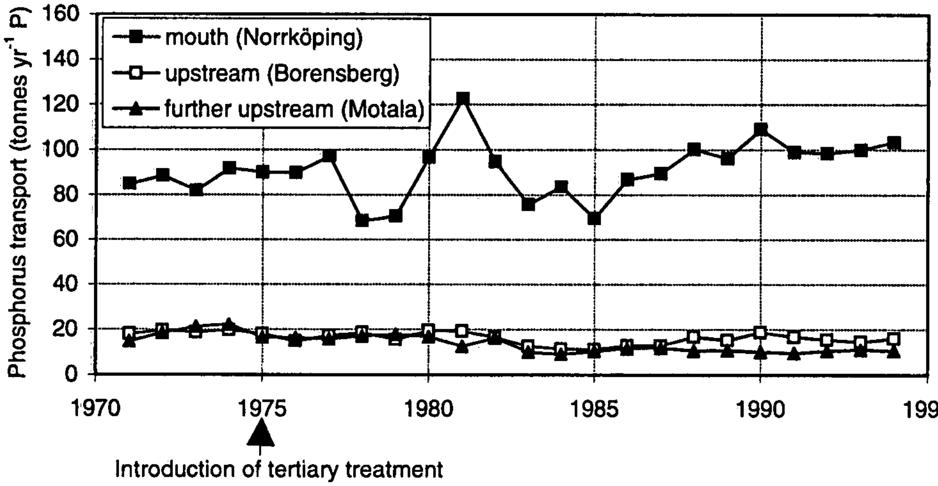

Figure 3. Annual phosphorus transports at three sites in the Motala River Basin in Sweden. Tertiary treatment was introduced around 1975 at all major municipal treatment plants located between the sampling sites at Motala and Norrköping.

Almost daily measurements of PO_4-P in the agriculturally dominated Odense River Basin in Denmark provide another example of the inertia of the systems controlling the export of phosphorus from land to sea. As can be seen in Figure 4, the concentration of phosphate decreased from 1987 to 1991 and thereafter levelled out. Furthermore, the downward trend was accompanied by a significant shift in the relationship between concentration and flow; the concentration peaks, that previously occurred during low-flow conditions, were practically absent during the years 1992 to 1996. This strongly indicates that the decrease in phosphate was due to removal of point emissions, and that the present load is primarily caused by diffuse emissions to water or possibly internal loading from the river bed. It is also noteworthy that, in both the Odense and Rhine Rivers, the phosphate concentration levelled out at values exceeding 0.05 mg L^{-1}, i.e. at concentrations far exceeding the natural background level. Several cases of delayed recovery of lakes (Sas, 1989) provide additional support for the conclusion that the concentration of phosphorus can be rapidly reduced from high to moderate levels, whereas further reduction is a more difficult and time-consuming task.

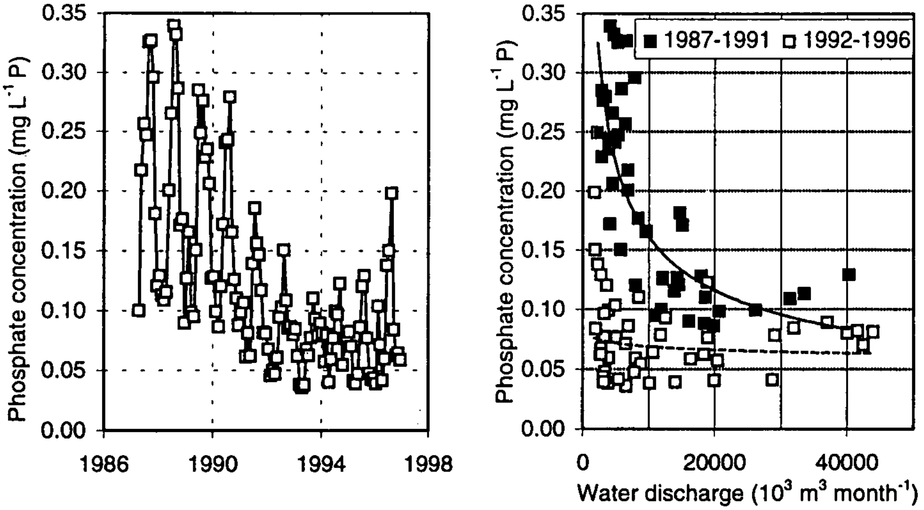

Figure 4. Monthly flow-weighted mean concentrations of PO_4-P at Kratholm on the Odense River: a) time series plot; b) scatter chart of concentration vs discharge. Source of raw data: County Board of Funen, Denmark.

In regard to the export of nitrogen from land to sea, point emissions rarely play a dominating role. Source apportionment studies have shown that even in densely populated river basins, such as that of the Oder, nonpoint sources can be responsible for as much as 70% of the transport at the mouth of the river (Tonderski *et al.*, 1997a). Moreover, implementation of nitrogen removal at wastewater treatment plants is still in its infancy, thus it is not surprising that there are few cases of downward trends in nitrogen that can be attributed to removal of point emissions. Detailed studies of the Rhine River indicate that such measures may have played a role in a recently noted downward tendency (Behrendt & Böhme, 1993; Stålnacke & Grimvall, 1997), and a nationwide evaluation of water quality trends in Swedish rivers revealed two examples of downward nitrogen trends that were caused by decreased industrial emissions (Stålnacke *et al.*, 1997b). However, none of the cited studies allows far-reaching conclusions to be drawn regarding the timescales of nitrogen losses from land to sea.

Water quality response to changes in land use and atmospheric deposition

It has already been pointed out that the situation in Eastern Europe is of particular interest in regard to diffuse losses of nutrients. Starting in the late 1980s, the application of commercial fertilisers dropped at an unprecedented rate and also the application of manure decreased significantly (Oláh & Oláh, 1996; Löfgren *et al.*, 1997; Tonderski *et al.*, 1997b). In the long run, such dramatic changes in agricultural practices will inevitably influence the losses of nutrients to water, and studies of small catchments in Slovakia (Pekárová & Pekár, 1996) and Estonia (Loigu & Vasilyev, 1997; Mander & Kull, 1997) have shown that the output of nitrate with water can respond rapidly to decreased fertilisation. The question is when and to what extent changes will appear on a scale of medium-sized to large river basins. In the following, we will focus on losses of nitrogen, in particular nitrate. The loss of phosphorus from agricultural land is primarily related to erosion and application of manure, hence such export can not be expected to respond directly to changes in the application of commercial fertilisers.

The Tisza River in Hungary (drainage area 157 000 km^2) probably provides the clearest evidence that decreased application of fertilisers in Eastern Europe has influenced water quality even in some fairly large catchments. From 1988 to 1993, the total consumption of commercial fertilisers in Hungary dropped from 617 000 to 124 000 tonnes yr^{-1} N (Oláh & Oláh, 1996), and Figure 2 shows that the concentration of nitrate at the outlet of the river under consideration was approximately halved from 1988 to 1993. Moreover, agriculture plays a dominating role in the Hungarian part of the Tisza River Basin, hence the observed shift in water quality was probably caused by changes in agricultural practices.

However, the cited trends in the Tisza River do not seem to be representative of Eastern European rivers in general. On the contrary, there is a remarkable nonappearance of trends in several major rivers. Statistical trend assessments of nutrient loads carried by the Daugava River and other Latvian rivers showed that most of the interannual variation could be attributed to natural variation in runoff (Laznik *et al.*, 1997). Also, a similar study of the Oder and Vistula Rivers in Poland showed that the flow-normalised riverine loads remained practically constant from 1989 to 1995 (Figure 5 and Tonderski *et al.*, 1997a). A comprehensive investigation of the input of nutrients to the entire Baltic Sea has provided additional evidence of the inertia of the systems controlling the export of nutrients from land to sea (Stålnacke *et al.*, 1997a). In spite of the fact that the study period covered 24 years, i.e. 1970 to 1993, the annual riverine loads of nitrogen to the Baltic Sea appeared to be practically constant after flow-normalisation.

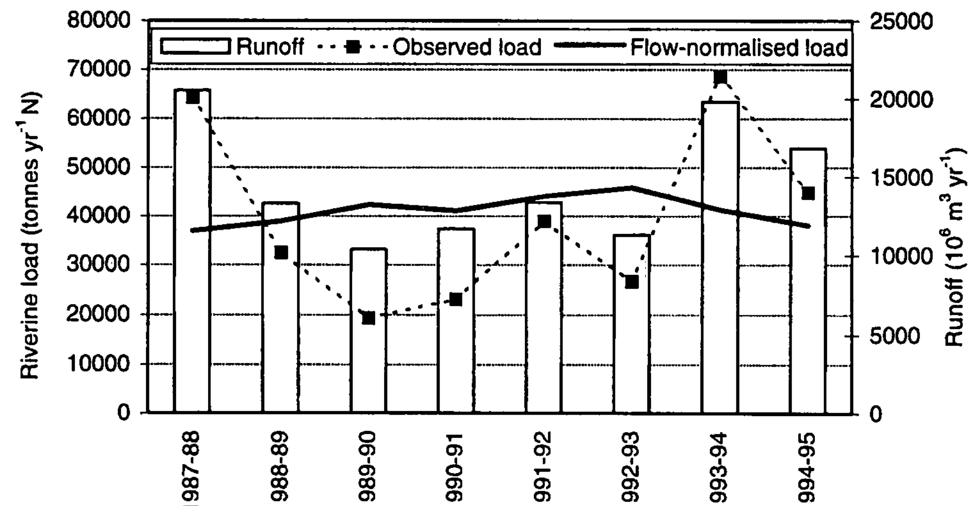

Figure 5. Runoff and observed and flow-normalised riverine loads of NO_3-N at Krajnik on the Oder River. Illustrated values are annual values from November to October. Source: Tonderski *et al.* (1997a).

Studies of the impact of anthropogenic activities on the loss of nutrients from forested catchments have mainly been focused on effects of clear-cutting and increased atmospheric deposition of nitrogen. A recently published summary of data from different parts of Europe (Gundersen, 1995) showed that nitrogen saturation is a reality in several small catchments receiving large amounts of nitrate and ammonium through wet and dry deposition, i.e. the uptake of nitrogen in stands and topsoil is too small to prevent significant losses to water. However, the chart also reveals substantial differences from catchment to catchment. Moreover, the impact of nitrogen deposition on the export of nitrogen from large forested river basins is a matter of controversy. Such river basins are primarily located in remote areas that receive moderate amounts of nitrogen, and the results in Figure 6 provide little evidence of increased losses of nitrogen to water at a deposition of up to about 15 kg ha^{-1} yr^{-1} N. If the data shown in Figure 6 represent stable conditions, apparently some catchments can accumulate as much as 50 kg ha^{-1} yr^{-1} N.

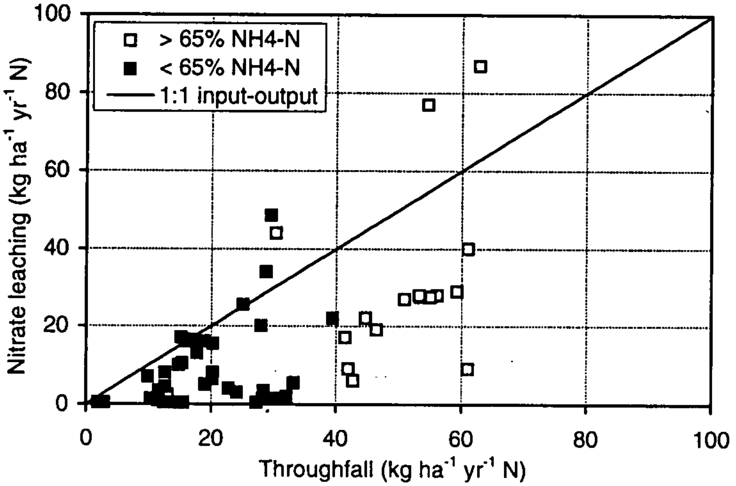

Figure 6. Throughfall and loss of nitrogen to surface water in small forested catchments in Europe. Source: Gundersen (1995).

Long-term experimental studies

Even though some of the results presented in this article strongly indicate that the timescales of nutrient losses to water are related to the size of the catchments under consideration, small-scale experimental studies can be of great value to elucidate the role of specific processes or environmental compartments. One of the classical experiments at Rothamsted, the so-called Broadbalk Winter Wheat Experiment, which goes back to 1852, illustrates how more than a century of application of nitrogen fertiliser can build up the pool of mineralisable nitrogen present in the top soil at harvest (Figure 7). If no cover-crops are used, this will inevitably cause increased losses of nitrate to water after the harvest. Furthermore, the losses along this pathway will decline very slowly with decreasing inputs of nitrogen fertilisers. In 1980, an ^{15}N experiment was superimposed on the Broadbalk Wheat Experiment, and that attracted additional attention to the crucial role of organic nitrogen in soil. Regardless of whether the ^{15}N-labelled fertiliser was applied in the amount of 48 or 192 kg ha^{-1} yr^{-1}, less than 2% of the applied inorganic nitrogen was present in inorganic forms after harvest (Shen *et al.*, 1989). The classical experiments at Rothamsted may also elucidate the long-term accumulation of nitrogen in forest ecosystems. In the 1880s, two plots of agricultural land were allowed to revert to woodland, and almost a century later the two plots were found to have accumulated nitrogen at an average rate of 65 and 23 kg ha^{-1} yr^{-1}, respectively (Jenkinson, 1991).

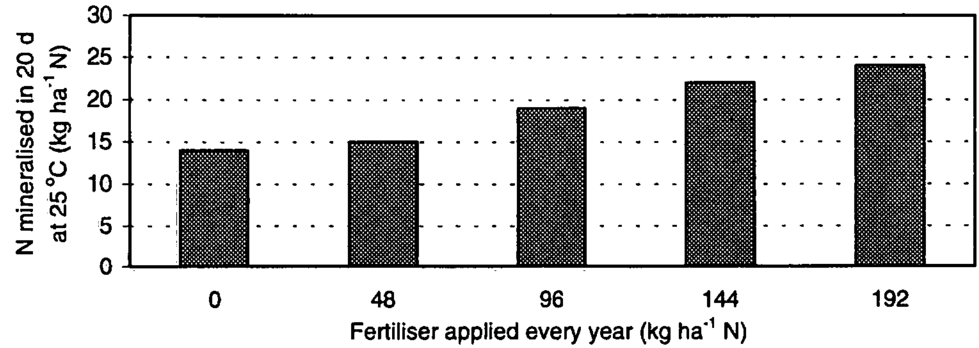

Figure 7. The effects of long-term application of nitrogen fertilisers on the amount of mineralisable nitrogen (20 d, 25 °C) in top soil (0 - 23 cm) from the Broadbalk Winter Wheat Experiment. Source: Shen *et al.* (1989).

Long-term fertilisation experiments in forest ecosystems are rare. However, one such experiment worth naming was started in 1971 in a pine forest in northern Sweden. After an initial period with relatively high input of nitrogen, different plots were given 30 to 90 kg ha^{-1} N annually. About 15 years later it was found that most of the nitrogen applied at the highest rate (on average 114 kg ha^{-1} yr^{-1} in 1971-1985) had disappeared from the studied ecosystem, whereas no less than about 65% of the nitrogen applied at the lowest rate (on average 38 kg ha^{-1} yr^{-1}) had been accumulated in the stands and the top soil (Figure 8). Together, the cited experimental studies show that the turnover of nitrogen in soil involves processes that operate on a timescale of decades up to a century or more

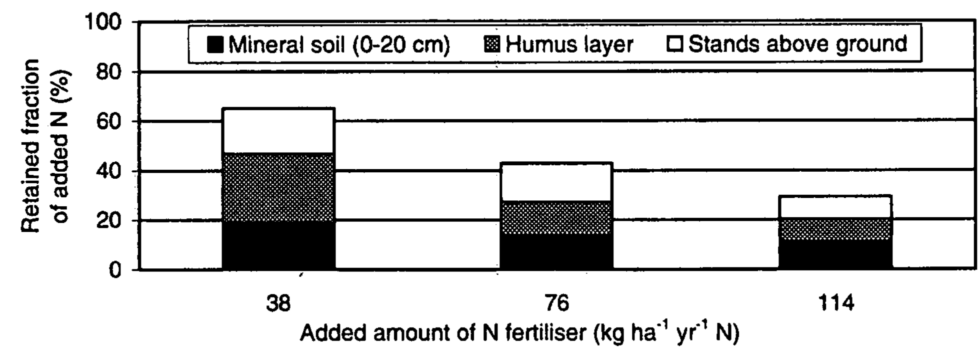

Figure 8. Estimated retention of nitrogen applied in a pine forest at Norrliden in northern Sweden. Source: Tamm *et al.* (1995).

Implications for the future loss of nutrients to the Baltic Sea and the North Sea

On a timescale of a few years, changes in the anthropogenic impact on water quality may easily be overshadowed by natural fluctuations in climate. This is illustrated by the trajectories of runoff and riverine loads of nitrate in Figure 9. A dry summer and autumn (1992) followed by an unusually wet winter can virtually flush nutrients from soil to water, and a long period of dry weather (1995-96) may cause a dramatic drop in both the amount of nitrate transported and the concentration of this ion in receiving waters.

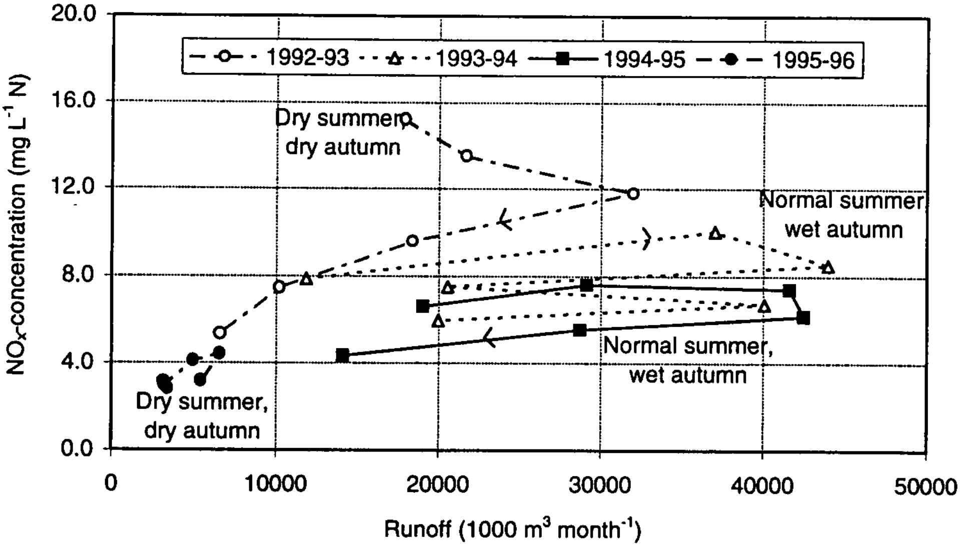

Figure 9. Trajectories of runoff and riverine loads of NO_x-N at Kratholm on the Odense River in Denmark. The values illustrated in the scatter chart represent monthly averages based on daily measurements in November to April each year. Source of data: County of Funen, Denmark.

The unclear water quality response to lowered application of fertilisers is noteworthy, regardless of climatic conditions. Some of the authors cited in the present article (e.g. Shen *et al.*, 1989; Löfgren *et al.*,1997) have emphasized that if large amounts of organic nitrogen have accumulated in soil during periods of higher application rates, nitrogen losses with agricultural runoff will decline very slowly, even though fertiliser inputs are being reduced. In particular this pertains to river basins where a lowered input of nitrogen has been accompanied by decreased harvests, because in that case the nitrogen that is mineralised may leach to water instead of being taken up by crops. However, lowering of fertiliser inputs has not led to decreased harvests in all parts of Eastern Europe. In Poland, for example, the total harvest has been maintained at almost the same level, despite a more than 50% decrease in the use of commercial nitrogen fertilisers since the late 1980s (Tonderski *et al.*, 1997b). Examination of data from small catchments in Poland indicated that, due to hydrogeological conditions that favour retention of nutrients, the losses were already remarkably low before the recent reduction in fertiliser application. Moreover, sources other than agricultural runoff, e.g. urban runoff, play a relatively large role in Poland, and interannual variation in such sources may have concealed a moderate decrease in the nitrogen losses from agricultural land. Groundwater aquifers with long residence times represent yet another explanation for the weak response to lowered fertiliser input rates.

It is also interesting to note that a purely theoretical analysis of pools and fluxes can explain why the response to increased input of fertilisers in the 1950s and 1960s (Schrøder, 1985; Behrendt & Böhme, 1993) appears to have been more rapid than the response to decreased input in the 1990s. The graphs in Figure 10 show how a system comprising two parallel compartments with different residence times (1 and 10 years, respectively) responds to inputs that are constant at first, then increase and finally decrease to the original level. The rapid response to increased input is due to the compartment with short residence time, which may represent the presence of rapidly mineralisable organic matter in soil. The slow and time-lagged response to decreased inputs is due to the compartment with long residence time, which may consist of a humus fraction in soil or a large groundwater aquifer.

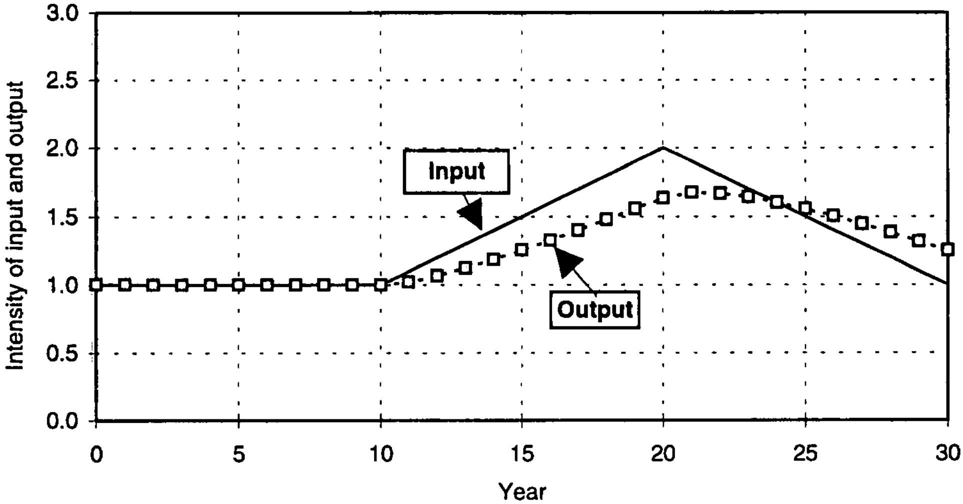

Figure 10. Impact of changed input on the output of a model comprising two parallel compartments with different residence times (1 and 10 years, respectively).

So far, the present discussion has focused on the question of how long it will take for decreased inputs or emissions in a drainage area to influence the output through the mouth of the river under consideration. However, attention should also be focused on the risk of an increased riverine export of nutrients, in particular nitrogen, since that export is controlled not only by emissions, but by retention of nutrients in terrestrial and aquatic systems as well. Budget calculations for entire European river basins, and subbasins thereof, have demonstrated that up to 80% of the phosphorus and nitrogen released to water is either trapped in sediments or removed by denitrification during transport from the source to the mouth of a river (Behrendt, 1996). Unfortunately, there is no guarantee that this retention can be maintained if Western European solutions and technologies are copied by Eastern Europe. Several scientists have deliberated the crucial role of buffer zones in river corridors (Haycock *et al.*, 1997). Other researchers have shown the risks of dealing with the nitrogen and phosphorus issues separately. For example, it has demonstrated that the retention of nitrogen in lakes and rivers may actually decrease, if the input of phosphorus is lowered by introduction of tertiary treatment of municipal wastewater (Chesterikoff *et al.*, 1992; Stålnacke *et al.*, 1997b). That possibility further widens the perspective on the timescales of nutrient losses from land to sea.

Conclusions

The inertia of the systems that control the loss of nutrients from land to sea was underestimated when the present goal of a 50% reduction was adopted.

The concentration of phosphorus can be rapidly reduced from high to moderate levels, whereas a further reduction, if achieved at all, may take decades.

The water quality response to lowered input of nitrogen to a drainage area may be slower than the response to the post-war increase in the input.

Acknowledgement

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NUTRIENTS WITH RIVERS TO THE BALTIC SEA

Per Stålnacke [1], *Anders Grimvall* [2] *and Andrzej Tonderski* [3]

1) Ph.D., Jordforsk - Centre for Soil and Environmental Research, N-1432 Ås, Norway
2) Assoc. Prof., Dept. of Statistics, Swedish University of Agricultural Sciences, P.O. Box 7013, SE-750 07 Uppsala, Sweden
3) Ph.D., Dept. of Water and Environmental Studies, Linköping University, SE-581 83 Linköping, Sweden

INTRODUCTION

The Baltic Sea (surface area 415,000 km^2), together with the lakes and watercourses in its drainage basin (1,745,100 km^2), represents one of the most intensively monitored aquatic systems in the world (Figure 1). Systematic determinations of nutrient concentrations in rivers was begun as early as the 1950s at some sites in Estonia and Latvia (Tsirkunov *et al.*, 1992), and in the mid 1960s, the first steps were taken towards inception of programmes for monitoring of water quality in Sweden and Finland. However,,it was not until 1977, when the former Soviet Union established a new water quality monitoring programme, that most of the Baltic Sea drainage basin came to include adequate analytical procedures and sampling schemes.

The first real attempts to estimate the total riverine load of nutrients to the Baltic Sea were made in the beginning of the 1980s (Table 1). These estimates were all based on secondary data, *i.e.* on data that had been collected and aggregated by various national agencies or international bodies (e.g. the International Council for the Exploration of the Sea; ICES). In 1987, Helcom published its first compilation of pollution loads (Helcom, 1987), and estimates presented had been obtained by examining runoff and concentration data. Unfortunately, the study period in that case was restricted to 1985, and the underlying reports submitted by some of the participating nations were incomplete. In 1993, Helcom published a second pollution-load compilation based on data from 1990 (Helcom, 1993a). Among the references listed in Table 1, a report by MENR (1990) and a follow-up article by Enell and Fejes (1995) are of particular interest. In contrast to the other studies, these two publications presented estimates that were not based on measured concentrations and runoff in the monitored rivers. Instead emission coefficients were assigned to different types of point and nonpoint sources, and such coefficents were then combined with assigned retention values according to a procedure that had been applied in Sweden (LRF, 1988).

The load estimates listed in Table 1 demonstrate that there are remarkable discrepancies between the results obtained by different investigators. Some of these dissimilitudes can be explained by differences in study periods or the definition of the study area. However, it is obvious that there are other dissimilarities that call for a closer examination of underlying data. Inasmuch as riverine loads of nutrients can vary strongly with fluctuations in runoff, it is also of great interest to analyse whole time series of nutrient concentration and runoff data. The results of such a study are presented in the following.

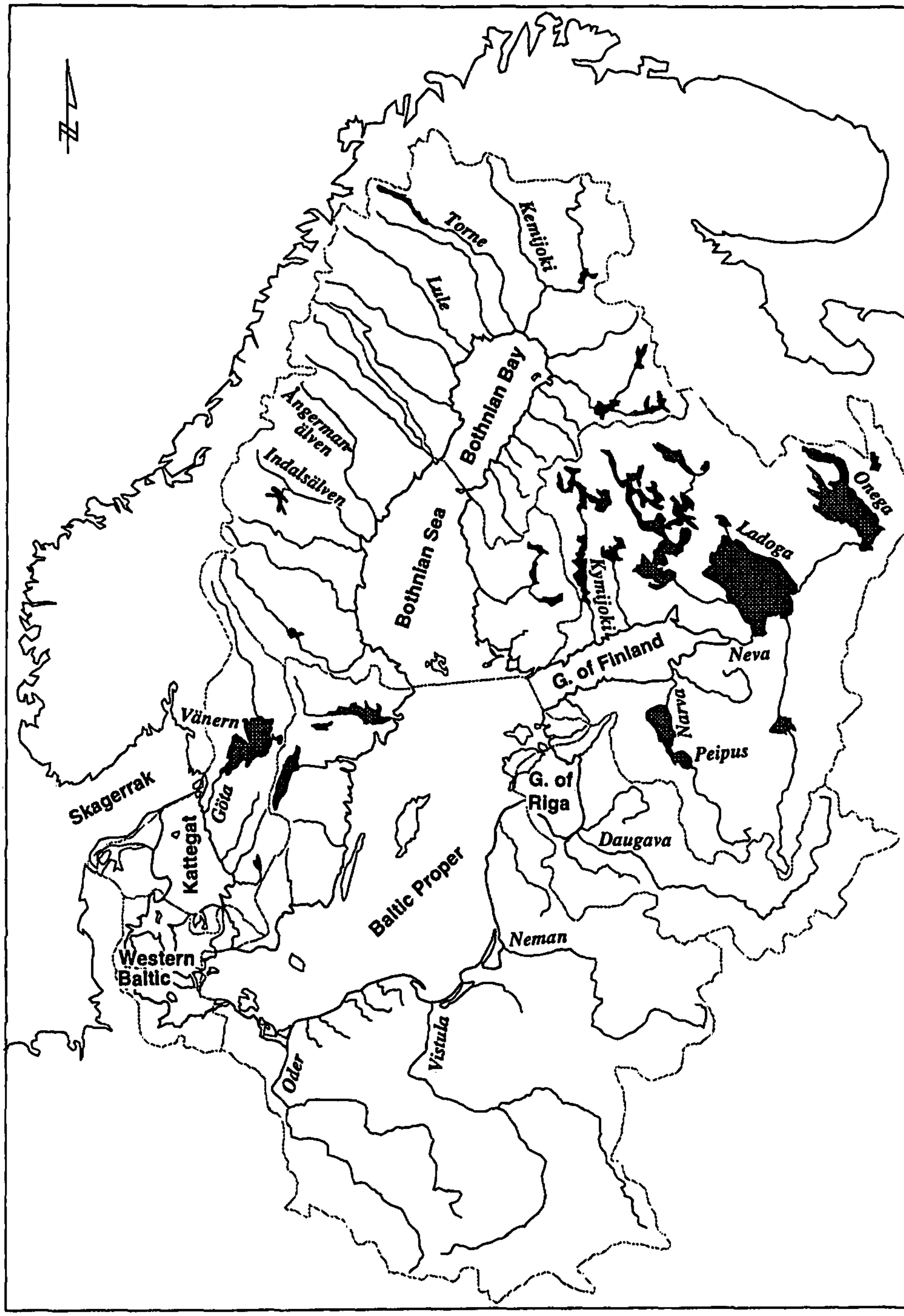

Figure 1. The Baltic Sea drainage basin and its major sub-basins and rivers.

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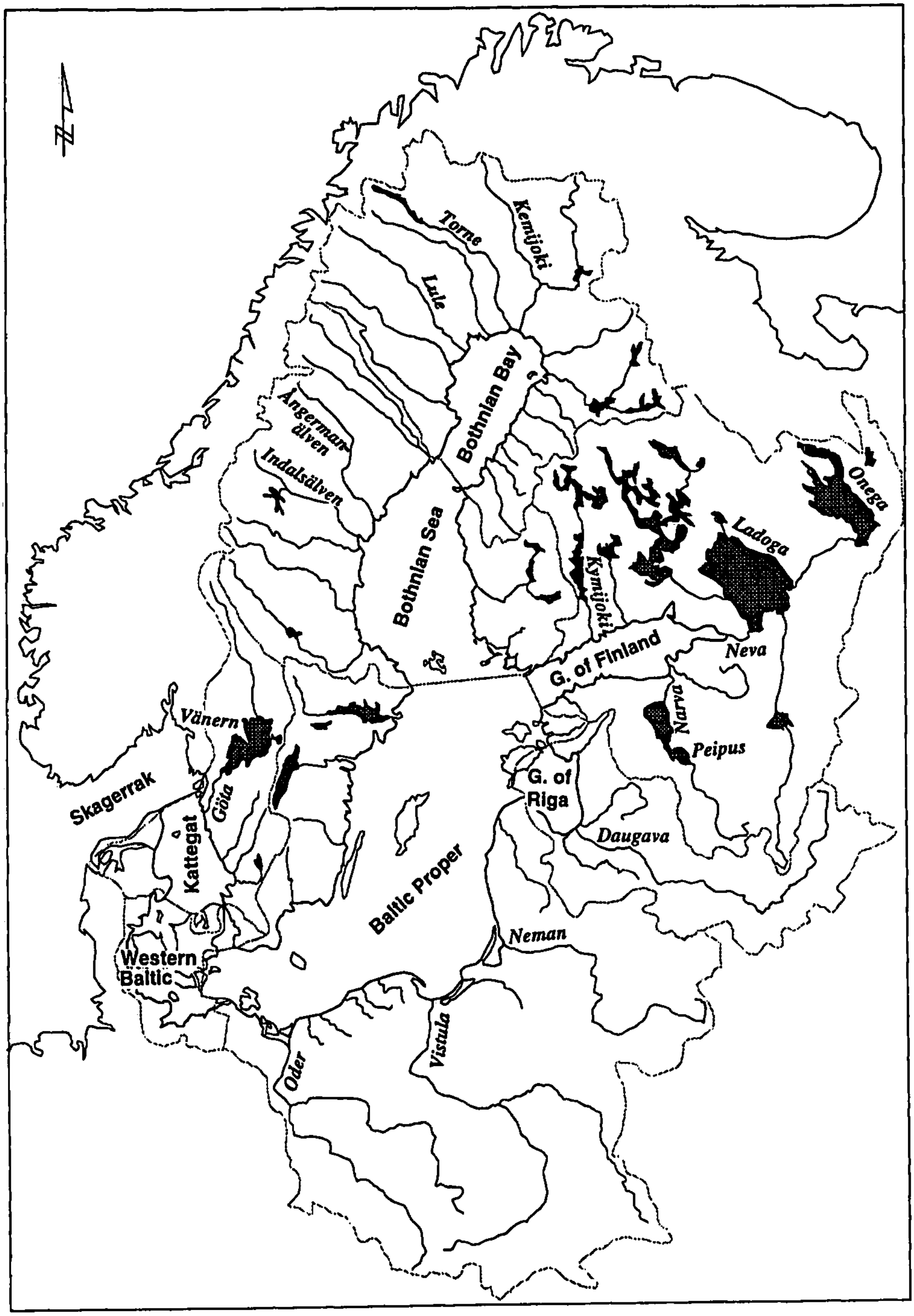

Figure 1. The Baltic Sea drainage basin and its major sub-basins and rivers.

Table 1. Estimates of the total riverine loads of nitrogen and phosphorus reported in the literature.

Reference	Study period	Nitrogen (tonnes yr^{-1} N)	Phosphorus (tonnes yr^{-1} P)
Pawlak (1980)	1972-77	265 225[a,b]	22 112[a,b]
Maksimova (1982)	1968-78	508 000	45 400
Larsson *et al.* (1985)	1977-83	640 500[b]	50 170[b]
Bernes (1988)	1977-88	831 245[c]	74 560[c]
Rosenberg *et al.* (1990)	1982-87	535 400[c]	47 290[c]
Rybinski (1989)	1985-89	692 894	38 119
Helcom (1993)	1990	567 739	33 360
Fotyma & Terelak (1994)	1990	733 000	53 100
MENR[d] (1990), Enell & Fejes (1995)	1990-93	979 000[c]	58 860[c]
Total range		265 000 - 979 000	22 000 - 59 000

a Excluding loads from the former Soviet Union (Russia and the Baltic States) to the Gulf of Riga and the Baltic proper

b Excluding loads to the Kattegat

c Including coastal point source emissions

d Ministry of Environment and Natural Resources in Sweden

DATABASE

Part of our research and the endeavours of the Swedish research programme "Large-scale Environmental and Ecological Processes in the Baltic Sea" (SEPA, 1990) involved collection of time series of nutrient concentration data for all major rivers in the Baltic Sea drainage basin. Parallel to this, a comprehensive database of runoff data was established at the Swedish Meteorological and Hydrological Institute (Bergström & Carlsson, 1994).

To ensure the best possible quality of collected nutrient concentration data, the present study was based almost exclusively on data from national monitoring programmes. More precisely, data were obtained from the following agencies or institutions: the State Hydrological Institute in St. Petersburg (Russia); the Tallinn Technical University and the Ministry of Environment (Estonia); the Latvian Hydrometeorological Agency in Riga; the Environmental Research Centre in Vilnius (Lithuania); the Institute of Meteorology and Water Management in Gdansk and Wroclaw (Poland); the State Agency of Water Management and Coasts (Germany); the National Environmental Research Institute in Silkeborg (Denmark); the Swedish University of Agricultural Sciences in Uppsala and the Swedish Meteorological and Hydrological Institute in Norrköping; and the National Board of Waters and the Environment in Helsinki (Finland). The resulting database comprised time series of nitrogen and phosphorus data for almost 150 rivers or streams in the Baltic Sea drainage basin. Most of the data series covered at least the period 1977-1993, and the sampling frequency varied from twice a week in parts of the Polish monitoring programme to approximately once a quarter in parts of the Estonian programme. To acquire further information about the present concentration levels, our study team at Linköping University organised sampling tours to the Neva, Narva, Daugava and Neman Rivers on 3, 7, 8 and 6 occasions, respectively, in 1992-1994. Furthermore, in 1991-1994, almost monthly sampling was carried out in the Vistula River (Sundblad *et al.*, 1994; Tonderski *et al.*, 1995; Tonderski, 1997).

Our statistical analysis of collected water quality data uncovered the existence of inconsistent or obviously incorrect data. The procedures used to reveal and remove such data, and to fill in gaps in the remaining data sets, are described in detail in a previous report (Stålnacke *et al.*, 1997); in the same paper, it is also related how total nitrogen (total-N) and total phosphorus (total-P) series were constructed for sampling sites in the former Soviet Union, for which such data were scarce. After removing the erroneous and uncertain data, we calculated monthly riverine loads of nutrients for the time period 1970-1993 and then aggregated the results to obtain estimates of riverine loads discharged to the major sub-basins of the Baltic Sea.

RESULTS

Examination of the completeness and quality of reported data showed that riverine loads of nutrients to the Baltic Sea could be reconstructed back to 1970, with the highest uncertainty for the estimates representing the early 1970s. We estimated that the average annual riverine load of nutrients to the Baltic Sea during the time period 1980-1993 was 825,000 tonnes N and 41,000 tonnes P (Figure 2). This is far more than the sum of the atmospheric deposition, N_2-fixation and direct emissions from cities and industries along the coast, which has previously been estimated to approximately 530,000 tonnes N and 19,000 tonnes P.

Considering that the present results and the most recent pollution load compilation by Helcom (1993a) were based on essentially the same data sources, the load estimates arrived at are remarkably different. Closer examination of the data showed that there were two major reasons for the discrepancies: (i) Helcom used values representing only inorganic nitrogen when total nitrogen data were missing, (ii) concentration data for some of the major rivers in the eastern and southern parts of the Baltic Sea drainage basin were obviously incorrect or inconsistent. The time series approach employed in the present study enabled more realistic reconstructions of missing total nitrogen concentrations and also played a crucial role in the identification of inconsistent or obviously incorrect data. Furthemore, we estimated the contributions from small rivers ($Q< 5\ m^3\ s^{-1}$) and from coastal areas between the monitored rivers, whereas Helcom omitted such contributions.

The dotted lines in Figure 2 show that the nitrogen and phosphorus loads were slightly higher in the 1980s than in the 1970s. In addition, the loads of both nitrogen and phosphorus were strongly correlated to the runoff. A substantial fraction of the interannual variation was thus removed when load data were flownormalised (solid lines in Figure 2). In fact, flow normalisation removed practically all signs of upward or downward trends in the annual riverine loads of total-N to the Baltic Sea. The flow-normalised phosphorus loads exhibited a weak upward tendency up to the mid or late 1980s and thereafter showed a small decrease in the 1990s. This decrease in phosphorus was mainly due to reduced loads in Polish and Danish rivers (Tonderski, 1997; Grimvall *et al.*, this issue).

Figure 3 provides information about the time-averaged water discharge and nutrient loads in the eleven largest rivers in the drainage basin of the Baltic Sea. The drainage area upstream of St. Petersburg in the basin of the Neva River accounted for 20% of the total runoff of water to the Baltic Sea, but only 7% and 8% of the loads of nitrogen and phosphorus, respectively. Instead, the Vistula River alone accounted for more than 14% (119,000 tonnes yr^{-1}) of the total nitrogen load and the Oder River for 16% (6,600 tonnes yr^{-1}) of the total phosphorus load.

The results also showed that six river basins, *i.e.* basins of Neva, Narva, Daugava, Neman, Vistula and Oder Rivers, contributed approximately 48% (401,000 tonnes yr^{-1}) of the total nitrogen load and 56% (23,000 tonnes yr^{-1}) of the total phosphorus load. Also conspicuous were the high nitrate-N loads in these rivers (Figure 3).

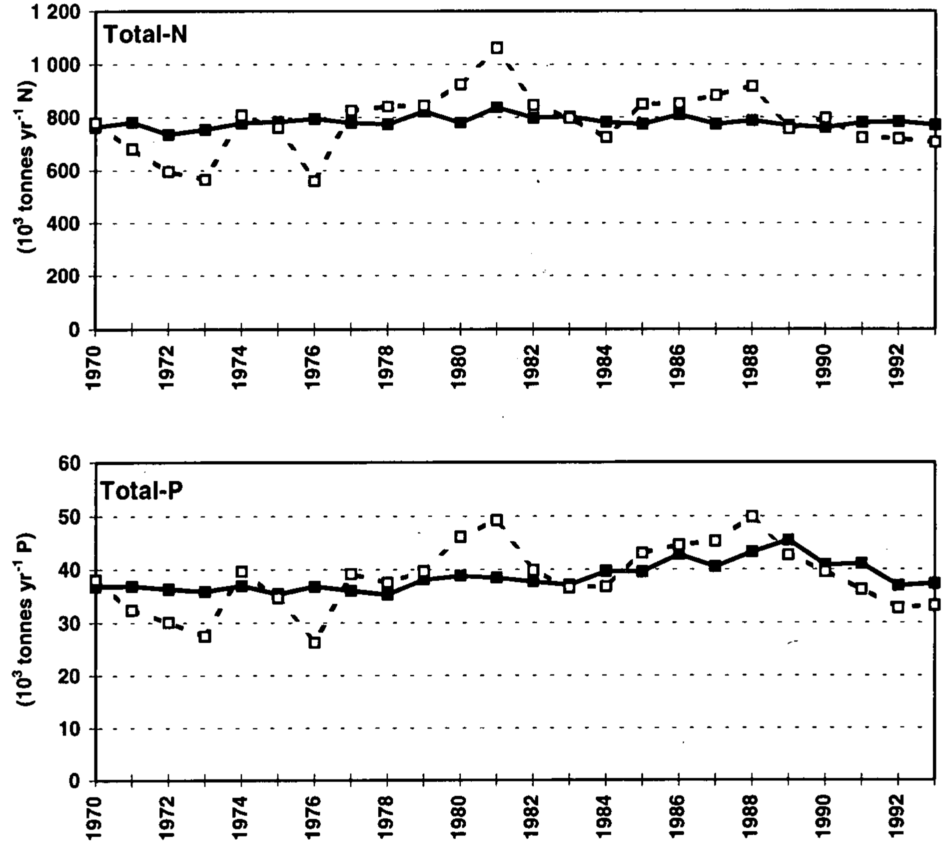

Figure 2. Annual riverine loads of nitrogen (top) and phosphorus (bottom) to the Baltic Sea, 1970-1993. The two curves represent loads before (dashed line) and after (solid line) flow normalisation. Source: Stålnacke *et al.* (1997).

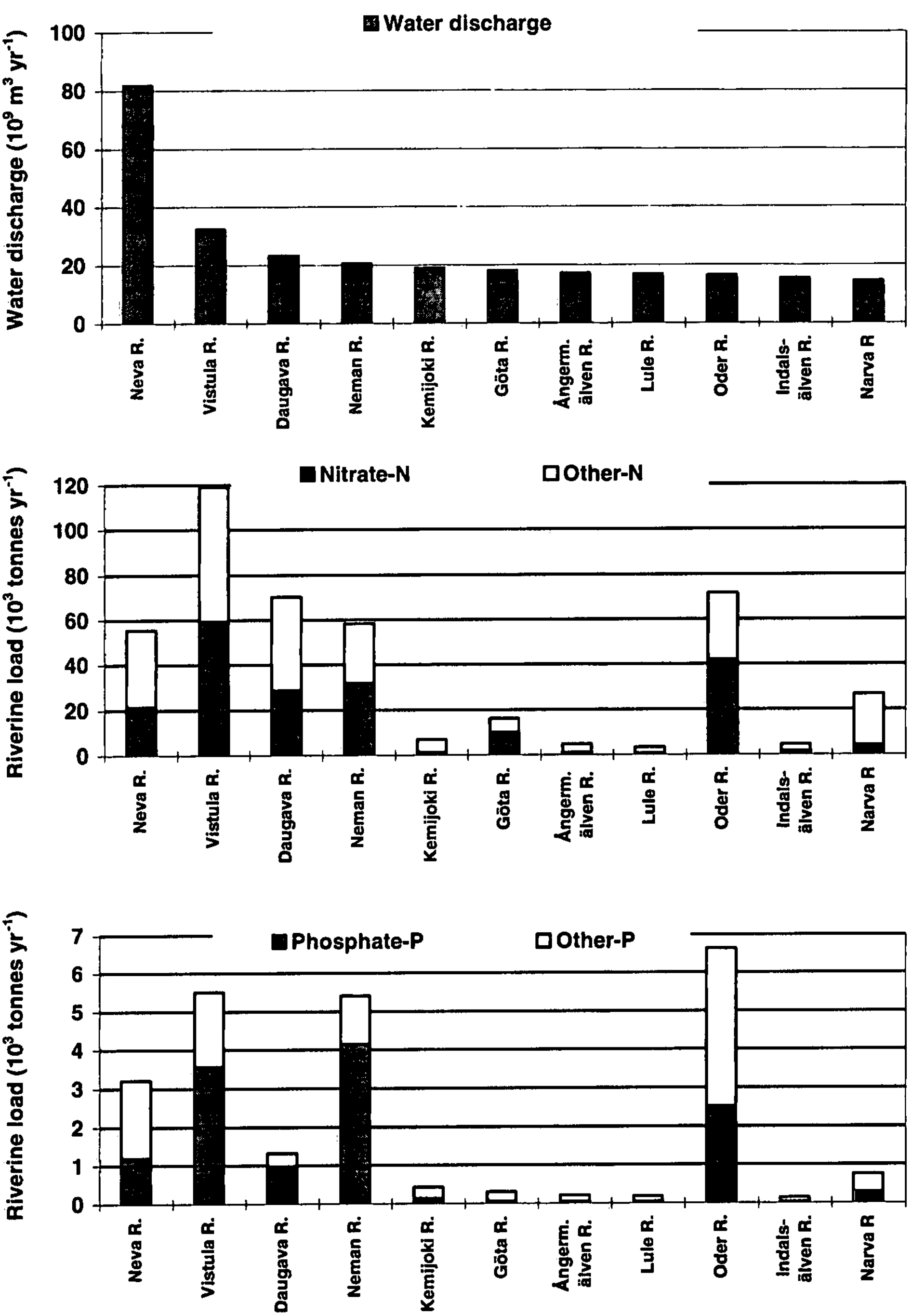

Figure 3. Time-averaged runoff and loads of NO_3-N, total-N, PO_4-P and total-P from the eleven largest rivers in the Baltic Sea drainage basin. Source: Modified from Stålnacke *et al.*, 1997.

DISCUSSION

Pollution of the marine environment has been the focus of several international conferences and conventions, and this has resulted in a stipulated goal of a 50% reduction in the nutrient load to the North Sea and the Baltic Sea by 1995. Some emission data for the first half of the 1990s are now available, and they clearly show that the cited goal will not be achieved (cf. Grimvall *et al.,* this issue). To some extent, this can be explained by delays in the implementation of proposed measures. The Ronneby Conference, held in 1990 adopted the Baltic Sea Declaration, and what is called the Joint Comprehensive Action Programme was established in 1992 (Helcom, 1993b). This programme pays special attention to reduction of nutrient emissions to water, and 132 pollution «hot-spots» were identified; mainly point sources along the Baltic Sea coast. The total cost to implement the whole action programme over the period 1993-2012 was estimated to 18 billion ECU. Phase I, which covers the time period 1993-1997, is addressing 47 of these hot-spots. If fully implemented, at a total cost of 5 billion ECU, these measures would decrease the annual loads of nitrogen and phosphorus to the Baltic Sea by 33,500 and 8,200 tonnes, respectively. The impact on the riverine loads discussed in this paper combined with estimates of contributions along other pathways show that the mentioned amounts represent about 2.5% of the total nitrogen load and 14% of the total phosphorus load to the Baltic Sea. Additional calculations show that point source emissions of nitrogen to the Baltic Sea drainage basin can contribute a maximum of 370,000 tonnes per year. Consequently, if the 50% reduction goal regarding nitrogen is ever to be achieved, more attention must be paid to the contribution of riverine loads and nonpoint sources to the total input of nitrogen to the sea. This calls for further studies of the sources of the nutrients exported in rivers. In addition, there is a strong need for models that can predict how the retention of nutrients in aquatic and terrestrial systems will be influenced by decreased emissions (see Grimvall *et al.*, this issue).

CONCLUSIONS

In conclusion, the present study showed that the load of nutrients carried by rivers to the Baltic Sea is larger than previously assumed and by far exceeds the input that occurs along other pathways, e.g. atmospheric deposition, nitrogen fixation by cyanobacteria and point source emissions from industries and urban areas on the coast of the the Baltic Sea. Examination of temporal variation in riverine loads to the sea showed that such inputs of nitrogen and phosphorus were fairly constant from 1970 to 1993. Natural variation in runoff was found to be the main cause of interannual variation. Although relatively accurate estimates of the total input of nutrients are now available, there is still substantial uncertainty regarding the role of different sources in the present nutrient loads. In addition, it is difficult to quantify the impact that specific interventions may have on future loads.

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WORKSHOP 5:

ENVIRONMENTAL IMPACT ASSESSMENT AND VALUATION OF ECOLOGICAL SERVICES

Professor Saburo Matsui, Japan (Chairman)
Professor Malin Falkenmark, Sweden (Rapporteur)

This workshop dealt with mainly three topics such as valuation of ecological services, EIAs and shrimp aquaculture.

The invited speaker Dr. Costanza introduced his recent result of **valuation of global annual ecological services** in which 17 types of ecosystem services were categorized. Then each of ecosystem services was counted for 16 different ecosystem areas of terrestrial and marine boimes. The total global flow values were estimated for each biome. Marine biome was estimated to contribute about 21 trillion US$/yr, while terrestrial biome estimated to be about 12 trillion US$/yr, which indicated more services with marine systems than those with land systems. Important results were that the coastal and shelf systems provide 60% and open ocean 40% of the total marine services. When he compared the total ecosystem services value with global GNP, 25 trillion US$/yr, it shows that more ecological services were given than human economic services. It became an important point of further study that natural food production services were so small compared to agricultural food production included in GNP that further precise analysis of division between agricultural food production and natural food production is necessary. This point reflected on the paper given by Professors Folke and Falkenmark, in which blue water and green water concepts were introduced to emphasize the importance of water use for agricultural production, which required largest amounts among various human water uses. They emphasized that the complementarity of blue and green water and the both water flows link the terrestrial ecosystems in the drainage basin to the aquatic ecosystems of coastal areas. This indicates the necessity of managing blue and green waters for coastal economic activities as well as ecosystem services. Ms. Williams emphasized the importance of valuation of aquatic ecosystems and management of coastal areas, which has been almost neglected.

EIAs are now introduced and practiced in both developed and developing countries. However, it shows several weak points of the procedures, scope, covering scale, base line data, and monitoring support, etc. The young scientist, Ms.Young introduced an environmental impact assessment case of a pulp mill proposal in which she reviewed the development of EIAs in Australia and pointed out the urgent necessity of extensive base line data on coastal areas, for which monitoring activity can support. The current EIAs of Australia needs improvement in this respect. Ms. Kusum introduced Sri Lanka experiences of EIAs in which they faced many difficulties in conducting EIAs including human capacity building, monitoring conductivity, local people participatory, etc. She emphasized the necessity of improvement in their EIAs in respect to the social impact assessment component by which they could improve the participation and gender issues. Dr. Kido introduced the statistical analysis of contamination of water and sediments of Seto Inland Sea, in which he utilized the results of monitoring data produced by routine official monitoring activities for the future environmental assessment of developing projects in the Sea. The most important result came from the discussion about the scale of EIAs in which most of EIAs have very limited scaling in both temporal and spatial perspectives so that regional, basin wide, and coastal perspectives are neglected. The concepts of sustainable development and river basin/coastal area management introduced questions of scaling of EIAs in both space and time.

Shrimp aquaculture practices of Gulf of Thailand and Vietnam Coastal Zones are in the manner of destroying coastal and marine ecosystems where mangrove forests are destroyed and fish ponds are constructed in not sustainable ways. There are improvement methods of shrimp culture for their local conditions including better selection of species and cultural seasons. International awareness of consumers is necessary to reduce the consumption of shrimps cultured in the condition of coastal ecosystem destruction. Mr. Tyson introduced a new approach that valuation of water benefits became more important in England and Wales where privatization of water works required evaluating their water work for decision makers when they select a new project out of different alternatives. Mr. Karmasinov of St. Petersburg introduced their new challenges in privatization of Vodokanal works in which they set up pricing systems of waste water discharge from industries.

In conclusion, the workshop put the following points for further clarification of land - coastal interaction in respect to ecosystem protection.

1. We need holistic approach to manage together river basin and coastal area.
2. We need correct valuation of ecological services specially elaborating natural food product and agricultural food product.
3. We need to reconcile human activities to ecosystem functions recognizing that ecosystem services provide larger values than human economic services.

THE ECOLOGICAL, ECONOMIC, AND SOCIAL IMPORTANCE OF COASTAL AND MARINE SYSTEMS

Robert Costanza, Professor, Center for Environmental Science and Zoology Department, and Director, University of Maryland Institute for Ecological Economics, Box 38, Solomons, MD20688-0038, USA

Coastal and marine systems have long been recognized as among humanity's most important natural resources. Their vastness has made them appear to be limitless sources of food, transportation, recreation, and awe. The difficulty of fencing and policing them has left them largely as open access resources to be exploited by anyone with the means. But in recent times we have begun to reach the limits of these systems and must now begin to utilize and govern them in a more sustainable way. This paper summarizes emerging information on the interrelated ecological, economic, and social importance of coastal and marine systems, and on developing institutions for their sustainable governance.

In addition to their traditional importance as sources of primary and secondary production, and biodiversiy, the importance of coastal and marine systems in global material and energy cycles is now beginning to be better appreciated. Integrated models of the global ocean-atmosphere-terrestrial system reveal the critical role of these systems in atmospheric gas and climate regulation, and for water, nutrient, and waste cycling.

Recent estimates of the economic value of the marketed and non-marketed ecosystem services of coastal and marine systems indicate a huge contribution to human welfare from the functions mentioned above plus raw materials, recreational, and cultural services. Marine systems have been estimated to contribute a total of about 21 trillion US\$ yr^{-1} to human welfare (compared to a global GNP of about \$25 trillion), with about 60% of this from coastal and shelf systems and the other 40% from the open ocean, and with the oceans contributing about 60% of the total economic value of the biosphere (Costanza et al. 1997). Coastal environments taken together cover only 6.3% of the world's surface but are responsible for 43% of the value of the world's ecosystem services.

The social importance of the coastal and marine systems for global transportation and as a unifying element in the cultures of many coastal countries cannot be overestimated. But the cultural traditions of open access must be replaced with more appropriate property rights regimes and governance structures. Sustainable governance emphasizes the need for an expanded deliberative process to develop a shared vision of a sustainable use of these resources.

ECOLOGICAL IMPORTANCE OF COASTAL AND MARINE SYSTEMS

Because of the relative vastness and inaccessability of coastal and marine systems, their scientific exploration had, in many senses, lagged behind the study of terrestrial systems.

But in recent times, new monitoring and remote sensing technologies have lead to an explosion of new scientific information about the oceans. Deep sea diving submersibles have allowed exploration of the deepest regions of the oceans, with the dramatic discovery of completely new life forms inhabiting deep sea thermal vents. Satellite remote sensing has allowed the observation and mapping of the entire ocean surface. This has led to the discovery and mapping of important new features of ocean structure and circulation, such as mesoscale eddies and the complex spatial patterns of marine photosynthesis .

This explosion of new information has allowed the development of sophisticated models of various aspects of marine systems and their links to the atmosphere and terrestrial systems. This activity has been stimulated by growing interest in the problem of global climate change and the important role of the oceans in moderating the climate and exchanging greenhouse gases with the atmosphere, along with growing recognition of the important linkages between terrestrial and marine systems.

ECONOMIC IMPORTANCE OF THE COASTAL AND MARINE SYSTEMS

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the earth's life support system, as described above. They contribute significantly to human welfare, both directly and indirectly, and therefore represent a significant portion of the total economic value of the planet. Because these services are not fully captured in markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans ' in the biosphere. The economies of the earth would grind to a halt without the services of ecological life support systems, so in one sense their total value to the economy is infinite. However, it is instructive to estimate the "incremental" or "marginal" value of ecosystem services - the estimated rate of change of value with changes in ecosystem services from their current levels. There have been many studies in the last few decades aimed at estimating the value of a wide variety of ecosystem services. These studies were synthesized by Costanza et al. (1997) who estimated the current economic value of 17 ecosystem services for 16 biomes, based on a synthesis of published studies and a few original calculations (Table 1). For the entire biosphere, the value (most of which is outside the market) was estimated to be in the range of $16 - 54 trillion/yr, with an average of $33 trillion/yr. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global GNP is around $25 trillion/yr. About 63% of the estimated value is contributed by marine systems ($20.9 trillion/yr). Most of this comes from coastal systems ($10.6 trillion/yr). About 38% of the estimated value comes from terrestrial systems, mainly from forests ($4.7 trillion/yr) and wetlands ($4.9 trillion/yr). Coastal environments, including estuaries, coastal wetlands, beds of sea grass and algae, coral reefs, and continental shelves are of disproportionately high value. They cover only 6.3% of the world's surface but are responsible for 43% of the value of the world's ecosystem services. These environments are particularly valuable in regulating the cycling of nutrients which control the productivity of plants on land and in the sea.

able 1. Ecosystem services and functions (From: Costanza, R. R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, S. Naeem, K. Limburg, J. Paruelo, R.V. O'Neill, R. Raskin, P. Sutton, and M. van den Belt. The value of the world's ecosystem services and natural capital. *Nature* in press)

ECOSYSTEM SERVICE*	ECOSYSTEM FUNCTIONS	EXAMPLES
Gas regulation	Regulation of atmospheric chemical composition.	CO_2/O_2 balance, O_3 for UVB protection, and SO_x levels.
Climate regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels.	Green-house gas regulation, DMS production affecting cloud formation.
Disturbance regulation	Capacitance, damping, and integrity of ecosystem response to environmental fluctuations.	Storm protection, flood control, drought recovery, and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.
Water regulation	Regulation of hydrological flows.	Provisioning of water for agricultural (e.g., irrigation) or industrial (e.g., milling) processes or transportation.
Water supply	Storage and retention of water.	Provisioning of water by watersheds, reservoirs, and aquifers.
Erosion control and sediment retention	Retention of soil within an ecosystem.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of silt in lakes and wetlands
Soil formation	Soil formation processes.	Weathering of rock and the accumulation of organic material.
Nutrient cycling	Storage, internal cycling, processing, and acquisition of nutrients.	Nitrogen fixation, N, P, and other elemental or nutrient cycles.
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds	Waste treatment, pollution control, detoxification.
Pollination	Movement of floral gametes.	Provisioning of pollinators for the reproduction of plant populations.
Biological control	Trophic-dynamic regulations of populations.	Keystone predator control of prey species, reduction of herbivory by top predators
Refugia	Habitat for resident and transient populations.	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or over wintering grounds.
Food production	That portion of gross primary production extractable as food.	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming, or fishing.
Raw materials	That portion of gross primary production extractable as raw materials	The production of lumber, fuel, or fodder.
Genetic resources	Sources of unique biological materials and products.	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants).
Recreation	Providing opportunities for recreational activities.	Eco-tourism, sport fishing, and other outdoor recreational activities.
Cultural	Providing opportunities for non-commercial uses.	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems

'e include ecosystem "goods" along with ecosystem services.

If ecosystem services were actually paid for, in terms of their value contribution to the global economy, the global price system would be very different than it is today. The price of commodities utilizing ecosystem services directly or indirectly would be much greater. The structure of factor payments, including wages, interest rates, and profits would change dramatically. World GNP would be very different in both magnitude and composition if it adequately incorporated the value of ecosystem services. One practical use of the estimates mentioned above is to help modify systems of national accounting to better reflect the value of ecosystem services and natural capital. Initial attempts to do this paint a very different picture of our current level of economic welfare than conventional GNP. For example, the Index of Sustainable Economic Welfare (ISEW) incorporates income distribution effects, congestion effects, and the loss and damage to natural capital. While GNP/capita continued to rise ISEW/capita parallels GNP/capita during the initial period, but then levels off and in some cases declines. This may be evidence for the "threshold hypothesis," that economic growth increases welfare only until a threshold is reached where the costs of additional growth begin to outweigh the benefits. ISEW, by doing a better job of including both the costs and benefits of growth can clearly show when this threshold has been passed. But the ISEW and similar measures are based on national accounts and do not adequately incorporate international resources like many coastal and marine systems. If we have passed the sustainable threshold without even taking these systems into account, our real position is almost certainly much worse.

SUSTAINABLE GOVERNANCE

Sustainable development is a long term social goal over which there is broad and growing consensus (WCSD 1987, Pezzey 1989, Costanza 1991, Pearce and Atkinson 1993, Costanza and Patten 1995). Establishment of this goal is fundamentally a social decision about the desirability of a survivable ecological economic system. It entails integrating the three goals of:

(1) maintaining an ecologically **sustainable scale** of the economy relative to its ecological life support system. This is sometimes referred to as **ecological sustainability.**

(2) maintaining a **fair distribution** of resources and opportunities, not only between the current generation of humans, but also between present and future generations (and in some definitions between humans and other species). This is sometimes referred to as **social sustainability.**

(3) maintaining an **efficient allocation** of resources that adequately accounts for natural capital and provides non-declining capital stocks and economic income into the indefinite future. This is sometimes referred to as **economic sustainability.**

Conventional economics (including environmental economics - defined as the application of conventional economics to problems of the environment) has concentrated on the third of these problems (efficient allocation) and therefore has not fully addressed the issue of sustainable development. Ecological economics is a transdsciplinary effort to extend the conventional approach by integrating the natural sciences (especially ecology) and the social sciences (especially economics but also sociology, psychology, political science and others) in order to address the interrelated issues of sustainable scale, fair distribution and efficient allocation in an integrated way (Costanza 1991, Costanza et al. 1997).

Operationalizing sustainable development thus implies operationalizing this broader agenda and developing governance policies and instruments based on a integrative systems approach.

The special characteristics of coastal and marine systems mentioned above lead to several unique problems that need to be addressed if they are to be governed sustainably. These include:

1. The open access and common property characteristics of coastal and marine systems requires that special measures need to be taken to regulate access. Some possibilities are discussed below.

2. The role of coastal and marine systems in the global ecological system, as discussed above, favour a tendency to free ride on conservation issues. This means that some countries or actors can benefit from the system without having to pay the cost of using it.

3. The intergenerational and interspatial effects of the use of marine resources result in a tendency to ignore effects that might be distant in time and space. There is a need to change the way such effects are handled.

4. The impact of human activity on coastal and marine systems is subject to fundamental uncertainty about the behaviour of the system, partly because of its complexity. This calls for new models of decision-making and different management rules based on maintaining the system within sustainable bounds and on exercising the precautionary principle in order to keep uncertainty within acceptable limits.

5. All of the above lead to "market failure." Hence, market prices are inadequate measures of the social value of ocean assets and require corrective incentives to guide behaviour.

6. Relative poverty is exacerbated by forms of globalization which ignore environmental externalities. Marine resource use is particularly susceptible to this problem.

Principles of Sustainable Governance

To operationalize sustainable development in the context of these special problems, several general principles have been suggested, including:

1. **Subsidiary principle:** governance should occur at the lowest organizational level possible in order to enhance democratic participation.

2. **Responsibility principle:** rights to use environmental resources carry attendant responsibilities to use them sustainably and fairly.

3. **Precautionary principle:** in the face of uncertainty concerning environmental resources and impacts, we should err on the side of caution.

4. **Participatory principle:** parties affected by a decision or process should participate fully in its formulation and implementation

Some specific ideas for **implementing these principles** for sustainable coastal and marine system governance are described **below.**

The Deliberative Process in Governance

What we are learning about the change process in various kinds of organizations and communities is that the most effective ingredient to move change in a particular direction is having a clear vision of the desired goal which is also truly shared by the members of the organization or community (Senge 1990, Weisbord 1992, Weisbord and Janoff 1995).

In another context, Yankelovich (1991) has described the crisis in governance facing modern societies as one of moving from public *opinion to* public.ludgment. Public opinion is notoriously fickle and inconsistent on those issues for which the public has not confronted the system level implications of their opinions. Coming to judgement requires the three steps of: (1) consciousness raising; (2) working through; and (3) resolution. A prerequisite for all three of these steps is breaking down of the gap between expert knowledge and opinion and the public - a breaking down of what Yankelovich calls the "culture of technical control". Information in the modern world is compartmentalized and controlled by various elites who do not communicate with each other. This allows experts from various fields to hold contradictory opinions and the public to hold inconsistent and volatile opinions. Coming to judgement is the process of confronting and resolving these inconsistencies by breaking down the barriers between the mutually exclusive compartments into which knowledge and information have been put. For example, many people in opinion polls are highly in favour of more effort to protect the environment, but at the same time are opposed to any diversion of tax revenues to do so. Coming to judgement is the process of resolving these conflicts.

According to Yankelovich, one of the most effective ways to start the dialogue and move quickly to public judgement is to present issues in the form of a relatively small number of "visions" which lay bare the conflicts and inconsistencies buried in the technical information. The decisions we face today about the future of coastal and marine systems (and the planet as a whole) are by far the most complex we have ever faced, the technical information is daunting (even to the experts), and we have very little time to come to public judgement. Integrated, participatory modelling and analysis of the problems is one way to pull the disparate bits of the problem together into a coherent picture that can help move to judgement (van den Belt, in press).

How does one integrate these goals and visions and their related forms of value into a social choice structure which preserves democracy? A two-tiered conceptual model (Costanza et al. 1997) makes value formation and reformation an endogenous element in the search for a rational policy for managing human activities. Figure 1 outlines this process. Tier 1 is the "reflective" level, where social discourse and consensus is built about the broad goals and visions of the future, and the nature of the world in which we live. This consensus then motivates and mediates the second, or "action" tier, where various institutions and analytical methods are put in place to help achieve the vision. There is feedback between the two tiers and the process of envisioning, goal setting, and value formation is an ongoing and critical one. There is a critical connection between value formation and decision-making, but the very existence and necessity of tier 1 is often ignored. The "culture of technical control" (Yankelovich 1991) which dominates our current social decision making, views the problem as merely a tier 2 implementation of fixed values.

Conventional social choice theory, has, in general, also tended to avoid this issue of the connection between value formation and the decision-making process. As Arrow (1951 p. 7) put it: "we will also assume in the present study that individual values are taken as data and are not capable of being altered by the nature of the decision process itself." But this process of *value formation through public discussion.* as Sen (1995) suggests, is the essence of democracy. Or, as Buchanan (1954 p120) puts it: "The definition of democracy as 'government by discussion' implies that individual values can and do change in the process of decision-making." Limiting our valuations and social decision making to a fixed set of goals based on fixed preferences prevents the needed democratic discussion of values and future options and leaves us with only the "illusion of choice" (Schmookler 1993).

Integrated Ecological-Economic Modelling and Assessment

Once the goal of ecological sustainability has been established in tier 1, addressing it in tier 2 requires a large measure of scientific assessment and modelling (Faucheux et. al. 1996). The process of integrated ecological economic modelling can help to build mutual understanding, solicit input from a broad range of stakeholder groups, and maintain a substantive dialogue between members of these groups. In the process of adaptive management, integrated modelling and consensus building are essential components (Gunderson et al. 1995).

A process consisting of 12 steps was developed to implement integrated assessment. The process assumes feedback loops from later steps to earlier steps in an adaptive management context, where policy recommendations are viewed as experiments rather than as answers (Walters 1986, Holling 1994):

1. Define the focus of attention.

2. Identify stakeholders.

3. Establish techniques to bring stakeholders together (e.g. roundtable).

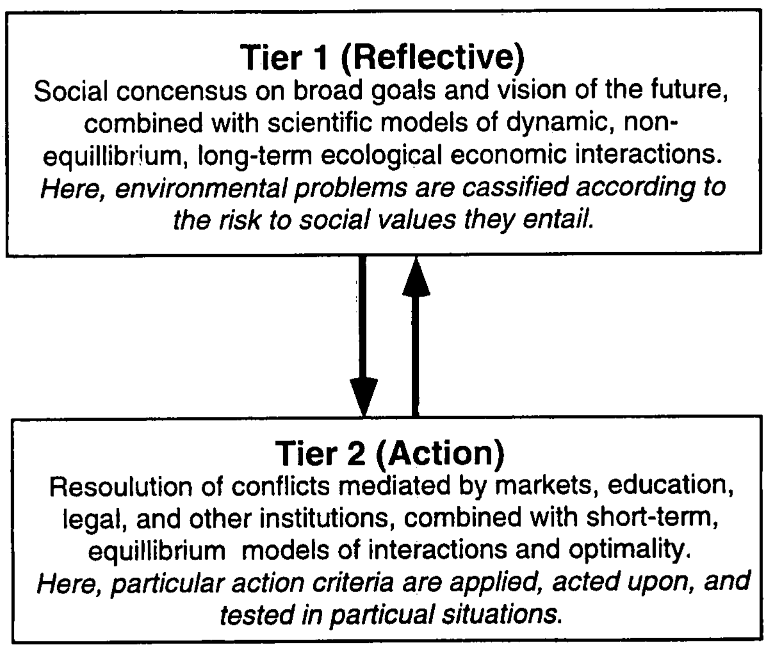

Figure 1. Two-tiered social decision structure (from Costanza, Norton, and Bishop 1997).

4. Seek agreement on acceptable facilitator.

5. Define stakeholder interests.

6. Hold roundtable.

7. Undertake a scooping exercise.

8. Build and run a scooping model.

9. Commission detailed modelling.

10. Present models.

11. Build consensus recommendations.

12. Proceed with, and of, the preferred monitor the development scenario.

A Three Step Modelling Process

Within steps 8-10 above, a three step modelling process can be used (Costanza and Ruth 1997). The first stage is to develop a high generality, low resolution **scooping and consensus building** model involving broad representation of all the stakeholder groups affected by the problem. STELLA 11 and similar software make this process feasible. This first stage scooping model can be used to answer preliminary questions about the dynamics of the system, especially its main areas of sensitivity and uncertainty, and thereby to guide the research agenda in the second stage.

The second stage **research** models are then more detailed and realistic attempts to replicate the dynamics of the particular system of interest. This stage involves collecting large amounts of historical data for calibration and testing and a detailed analysis of the areas of uncertainty in the model. Resolution is medium to high, depending of the results of the scooping model.

The third stage is aimed at models that can be used to answer particular **management** questions. These models must be based on the previous two stages, and can simply be the exercising of the research models to produce future scenarios, or they can be a further elaboration of the research models that allow them to be applied to management questions. In general, these will be medium to high resolution models.

Each of these stages in the overall modelling process has useful products, but the process is most useful and effective if followed in the order described. Too often we jump to the research or management stage of the process without first building adequate consensus about the nature of the problem and without involving the appropriate stakeholder groups. Below we discuss these three stages in more detail, before describing some case studies of how they have been used.

New Property Rights Regimes

There is a major challenge in designing institutions and property rights regimes that are in tune with the functions of ecosystems and the goods and services that they generate. How do we design institutions and property rights regimes that account for the complex flows and feedback between systems and that maintain the buffer capacity to ensure a continuation of these flows? Luckily, there are design principles derived from studies of long-enduring institutions that have, at least to some extent, been successful in managing ecological resources in a sustainable fashion (see e.g. Ostrom and Schlager 1996). The design principles include: clearly defined boundaries for the use of the resources, as well as clearly defined individuals or households with rights to harvest the resources; rules specifying the amount of harvest by users related to local conditions and to rules requiring labor, materials, and/or money inputs; collective-choice arrangements; monitoring of resource conditions and user behaviour; graduated sanctions when rules are violated; conflict-resolution mechanisms; long-term tenure rights to the resource and rights of users to devise their own institutions without being undermined by governmental authorities; and for resources that are parts of larger systems appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities need to be organized in multiple layers of nested enterprises (Becker and Ostrom 1995).

Some of the most sophisticated property rights institutions are found in areas in which these systems have developed over a long period of time, on the order of hundreds of years. Examples include Spanish *huertas* for irrigation, Swiss grazing commons, and marine resource tenure systems in Oceania (see Berkes 1996). Yet other systems have collapsed and recovered over a period of time, sometimes more than once. In contrast, many traditional local communities have recognized the necessity of the coexistence of gradual and rapid change. In their institutions they have accumulated a knowledge base for how to respond to feedbacks from the ecosystem. Holling et al. (1995) argue that these societies are successful in managing their resources sustainably because they have developed social mechanisms that interpret the signals of creative destruction and renewal of ecosystems and cope with them before they accumulate and challenge the existence of the whole local community. Disturbance has been allowed to enter at smaller scales, instead of being blocked out as is often the case in contemporary society. There is a culturally evolved 'monitoring' system that reads the signals, the disturbances, and thereby is more successful in avoiding the build up of an internal structure that will become brittle and invite large-scale collapse. The local institutions have evolved so that renewal occurs internally while overall structure is maintained. The accumulation and transfer of this knowledge between generations has made it possible to be alert to changes and continuously adapt to them in an active way. It has been a means of survival (Holling et al. 1995).

We can learn from those local institutions that do not undermine their existence by degrading their ecological life-support system, thereby losing ecological and institutional resilience. A major task for modern society is to find similar ways of responding to changes in ecosystems. At present there is a pervasive lack of social mechanisms for dealing with changing environmental conditions.

Sustainability requires that human social systems and property rights regimes are adequately related to the larger ecosystems in which they are embedded. Understanding the complex evolutionary dynamics of these ecosystems is essential, but we must acknowledge and deal with the inherently limited predictability of complex systems. Because our knowledge of the structure and function of ecological systems is limited, and because we **do** know that sustainability depends on these systems, we must take a precautionary approach to their management (O'Riordan and Jordan 1995). Complex adaptive systems require "adaptive management" (Holling 1978). This means that we need to view the implementation of policy prescriptions in a different, more adaptive way that acknowledges the ever-present uncertainty and allows participation by all the various stakeholder groups. Adaptive management views regional development policy and management as "experiments," where interventions at several scales are made to achieve understanding and to identify and test policy options (Holling 1978, Walters 1986, Lee 1993, Gunderson et al. 1995) rather than as "solutions."

There are several recent examples of new property rights systems employing adaptive management. One particularly relevant example is the recently passed legislation in the Australian state of New South Wales (NSW) to introduce a fishery share system (New South Wales 1994). It is similar in general form and purpose to the "ITQ" or individual transferable quota, fishery management systems found in New Zealand, Iceland, Australia, Canada and other countries, but has special design features, including the allotment of shares for "fisheries" that include many different species (Young 1992). The system is designed to give fishers security within the context of an adaptive resource management system designed to ensure that fishery use is sustainable and consistent with social objectives as they change through time.

Young (1997) describes the NSW share system and its relationship to quota systems as follows:

> "Most individual transferable quota regimes are for single species; accordingly, they do not encourage fishers to recognize the interdependence of species. Moreover, it is arguable that they neither create a strong sense of industry responsibility for the state of a fishery nor encourage participation in the management process. Weighing these and other considerations, the NSW system grants each fisher a guaranteed opportunity and compensatible right to a proportional share of all the commercial opportunities in the fisheries they use. The term "share" is used intentionally to stress the idea that each shareholder owns a legally enforceable share of each fishery's commercial opportunities. The legislation establishes a "core property right" as a legally transferable entitlement to a proportional share of all the commercial fishing opportunities associated with the fishery.
>
> Wherever possible, corporate-like administrative structures are used as these are well understood by fishers. Effectively, each person is given a guaranteed share of the opportunity set out in a periodically revised management plan for the species that comprise the fishery. Formally, each fisher is entitled to a share of any allocation of quota and gear or input restriction in proportion to the number of shares they hold. If they want to use a larger boat or bigger net, then they must buy shares from people

already in the fishery. Similarly, allocation of any quota is in proportion to the number of shares held. The corporatised structure enables reference to corporate management experiences and enables both input and output controls to be varied equitably without effecting resource security."

The NSW share system's conceptual framework is of relevance to other fisheries and also many other natural resources. It represents an approach to adaptive management and common property regimes that appears to be efficient, fair, and sustainable. Because it conforms to the principles discussed above, it may be a viable model for broader ocean governance issues.

Taxes and Other Economic Incentives

Using economic incentives to achieve environmental goals can be much more efficient than traditional command and control regulation, if the incentives can be put in place and enforced at relatively low cost. This is a key point for coastal and marine systems, since one of their main characteristics has been the difficulty of monitoring and policing almost any kind of intervention. This situation is changing, however, and the time may be ripe for various kinds of economic incentives, especially if they can be incorporated into community-based management and co-management approaches as discussed above. Using self-policing, share-based common property systems, and trust building mechanisms can significantly lower the costs of implementing any incentive scheme, or any direct regulation scheme for that matter.

The key point is that taxes or other economic incentives must be seen as one instrument from which the community can choose in designing its ecosystem management systems. While it is not a panacea, this instrument can be quite effective in the appropriate situations. For example, one such situation being discussed recently is the idea of "ecological tax reform".

There is a growing consensus among a broad range of stakeholder groups in the US, and even more so in Europe, concerning the need to reform tax systems to tax "bads" rather than "goods." Taxes have significant incentive effects which need to be considered and utilized more effectively. The most comprehensive proposed implementation of this idea is coming to be known under the general heading of "ecological tax reform" (von Weizsäcker and Jesinghaus 1992, Costanza and Daly 1992, Passell 1992, Repetto et. al. 1992, Hawken 1993, Costanza 1994). Earlier discussions of similar schemes were given by Page (1977) who considered a national severance tax, and Daly (1977) who discussed a depletion quota auction.

The basic idea is to limit the throughput flow of resources to an ecologically sustainable level and composition, thus serving the goal of a sustainable scale of the economy relative to the ecosystem, a goal until recently neglected. The more traditional goal of efficient allocation of resources is also served by this instrument because it raises the tax on bads and lowers the tax on goods--it internalizes externalities. The third goal of distributive equity is both helped and hindered. Since the throughput tax is basically a capturing for public purposes of the scarcity rent to natural capital as economic and demographic growth increases its value, it has some of the equity appeal of Henry

George's rent tax. However, like all consumption taxes it is regressive. This could be counteracted by retaining the income tax at the extremes - a positive income tax for high incomes, a negative income tax for very low incomes, and a negligible income tax between the extremes. Of the three major goals of economic policy (sustainable scale, efficient allocation, and just distribution) the ecological tax reform serves the first two quite well, and the third partially, requiring some supplement from an attenuated income tax structure.

The idea is to gradually shift much of the tax burden away from "goods" like income and labour, and toward "bads" like ecological damages and consumption of non-renewable resources.

Such a system would need three components:

1. A **natural capital depletion tax** aimed at reducing or eliminating the destruction of natural capital.

2. The **precautionary polluter pays principle (4P)** (Costanza and Cornwell 1994) would be applied to potentially damaging products to incorporate the cost of the uncertainty about ecological damages as well as the cost of known damages.

3. A system of **ecological tariffs** aimed at allowing individual countries or trading blocks to apply 1 and 2 above without forcing producers to move overseas in order to remain competitive.

Such a system would have far-reaching implications, and would simultaneously encourage employment and income, reduce the need for government regulation, and promote the sustainable use of natural resources and ecosystems. Reducing taxes on income and labour encourages employment because it reduces the cost of labour to employers. It also encourages work because it increases net pay for workers. Both are good for the economy. Taxing depletion of natural resources and pollution effectively works them into the market system so polluters and depletors pay for their actions, and have a reason to lighten their impact on the environment. Because of the revenue neutral aspect of the tax shift, it does not raise costs for business, but rather gives businesses appropriate incentives to develop new technology, improve production efficiency, and improve their environmental performance.

Such a tax shift could work well for national economies, and by extension their exclusive economic zones in coastal and marine systems. But the problem remains of what to do about the fact that the open oceans are under no country's exclusive jurisdiction. This will require new international agreements and institutions. But, as indicated above, the possibilities for using taxes and other economic incentives should be among the tools available to the international community as it begins to design a sustainable governance system for coastal and marine systems.

CONCLUSIONS

Coastal and marine systems are ultimately the heritage of all of humanity. Their role and value in supporting human life are only now becoming fully recognized. Ecological sustainability, economic efficiency, and social fairness need to become joint objectives in order to adequately maintain coastal and marine systems as humanity's common heritage. Coastal and marine systems are too important to humanity's survival to allow their continued exploitation as if they were infinite.

Governance systems, property rights regimes, and economic incentives that can adequately deal with the inherently common property nature of coastal and marine systems are sorely needed. Creative deliberation and consensus building among the various stakeholder groups is an essential, and still largely missing, element. Innovative common property regimes, like the "fishery share" system in New South Wales, may provide models that simultaneously meet the joint goals of efficiency and fairness.

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ENVIRONMENTAL IMPACT ASSESSMENT AS A TOOL FOR THE APPRAISAL OF PULP MILL PROPOSALS IN TASMANIA, AUSTRALIA

Emma Louise Young, PhD Student, Graduate School of the Environment, Macquarie University, NSW 2109 Australia.

1. Introduction

The pulp and paper industry has a long history of water pollution from acute and chronic toxic waste (Reiter 1990, McLeay 1991). The effects have been identified some distance from the point of discharge, as in Sweden(DPIE 1989: Attachment 1) and have affected fish and caused the closure of shellfisheries in Canada (Reiter 1990, McLeay 1991).

The Australian and New Zealand Environment Council (ANZEC 1991:17) have noted that chlorinated organics, a major pollutant from pulp mills, causes a variety of effects on aquatic biota. These include 'histological change, metabolic, respiratory and behavioural effects, decreases in tolerance levels and primary productivity, growth and reproduction effects'.

Environmental impact assessment (EIA) can be used as a primary tool for the evaluation of the potential impacts of new pulp and paper plants. For the purposes of this paper I have adopted the definition of EIA given by Gilpin (1995:4): 'the official appraisal of the likely effects of a proposed policy, program, or project on the environment; alternatives to the proposal; and measures to be adopted to protect the environment'.

A case study of the proposal for an export kraft pulp mill at Wesley Vale in Northern Tasmania is introduced with a discussion of the environmental legislation that applied in Tasmania at the time of the proposal. This is followed by an analysis of the environmental assessment process that was used throughout the development process. The paper concludes with a discussion of EIA legislation that has been introduced since the time of the proposal and an assessment of its effectiveness.

2. Commonwealth and State joint assessments

The Wesley Vale pulp mill proposal was assessed under both Federal (Commonwealth) and State environmental legislation. The Australian Constitution provides the basis for the division between Commonwealth and State responsibilities in relation to the environment and as no direct legislative powers in relation to the environment are included within the Constitution, power resides with the States. There are however four sources of Federal Power that allow intervention in relation to environmental matters:

- the Trade and Commerce Power, s.51(1) allows the Federal Government to make laws with respect to trade and commerce with other countries and among the States;
- the Corporations Power (s.51(20)) allows the Federal Parliament to make and exercise laws in relation to foreign corporations, and trading or financial corporations:
- the Federal Financial Powers include the taxation power (s51(2)) which allows specific purpose grants to the States (s.96), and the power to spend money for the purposes of the Commonwealth (sections 81-83); and

- the External Affairs Powers (s.51(29)) may be exercised if a matter is of international concern and as such is addressed in an international treaty (Bates 1992; Fowler 1993).

The federal *Environment Protection (Impact of Proposals) Act 1974* [the EP(IP) Act] requires assessment on environmental, economic, social and technical aspects of a proposal. The provisions of the Act can be implemented under one or more of the four federal powers of the Constitution which involves a decision by a Minister of the Commonwealth Government.

The Wesley Vale pulp mill proposal was assessed under both federal and state environmental legislation. At the time of the proposal the assessment process was initiated under the Tasmanian *Environment Protection Act 1973* as revised in 1984. The provisions for state EIA were outlined in *'Guidelines and Procedures for Environmental Impact Studies'* 1974. Under the Act three levels of assessment are provided for(Thomas 1996):

1. For small developments that are unlikely to cause significant environmental impacts a development proposal (DP) is required. It describes the proposal and any potential environmental management problems.
2. A DP and an environmental management plan (EMP) are required if a proposal may have substantial environmental effects, if it is in an environmentally sensitive area or if it is likely that it will attract significant public concern.
3. The third category of assessment applies to proposals that have substantial expenditure, and have the potential to substantially affect the environment .

The Wesley Vale proposal was classed as a scheduled premises under the Act, requiring a licence to operate. Due to the scale of the proposal, and the significance of potential environmental impacts, an Environmental Impact Statement (EIS) was required.

3. Case Study: Wesley Vale Pulp Mill Project

Background

The Wesley Vale Bleached Eucalypt Kraft Export Pulp Mill Project (the proposal) was put forward by the proponents North Broken Hill Limited (NBH) and Noranda Forest Inc.

In the 1970s the Commonwealth Government issued woodchip export licences to Australian Pulp and Paper Manufacturers (APPM), then a subsidiary of NBH. The Commonwealth also created a strategy to increase efficiency in the pulp and paper industry and to make the industry internationally competitive. By the end of 1987 NBH had allocated A$2 million to undertake detailed technical studies and continued to search for international investors. Already public opposition to the proposal was growing, initiated by the Concerned Residents Opposed to Pulpmill Siting (CROPS) (Lawrence 1991; Chapman 1992; Crowly 1994). On 30 March 1988 the proponents released an *Environmental Review of an Export Pulp mill at Wesley Vale, Tasmania.* CROPS stated that the document 'provided no quantitative or qualitative information to justify Wesley Vale or the mill site and it served to fuel the siting controversy' (Milne 1990: 84).

The search for international investors resulted in the incorporation of Noranda Inc. as a 50% partner after an application to the Foreign Investment Review Board (FIRB) for investment in the mill. This application resulted in the assessment process being initiated under the Commonwealth EP(IP) Act 1974 administered by the then Department of the Arts, Sport, the Environment, Tourism and Territories (DASETT).

Environmental Assessment and Legislation Involved:

At this stage environmental impact assessment was occurring at both State and Commonwealth levels. The then Prime Minister Hawke stated that the proponents would prepare an EIS in agreement with the Tasmanian State Government guidelines with a 30 day public review period.

On 27 October 1988 the proponents released the *Export Pulp Mill Project, Wesley Vale, Tasmania, Environmental Impact Statement* requiring public submissions by 3 December 1988. In November, NBH suggested to the State government that normal planning appeal procedures be relinquished (Lawrence 1991; Chapman 1992). This resulted in the Northern Pulp Mill Agreement Act 1988. The Act effectively abolished the right of the public to challenge, object, appeal or review any decisions made under the Environment Act.

The Act also established guidelines for an environmental management plan should the proposal go ahead. These provisions were disputed by the proponents. Under the terms of the Act (s.10.6.3) an assessment report was produced by both the Department of Environment (DoE), Tasmania, and the Commonwealth DASETT to assess the adequacy of the EIS. There was strong concern over the adequacy of the EIS by many government departments and private groups and individuals and of the 81 submissions from members of the public, and from government departments, only three gave support for the project (Lawrence 1991; Chapman 1992). The submissions raised 18 major areas in which inadequacies were found. These included criticisms on the effluent disposal to the Bass Strait. A need was seen for more baseline data and information regarding bioaccumulation of toxins in foodchains. Criticisms were also expressed (DASETT 1989; DoE 1989) on:

- the lack of information on the effects of organochlorine emissions on the environment;
- the effect of the resource use and the impact of large areas of clearfell in the tourist industry; and on
- the lack of references and use of false statements within the EIS

A requirement to submit an Addendum to the EIS to respond to major inadequacies of the EIS identified by both the public and numerous government departments was issued. This was fulfilled on 20 December 1988 by the release of the *Export Pulp Mill Project, Wesley Vale, Tasmania, Environmental Impact Statement, Addendum* (DoE 1989). On the 4 January 1989 United Scientists for Environmental Responsibility and Protection (USERP) 'highlighted ... major deficiencies in the EIS addendum, saying it contained false arguments and major mistakes and omissions in a bid to evade vital issues' (Advocate 1989).

On 21 February 1989, after twelve hours of debate, the Northern Pulp Mill (Doubts Removal) Agreement was finalised between the State of Tasmania and the proponents. The aim of the agreement was to remove any doubts in sections 3 to 12 and section 14 of the Northern Pulp Mill Agreement 1988. The new legislation, consisted of reviewed environmental guidelines and principles stating the meaning and application of the Act. The new environmental guidelines stirred up major public outrage. There were a number of official responses on information addressed in the EIS and the Northern Pulp Mill (Doubts Removal) Agreement (Lawrence 1991; Chapman 1992).

Basten (1989) was asked to advise on whether the proposed mill effluent and the Northern Pulp Mill legislation would be in contravention of the *Environment Protection (Sea Dumping) Act 1987* (Tas) (Sea Dumping Act). The Sea Dumping Act aims to give effect to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the Convention). This is contained in Schedule 1 of the Act (Basten 1989). Section 15(3) states that '... a permit for dumping or loading shall not be granted in respect of any wastes or other matter to which Annex 1 to the Convention applies' (Basten 1989:3).

Organohalogen compounds are referred to in Annex 1 of the Convention, thus incorporating total organochlorine load (TOCL) and Adsorbable Organic Halides (AOX) in the mills effluent stream. TOCL and AOX are major parameters used in the assessment of mill environmental effects. Basten (1989:3) states that 'the prohibition in s6 appears to be absolute in practical terms with respect to the proposed mill'. As a result Basten concludes that: 'the present proposal will involve a breach of s6 of the Environment Protection (Sea Dumping) Act 1987 (Tas). That Act is part of a package of state and federal laws designed to give effect to the Convention on Marine Pollution. It would not be appropriate for the Commonwealth to approve any proposal involving a possible breach of that legislation' (Basten 1989:12).

The federal DPIE stated that: 'the 'doubts removal' legislation significantly relaxes the nature, extent and application of environmental controls and raises ... major questions as to whether the Tasmanian legislation provides an adequate basis for establishing enforceable controls to achieve an acceptable level of environmental performance' (DPIE 1989: Attachment 3).

Furthermore, the relaxation of definition from 'best practicable' to 'commercially proven and widely accepted' technology greatly reduces the onus on the company to include 'state of the art' production and waste treatment processes. Questions were also raised as to the ability of the Tasmanian Government to establish and enforce pollution controls (DPIE 1989).

The Proponents' Position Paper

In February, 1989 North Broken Hill released a Position Paper on the environmental issues associated with the proposal. It stated that 'there will be no negative impact of any consequence on the marine or air or land environments due to the mill operations'(North Broken Hill Ltd 1989:1).

The DPIE, in one of a number of responses, stated that 'the material supplied contained factual errors and distortions which seriously weaken the proponents' claim that there will be no effect of any consequence on the environment' (DPIE 1989: Attachment 1). For example, the proponents comments included that any adverse effects of Swedish pulp mill effluent on the health and growth of fish only occurred at distances 8-10km from the discharge pipes. The DPIE however stated that 'Swedish research has in fact found effluent effects up to 20km from discharge points' (DPIE 1989: Attachment 1). The Commonwealth Scientific and Industrial Research Organisation (CSIRO 1989:14) stated that 'it is not possible to claim that the mill operations will have zero environmental impact'. North Broken Hill went on to say that the adjacent coast of the proposed mill site had no established commercial fishing operations. This statement was stated to be false, as amongst other fishing activities, there are shark, abalone, trout and salmon commercial operations along the adjoining coastal zone (DPIE 1989). The CSIRO responded by stating that the proponents knew the information they provided was false 'because the information on the commercial catches in the area was provided explicitly in tabular form in a document prepared by the Tasmanian Department of Sea Fisheries in response to the company's environmental impact statement' (CSIRO 1989:14).

Official Responses to the Proposal

On 2 March 1989 there was an official request from the State Government to the CSIRO to advise on whether the proposal should proceed, and if so whether any conditions would be required. The submission stated that there 'is a lack of hard data on which to base solid predictions' with respect to emissions produced from the pulp mill operations (CSIRO 1989: i). The CSIRO found a number of areas in which further information would be required. These included an assessment of the capacity of the Bass Strait to dilute mill effluent and a requirement for more data on ocean movements within the outflow area; a lack of detailed local meteorological measurements made an assessment of the atmospheric effluent discharge impossible; and there was no information on the biological implications of the mill. As a result of the limited information provided the CSIRO stated that four major studies would be essential before the mill could become operational (CSIRO 1989).

The agreement between the proponents and the Tasmanian Government specified that the proponents cannot be held responsible for any pollution unless it is proven that they were the source of that pollution. Thus, without baseline data any assessment of short or long-term effects of the effluent produced would be impossible (Lawrence 1991; CSIRO 1989).

The USERP also made a response to the Wesley Vale proposal. They unanimously concluded: 'that the EIS is inadequate, contains serious errors and is misleading through its selective omission of details. On the basis of this poor document, no guarantee can be given that this will be an environmentally safe operation' (USERP 1988: 1-2).

On the 14 March 1989 the Federal Cabinet considered the proponents application for foreign investment approval. After a four hour debate support for the mill was given. Cabinet supported an addition of stronger environmental guidelines than those expressed in the Northern Pulp Mill (Doubts Removal) Agreement. They also stated that there was a possibility of further new guidelines after the completion of environmental studies. The following day the proponents met with key Ministers and reaffirmed their position that they would not tolerate such environmental guidelines or further revision and elected to abandon the project stating the project would not be viable with such guidelines in place (Lawrence 1991; Chapman 1992). The Commonwealth Government, on 12 December 1989, introduced the *Guidelines for New Bleached Eucalypt Kraft (BEK) Pulp Mills.* Since the Wesley Vale proposal new Tasmanian legislation relating to EIA practices have been introduced (see Tables 1 and 2) along with new Commonwealth pulp mill environmental guidelines (see Table 3).

4. Current Legislation and Guidelines

Table 1 provides an overview of the Tasmanian legislative provisions for EIA. The system includes the; *Environmental Management and Pollution Control Act 1994* (EMPCA), the *State Policies and Projects Act 1993* (SPPA) and the *Land Use Planning and Approvals Act 1993* (LUPAA)

Legislation	**Assessment of impacts by:**	**Triggering of EIA**	**Provision for public comment**	**Provision for public appeal**
EMPCA	Board of Environmental Management and Pollution Control	Application for a planning and/or pollution control licence	Yes - level 1&2 projects	Yes for level 1 and 2 projects
SPPA	Sustainable Development Advisory Council	Level 3 project of state significance	Yes for level 3 projects	No for level 3 projects
LUPAA		Application for a permit for a level 1 project		

Table 1: Overview of Tasmanian Environmental Assessment Requirements

Of note is the discretionary nature of the decision as to whether a document will be made publicly available or not. This decision is made by the relevant Minister. There is also no formal requirement for formal documentation or for the preparation of an EIS

LEGISLATION	**CLASSIFICATION OF PULP MILL**	**REQUIREMENTS**	**PROVISION FOR PUBLIC APPEAL**
EMPCA	Level 2 activity	EIA	Yes
SPPA	Level 3 activity	Integrated assessment	No
LUPAA		Discretionary permit	

Table 2: Classification of pulp mills under Tasmanian environmental legislation.

SIMILARITIES	DIFFERENCES
• Scope • Approval Process • Need for wide consultation • Review of guidelines every 5 years • Public reporting of the mills performance • Objectives	• Emission standards • Environmental impact • Breach of emission limits • Reporting obligations

Table 3: Similarities between the 1989 and 1995 guidelines for BEK pulp mills

The review of the guidelines every five years is to take account of any technological improvements. There is however a need to decide whether this is economically, not environmentally sustainable at a specific site. The placement of annual reports on public record may be avoided under the revised guidelines as this is a discretionary decision. The revised guidelines remove the possibility of mill closure if the emission limits are breached. The limits for major pollutants (i.e. COD, BOD_5, organochlorines and sulphur dioxide limits) have been reduced to limit environmental impacts. The remainder of the document remains the same as the 1989 guidelines. There are no other guidelines in place either at a State or Commonwealth level in relation to any other type of pulp mill.

5. Discussions

The Wesley Vale Pulp Mill proposal provides a good example of how a legislative framework for EIA may be subverted to limit the extent of the assessment of the potential environmental effects of a proposed development. There are also major inconsistencies in the application of EIA processes between the Commonwealth and State.

Initially the proposal was to proceed under Tasmanian guidelines, but with the application for foreign investment, conflicting processes were required under the Commonwealth regulations. This confusion about approval procedures led to the allocation of the Commonwealth responsibilities to the Tasmanian State Government. Subsequently the Tasmanian Government introduced legislation removing the public right to appeal planning decisions, thus increasing ministerial discretion and decreasing public accountability.

An EIS was produced that was grossly inadequate and was not in compliance with the Tasmanian guidelines. Both the Commonwealth and Tasmanian State government departments presented assessment reports on the EIS resulting in some duplication of procedures by both governments. As a result of the assessment an addendum was required under Tasmanian procedures. Both the EIS and EIS Addendum produced for the Wesley Vale proposal showed inconsistencies and a lack of data, suggesting a major problem with the effectiveness of EIA investigations. An evaluation of the addendum was prevented by the proponents withdrawing their proposal. Strategic Environmental Assessment (SEA) of the pulp and paper industry in Australia may help prevent these problems from occurring (Therivel & Partidario 1996).

As the need for EIA in Tasmania is dependent on an application for a planning permit and/or pollution control license, the triggering of EIA may occur too late in the decision-making process. For example, the consideration of alternative development processes or procedures can only occur once the proponents have already made an application for a specified process at a specific site.

Level 3 assessments occur in response to projects of state significance (i.e. major development projects) and as such it would seem that there would be greater stakes involved, and thus a requirement for greater accountability through an appeals process. The removal of the public right to appeal with respect to these developments reduces public involvement in the assessment process. This provides a formalised process to 'fast track' specific developments through the approval process without allowing for effective public participation in the approval process as occurred in the case study provided.

In the Tasmanian legislation the lack of provision for adequate post-decision monitoring results in the omission of an assessment as to whether the controls put in place were adequate or whether predictions were correct. If monitoring provisions were in place they would provide for useful indications as to any changes that would be required in approval procedures and/or information required in EIA processes.

6. Conclusions

The EIA regulations governing the pulp industry in Tasmania are confusing. An appropriate means to implement such regulations could be in the form of specific legislation relating to pulp mills and any EIA procedures that must be followed without exception. These regulations should not be limited to a specific technological method of production. It may be that National EIA or SEA legislation could lead to better integration and a more consistent and effective implementation.

There is a requirement for environmental assessments to be made objectively, comprehensively and by those with expertise in the area of the proposed development. To objectively produce an EIS for example, it must be produced by those who do not hold a stake in the event of the proposal going ahead. This would require the production of an EIS by an individual or group of people other than the proponent or those government bodies that are involved in the approval process. Alternatively, the assessment process should be more transparent and accountable to the public. As there are no public appeal rights for level 3 projects of state significance in Tasmania the incorporation of this process into the legislation is recommended to increase public accountability of decisions made.

There is a requirement to reduce Ministerial discretion for key decisions in the approval process within Tasmania and increase public accountability where discretion does apply.

The incorporation of post-decision monitoring into EIA principles is recommended. This should include the provision for public participation in their design and would increase the accountability of decisions made previous to the approval of a proposal. One way that monitoring could be incorporated into the EIA process is by the redefinition of the scope of an EIS to include post-decision monitoring.

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LINKING WATER FLOWS AND ECOSYSTEM SERVICES: A conceptual framework for improved environmental management

Carl Folke, Professor [1,2] and Malin Falkenmark, Professor emeritus [1,3]
[1] *Natural Resources Management, Department of Systems Ecology, Stockholm University, S-106 91 Stockholm.*
[2] *Beijer International Institute of Ecological Economics, Royal Swedish Academy of Sciences, Box 50005, S-104 05 Stockholm*
[3] *Swedish Natural Science Research Council, Box 7142, S-103 87 Stockholm, Sweden*

1. Introduction

There is a well known and important link between an enclosed coastal sea and its drainage basin, from which the freshwater outflow feeds into the coastal sea system. The precipitation over the drainage basin is partitioned between green and blue water branches (Fig. 1). There has been a lot of attention on the blue water, that is the water appearing as runoff in aquifers and rivers (Falkenmark and Mikulski 1994), and that is used directly in human activities (Gleick 1993).

Blue water scarcity is an issue that is increasingly emphasized (e.g. Postel 1992). There are several regions facing serious blue water shortage (Falkenmark 1989,1997). Reduction of blue water quality as a consequence of human activities, is a major problem in many areas. Both surface water and ground water are polluted and coastal areas eutrophicated. In most parts of the world the blue water is fed with an anthropogenic load flowing out into coastal sea ecosystems.

The green water, that is the water used by terrestrial ecosystems, has received less attention (Falkenmark and Lundqvist 1997). Its use in food production has been partly accounted for in global water budgets (Postel et al. 1996, Pimentel et al. 1997), but the effects on water use and availability, on ecosystem services, and on human wellbeing from land use changes that switch from green water to blue water use and vice versa have not been thouroughly investigated.

An ecosystem approach has to explicitly account for the green water flows, recognizing that ecosystems are not just passive receivers of water. They are living systems that actively modify and redirect water flows.

The whole drainage basin, including the coastal sea, may be seen as large-scale system producing interlinked natural resources and ecosystem services that are required for human activities on land and in the sea. Freshwater plays a critical role in this basic life-support.

Founded on a systems perspective, we stress in this paper the complementarity between green and blue water flows that links the terrestrial ecosystems in the drainage basin to the aquatic ecosystems in the coastal region and to human activities. This complementarity has to be made explicit if management of coastal seas and their drainage basins is to be improved.

We conclude that to improve the state of coastal seas, the combined hydrological/ecological effects, positive as well as negative, upstream in the drainage basin have to be explicitly taken into account. Social and economic activities in the drainage basin have to develop in tune with the hydrological/ecological precondition for human wellbeing.

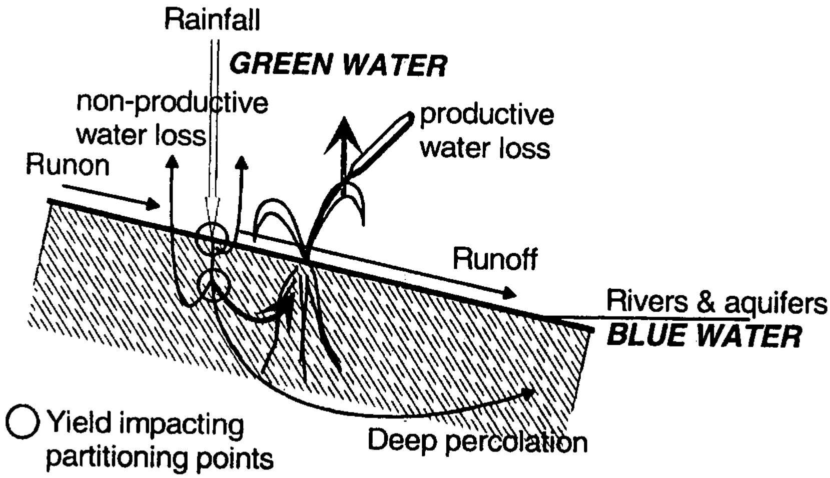

Figure 1. Distribution of rainfall between green water and blue water flows (from Rockström and Tillander 1997).

2. Complementarity between water flows and ecosystem services

2.1 Water's three processor properties

Water - through its physical, chemical and biological involvement - has fundamental balancing functions in the natural landscape, integrated into a conceptual energy transport-reaction model (ETR model), dealing with the dissipation of the daily energy pulse (Ripl 1995). Water dissipates the solar energy pulse in space and time through three main processor properties of water:

- physical through the interaction between evaporation and condensation
- chemical through the interaction between crystallization and dissolution
- biological through the interaction between cleavage of the water molecule in photosynthesis and re-assemblage through respiration.

In the first role water distributes potentials using the enthalpy leap between liquid water and water vapor or ice. The result is "an almost perfect water cycle hardly involving irreversible matter flow and therefore close to a Carnot process extremely low in entropy gain". The second role is based on the polar property of the water dipole which through the dissociation of water lets water act as a weak acid, enabling chemical reactions at an interface with solid matter and leads to dissolution of ionic lattices into dissolved ionic charges. This property is connected with an irreversible charge loss to the sea. The third role is linked to highly structured organic molecules which can absorb and channel light in such a way that the water dipole is disintegrated. The liberated hydrogen can reduce carbon dioxide, forming carbohydrate radicals and finally sugars or cellulose. In this process oxygen is liberated to the environment. The water molecule is reassembled in the opposite reaction, respiration.

By these three processor properties, water plays a set of different roles in the ecosystem. Primary producers are process carriers by storing energy but process controllers by pumping water. Decomposers - process carriers responsible for mineralization of detritus - are activated by water flow and stopped when water flow is ceased. Water is also an energy dissipative, cooling, transport and reaction medium.

Different landscape types (e.g. fields, forests, meadows, wetlands, sealed urban areas) partition precipitation in different ways into green (mainly vertical) and blue (predominantly horizontal) water flows. They also differ in terms of water-carried losses of minerals, nutrients, and organic matter. Cycling water is active also in the accumulation of toxic substances in the topsoil while soluble nutrients are dissolved and carried away. By the latter processes open fertilized agricultural areas are often "bleeding" nutrients, carried by rivers to the sea, and causing eutrophication. In the following we will discuss the links between green and blue water cycles and ecosystem services.

2.2 A conceptual framework integrating green and blue water cycles with ecosystems

Rarely, have hydrologists or ecologists addressed the green water use in terrestrial ecosystems that is required for the production of natural resources and ecosystem services. The exception is agricultural production. Many studies have quantified the blue water requirements in agriculture through irrigation, dam constructions, fossil water use etc. Recently, there have been studies that quantify the green water use ranging from local (Rockström 1997) to global water appropriation in agriculture (e.g. Pimentel et al. 1997).

The green water use in terrestrial ecosystems like boreal and tropical forests, mangroves, and savannas for production of natural resources like timber, fuelwood, grazing animals, or food and medicine have seldom been taken into account in freshwater assessments. This is very much true also for essential ecosystem services on which human societies depend. Without water there would be no such services. Figure 2 presents an integrated conceptual model of links between blue and green water flows and between terrestrial and aquatic ecosystems.

2.3 Ecosystem services

The work by nature in generating and sustaining ecosystem services have recently received a lot of attention (e.g. Baskin 1997, Costanza et al. 1997, Daily 1997). But to our knowledge no attempts have been made to quantify green water use for the sustainance of these services. The services that ecosystems generate include pollination of crops and predation on pests by birds and insects, production of timber by forests, assimilation and recycling of nutrients, and generation of soils in terrestrial systems. Ecosystems influence the climate and contribute to the maintenance of the composition of the atmosphere, waste assimilation from human settlements, maintenance of species and a vast genetic library, and of the scenery of the landscape, recreational sites, aesthetic and amenity values (Ehrlich and Ehrlich 1981, Folke 1991, de Groot 1992). Ecosystems also contribute to the blue water used by humans, by the service of water filtering for improved quality, and by facilitating infiltration thereby reducing river flow seasonality.

This work is performed by life-support systems; organisms interacting in foodwebs and linked to hydrological, biogeochemical, oceanic, climatic and energy flows. There cannot be any production of renewable resources and ecosystem services without ecosystems "producing" them. of trees. Trees are not just a biomass, but a part of the ecosystem in which they live, in which they are produced. Trees interact with microorganisms in the soils, insects, birds and other plants and animals. The interactions that produce and sustain the trees are inherently complex (Costanza et al. 1993). Ecosystems are multifunctional. For example, a forest produces not only timber but also assimilates nutrients and carbon dioxide.

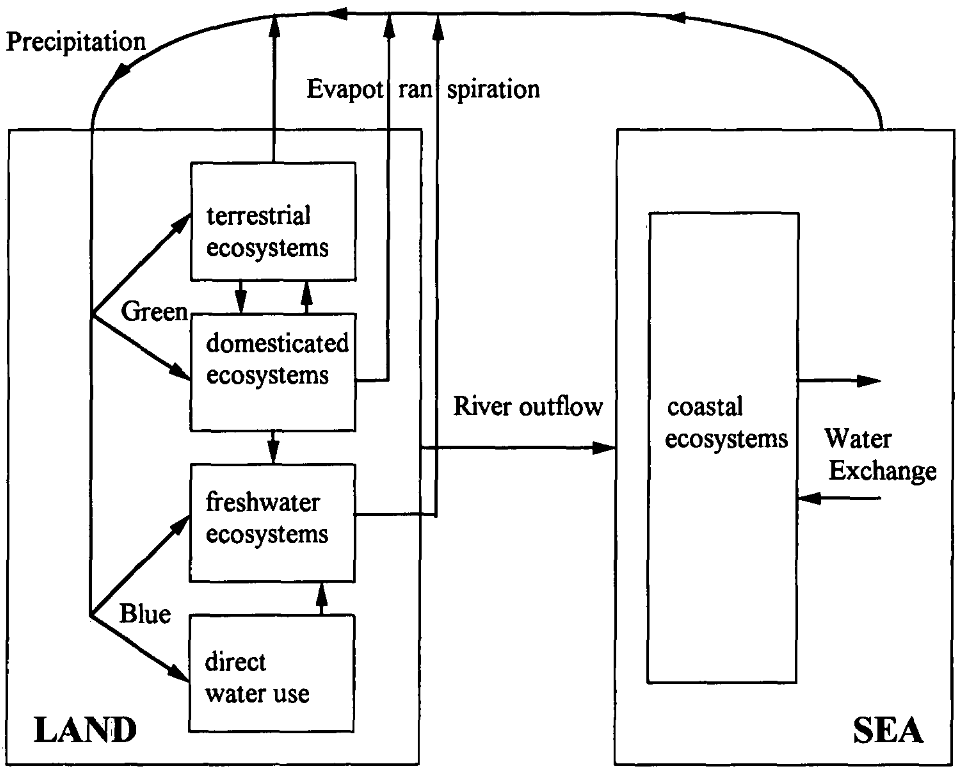

Figure 2. A conceptual model of the complementarity between water flows (green and blue) and ecosystems.

Biological diversity seems to play an important role in generating and sustaining the flow of renewable resources and ecosystem services, by running critical processes and functions in ecosystems (Tilman and Downing 1994, Naeem et al. 1994), and contributing to the capacity of ecosystems to absorb disturbance, including human disturbance (Holling et al. 1995, Folke et al. 1996). Thereby biological diversity sustains social and economic development (Perrings et al. 1992), and the capacity to absorb disturbance, the resilience of the system, can be viewed as "natural insurance capital" for securing the generation of essential ecosystem services under current and future environmental conditions (Barbier et al. 1994).

Water is required for the generation of essential ecosystem services. Therefore, the allocation of increasingly scarce freshwater resources is not only an issue of blue water use for households, industry and irrigation. The green water appropriation required for maintaining ecosystem functioning, biodiversity and resilience (capacity to absorb disturbance) (Holling 1973) that generate essential ecosystem services has to be accounted for in combination with blue water use in freshwater assessments and land use decisions.

2.4 Ecosystem services and human freshwater use in the Baltic Sea Drainage Basin

Jansson et al. (1997) estimate the blue and green freshwater appropriation by people in the Baltic Sea drainage basin. Eighty-five million people live in this large-scale drainage basin. In cities, settlements and industries people do not use more than 3-4% of the annual precipitation in the drainage basin. A decision maker may therefore conclude that there is an almost infinite freshwater supply in the region. But this is very much a partial truth based on a lack of understanding of the complementarity between freshwater and ecosystem services appropriated by the same people. The 85 million people eat grains and livestock from agricultural land, use trees from forests for pulp and paper, furnitures etc., and appropriate wetlands, lakes, forests and agricultural ecosystems for processing nutrient and carbon dioxide emissions. The generation of such ecosystem support requires freshwater. If the green water use to produce these few but essential natural resources and ecosystem services is added to the direct water use, the people in the Baltic Sea drainage basin appropriate, as a minimum estimate, as much as 40-60% of the annual precipitation. Since people do not live on drinking water and food only, but also depend on essential ecosystem services, there are important trade offs between blue and green water use that need to be made explicit.

3. Examples of mismatches in the management of landscape-waterscape links

3.1 Aral Sea: evaporative water use upstream a closed lake

The most wellknown example of water-related complementarity between human activities in the drainage basin and the biodiversity and ecosystem services in "coastal waters" is the Aral Sea basin. In the early part of the 20th century the Aral Sea was fed by two rivers: the Amu Dar'ya and Syr Dar'ya, pooring 55 km3/yr of water into the Aral Sea. The water in the two rivers is the life-blood of the agricultural economies in five Central Asian republics of the former USSR with altogether 35 million inhabitants, supporting 7.6 million hectares of irrigated crops in an arid region with thermal conditions favourable for cotton and other heat-loving crops. By 1990 the rivers combined discharge had dropped to less than 10 percent because of diversions for irrigation (Postel 1995). The Aral Sea drainage basin contains one of the most complicated water development systems of the world: more than 20 large and middle sized reservoirs and 60 canals have been constructed since the 1950's. The Karakum canal is the centerpiece diverting water from the Amu Dar'ya over 840 km to the vast Karakum desert.

When 90 percent of the inflow to the lake vanished, the water level rapidly decreased in response to a high lake evaporation. The recession of the lake has left large parts of the former sea bottom dry and covered with the salts left behind in the evaporation process. In 1988 the lake split into two and by mid 1990's the sea area had dropped by half with only one fourth of the original sea volume left.

A long chain of ecological destruction and human suffering has developed. Most of the fish species have disappeared together with a fish catch of originally some 44 000 ton/yr and 60 000 jobs linked to it. A wind-borne mix of toxic dust and salt is dumped on surrounding farmland producing great harm to the crops. The loss of most of the diluting river flow results in hazardous water supplies which has lead to a depening public health crisis with frightening health effects: typhoid fever, hepatitis, cancer. Both river deltas have degraded and their vegetation of water-loving trees and scrubs have decimated destroying vital fauna habitats and decreasing the number of nesting bird species (Postel 1995).

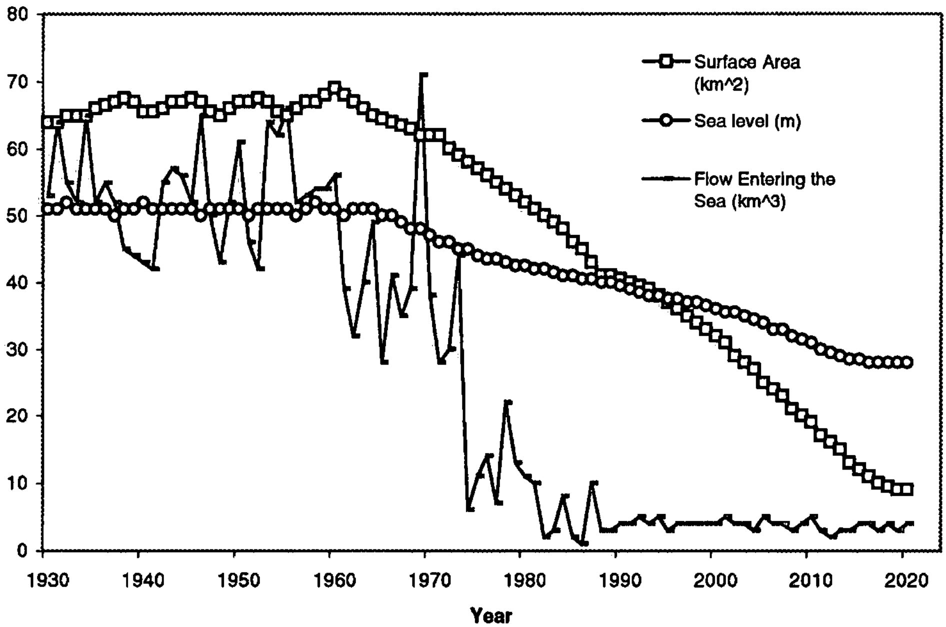

Figure 3. The dramatic decrease since the 1960's of river flow, surface area and sea level of the Aral Sea, including a "business-as-usual" projection up to 2020 (Raskin et al. 1992)

Another illustration of mis-management of water in the landscape-seascape is the Colorado river in North America which no longer reaches the sea at all (Postel 1995). The once-productive fisheries in the Sea of Cortez have declined dramatically and the delta is now a "dessicated place of mud-cracked earth, salt flats and murky pools" (Postel 1995). In other parts of the world there are further examples of rivers where the water has been transferred to support human activities in or even outside the river basin: Yellow river in China, Jordan in western Asia, Nile in Africa. The same is true for several east going rivers in southern Africa. The two dominating human activities that generate this emptying of rivers are water supply of megacities and cash crop production by irrigation. Such mining of water turns a renewable water resource into a non-renewable resources, which also results in loss of other renewable resources and ecosystem services. It provides short term economic benefits, but long term ecological and social costs.

3.2 Semiarid forestry

Changes in consumptive green water use (water consumed by the biota) tend to be reflected in effects on the blue water branch. Both South West Australia and Hungary have experienced water table rise with accompanying salinization in response to forest clearing (Tanuguchi and Bari 1997). On sloping terrain, deforestation tends to produce water flow increases (Sandström 1995).

With rising needs for fuelwood and timber to support a rapidly expanding population in areas with high evaporative demand such as arid and semiarid regions the opposite effect comes into focus. Increased plant production needs water and thereby competes with blue water flows, which has caused groundwater or river depletion. For 25 years the South African forestry industry has been subject to an Afforestation Permit system with the purpose of "protection of natural resources" with focus primarily on blue water protection (van der Sel 1997) The response to afforestation tends to be more rapid where precipitation is higher (Taniguchi and Bari 1997). The fact that consumptive water use if forestry is larger where green water is easily available, as in riparian zones, has caused South Africa to restrict afforestation to intitially 20 m, later 30 m away on both sides of perennial streams and to 50 m from wetland sites (van der Sel 1997)

In arid and semi-arid regions trees compete with human needs for drinking water, and water for food production. But humans also need trees for building material and firewood. There is a trade off between the allocation of scarce water resources for drinking, for grain production, for producing firewood, as well as for other services that water flows and ecosystems generate.

3.3 Coral reefs

Coastal areas are affected by land use change. For example, to secure the ecosystem services generated by a coral reef, it is not sufficient to look at only the effects of fishing, diving or coral blasting. The impacts caused by mangrove destruction and forest clear cutting upstream, have to be accounted for, since such land use changes will increase blue water flows and carry more organic matter and nutrients into the coastal waters surrounding coral reefs. Other human activities on land, such as waste discharges of nutrients and toxic substances from industries, infrastructure development, agriculture, urban growth, land use change, and a growing human population will indirectly impact coral reefs. These activities on land will redirect and alter water flows into coastal areas both in terms of frequence, magnitude and quality. Altered pulses and frequencies of river flow may negatively affect biodiversity and food resources of coastal people, as well as important economic sectors like tourism or fisheries.

This is illustrated by coral reef degradation around the coastal waters of Jamaica. The human population on Jamaica was about a million in 1925 and is about 2.5 million today, and virtually all of the native vegetation have been cleared for agriculture and urban development (Hughes 1994). Most of the Jamaican reefs have been seriously deteriorated, due to a combination of reduced herbivory due to overfishing and disease, and to increased fertilization by nutrients derived from inappropriate land and sewage management practices. Excess nutrients enter Jamaican coastal waters from streams and rivers, submarine springs supplied by groundwater seepage, and towns (Goreau 1992). Eutrophication and overfishing have become so serious that many reefs which formerly had more than 95% live coral cover are now more than 95%

algae covered. In particularly, reefs in bays and shores with restricted water circulation have been wiped out.

There are reefs in Jamaica off un-populated shores in open waters and in areas with strong offshore currents that show little or no sign of eutrophication. Reefs are occasionally hit by natural disturbances like hurricanes or diseases. Such disturbances are part of ecosystem development (Holling et al. 1995). Prior to intensified human development on land the coral reefs bounced back rapidly from natural disturbances. But after the two hurricanes in the 1980s there has been little coral settlement and slow recovery on reefs off populated shores (Goreau et al. 1997). This is largely a consequence of reef recruitment areas in hurricane protected bays having been wiped out by human activities on land and in the sea.

Obviously a sound and sustainable management of interacting green and blue water flows and the natural resources and ecosystem services that they sustain have to be based on a conceptual framework that incorporates the interactions between ecosystems and human activities in the drainage basin with the response in the coastal sea. The Jamaican case also highlights the necessity to combine analyses of water quantity and quality in relation to land use change.

4. Making situations of choice explicit

4.1 The predicament

Particularly in water-scarce regions with high evaporative demand, such as semi-arid and arid environments, a situation of choice will develop between water uses for terrestrial ecosystem services in the basin, human direct water use, and water outflow to aquatic ecosystems and coastal seas. To handle this situation it is useful to distinguish between evaporative water use, polluting water use, and in stream water use. The evaporative water use is divided into the water that evaporates from the surface and the water transpired by the biota. For example, in Namibia 83% of the annual precipitation evaporates more or less directly, 14% is transpired by the biota and only 3% enters streams and groundwater (Falkenmark and Lundqvist 1997).

Terrestrial ecosystem services are basically linked to evaporative water use, whereas aquatic ecosystems and human water-dependent activities are linked to non-evaporative, but often polluting or in stream water use. The challenge is to combine the mix of direct and indirect water uses in a fashion that generates both water for households, industry, food and essential ecosystem services in the long run.

4.2 Cape Town: combined management of water use and ecosystem services

The South African fynbos ecosystem provides a comprehensive example of hydrological/ecological knowledge translated directly into policy and action. The fynbos is the predominant vegetation of the Cape Floristic Region supporting 8,500 plant species, of which 68% are endemic. The region is one of the so called biodiversity "hot spots" of the world.

Alien invasive plants, all shrubs and trees from other fire-prone, Mediterranean-climate ecosystems are the major human-induced threat to fynbos ecosystems including their role in ground water recharge and modification of river flow seasonality (Cowling 1992). The alien trees and shrubs eliminate native plant diversity and reduce ground water recharge and river flow from fynbos ecosystems by 30-80%. Without management, pristine drainage basins will have alien plant cover of between 80-100% after 100 years (Le Maitre et al. 1996). Figure 5 shows the increase in evapotranspiration and reduction in river flow due to alien plant invasion.

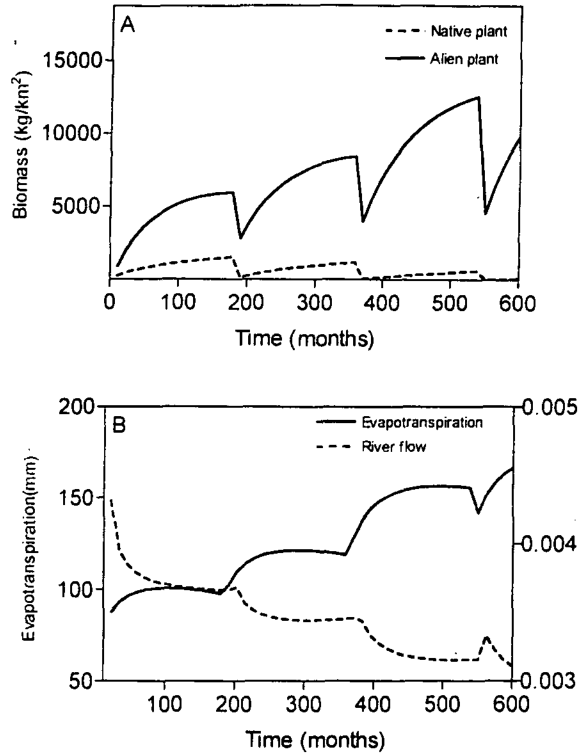

Figure 4. Changes in (A) alien and native plant biomass and in (B) river flow and evapotransporation over 600 months for an invaded mountain fynbos ecosystem (from Higgins et al. 1997).

Other major ecosystem services of the fynbos, in addition to providing substantially more water for human use than the invaded system, include wildflower harvesting, biodiversity storage for various uses including floricultural varieties. Other non-functional but economically important services include hiker and ecotourist visitation, and aesthetic as well as cultural and existence values (Cowling et al. 1997).

The value of the services of a pristine fynbos system reached more than 82 million US$ annually and was derived from the development of a dynamic simulation model that integrated hydrological/ecological and economic data and processes (Higgins et al. 1997). Clearing alien species amounted to only 0.6-4.8% of the value to society of the water flow and ecosystem services supplied by fynbos drainage basins. Alternative technical solutions to water supply would cost 1.8-6.7 times more than saving water through fynbos catchment management (van Wilgen et al. 1996).

The analysis was presented to the South African Minister of Water Affairs and Forestry, who decided to invest 100 million Rand (more than 20 million US$) annually to clear the fynbos of invading alien plants, starting in 1995. The "alien plant removal from watersheds project" will generate thousands of jobs, involve numerous training programs that will communicate hydrological/ecological knowledge, provide water to the region and safeguard many thousands of plant and animal species (R. Cowling, University of Cape Town, pers.comm.).

4.3 Competition in the freshwater-seawater continuum

In the river basin upstream land and water uses are linked to downstream aquatic and coastal ecosystems by the water cycle. Figure 4 illustrates in a simplistic manner links between ecosystem services and water flow in the landscape-seascape. When land and water use changes are taking place upstream this will affect ecosystem services downstream and in the coastal sea, as illustrated throughout this paper. The changes may alter river flow, its seasonality as well as its chemical composition in the following way:

- river flows respond to changes in evaporative water uses, green as well as blue water uses,
- river water quality responds to pollution loads both from waste water outputs, leaching waste deposits, and leaching of nutrients and other compounds from disturbed landscapes,
- especially blue water quality degradation influences downstream useability of the river water.

If a decision is made to expand an urban area, or to clearcut a forest, water flows will be affected. This will affect the surrounding terrestrial, aquatic and coastal ecosystems, their functional diversity, their buffering capacity, and their generation of essential ecosystem services for other human activities. A drainage basin perspective is needed, where humans, water flows and ecosystems are analyzed as one system, in a continuum from upstream to downstream to the coastal sea.

Such management is attempted by e.g. the Murray Darling Basin Commission in Australia, an inter-governmental agency that developed for active regional scale multiple use management. In the large-scale Murray Darling River system there are major resource allocation issues in relation to water scarcity, urbanization, tourism, primary industry and biological diversity that need to be approached from a large-scale drainage basin perspective.

Linked large-scale drainage basin management of freshwater, natural resources ecosystem services, and coastal ecosystems was also practiced in ancient cultures. In ancient Hawaii river valleys were managed as integrated systems, from the upland forest all the way to the coral reef (Costa-Pierce 1987). Similarly in the Solomon Islands a *puava* in the widest sense includes all resources and ecosystems in a drainage basin, from the top of the mainland mountains to the open sea outside the barrier reef (Hviding 1990).

But there are also linked water and ecosystem management situation of serious conflict. The Okawango delta in Botswana downstream is threatened by the plans in Namibia upstream in the drainage basin to build a dam to secure their water flow and food production. Who has the right to the water, and who will pay the cost of the side-effect? Problems of jurisdicion, national sovereignity, and other social, legal, and economic considerations will escalate with a growing human population and intensified internationalization. Effects of many local decisions on land and water uses can accumulate and cause large-scale transboundary impacts, such as loss in freshwater and loss of essential ecosystem services elsewhere (Holling 1994, Andersson et al. 1995).

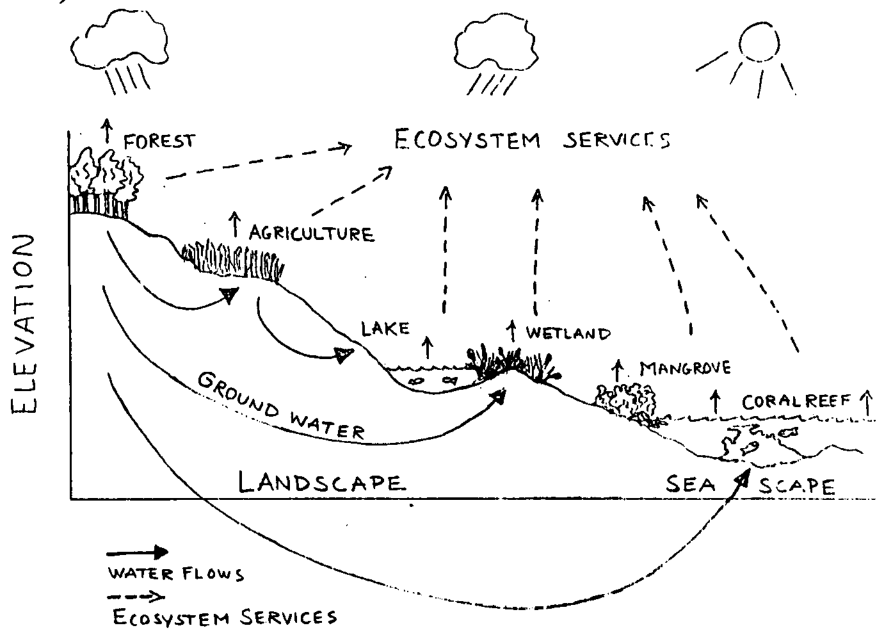

Figure 5. A conceptual model of the links between freshwater flows and ecosystem services in a drainage basin perspective.

5. Conclusions

The capacity of nature's life-support system to sustain social and economic development is seldom accounted for in society. It is "hidden" in the sense that it is not reflected in the prices of good and services bought and sold on markets, and often not even perceived by decision-makers. Hydrologists and ecologists have tried to illuminate the value of this capacity in different fashions.

Hydrologists have stressed the necessity of an improved management of increasingly scarce freshwater resources (Gleick 1993). Ecologists have stressed the necessity of taking the capacity of ecosystem support into account (Odum 1989), including the critical role of biological diversity, and with a recent focus on the services that ecosystems generate (de Groot 1992, Daily 1997, Baskin 1997, Costanza et al. 1997).

In this paper we have shown the necessity of combining these two approaches. The paper has highlighted the clear links between terrestrial ecosystems and green water consumption, between blue water-based irrigated agriculture and the losses caused to the downstream river system and the aquatic and coastal ecosystems. We have illustrated that both flow changes and water quality changes are generated by changes in land and water uses up in the drainage basin, and that these changes will impact on essential ecosystem services.

A lot of choices are constantly made, but the potential effects on life-support systems of these choices are only partly incorporated in decision making. In this predicament it is essential to strive towards an acceptable overview of and an integrated approach to the overall system with its linkages between water flows, seasonality and quality and the resulting ecosystem services.

We stress the importance of a drainage basin approach where interdependencies between water flows, ecosystem function and services, and the state of coastal seas are made explicit. If management of coastal seas is to be improved this will imply constraints to upstream activities. Decision makers are in other words facing a severe dilemma especially in situations where the river basin encompasses several countries.

For example, allocation of freshwater between ecosystems, human water-dependent activities, and the coastal seas may become explicit. Novel approaches will be required, and are already being implemented, like pollution reduction through redirection of water flows into old or newly created ecosystems (Mitsch and Jörgensen 1989), or by reducing water runoff and soil erosion in agriculture by interplanting of suitable crops (Pimentel et al. 1997). Such measures serve as pollution barriers or sinks and improve the downstream useability of the water and the state of aquatic ecosystems. The use of precipitation over the drainage basin should be improved so as to secure food for the population, provide employment, generate income, and at the same time protect crucial ecosystem services on land and in the coastal sea.

Basically, certain minimum amounts of natural resources and ecosystem services are needed to sustain a society. This is sometimes spoken of as critical natural capital (Jansson et al. 1994). This minimum amount cannot be challenged since that would cause society to collapse sooner or later. As long as society remains above this threshold societal decision making retains its degrees of freedom. Once below that threshold no degrees of freedom is left. The human use of natural resources and ecosystem services is dependent on the existence, operation and maintenance of a multifunctional ecosystem linked to other multifunctional ecosystems, to energy, biogeochemical and hydrological flows, and to other human uses and misuses affecting those flows. Due to the scale of human activity, such cross-scale interactions, both temporal and spatial, will increasingly affect the flow of essential water resources and ecosystem services on which human welfare depends (Levin 1992, Holling 1994).

To improve the chances for long-term sustainable solutions the biophysical preconditions for social and economic development have to be made explicit, and be given more weight in decision making than today. Improving the understanding of the links between blue and green water flows and ecosystem services and how different human activities relate to and change those links is a research area with great potential. Such research may reveal crucial biophysical trade offs seldom perceived in decision making, and the information gained may aid the difficult management of human activities of drainage basins, rivers and coastal seas.

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WORKSHOP 6:

CURBING OUTFLOW OF POLLUTANTS FROM DOMESTIC WASTE

Professor Poul Harremoës, Denmark (Chairman)
Mr Jan Falk, Sweden, (Rapporteur)

The aim was to have a session devoted to "ecological engineering" as a new design approach, that integrate human society with its natural environment for the benefit of both. However, the workshop received contributions that are best structured into three brackets: Ecological engineering, public health engineering in developing countries and advanced wastewater treatment

1. Ecological engineering

"Ecological engineering" is a combination of theoretical and applied ecology on the one hand and traditional engineering on the other hand. "Ecological engineering" has been practised before (e.g. river management), and has been dominated by empiricism. The novelty is to combine with a systematic approach based on theoretical ecology which makes it a new discipline. The potential is due to the generally unrecognised stock of natural capital and the extent of natural services which are available for "Ecological engineering". The fundamental concepts are based on self-design, ecosystem conservation, focus on manipulation of biological systems and improved knowledge of ecosystem performance. The potential is vast, but there is a need to learn more about ecosystem properties and cause-effect relationships.

The principle of "Ecological engineering" was illustrated by a Japanese example of prevention of eutrophication in an enclosed coastal sea. The example involved: On-site water purification using grazing animals (mussels) and macro algae, on-site sediment purification using benthic animals (polychaetes) and development of ecological models for management of nutrient levels. The project involved development of commercial products from the animals and the algae produced.

2. Public health engineering in developing countries

Several papers were related to the traditional water-environment-hygiene-health interactions in the developing world. Again it was manifested, that lack of sanitation is a serious threat to public health, that application of raw wastewater to agriculture cause water borne diseases - especially irrigation of vegetables, which is long since well established vehicle for transmission intestinal diseases. After decades of international efforts to cope with this problem, it is striking that the poor performance of the urban system in the developing world does not seem to be affected.

It was agreed that the there is a need to reappraise the basic approaches that basic sanitation in the developing cities has to be based on the principle of faeces and urine separation, local handling of the waste and recirculation of nutrients, that the public need education and should participate in the projects and that the problems of the megatropolis should be tackled at the cause by curbing the migration to the cities. This is a social/economical problem, not a technical one.

3. Advanced wastewater treatment

Included in the workshop was several papers devoted to advanced treatment of wastewater and leachate from landfills, including novel techniques over a broad spectrum of physical, chemical and biological methods. The potential is that wastewater can be treated to any degree of purity at increasing cost and that there will always be a residue in the effluent. Near-zero performance at an acceptable cost has the potential to solve many problems of water scarcity. As long as water is not evaporated during usage in the city it is available for reuse after adequate treatment.

The workshop illustrated the diversity of the problems involved and of the solutions available in time, space and cultural/economic circumstances. There is no unique solution. Water is a reusable resources that should be protected against pollution by coping with the sources of the pollution and by proper treatment before and after usage, all depending on the local circumstances.

ECOLOGICAL ENGINEERING: ENHANCING NATURE'S ECOLOGICAL SERVICES

W J Mitsch, Professor of Natural Resources and Environmental Science, School of Natural Resources, The Ohio State University, 2021 Coffey Road, Columbus, Ohio 43210, USA

Nature's services are now being increasingly recognized as major contributions to the world's economy. Stated another way, we now see the value of natural ecosystems in providing services such as clean air, clean water, and biodiversity protection. Without these services our economy would incur great expenses to provide the same. Nature's services were recently defined as the "flow of materials, energy, and information from natural capital stocks which combine with manufactured and human capital stocks to produce human welfare" (Costanza et al., 1997). That study estimated that the value of these natural services may be $US 33 trillion.

Ecological engineering is poised to be the approach by which we can amplify and even increase the services that natural systems provide. This relatively new field has been defined as the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both (Mitsch, 1993, 1996). As the design, restoration, and creation of ecosystems, ecological engineering can be considered a third leg of the field of ecology (Fig 1). It is neither theoretical ecology nor is it applied ecology. Yet it is based on the principles and practices of both. There is also an important feedback from ecological engineering to the science of ecology as illustrated in Fig 1. Bradshaw (1987) calls this the the "acid test of ecology." By building and restoring ecosystems, we will truly test the ecological theories that have developed over the past 100 years. Cairns (1988) suggests that by restoring ecosystems, we will expose limitations of existing ecological theories and concepts.

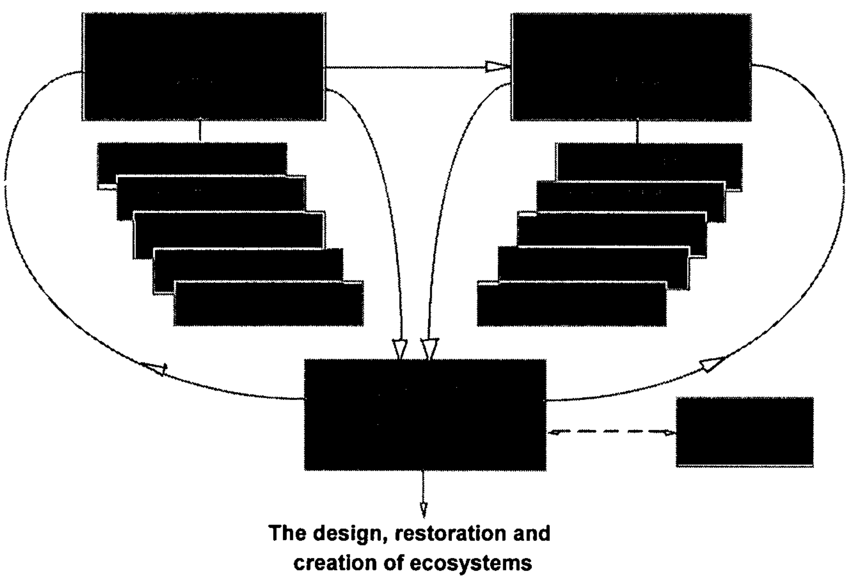

Figure 1 Relationship of ecological engineering with the traditional fields of ecology (from Mitsch, 1993).

Just as ecological engineering is not exclusively in the field of ecology, neither is it defined in current engineering approaches. Engineering concerns itself with technological design to provide for human welfare (Fig 2, top). Engineering is the application of energy, particularly fossil fuels (as manifest in our economy), to solving problems and providing for human welfare. The emergence of engineering as a profession paralleled the major development of fossil fuel energy starting in the 19th century. Before this "Industrial Revolution," engineering as a profession was not well developed and agriculture (process of concentrating and capturing solar energy) dominated developed societies. Ecological engineering offers an approach where some of our technology but a great deal of solar energy from natural ecosystems are matched to provide for human welfare (Fig 2 bottom).

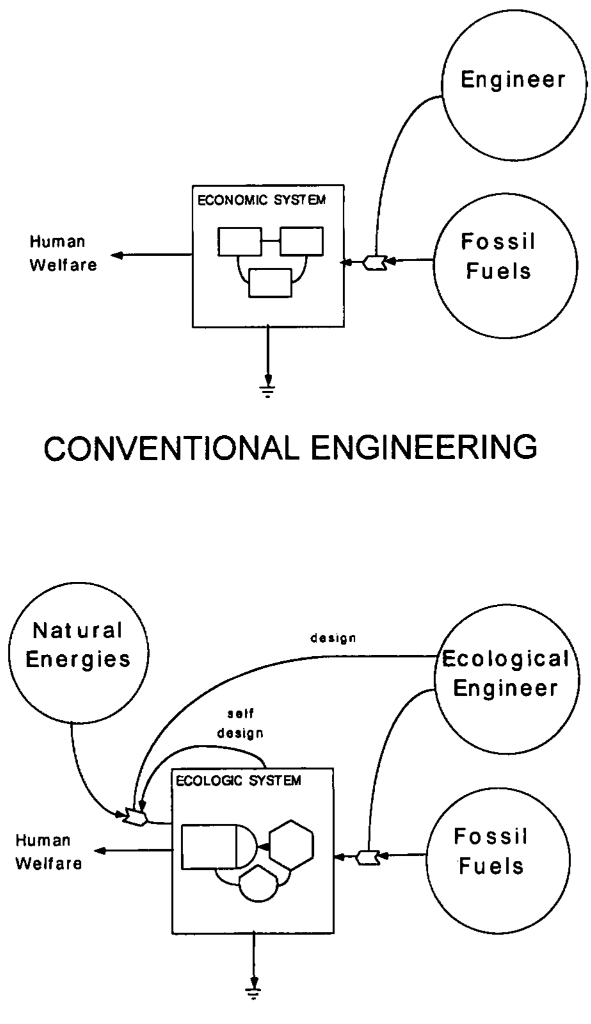

Figure 2. Contrast between conventional engineering (top diagram) and ecological engineering for providing human welfare.

There are several aspects of ecological engineering that separate it from conventional engineering. One is a reliance on self-design, which means that the biological components of the ecosystem organize themselves into an ecosystem, given the forcing functions imposed on the system by the ecological engineer. The application of self-design, sometimes referred to as self-organization, in ecosystem restoration and creation is that if an ecosystem is open to allow seeding, through human or natural means, of enough species' propagules, the system itself will optimize its design by selecting for that assemblage of plants, microbes, and animals best adapted for existing conditions. This "self-designed" ecosystem will ultimately supersede any engineered, botanical, zoological, or microbial design imposed on the system by humans. The ecosystem provides part of the "design" to the system.

A second aspect of ecological engineering that causes it to differ from conventional engineering is the implicit inclusion of ecosystem conservation in ecological engineering. Aldo Leopold stated that the first rule of a tinkerer was to not throw away any of the parts. Ecological engineers are tinkerers in the real sense. The "parts" that we would never throw away are the vast number of species on the earth.

Over the past few years, ecological engineering has begun to coalesce as a distinct application of the science of ecology (Mitsch and Jørgensen, 1989; Etnier and Guterstam, 1997; see short historical account in Mitsch, 1997). Applications range from mine spoil reclamation, prairie restoration, and biomanipulation of lakes and reservoirs to solar-powered wastewater treatment plants, sustainable agroecosystems, and constructed wetlands for wastewater treatment (Fig 3). Successes of ecological engineering make it an increasingly attractive alternative to traditional engineering approaches, which are often much more expensive to construct and sustain.

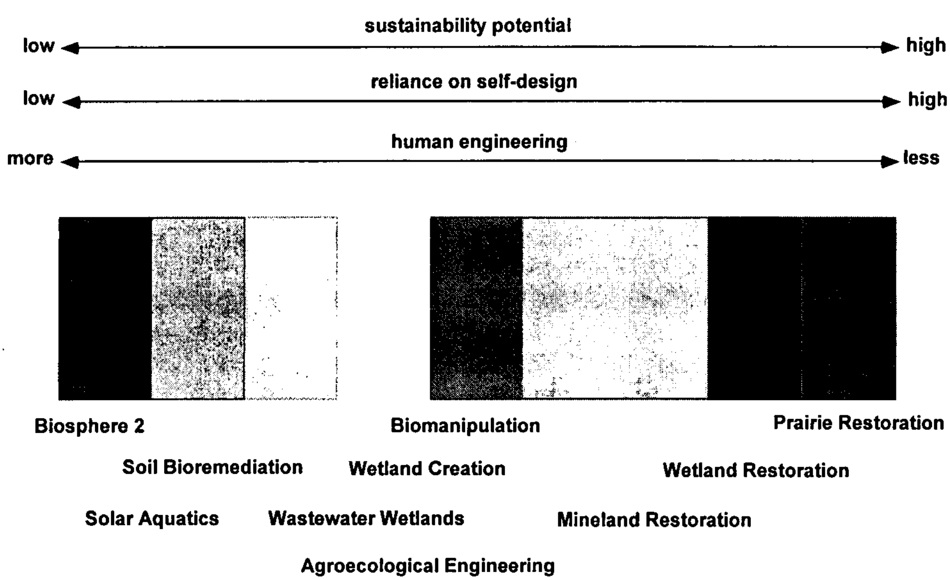

Figure 3. The ecological engineering "spectrum." Applications to the left are intensive in high energy subsidies and less reliance on self-design; applications to the right are the reverse.

A SCOPE Project on Ecological Engineering

The need for ecological engineering and ecosystem restoration is increasingly recognized in the developing and developed worlds. In the developed world, we are recognizing that not all environmental problems are solvable by conventional technological means nor within foreseeable nonrenewable energy limits. We appear to be playing a "shell-game" with pollution, continually solving one problem only to create another. In countries with limited financial flexibility, ecological engineering is attractive for its relatively low capital requirements during project development and maintenance.

Increases in the level and sophistication of activity in ecological engineering as well as the need for synthesis and integration of the field served as stimuli for the development of a SCOPE (Scientific Committee on Problems of the Environment) project on this subject. The international project was first proposed to SCOPE in Paris in February 1994. Soon afterwards, an international Scientific Advisory Committee (SAC) of this project, now entitled "Ecological Engineering and Ecosystem Restoration" was formed and convened as the body responsible for the progress of the overall project. The membership of the SAC committee was formally approved at SCOPE's General Assembly in Tokyo in 1995). The goals of the SCOPE project on ecological engineering are summarized in Table 1.

Table 1. Specific goals of the SCOPE project on ecological engineering and ecosystem restoration

- development and synthesis of the ecological and engineering bases for ecological engineering

- presentation of case studies of ecological engineering from developing and developed countries

- merging of theory and empiricism about ecological engineering

- identification of educational approaches and national and international stimuli for ecological engineering

To accomplish these objectives, the SCOPE ecological engineering committee is planning several international workshops on ecological engineering. Each will have a regional focus directed at major themes of ecological engineering in that geographical area and economy. The first workshop of this series was held in Tallinn, Estonia, on 6-8 November 1995 with the support of UNEP (United Nations Environmental Programme) and its IETC (International Environmental Technology Centre). The overall theme was "Remediation of Ecosystems Damaged by Environmental Contamination." Twenty-seven participants, representing 13 countries and including 17 of the 18 invited participants, met for the workshop in Tallinn. Half of the workshop participants were from Central and Eastern Europe. Some findings of the Estonia workshop are listed in

Table 2. Several papers from the Estonia workshop were published in a special issue of *Ecological Engineering* entitled "Remediation of Ecosystems Damaged by Environmental Contamination" (Mitsch and Mander, 1997b; Table 3).

This special issue gives a good example of the breadth of ecological engineering. In one paper, Ukrainian ecologist Davydchuk (1997) describes ecosystem recovery at one of the most potentially damaging events of the 20th century—the Chernobyl nuclear power plant accident in northern Ukraine in 1986. About 700 square miles [1850 square kilometers] of arable land and 600 square miles [1570 square kilometers] of forest were severely contaminated and hence lost from human use as a result of the disaster. Davydchuk summarizes three types of ecosystem remediation that have taken place in the 10 years following the accident: 1) maintenance of the forests to limit pests and fires; 2) artificial reforestation; and 3) natural restoration. He and fellow scientists in the Ukraine found that natural restoration to grasslands and forests from former farm fields helped to stabilize the radioactivity as well or better than any hard engineering solutions, resulting in less radioactivity in downstream water supplies. Davydchuk proposes that similar ecological engineering approaches should be taken into consideration as strategies for still-polluted zones around Chernobyl.

Table 2. Some general findings of the SCOPE workshop in Estonia (from Mitsch and Mander, 1997a)

- Ecological engineering is one of the approaches that can be used to develop sustainability.
- Ecological engineering is a multi-prone complex activity.
- Performance standards need to be met with ecological engineering - legal, local, and international.
- A combination of technological and ecotechnological work best.
- Political will must be part of solution - local and national.
- The limited life and/or saturation of ecological engineering is a potential problem for which there are no apparent solutions.
- Ecological engineering has to develop with engineers and ecologists.

Table 3. Contents of the Special Issue of Ecological Engineering "Ecological Engineering in Central and Eastern Europe: Remediation of Ecosystems Damaged by Environmental Contamination" (Mitsch and Mander, 1997b)

"Remediation of ecosystems damaged by environmental contamination: Applications of ecological engineering and ecosystem restoration in Central and Eastern Europe," W J Mitsch (USA) and Ü Mander (ESTONIA)

"Restoration of mined lands -- using natural processes," A Bradshaw (UK)

"Acidification: Its impact on the environment and mitigation strategies,"
L Pawlowski (POLAND)

"Rehabilitating degraded forests in Central Europe into self-sustaining forest ecosystems," J Fanta (THE NETHERLANDS)

"Efficiency and dimensioning of riparian buffer zones in agricultural catchments," Ü Mander, V Kunsemets, K Lohmus, and T Mauring (ESTONIA)

"Ecosystem remediation in radioactively polluted areas: The Chernobyl experience," V Davydchuk (UKRAINE)

"Remediation of depleted soils by addition of ion exchange resins," V.S. Soldatov, L. Pawlowski, E. Kloc, I. Szymanska, and V.V. Matushevich (POLAND and BELARUS)

In other papers, Pawlowski (1997) and Fanta (1997) describe the need for ecologically based forest restoration in the "Black Triangle," a heavily polluted region of Central Europe near the intersections of Poland, the Czech Republic, and Germany. After 300 years of poor forestry practices and 50 years of acid rain caused by excessive air pollution, traditional forestry practices and artificial chemicals are not the answer, according to Fanta (1997). He states that "restoration can only be achieved through natural processes which will take decades, or even centuries. The colonization of degraded sites by pioneer tree species is proving to be more beneficial to the restoration of soil processes than any artificial manipulation of sites."

Bradshaw (1997) shows in another paper in this special issue that self-sustaining ecosystems can be developed even in totally degraded environments by carefully applying ecological engineering approaches in which natural processes are harnessed. And the cost to humans is less, too.

Other articles in the special issue on using nature to clean up Central and Eastern Europe describe use of stream-side vegetation in Estonia to control agricultural water pollution (Mander et al., 1997) and remediation of degraded soils in Poland and Belarus using recycled water demineralizer resins as sources of plant fertilizers (Soldatov et al., 1997).

A successful start to the SCOPE project "Ecological Engineering and Ecosystem Restoration" was achieved by the workshop in Estonia. The publication of the special issue will serve as a major milestone for ecological engineering. While the results and discussion were particularly relevant to Central and Eastern Europe, the workshop and publications point out the universality and the importance of ecological engineering.

Where Do We Go From Here

There are several things that need to be done for ecological engineering to flourish.

1. Ecologists need to recognize the applied nature of their field to offer prescriptions, not just descriptions, for environmental problems.

2. Engineers need to understand that biological and ecological sciences are fundamental to their tasks.

3. A formal accreditation of ecological engineering, for which ecologists need to recognize the importance, should be developed.

4. Universities need to integrate ecology and engineering into rational and rigorous programs of ecological engineering.

5. Ecologists and engineers need to work together and understand each other's language.

6. The international dialog needs to continue to establish the scientific basis, limitations, and opportunities of ecological engineering.

Conclusions

Ecological engineering is a field dedicated to addressing and solving real-world problems. It is also a field that can be used to amplify the services provided by nature. The applications are particularly pertinent in economies where advanced technological approaches to environmental management are difficult if not impossible. The success of ecological engineering will require a continuing dialogue and increasingly close interactions among practitioners, traditional engineers, ecologists, and, when the new profession is firmly established—ecological engineers.

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FOR A NEW APPROACH TO WATER DRINKING PROMOTION IN A POLLUTED ENVIRONMENT

Kouassi Sébastien Dohou, assistant-researcher, Laboratoire de climatologie/FLASH/ UNB, 03 B.P. 1912 Jéricho COTONOU, BENIN

INTRODUCTION

The region of Pobè-Sakété-Ifangni received its drinkable water equipments in 1983 (Pobè-Sakété) and 1987 (Ifangni). The main objective of this installation is to improve people's health. But, a few years later, the sanitary statistics show that rate of water disease's do not decrease.

Then, it is necessary to make complementary actions to bring people to use water in a better way, to protect their environment, to incite to consume drinkable water. That is what "Composante Sanitaire" project has been dealing with since 1991. But, because of the strategy developed, the project did not reach its expected objectives.

I - PHYSICAL ENVIRONMENT: CONSTRAINT AND OPPORTUNITIES IN WATER AND ENVIRONMENT MANAGEMENT

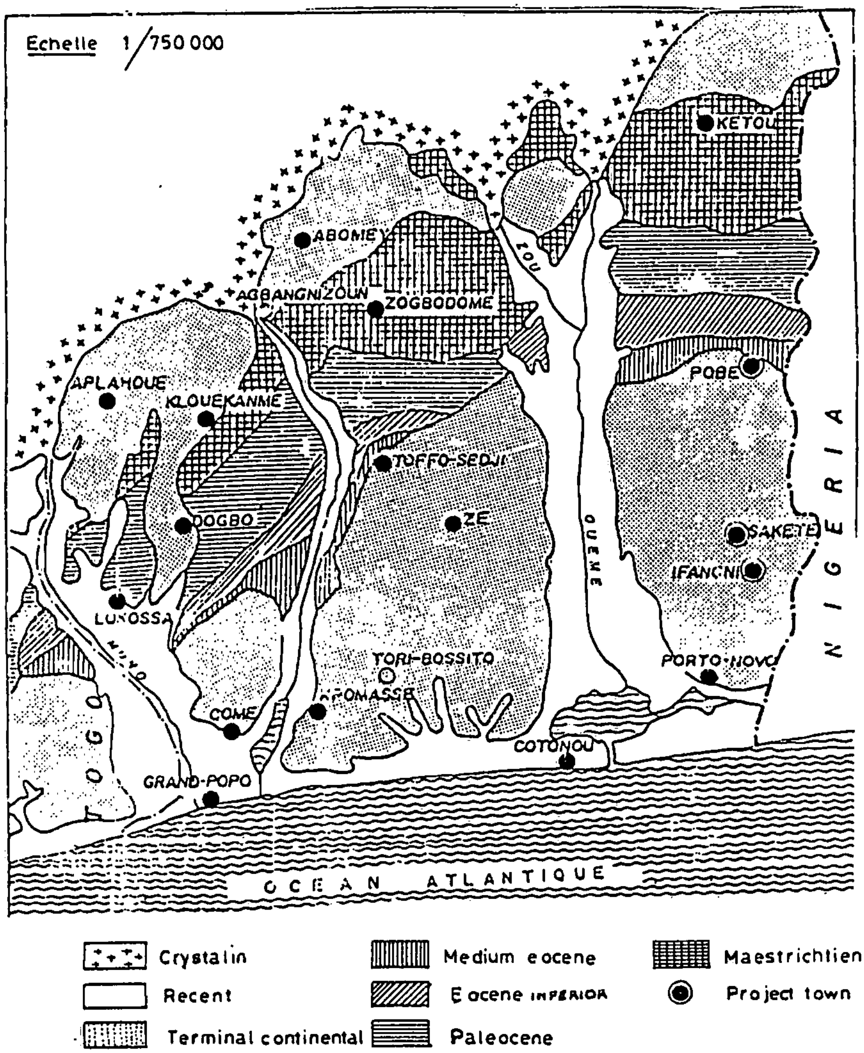
1 - Physical data

The region covers 1112 square kilometres with 67.169 inhabitants from which three ethics groups are outstanding: Gun, Nago and Yoruba.
The main geological structure developed in the region is the Terminal Continental with sandy-clay series which impede travellings, particularly in rainy seasons. Flood events are periodically hanging over the lower valley of the river, with water diseases consequences.

The relief is constituted of a plateau with shallows in places, strictly situated on the Continental terminal series. With regard to its geological characteristics, the Terminal Continental must be considered as an empty reservoir. Water is very deep within it, and often under the sterile clay under 50m, making clay layer very difficult. The well may go under 150m depth. This situation is still more difficult in limestone series as at Pobé where calcareous series lie on the Terminal Continental (FIG n°l).

In this case, the discharge varies from 0 to 90 cubic meter/hour. The ground water is so deep that rainfall amounts cannot recharge it. The region is of subequatorial climate with rainfall amounts which vary from 1100 mm to 1300 mm. The hydrogeological context is a major constraint for water supply in the region because of.
(i) The Terminal Continental sterility;
(ii) The clay outcrops
(iii) The insufficiency of rainfall
In face of such a difficulty, people are obliged to use rivers, lakes and water from rainwater.

Fig n° 1 **COASTAL SEDIMENTARY BASIN OF BENIN: Geological situation**
(From SLANSKY, 1962)



The soil of the plateau contains clay. That characteristic influence the disponibility of water. Flows varie often in quantity from 0 to 90 cubic meter.

In addition, the region is confronted with specific environmental problems: soil and rivers degradation, mis management of domestic waste, flood risks... In such a compelling environment, we wonder ask how people who live there adapt themselves?

2 - Social realities

People of Pobè-Sakéte-Ifangni plateau have a high culture of grouping organization and with a strict respect of social established hierarchy. Each social category has an exact part. Then, the elders are the tradition guarantors. They look after the social order through reverence to divinities. Divinities which regulate their live, water resource management and environment protection. With divinity's masks, people communicate and protect the flora, the faun, public places, forbidding water supplying in such and such a river, deposing household rubbish here and there. Trade activities are another characteristic of this people, particularly, water sale.

In fact, the water sale in the region dates from an old tradition. Before 1983 when the Benin's Society of Electric Power and Water Supply settles the first water supply network in the region, people collect rainwater in tanks in order to resell it during the dry season. With the Benin Society of Electric Power and Water Supply network, only some rich men subscribe to water supply. The subscribers resell the drinkable water to non-subscribers. Water which in paid at 115 Fcfa/cubic meter by subscribers is resold in detail at 666 Fcfa/cubic meter to non-subscribers, i.e. at a rate of 580 per cent.

As for method of domestic waste and water, there is no management department in the region. Domestic waste water are systematically flown on the paths. The waste heaps are used asavatory. Then, all the cities become a hotbed of waterborne diseases by insects, flies, mosquitoes and parasite proliferation which pollute water and food. So waterborne, diseases such as malaria, parasitism and diarrhoea prevail in the region.

The sanitary problems linked with water quality, hygiene and environment exist a long time. Physical and social realities are credited as factors which endanger people's life. They are constraints for people wealth. But they constitute also a real opportunity for measures to master and improve the situation. Then, the different parts developed in this first part prove the exactness of "Composante Sanitaire" project establishment in the region.

II - THE RATIONALE OF THE PROJECT

In 1989, a social investigation allowed to appreciate the sanitary state of the region. From this investigation, it was clear that the drinkable water network installation in the region had not improved the sanitary state. But it showed that disease risks are not linked with water quality but with domestic waste, waste water and drinkable water management. Therefore, the most important diseases in the cities are malaria, diarrhoea and parasites. For instance, the statistical series show 338 parasites case, 235 diarrhoea and 1387 malaria cases in Ifangni, i.e. respectively 13.1%, 8.4% and 54 % of all affections. So waterborne diseases amount at 75.5 % of all diseases in this town.

<u>Evolution of Parasitosise</u>

TOWNS /YEARS	1989	1993	1995
Pobé	750	630	811
Sakété	1250	65	253
Ifangni	380	00	05

1 - The expected objectives of the project

They are as follow.

- To equip towns with sanitary services as private and public latrines, domestic waste, collection to dig gutters,...
- To train some hygiene and sanitation agents.
- To make people aware in hygienic behaviouring;
- To initiate people to subscribe directly to the Benin Society of Electric Power and Water Network service.

Therefore, the following objectives should be attained:

- 80 % of the population become aware of hygiene issues.
- 80 % of the population subscribe directly to SBEE water services;
- Number of latrines increase at 10 %.

2 - The project results

Three years after the project came at its end, the sanitary state is not improved.

(i) Waste water and domestic waste continue to be discharged in the streets

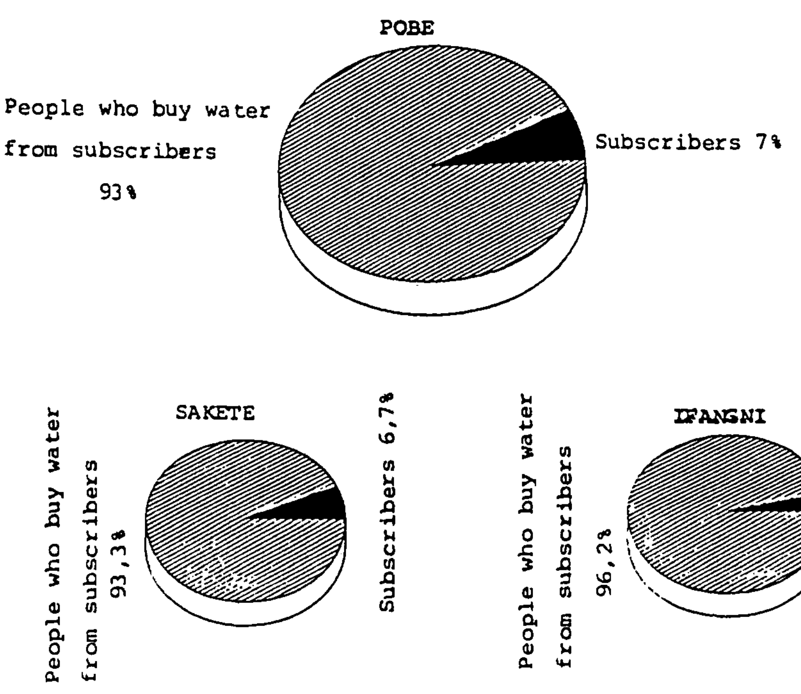
(ii) The rate of sanitary service has not increased. The rate of latrine is 5% instead of 10%

(iii) The subscribers number has not increased seriously. 7,1% in Pobè;. 6,7% in Sakété and 3,8% in Ifangni when it should increase at 80% (FIG n° 2)

(iiii) The rate of diseases is increasing since 1993 (FIG n° 3,4,5).

Overall, these results show the project has failed and the hydrous diseases are increasing. How the project failure can be explained?

Fig n°2 - <u>RATE OF SUBSCRIBTION TO WATER SUPPLY SERVICE</u>



III - THE ANALYSIS OF THE PROJECT FAILURE CAUSES

The project failure can be explained by many reasons, meanwhile it could succeed.

1 - The weakness of the project

There were many constraints to water promotion in Pobè-Sakété-Ifangni towns. These constraints should be minimized for giving chance of success to the project objectives, but they were neglected. These constraints are:

- The low income in comparison with the project requirement from the beneficiaries;
- The ethnic diversity
- The historical and the psychological rancour between collectivises and the administration related to their land expropriation procedure,
- The centralised administration system which makes the Government the only pioneer in financing and realization of projects.

The non integration of those constraints in the sensibilization campaign does not make easier the people participation. People agreement is not obtained. These are some deficiencies in the project conception, because people were not associated in its identification, its conception and its implementation, they do not seem to be concerned in the project activities. Well, if the priorities of the project were identified by people themselve, the constraints and the possible trumps would be detected.

2 - The principal trumps for the project success

There are in the region a lot of trumps which could contribute in the project success. That concerns the rich documentation existence a highly structured organization. In this purpose, the project was established on a most difficult socio-political context. In fact, as mentioned above, traditional structure exists in the region, which is ruled by the elders. This organization is the regulatory mechanism of water resources and environment management It has not be involved in the project activities. So, new knowledge related to environment protection introduced in the region is considered as opposite to former traditional established hierarchy.

FIG N°3 PARASITOSIS

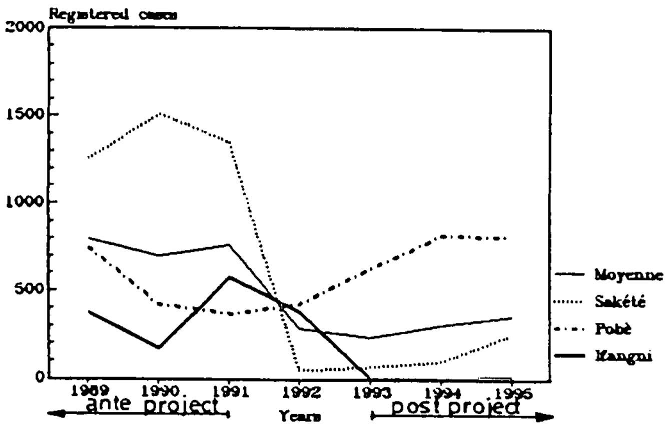


FIG N°4 DIARRHOEA

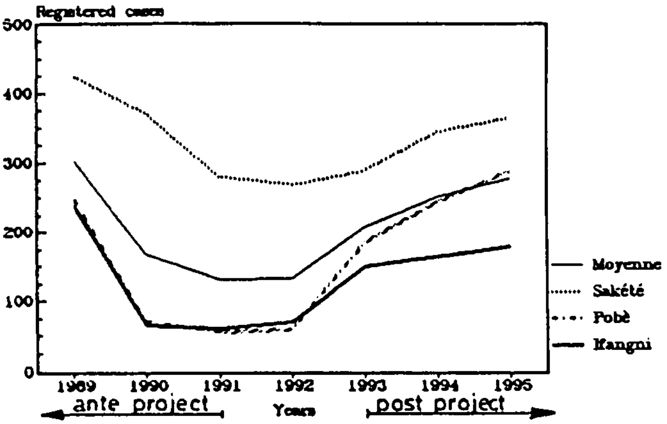
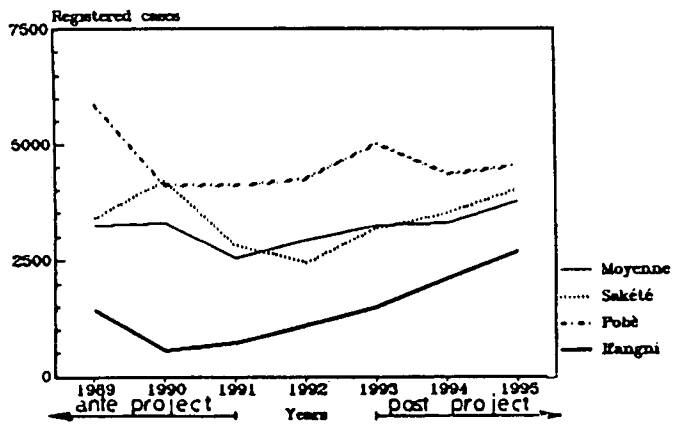


FIG N°5 MALARIA



CONCLUSION

The failure of the project is due to the methodology which was used and does not take into account the realities of the region. In fact, it was considered as a foreign initiative and people participation was not effective. Then, it is clear that a water promotion project does not depend not only on its justification but also on the social realities of the region, which are favourable to public participation as a vital at feature in water resources and environment protection.

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YOUNG SCIENTISTS RESPONSIBILITY IN THE FUTURE

As young scientists, water resources and the other natural resources management in a better way the future must be our most important challenge. Our present reflection efforts about natural resources must shose the future perspectives especially of water and environment management in the World. In water and environment resources management, there is no barrier between the different regions of the Earth. So die cause of Earth is that of all manking to great extent.

Many problems related to environment and water supply exist and will arise, which are not local but universal, and through which all countries are affected and in the resolution of which everybody is concerning. So we must be able to contribute anyway in finding solution.

Meanwhile, the situation is not same all over the World. The case of African countries, and especially Benin, is particularly serious. In this part of the Earth, young scientists must be particularly actives in contributing to improve the situation.

But for this purpose, they have to gain multidisciplinary skillers they cannot get in their home countries because there is no adequate capacity building opportunities.

In that way, I would want to appeal to the general meeting to supply young scientists of Africa with such opportunities to again experience in water and environment issues in order to give them the possibility to play their future role - to really be the 'Advocates for Future.' For they constitute the future generations.

KOUASSI SEBASTIEN DOIIOU

WORKSHOP 7:

GREENING OF INDUSTRY: CURBING OUTFLOW OF INDUSTRIAL POLLUTANTS

Mr Jim Oatridge, USA (Chairman)
Mrs Ulla-Britt Fallenius, Sweden (Rapporteur)

Many industries constitute pollution hot spots in the drainage basin or on the coast of enclosed coastal seas. There is currently a move towards integrated and preventive management practices and away from "end-of-pipe" solutions. Many companies now use competitive advantage in many ways, including integration of environmental protection into strategic planning, such as life-cycle analyses in product development, the use of clean process technology and waste minimization and control of emissions from waste.

It was confirmed from the workshop presentations and discussions that industries are now more aware of their responsibilities concerning environmental issues and the roles that business play in society. Some of the presentations and the discussions confirmed that the use of cleaner technology pays back rather quickly both from economical and environmental point of view.

To be successful it was agreed that there is a need to be creative in development of partnerships between government (local and national), the business community and the universities. International co-operation will be even more important.

Leaderships and incentives

In terms of conclusions, five points were named:

- In many cases technical solutions already exist. There needs to be a greater incentive to take up new or improved technics.
- Environmental and business leadership is crucial and leads to business opportunities and competitive advantage.
- Governments have an important role in establishing a regulatory framework with targets to be achieved, timetables, enforcement and evaluation.
- Measurements is essential (what you don't measure you don't manage).
- More compliance does not guarantee a license to operate. Business has to operate as part of society.

THE BALTIC SEA 2008

Curt Nicolin, Econ. Jur. and Techn. Dr h.c., Box 7373, S-103 91 Stockholm, Sweden

Since the environment conference in Rio the world population has increased by 450 million people and the environmental situation as a whole has not improved. I think it is fair to say that the population growth and the threat of negative environmental development are the two major problems of humanity. The living standard we enjoy in today's industrialized world is basically the result of market economy. Unfortunately, many countries, among them Europe, have not fully adhered to the principles of market economy. Market economy has effects which are generally not observed, e.g. when market economy is introduced in developing countries the economy grows and that promotes a lower birth rate. I have studied a number of developing countries which have transferred into market economy. I found that all of them had got increased growth. When it comes to 3 % or more the net reproduction rate goes down in all countries I have studied. Let me take just one example. The Thai economy during the period 1963-1987 had an average growth of roughly 5 % and the net reproduction rate fell from roughly 2.49 to roughly 1.15. In 1963 the average number of children per woman was very close to 5 and in 1987 it was only 2.3. Just imagine the difference between 5 children per woman and 2.3. In all likelihood Thailand in a few more years comes down to only 2 children per woman which we have in most industrialized countries. There is of course another effect and that is that average age grows. The average time of life is in many of the industrialized countries 80 years and in some of the poorest about 40 years of age. This secondary effect is not as strong as the first one. To master a positive environmental development you must use economic resources. It goes hand in hand with development of market economy. Should not the support given to developing countries by the industrialized world take the form to help them introduce market economy and to help them start schools. With time they will learn to achieve industrial cooperation with the developed world. In many countries the government gives contributions to children. Is it not likely to promote population growth ? Should we not try to find other ways to solve economic problems and avoid the potential growth effect on the population. The highest spread of income between rich and poor is in the poorest countries. You can also observe in the other end of income that among the OECD countries the US has the lowest spread between rich and poor measured with income of the 20 % with highest income earnings and the income of the 20 % with the lowest income earners.

In later years market economy has to a certain extent lost its positive reputation. Market economy is based on economic freedom which has to be protected by institutions and laws. As a matter of fact market economy can be said to be the economy of economic freedom. Why should we not call it Economy of Freedom that could give an input to improve the reputation as one of the greatest assets that humanity possess. The solutions of problems that economy of freedom brings is much superior to solutions by force. Obviously, the business sector has a lot to contribute.

The Baltic Sea is something between a lake and a sea and has brackish water. It is surrounded by quite a number of nations. The water quality has deteriorated for a long time and particularly after the 1940s. Helcom in Finland has a task given by the nations around the sea to look into the water quality situation in the Baltic Sea.

Inside the Swedish ICC I have initiated a program for improvement of the water quality in the Baltic Sea. The Board of ICC in Paris has later very positively accepted that all the National Committees around the Baltic Sea participate in this program. Some researchers have analyzed the situation and possible actions. The findings were that it deteriorated rather slowly until the 1940s and thereafter very much faster. Further, they found that the limited efforts that have been made locally to improve the situation have proven to be successful. That has encouraged us to set targets that the water quality of the Baltic Sea year 2008 should be roughly of the same quality as in the 1940s. The preparatory work is going on and is planned to be finished by year 1998. The whole program should meet the target by year 2008. The judgment is based on the experience to reduce lead time to fractions of what is "normal".

Interest on work in process rises very fast with time. I found some years ago that a project with a lead time of 10 years can expect to get interest cost equal to the cost of building the project. This is of course "a rule of thumb" but I believe it to be a useful indication.

The pollution of the Baltic Sea has many sources and are of different types. Release of waste water is a very important part. It is also fair to say that a lot has been done on this source and is being continued. From farming we get the highest release of nitrogen. There is a process of treating household waste developed in America. The household waste is mixed with slam from sewage water purification plants and is thereafter fermented. A Swedish entrepreneur has bought a license from America and have added a process to produce pellets. The intention is to use it as manure. This has been tried in forests for some years with promising results. Apart from being a source of fertilizers it contributes to humus. It is important as our farm land is gradually losing humus. This is an example of a re-cycling that will also affect the Baltic Sea water positively.

Another serious source is exhaust gases from automobiles. The coal mines in Poland pump a lot of water in the Baltic Sea. This water contains about 10 % salt of various types, among them heavy metals.

We find in deep water in many parts of the Baltic Sea that a few meters below the surface there is hydrogen sulfide. In such water neither vegetables nor animals can live. The reason is lack of oxygen in that type of water. We know that the Baltic Sea now and then has inflow of water from the Atlantic. Temporarily that improves the situation but still it offers problems.

Another source is oil released from tankers and of course many other sources of pollution.The various problems have to be tackled on their own merits.

Long before "The Baltic Sea 2008" was discussed and defined there have been initiatives taken to improve the environment of the Baltic Sea area, e.g. by our Prime Minister Mr. Göran Persson, but these initiatives were not concentrated on the quality of the Baltic Sea water in defined and measurable targets.

”The Baltic Sea 2008” has established a valuable cooperation with Helcom.

The financing of this project is of course a crucial task. The basic proposal is, that every country contributes corresponding to the size of its population. This is, however, not very likely. Therefore I think that the western countries around the Baltic Sea have to contribute more in relative terms.

To lessen the burden we further propose, that the eastern countries should give support by increased imports from the western countries.

The extra export from the western countries should be corresponding to the contribution they give to the eastern countries.

The scheme is of course highly dependent on good collaboration between the governments and the private business in the Baltic Sea countries.

We also propose, that we should establish local groups of one eastern and one western country, who will work together. The idea of pairing countries is to simplify administration.

This cannot exclude a united body for the whole program. It is preferable, that such a regional committee representing politicians and industry in all countries should be established. It is not enough to have a finishing date, year 2008, but there must be a number of partial targets. The working groups shall regularly report to the regional group. It is important, that we all the time can follow the development and make necessary corrections in the work. The suggested program for the Baltic Sea water is of course highly involved in the bigger program for the Baltic Sea area.

In business we have a saying that what is measured will be improved and what is not measured falters. Another conviction is that a target must be specified in measurable figures and the finishing date of completion be specified. Otherwise it is no target.

All the nations around the Baltic Sea have good arguments to restore Market Economy or establish it. Or even better: to establish the Economy of Freedom as I first described. Such a project would have extremely positive aspects in many directions. Let me point out that it would greatly support the financing of ”The Baltic Sea 2008”.

Let me end by stressing our ambitions to be so successful that we become an example in many areas of the world.

COLLABORATION BETWEEN INDUSTRY, UNIVERSITY AND GOVERNMENT AS A KEY STRATEGY IN ACHIEVING CLEANER PRODUCTION: CASE STUDY OF MAURITIUS

Dr Toolseeram RAMJEAWON, Senior Lecturer, Department of Civil Engineering, University of Mauritius, Reduit, Mauritius

The societal shift to Cleaner Production (CP) requires the active involvement of government, industry and research and educational institutions. CP cannot be achieved by one group alone - partnership between these three groups not always used to working together is required. Partnership enables a greater mobilization of skills and resources, allows problems to be addressed in a more integrated way and avoids unnecessary duplication of effort and cost. It also help traditional adversaries to broaden their perspectives, facilitates the flow of information and improve mutual understanding. A strong partnership between government, industry and the scientific community is the foundation on which CP will need to be built.

Table 1 summarizes the more relevant problems regarding these three actors that play an important role in CP promotion. Government has a strategic role to play in, providing the necessary framework and stimulating industry demand for CP. Appropriate legislation, effective enforcement, economic incentives, voluntary agreements, demonstration projects and information and promotion programmes provide a variety of policy instruments which government can implement. Education and training activities are crucial for the promotion of CP and different strategies can be used to integrate this concept in university curricula; from single lectures in existing environmental course modules to development of new postgraduate programmes. Students and university staff can gain practical experience by assisting industry in CP activities. Training should produce innovators and to make this link involves integrating personnel from both the company and research institutions into relevant R & D activities. During the synthesis phase of an environmental auditing exercise, the ideas for CP options may come from literature search, from personal knowledge, from example in other companies, from specialised data bases or from some further R & D. A creative intellectual environment based on the widest possible experience is thus needed in order to think of all possibilities.

Demonstration projects are an important vehicle for education and training involving participation at all levels within a company and of academics from research and educational institutions. The attraction for industry for a better university/industry interaction is that it benefits from a relatively unbiased advice and a cheap research facility with no ongoing personnel costs.

While it is industry that ultimately must implement CP, the role of government and university is to provide an environment that will accelerate the process and encourage industry to initiate its own CP programme. Attention should be directed at the following three issues:

Table 1 : Problems of University, Industry and Government in the promotion of Cleaner Production (CP)

Industry	Government	University/Research Institutions
Lack of a "Waste Management Culture", leading to the mix of wastes at the source	Lack of clear and continuous policies to support CP	Slowly updated and rigid educational technological programmes that do not reflect the actual needs of the industries and countries in the region
Lack of trust in government authorities and ignorance of existing environmental regulations	Incomplete regulatory framework and uneven enforcement	Poor mechanisms to facilitate the establishment of links with industries to support technology innovation
Lack of support by industry managers for the implementation of environmental management policies because the cost of pollution control has not been included in their production costs	Inappropriate standards - copied from industrialized countries	Lack of a "language" to communicate with both industry and government
Great differences in the capacity to deal with pollution prevention and control between large industries and SME's	Inefficient coordination among different agencies at different levels	Slow response to the demands of the industries and in the delivery of results of their studies and projects
Poor environmental awareness among workers and managers	Lack of economic incentives by government to foster technological change	Promotion criteria and research funding are less based on the practical applicability of the research and in the bridging efforts between disciplines and between university and society
Consultant firms use a "technology colonization" approach based on the import of foreign technologies	Inadequate mechanisms of communication with the industrial sector	
	Government-state owned industries have generally a poor environmental performance	
	Lack of trust in industries	
	Lack of human resources and infrastructure to support CP programmes and to enforce regulations	
	Lack of an education policy concerning environmental education throughout the educational programmes	

(a) providing information about the technology involved and the environmental tools industry needs to make CP assessment of its activities and products.
(b) organizing training on CP specially for SMEs
(c) helping to change educational curricula, in order to integrate the environmental dimension in all engineering and business management courses. CP promotion requires the reinforcement of CP curriculum in university engineering education. Most curricula at the university level include the study of environmental engineering topics as part of the civil engineering course. However, the principal developers and deployers of CP technology in industry are chemical and mechanical engineers and these people should therefore be well prepared for this task through university programs that include CP curriculum.

In its present state of development when Mauritius is poised to diversify its economy and stands at the threshold of the phase of rapid industrialisation, one of the challenges it faces is that of introducing the CP concept in industry. This paper presents the types of collaboration which have been initiated between industry, university and the authorities. There are growing signs of interest in research in private firms. But the major thrust for the future lies in a more productive role for the government in inspiring new R & D initiatives and endeavours. The government has recently set up a research council whose primary objective is to foster and co-ordinate R & D policies on a national basis. Environment-related projects account for nearly 35% of the council's R & D funding and 75% of its funding goes to the university. The teaching company scheme has been initiated, in which the university and a company participate jointly in an industrial project funded partly by the research council. This scheme operates mostly at the postgraduate level and the research council mainly gives a research grant to the student while other expenses are met by the industry and the university.

Training workshops on CP are run by the university in collaboration with private sector organizations. Modules which have been developed use interactive teaching methodologies such as case studies, simulation exercises, problem solving and group exercises. This educational approach is based on the understanding that people learn more fully by doing than by listening passively.

A short term goal in the promotion of CP is to set up one effective cleaner production demonstration project that will launch a snowball effect throughout the industrial sector, and which will eventually spread to other industries. Two such demonstration projects, funded by the industries and the authorities have been set up in a cane-sugar factory and a textile dyeing factory by academic staff. These demonstration projects are useful in revealing obstacles to progress both within the companies and in the relationship of companies to the outside world. The aim of such demonstration projects is also to enhance the institutional and research capacities for cleaner production within industry, government and academia.

WORKSHOP 8:

NON-POINT POLLUTION: CURBING OUTFLOW OF AGRICULTURAL POLLUTANTS AS GLOBAL FOOD NEEDS RISE

Professor Curt Forsberg, Sweden, (Chairman)
Mr Gunnar Persson, Sweden, (Rapporteur)

The aim of this workshop was to discuss how to reduce the flux of waterpolluting elements and compounds from farmers land, and deposits of urban sludge, waste and ash to the coastal waters.

Introductionary, the chairman called attention to the scale of the problem to reduce the flux of nutrients from land to water.

In spite of the use of different policy, regulatory and economic instruments, it seems to be very difficult to stop large scale losses of nutrients. The primary driving force for the increasing nutrient load on fresh and marine waters is the growing world population, projected to double from now roughly 6 billion to more than 12 billion within the next 50 years. In order to feed a growing population, there is a need of an increased production of vegetative and animal food. For this purpose more fertilizers and more water for irrigation will be consumed. Based on exsisting agricultural practise an increasing food production will be difficult to manage without substantial losses of nutrients to the waters, especially in the absence of effective nutrient recycling systems.
A growing world population will also produce increasing volumes of organic wastes, sewage, sludge and ashes and increasing emissions of N by combustion of N-containing fuels. Both point and non-point source pollution will increase. The degree of urbanization is predicted to increase, which means that more sewage will be channelled to the waters. It also makes recycling of nutrients from town to farmers land more difficult. In addition, there seems to be an over-consumption in many countries of N (in animal protein) and P (as food additives), which strengthen the losses of these nutrients.
An increasing world population will probably give rise to increasing emissions of N to the atmosphere as N-oxides from the transport sector, and ammonia coming cheifly from agriculture livestock farming and storage and use of manure. It will be an enormous challenge to reduce the flux of nutrients from land to coastal waters. It will also take time as the alternatives are not yet very clear. There is a number of barriers to overcome, but also a lot of space for new policies and innovations.

In the introductionary invited paper it was reported that developing countries often have little control over municipal and industrial effluents, and that their water quality programs usually are not capable to discriminate between different types of pollution sources. For agriculture serious widespread degradation of water resources may go unrecognized, e.g., nitrate pollution of groundwater and downstream pollution from animal raising.
The following major issues were addressed: 1. Integrated basin management needed for rational allocation of water distribution and pollution control. 2. Improvement of databases needed for management decisions. 3. Improvement of the control of sediment

(erosion), fertilizers and pesticides. 4. New solutions for agricultural decision-making is possible by using new advances in monitoring and information technology.

The 10 papers presented covered control aspects of specific polluted water areas, as well as more principal discussions on how to curb the outflow of agricultural pollutants. Case studies from Lake Victoria, Maryland's Chesapeake Bay basin, and the Porijogi River catchment in Estonia were presented, together with more principal studies based on experience from India, Lithuania, Poland and Sweden.

Water quality in lake Victoria has declined in the past few decades, due to eutrophication arising from increased inflow of nutrients, coming largely from upstream situated agriculture areas. The rate of eutrophication is reflected by the rate at which the water hyacinth is becoming abundant in the lake. A number of control measures was discussed, which in principle was the same as those discussed in other presentations. These measures are summarized below.

Successful reduction of N losses was reported from the voluntary Maryland Nutrient Management Program (Chesapeake bay), by introducing nutrient management plans, documents which incorporate soil test results, yield goals and estimates of residual N to generate field-by-field nutrient recommendations. Particularly successful elements of this program are a nitrate test for corn and services for manure testing and spreader calibration.
Another case study from this area demonstrated that watersheds with shallow aquifers and well-drained soils enhanced efficient transport of N leached from cropland to riparian vegetation. Riparian forest acted as a nutrient source for stream P, probably due to P mobilization under low redox conditions. These losses of nutrients, which at least in part could be coupled to soil texture, may be difficult to control.
The case study from Estonia demonstrated a substantial catchment decrease in losses of inorganic N, from 15.6 to 2.7 kg ha-'yr-1. The reason to this was an increase in fallow and abandoned lands and a decrease in arable lands. Intensive climatic fluctuations coincided with the changes in land use, with decrease both in mean seasonal and annual runoff.

A contribution from a Swedish fertilizer industry presented promising goals for their activities, e.g., there should be no direct outflow of nutrients from fertilizers, the input should be in relation to the requirements of the system, and agricultural management should minimize nutrient losses to the environment. Development of recycling along two lines was discussed.

A study from India presented a system for echo-farming aiming at among other things recycle organic residues in an energy efficient way. It was concluded that this type of farming is highly knowledge intensive, labouroriented and complex. A high degree of motivation is needed for managing this systems.
A Polish paper demonstrated the need of wastewater management in rural Poland, where only 4yo of all farms are served by wastewater treatment systems. A survey of sediment deposition in a flooded delta of a river in Lithuania was presented together with models of the processes.

A summary of a Swedish presentation on a catchment-oriented and cost-effective policy for water protection, complemented with proposals from the other papers, may reflect the control measures discussed, namely:

1. Watershed management requires development and utilization of relevant watershed databases concerning governing factors for nutrient losses.
2. There is a need for echotechnological measures, e.g., restoration of ponds and wetlands in order to increase removal of nutrients during runoff.
3. Environmental programs for good and sustainable farming and water quality should be developed. For water quality purposes the plan must include proposals to:
   - avoid overdoses of fertilizers
   - improve manure management
   - increase cultivation of winter crops, especially catch crops
   - reduce erosion losses by leaving uncultivated buffertzones of land alongside the watercourses
   - use contour cropping
   - reduce soil tillage in autumn
   - increase nutrient retention in ponds and wetlands
   - ban reclamation of wetlands for agriculture
   - ban use of phosphate based detergents

No new methods or systems for optimization of the recycling of N and P were presented.

MANAGING WATER POLLUTION FROM AGRICULTURE IN A WATER SCARCE FUTURE

Edwin D. Ongley, Director, GEMS/Water Collaborating Centre, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6, Canada.
Arumugam Kandiah, Senior Officer, Land and Water Development Division, Agriculture Division, Food & Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100 Rome, Italy.

INTRODUCTION

Freshwater is a finite and essential resource; it exercises a pervasive influence in all sectors of all societies, but most visibly in public health, food security, in economic and social development, and in environmental health. Nevertheless, experts predict a global crisis in much of the developing world early in the 21st Century (United Nations, 1997) because of water scarcity and by loss of beneficial use from gross pollution in large parts of the world. The implications for agriculture of a global freshwater crisis are especially serious. There are many who believe that food security will become the principal driver of national water programs in the next century.

The food security debate is largely driven by the need to meet population growth (some 90 million new consumers per annum), and changing dietary habits, especially in Asia, that is increasing the demand for grain disproportionately to population growth. However, there are two contrasting views of the food security issue. One, supported by the FAO, is that food security will be achieved by a (global) annual and achievable growth rate of some 1.8% (Alexandratos, 1995) through modest increases in irrigation and dryland agriculture and in further intensification of production. The opposite view, held by the Worldwatch Institute (Brown, 1996), is that the world has crossed a unique threshold in which the reasons for the immense increases in agricultural productivity in the present century no longer apply. Suddenly, agricultural expansion is now limited by lack of new land (in some countries a decrease in arable land due to urban and related pressures), lack of new sources of water and increasing competition from other economic sectors for the resource, decreasing effectiveness of fertilizer to further increase yields, and vagaries of climate change.

Which ever view prevails is not especially relevant to this paper. What is important, however, is that food security will lead to: (1) searches for ways to intensify production both of rainfed and irrigation agriculture, and of aquaculture; (2) further expansion of rainfed agriculture into marginal lands that are highly susceptible to erosion; and (3) intensification of livestock raising, especially in Asia, to meet increasing demand for protein. The result will certainly be an increasing likelihood of surface and ground water pollution from these agricultural activities.

WATER SCARCITY - SETTING THE STAGE

United Nations (1997) predictions of global population increase to the year 2025 require an expansion of food production of about 40-45%. Irrigation agriculture, which currently comprises 17% of all cultivated agricultural land yet produces nearly 40% of the world's food will be an essential component of any strategy to increase the global food supply. Currently 75% of irrigated land is located in developing countries; by the year 2000 it is estimated that 90% will be in developing countries.

A dilemma for agriculture will be that food security will place greater demands on irrigation precisely at a time when water scarcity will decrease the availability of water for agriculture. However, projections of water requirements to meet food security to 2025 range from a 50-100% increase over current levels of water use. United Nations notes that projections to 2025 would require virtually all economically accessible water in the world to meet agricultural, industrial and household needs. Such a scenario is, of course, impossible because of the inability to move available water to locations of demand (across continents) and because such projections assume efficient policy and administrative processes that optimize water use at national levels. Clearly, the allocation of water resources (including groundwater) will become a major issue for agriculture, especially as national governments attempt to balance economic growth with food security concerns.

WATER QUALITY FROM AN AGRICULTURAL PERSPECTIVE

Agriculture, as the single largest user of freshwater on a global basis -- some 70% of the total available supply of freshwater, and as a significant cause of degradation of surface and groundwater resources through erosion and chemical runoff, has cause to be concerned about the global implications of water quality. The associated agrofood-processing industry is also a significant source of organic pollution in most countries. Aquaculture is now recognised as a potentially major problem in many freshwater, estuarine and coastal environments, leading to eutrophication and ecosystem damage.

Relatively few countries attempt, or are able, to assess the relative role of agriculture in national water pollution inventories. In part this reflects the absence of relevant data, as noted below. In developed countries where there has been major emphasis on point source control the relative importance of agriculture in water pollution is high. In the United States fully 72 % of assessed river length and 56% of assessed lakes are impacted by agriculture. These finding caused the US-EPA (1994) to declare that agriculture is the leading source of impairment in the Nation's rivers and lakes. Agriculture is also cited as a leading cause of groundwater pollution in the United States.

Since the 1970's there has also been growing concern Europe over the increases in nitrogen, phosphorus and pesticide residues in surface and groundwater. Intense cultivation and "factory" livestock operations led to the conclusion that agriculture is a significant nonpoint source contributor to surface and groundwater pollution (Ignazi, 1993). The EEC has responded with a Directive (91/676/EEC) on "Protection of waters against pollution by nitrates from agricultural sources".

Data on water pollution from agriculture in developing countries are limited. However, according to various surveys in India and Africa, 20-50% of groundwater wells contain nitrate levels greater than 50 mg/l and in some cases as high as several hundred milligrams per litre (Convey and Pretty, 1988). In the developing countries, it is usually wells in villages or close to towns that contain the highest levels, suggesting that domestic excreta are the main source, though livestock wastes are particularly important in semi-arid areas where drinking water troughs are close to wells.

Role of Agriculture in Erosion/Sedimentation
Amongst the range of anthropogenic activities, agriculture is one of the major producers of sediment. Unlike other major contributors of sediment such as construction activities that are usually intense but short-term in duration, sediment loss from agricultural surfaces is long-term and widespread. Pollution by sediment has two major dimensions (Ongley, 1996).

1. One is a ***Physical Dimension*** -- top soil loss and land degradation by gullying and sheet erosion and which leads both to excessive levels of turbidity in receiving waters, and to off-site ecological and physical impacts from deposition in river and lake beds.

2. The second is a ***Chemical Dimension*** -- the silt and clay fraction (<63 m fraction), is a primary carrier of adsorbed chemicals, especially phosphorus, chlorinated pesticides and most metals, which are transported by sediment into the aquatic system.

Role of Agriculture in Eutrophication
In their summary of water quality impacts of fertilizers, FAO/ECE (1991) found that fertilization of surface waters (eutrophication) results in explosive growth of algae which causes disruptive changes to the biological equilibrium [including fish kills]. Also, groundwater is being polluted mainly by nitrates and, in several areas, is polluted to an extent that it is no longer fit to be used as drinking water according to present standards. While these problems were primarily attributed to mineral fertilizers, in some areas the problem is particularly associated with extensive and intensive application of organic fertilizers (manure). Manure produced by cattle, pigs and poultry are used as organic fertilizer the world over. To this is added human excreta, especially in some Asian countries where animal and human excreta are traditionally used in fish culture as well as on soils. Although national data are not available on this issue from Asia-Pacific, the extensive use and disposal of human and animal excreta on agricultural land may pose a significant water quality problem for downstream users in some countries (ESCAP, 1997).

Role of Agriculture in Pesticide Contamination

Agricultural use of pesticides is a subset of the larger spectrum of industrial chemicals used in modern society. Because the environmental burden of toxic chemicals includes both agriculture and non-agricultural compounds, it is difficult to separate the ecological and human health effects of pesticides from those of industrial compounds that are intentionally or accidentally released into the environment. Although pesticide use is low to nil in traditional and subsistence farming in Africa and parts of Asia pesticide consumption has strongly increased in intensive farming systems, notably in irrigated agriculture in many developing countries. In India, consumption increased nearly 50-fold between 1958 and 1975, yet Indian consumption in 1973-74 was reported to be averaging a mere 330 g/ha, compared to 1483 g in USA and 1870 g in Europe (Avcievala, 1991). Nevertheless, the excessive and inappropriate use, inappropriate storage including leakage and intentional dumping especially in developing countries, have well documented environmental, public health, and water quality impacts (summarized in Ongley, 1996).

Irrigation Impacts on Surface Water Quality

In addition to problems of waterlogging, desertification, salinization, erosion, etc., that affect irrigated areas, the problem of downstream degradation of water quality by salts, agrochemicals and toxic leachates is likely to increase with intensification of agriculture. Irrigation agriculture, especially in tropical and subtropical environments, usually requires modification of the hydrological regime which, in turn, creates habitat that is conducive to breeding of insects such as mosquitoes which are responsible for a variety of vector-borne diseases. In addition to pesticides used in the normal course of irrigated agriculture, control of vector-borne diseases may require additional application of insecticides such as DDT which have serious and widespread ecological consequences (Ongley, 1996).

RECOMMENDATIONS FOR MANAGING WATER POLLUTION FROM AGRICULTURE IN THE FUTURE

In a water-scarce future it is agriculture that will suffer from the increasing competition for available water resources. Although it is not yet clear whether food security concerns will, in fact, cause governments to expand agricultural lands and especially irrigated lands, food security will certainly lead to some very "hard" choices for governments. Whether or not there is geographical expansion, there will inevitably be a push towards much greater efficiency in agriculture and, where possible, increased yields from existing agriculture. From a pollution perspective, the shift in dietary habit, especially in Asia, is cause for concern. Increasing consumption of protein is raising the demand for greater livestock, poultry and fish products. This has three dimensions for water pollution: (1) increased demand for grain for feed which will have traditional impacts in terms of sediment/fertilizer/pesticide runoff, etc.., (2) intensification of poultry, livestock and aquaculture operations with concomitant larger amounts of wastes that are likely to increase organic and microbiological pollution of surface and groundwater; and (3) wastes from a growing food processing industry including slaughter-houses that will expand to meet consumer demand for larger amounts of protein.

Managing water pollution from agriculture in the future has technical, institutional, policy, and legal dimensions which are too complex for detailed analysis here. We emphasis here, therefore, several important issues that will be essential not only for managing water pollution from an agricultural context, but also for placing the pollution potential of agriculture into the larger pollution remediation context.

1. The Data Crisis

The deteriorating present condition of freshwater quality and the dire projections of the quality of the resource to 2025 tend to be based on informed opinion and on effluent forecasts rather than on the capability of carrying out a detailed assessment from current water quality data. This largely reflects a profound data crisis, that is, the lack of reliable water quality and quantity data for large parts of the world. The data crisis has been noted by the United Nations (1997) in their comprehensive water resources assessment and also by UNIDO (1996) in their attempt to forecast pollution factors.

The data problem was summarized by Ongley (1994) at the 1993 Stockholm Water Symposium as: "... a common observation amongst water quality professionals is that many water quality programs, especially in developing countries, collect the wrong parameters, from the wrong places, using the wrong substrates and at inappropriate sampling frequencies, and produce data that are often quite unreliable; the data are not assessed or evaluated, and are not sufficiently connected to realistic and meaningful program, legal or management objectives. This is not the fault of developing countries; more often it results from inappropriate technology transfer and an assumption by recipients and donors that the data paradigm developed by developed countries is appropriate in developing countries."

In addition to an inappropriate data paradigm in developing countries, there are economic and institutional reasons for the data crisis. Economic recession has shrunk or terminated hydrometric and water quality data programs in many countries. In others, especially in rapidly developing countries, the infrastructure and technology required to produce reliable data is lacking. The data crisis is being flagged in several fora as a national catastrophe at a time when countries need reliable information upon which to make cost-effective investment decisions on remediation and development. The data crisis will become even more critical as nations attempt to cope with increasingly difficult water allocation decisions (including the need for waste assimilation) as competing demands outstrip the available resource.

The role of agriculture in surface and groundwater water pollution, especially in developed countries where point sources have been the target of pollution control measures for many years, can be substantial and is well documented. However in developing countries which characteristically have little control over municipal and industrial effluents, and have water quality data programs that usually are not capable of discriminating between different types of sources, the relative role of agriculture in national water pollution inventories is not known. In a water-scarce future, the ability to make informed choices of agricultural development options, for predicting the outcomes of those options, and for minimizing water quality impacts with the most cost-efficient controls and trade-offs with other economic sectors, requires a national agricultural policy that is firmly based on reliable water quality and quantity data, and the ability to deploy these data to make accurate projections of on-site and off-site pollution management costs versus cost of loss of beneficial use down-stream. Modernization of water quality data programs to meet these information requirements are discussed in Ongley (1997).

The impact of the data crisis on agriculture and on national pollution abatement planning and investment programs can be summarize as:

1. Serious widespread degradation of water resources that can be primarily attributed to agriculture, as in nitrate pollution of groundwater, may go unrecognized;

2. Spatially limited downstream pollution from small-scale agricultural practices such as animal-raising are not recognized yet may have severe public health consequences;

3. The presumption of widespread pollution from agricultural practices may not be warranted relative to other contributors of nutrients, sediment, and toxic substances;

4. Prediction of downstream pollution for new agricultural development schemes (e.g. irrigation expansion) is not possible, and

5. Investment decision-making for point or nonpoint pollution control is unable to assess the cost-benefit of different pollution abatement options.

2. Comprehensive Basin Management

Much has been written on the subject of comprehensive (integrated) river basin management. Essentially, it implies that planning, development and management of human activities within river systems can only be cost-effectively addressed within an holistic framework. In many countries the river basin authority has been adopted as the management framework, however in many cases these are primarily established for hydraulic regulation and flood control rather than for more comprehensive regulation of water intakes and discharges and the control of point and nonpoint source pollution. Especially in developing countries where social values are not based on market principles, a holistic mechanism is essential to balance market economics where "money talks" but does not necessary "talk sense", with traditional social values.

3. Internalization of Costs

Although the control of sediment, nutrient and pesticide loadings from rain-fed and irrigation agriculture is a major factor in improving downstream water quality and associated ecological impacts, implementation of control measures will only be successful if the farmer can determine that it is in his economic interest to undertake such measures (Ongley, 1996). Therefore, the economic benefits such as maintenance of soil fertility, reduced energy consumption in minimum till situations, etc., relative to economic costs of excessive fertilizer and pesticide usage and loss of productivity by "mining" of soil capital, must be clearly demonstrated at the farm level. It must be seen to be in the farmer's interest to implement such measures if they are to be broadly successful in reducing off-site environmental damage .

4. Use of New Information Technologies (IT) for Decision-Making

Part of the historical problem of environmental management has been the difficulty to cost-effectively transfer knowledge and experience from developed to developing countries. In agriculture, as in other fields, innovative use of IT within decision-support applications has enormous potential to alleviate this situation. Published guidelines in fields such as wastewater use in agriculture, optimizing water use in irrigation, and scoping probable impacts of agricultural projects on water quality, to name but three examples, are seriously limited by: space and cost limitation of printed guidelines; cost of frequent up-dating and printing of guidelines; inability to incorporate the complexity of real-world situations into printed guidelines; and difficulty in circulating printed guidelines to potential users.

Guidelines represent, however, a knowledge base which can be incorporated into electronic IT products. The creation of electronic "Advisors" is relative inexpensive, can be easily up-dated, and is circulated via the Web or on diskette. The User is presented only with the information that applies to his particular situation. In assisting the User to reach a decision, the Advisor can be designed to so that the User is presented with options, and is informed of the degree of confidence placed on the identified options. Further discussion on this topic and examples for agriculture are found in Ongley (1996); Ongley and Kandiah (1997) describe a current FAO project in which an IT-based advisor is being designed to predict the potential for off-site water quality impacts of proposed agricultural development projects and to allow project proponents to game with alternative land and crop management scenarios.

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THE EFFECTS OF FOREST ON STREAM WATER QUALITY IN TWO COASTAL PLAIN WATERSHEDS OF THE CHESAPEAKE BAY

Mayers MG, Fisher TR, Horn Point Environmental Labs, University of Maryland-CEES, P. O. Box 775, Cambridge, Maryland 21613 USA,
email: mmnorton@wam.umd.edu, *fisher@hpel.cees.edu.*

Chesapeake Bay is the largest estuary in North America. Studies conducted since the 1970s indicate that increases in the intensity of agriculture, population growth, and sewage discharge are causing the Bay to become eutrophic. Agriculture, specifically commercial fertilizers, are identified as the primary nonpoint source of nitrogen (N) and phosphorus (P) to Chesapeake Bay and contribute ~40% of the total nutrient load. In an attempt to understand the role of forest in retention of agricultural nutrients, water quality studies were conducted in two adjacent watersheds dominated by agriculture.

Project Results

The Chester and Choptank Rivers drain small, coastal plain basins (128 and 206 x 10^3 km^2, respectively) into subestuaries of the Bay. Land cover in these basins is similar and dominated by cropland and forest (Table 1).

Table 1: Land cover in sub-basins of the Chester and Choptank selected for study.

Land Cover	Ave. Chester% (SD)	Ave. Choptank% (SD)
Cropland	65.3(13.4)	62.9(11.6)
Developed/Urban	1.9(1.7)	2.8(2.1)
Feedlots	0.5(0.6)	0.6(0.6)
Forest	31.9(13.3)	33.6(11.6)
Water	0.4(0.7)	<0.1(0.1)

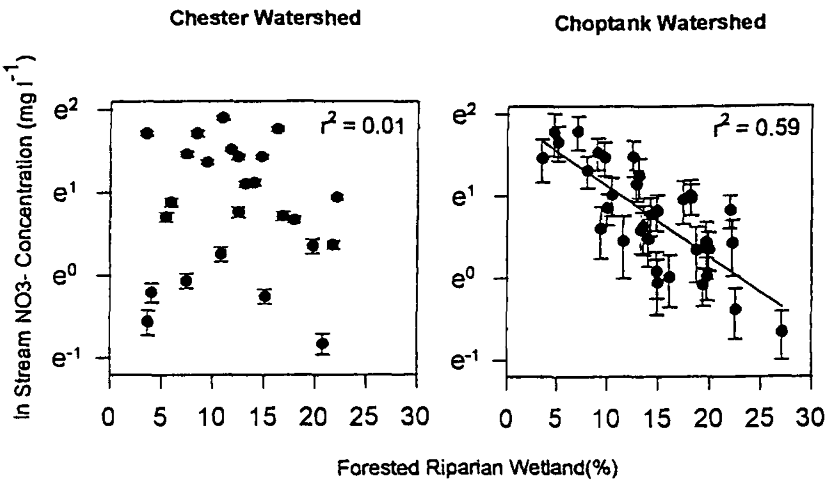
Although the Chester and Choptank streams were sampled during different years, precipitation and temperature averages closely approximated long-term averages. Sampling of streams in selected subwatersheds resulted in statistically similar TN and NO_3- concentrations, but TP concentrations were significantly higher in the Chester (Table 2).

The relationships between land cover and stream nutrients in the two watersheds were very different. Cropland and forest represent major nutrient sources and sinks, respectively, in the Choptank. Landscape position analysis revealed that cropland close to streams (100-300 m) explained ~64% of the stream N concentrations. Forest, particularly riparian wetland forest, exhibited strong inverse relationships with stream TN and NO_3- in the Choptank (Fig. 1).

Table 2: Average annual stream nutrient concentrations (mg l^{-1}).

Nutrient	Ave.Chester% (SD)	Ave.Choptank% (SD)	Sign. Diff
TN	3.686(1.745)	3.421(1.738)	NS, P>0.05
TP	0.099(0.055)	0.058(0.024)	S, P<0.05
NO_3^-	2.869(1.839)	2.521(1.516)	NS, P>0.05

Figure 1: Forested riparian wetlands and stream nitrate concentrations in sub-basins of the Chester and Choptank selected for study.



In addition, riparian forest, stream order location, and buffer width were found to be important characteristics influencing stream N concentrations. Forest was identified as both a TP source (0-100 m from streams) and sink (100-300 m from streams). While forest functions as an effective sediment trap, P sorbed to soil surface may be mobilized under low redox conditions, such as those close to streams. Forest has two basic functions in the Choptank watershed. Forested uplands represent areas where no fertilizer is applied, and riparian forested wetlands represent areas of potential denitrification.

Unlike the Choptank, land cover and stream nutrients in the Chester watershed exhibit few significant relationships. Riparian forested wetlands have no apparent effect on stream nutrients (Fig. 1), and riparian forest extent, stream order position, and width were also not significantly related to stream N and P. Only upland forest exhibited a significant negative correlation with stream TN and NO_3^-. Although total cropland was not significantly correlated with stream nutrients, cropland in close proximity to streams (100-300m) had a significant correlation with TN and NO_3^-. Clearly, nutrients originating from cropland in the Chester are interacting with some other landscape feature which results in differences between the way land cover affects water quality.

Additional watershed variables indicated significant differences in soil drainage (Table 3). The relative lack of well-drained soils in the Chester may cause an important difference in the path N and P take through the landscape. Average stream TP concentrations in the Chester are significantly higher than those in the Choptank although the two watersheds contain similar amounts of cropland. Steeper stream slopes (5.10 m km^{-1}) and smaller amounts of welldrained soil result in higher soil erosion and P mobilization potential in the Chester compared to the Choptank (3.26 m km^{-1}).

Table 3: Soil drainage characteristics in sub-basins of the Chester and Choptank selected for study.

Soil Drainage	Ave. Chester%(SD)	Ave.Choptank%(SD)
Well-drained	1.4 (1.6)	28.9(23.6)
Moderately well-drained	48.2(17.2)	18.2(9.3)
Poorly-drained	18.0(17.9)	17.4(7.18)
Very poorly-drained	32.4(19.3)	35.6(25.8)

Management Implications

Watersheds with shallow aquifers and well-drained soils enhance efficient transport of N leached from cropland to riparian vegetation. The Choptank watershed contains these physical features and riparian wetlands are associated with lower stream nitrogen (Fig. 1). However, riparian forest acts as a nutrient source for stream TP, probably by P mobilization under low redox conditions. Forest analyses support the placement of upland forests at field boundaries to prevent soil P deposition in riparian forests, in addition to contiguous riparian forest as potential denitrification sites.

Watersheds which lack well-drained soils do not efficiently transport N through their shallow aquifers. Nutrients originating from cropland may have a more indirect path though the landscape before being discharged into local streams, making N management more difficult. Poor drainage and steeper terrain result in higher potential for P transport, and placement of upland forest around agricultural areas may decrease P stream concentrations in the Chester.

WORKSHOP 10:

STRATEGIES AND INSTITUTIONAL ARRANGEMENTS FOR RESOLUTION OF STAKEHOLDER CONFLICTS IN DRAINAGE BASINS AND COASTAL SEAS

Professor Nobuo Kumamoto, Japan (Chairman)
Professor Peter Söderbaum, Sweden (Rapporteur)

Conclusions:

Conflicts related to water and land use often involve a conflict between various interests and stakeholders. One approach may be to initiate a dialogue and negotiation process between stakeholders to clarify possible valuational and ideological standpoints, alternatives of choice and expected impacts. Institutional arrangements such as systems of property rights (sometimes classified as private property, state property, common property and open access) are of importance for co-operation between stakeholders.

About 24 presentations were made in the workshop which makes it difficult to do justice to each one of them. It was also argued that each person will draw his/her particular conclusions from the workshop and that conclusions not shared by all may be as important as shared conclusions.

While sitting in one room, we were travelling around the world: different parts of the USA, Mexico, Japan, India, Thailand, the Black Sea, Danube and the Baltic with many countries involved. We believe that these places differ a bit and that sociocultural, physical-geographical conditions makes it difficult to find one set of recommendations for all parts of the world. There was, however, some degree on concensus on meaningful concepts and approaches.

As invited speaker Susan Hanna reframed the questions raised for the workshop about property rights a bit in the following way: Who is entitled to make decisions about natural resources? And her answer is that all stakeholders must be involved in the process. By comparing different watersheds with their institutional arrangements, something can be said about arrangements that have good chances of being successes or failures.

The idea of comparing property rights and institutional arrangements in different watersheds was also advocated in a contribution from India. But also other kinds of institutional arrangements were discussed, for instance the organization of a programme at the international level for the Danube basin (with Danube Watch as a newsletter) and the even more fundamental issue of the role of municipalities with respect to water issues in Russia.

Our discussion was not limited to property rights in some narrow sense. Thus the need for visions of a sustainable future society and for specific programme areas or projects was emphasized. Concepts such as 'sustainability' (Ludmila Zhukova) or 'collective ecological safety' which will contribute to the development of an international legal framework (Ludmila Romaniuk) can serve this function of keeping our visions alive.

Our young scientist from Poland pointed to the need for new thinking rather than studying that which already exists. Organizations and institutional arrangements which are innovative should also be considered. We should welcome new ideas at the local as well as the transnational level. As an example of the latter kind, the contribution about the Global Environmental Facility could perhaps be seen, especially its role as facilitator in relation to other organizations.

Some speakers saw a historical/evolutionary approach as meaningful in attempts to understand the present situation with respect to institutional framework and management/participatory system. The contribution by Hector Garduno, invited speaker from Mexico, can be seen in this light as well as a presentation about the coming into being of the Clean Air Act in the USA.

An 'ecosystem approach' focusing on watersheds or water basins was considered very useful provided that it is not limited to natural systems but also includes considerations of sociocultural factors and institutions. Interaction among scholars from various disciplines and transdisciplinary approaches were recommended. Focusing on actors and their attitudes and perceptions can add to our understanding of the present situation. Christine Bismuth from Germany presented interviews with various professional categories, NGO-representants and others about their perceptions and understanding of the sustainability concept in relation to water issues.

Interaction among, and involvement of various actor categories and stakeholders was a recurrent theme in many presentations. Citizens should participate, but also business corporations and farmers, for example. An example of stakeholder involvement was given in a Swiss presentation about the Great Lakes case (Gurtner-Zimmermann). As part of so called Remedial Action Planning 'public advisory committees' were used. In order to facilitate stakeholder involvement, presentation of information and access to information were seen as key factors. New technologies such as Internet will solve some part of these problems at least in some countries. More established technologies may also prove useful as in the example of a film from Japan about the Minamata disease that is mercury poising of fish with consequent serious health hazards for the human population.

Although education was the subject of a different workshop, we could not refrain from pointing to its importance also as part of stakeholder involvement. Learning or Human Resource Development is necessary for all professional categories and not only for citizens. Scientists are not excluded from this imperative. Connected with learning as a process is lifestyle changes which were emphasized in a contribution from Japan (Satoru Fujii, Osaka City).

Our chairman pointed to the need to clarify the concept of stakeholder, which is often used as a matter of standing to sue at court. We agreed that there is a legal definition which may change over time and which identifies those who can refer to a 'substantial involvement' and have a legal right to influence a case. According to a broader definition, stakeholder refers to interested party, that is a person or organization who is affected and in that sense has something 'at stake' in relation to a specific activity or issue. In the broadest possible sense, a person may argue that he or she is concerned about an issue in some other part of the country or the world. Participation in a conference such as Stockholm Water Symposium has increased our understanding not only of things which happen in our neighbourhood but also about activities and environmental issues in other parts of the world. And as we all know, these processes at different places interact in various ways.

One essential policy aspect for resolution of stakeholder conflict, according to our chairman, is that in addition to the original assessment of the impacts of a project or plan a reassessment takes place after a certain period of time in order to re-evaluate impacts on the environment and oil related interests.

Another part of our discussion had to do with economics. This subject was discussed in very practical terms, that is financial incentives for those who use water or pollute waters, but also in theoretical terms. Colin Green asked if Blue whales are comparable to large cups of coffee and thereby challenged neo-classical theory according to which all kinds of 'commodities' could be traded against each other in monetary terms. He suggested that the now dominant neo-classical economics is part of the problems that we face and that some new thinking is needed in economics. Although this judgement is shared by the present rapporteur, it may not be shared by all participants in the workshop. But again, an argument that is not shared by all may therefore not necessarily be less important.

As conclusion, our chairman argued that strategies and institutional arrangements for resolution of stakeholder conflicts in drainage basins and coastal seas can only be arranged with broader considerations of elements related to stakeholder interests and through a reasonably fair compromise within the scope of relevant law principles.

INSTITUTIONS AND THE RESOLUTION OF RESOURCE CONFLICTS: PRINCIPLES AND PRACTICE

Susan Hanna, Professor, Department of Agricultural and Resource Economics, Oregon State University, Corvallis, Oregon 97331-3601, USA

Abstract: Resource conflicts arise for many reasons, and the more complex the ecosystem the more the potential sources of conflict. The persistence of conflict will at least increase the costs of resource management; at worst it will prevent a resource management plan from being implemented. Since conflicts are inevitable when resources are limiting, an ability to resolve them is essential. Research in the institutions of resource management has shown that there are basic incentives by which people function in resource settings, and these incentives affect the extent to which conflict resolution is possible. This paper examines how resource management institutions incorporate the incentives in both principle and in practice. The theoretical basis for their role in management is presented, followed by empirical examples of their role in the practice of conflict resolution. Examples are given of three institutional arrangements for conflict resolution in drainage basins, estuaries and coastal seas of the Pacific Northwest of the United States.

INTRODUCTION

Conflicts between user groups are the stumbling blocks of natural resource management. Conflict, if not resolved, will increase the costs of management and may in the worst cases prevent management from being implemented. The more complex the ecosystem within which management takes place, and the more complex the uses of that ecosystem, the more potential sources of conflict. By themselves, coastal seas and rivers are complex systems. Taken together, their interactions are even more complex. These complexities create difficult design problems for institutions Land and water systems have different structures and dynamic processes and yet are dependent on one another for healthy function. Uses of land and sea ecosystems are sometimes coordinated but are more often in conflict as effects of one activity spill over to others. Rivers and coastal seas form their own eco-regions, yet the boundaries of these systems are usually inconsistent with boundaries established to control the use of individual resources.. Boundary inconsistency added to diverse ecological and human components guarantee the existence of conflict.

CONFLICT: OLD AND NEW

Conflicts in resource use have existed as long as scarcity. Conflicts arise because people have different ideas about how resources should be used, who should use them, how much should be used and how much should be saved for the future. Conflicts result when ecosystems are managed under fragmented authorities and when decisions between those authorities are inconsistent. Conflicts are created when the distribution of external costs of resource activities are disproportional; when those who bear the costs are not those who benefit. Conflicts also arise over how to interpret and apply the incomplete scientific information about ecosystem structure and function.

While conflict itself is nothing new, its importance to environmental resources is increasing because it is more diffuse, longer lasting, and a more serious impediment to the functioning of resource management institutions. Diffuse and continuing conflict is both costly and damaging even in a single-species context. It does far greater harm when the context is broadened to complex and interacting ecosystems.

One contributor to conflict is the decisionmaking process. Three types of decisions comprise resource management: conservation decisions about limits on resource quantities used; regulatory decisions about the means and rate of removals; allocation decisions about the division of resources between user groups. Conservation decisions usually generate the least conflict, because their impacts tend to be shared among all users and because most user groups favor maintaining resource productivity. Regulation decisions intended to implement conservation goals are generally constructed to avoid conflict between user groups. Allocation decisions are the most conflict-ridden for a number of reasons. They represent competition between user groups or disagreement over objectives, and can signal clashes in values. In addition, allocation decisions are typically delayed until resources are fully exploited or overexploited and harvest capacity is excess (Hanna and Smith 1993).

Conflict is also generated by the process of defining objectives for resource management. Conflicts over how to both use and protect the interface between drainage basins and coastal seas will continue to increase with population growth, economic development and cultural diversity. As population grows, the impacts of human activities reach further. As economic development proceeds, incompatibilities between activities such as commercial fishing, ecotourism and waste disposal are exaggerated. And as cultural diversity increases, a wider array of perspectives on the appropriate rates and styles of use are expressed.

PRINCIPLES: HOW INSTITUTIONS MANAGE CONFLICT

There are basic incentives by which people function in resource settings, and these incentives affect the extent to which conflict resolution is possible. At the most fundamental level, people are motivated to reduce uncertainty, manage transactions costs, and compete for advantage. An institution's performance is affected by its ability to design around these behaviors rather than be shaped by them, and how it accommodates behavior is critical to the reduction or enhancement of conflict.

Uncertainty: Natural and human systems are variable as well as complex. This variability ensures incomplete knowledge, creating *fact uncertainty*. In addition, users of natural systems often must cope with *tenure uncertainty*, which results from unspecified property rights or political variability. When tenure uncertainty is present, users have no assurance that their participation in resource use or management will continue. The net effect of these two types of uncertainty - when people have less than full information or are unsure about their continued access to the resource - is a discounting of the value of the future and an intensification of resource use.

What we ask of natural resource institutions is that they counter the effects of uncertainty to promote both sustainability and intergenerational equity. Sustainability requires expanding the time horizon of management far enough into the future that the biological, physical and human time scales are aligned. Intergenerational equity requires aligning private time horizons with longer social time horizons so needs of future generations are considered. Despite these good reasons to lengthen the time horizon over which ecosystems are managed, forces generated by the two types of uncertainty make it very difficult to do so. What we can do is structure management to reduce fact uncertainty through the most efficient provision of information, and to reduce tenure uncertainty through a clear and stable specification of property rights.

Transactions costs: All management creates transactions costs through information collection, coordination, decisionmaking, monitoring and enforcement. The more complex the system, the greater the transactions costs. Transactions costs are also affected by the degree of ecosystem health. As ecosystem goods and services degrade or become increasingly scarce, management must account for more tradeoffs between ecosystem commodities and services, between user groups, and between present and future. Understanding, coordinating and deciding about these tradeoffs becomes more costly as scarcity increases. Managing interfacing ecosystems generates particularly high costs of coordination, consultation and monitoring.

Participants in resource management often attempt to reduce their share of transactions costs by shifting costs to others or by opting out of management. It is in the interests of a resource management institution to keep transactions costs as low as possible and to guard against the inequitable distribution of those costs. Institutions that provide the greatest scope for efficiencies in information provision and monitoring tend to leave the least scope for cost-shifting. In contrast, institutions that create winners and losers in cost-bearing create conflict and undermine the legitimacy of management. This type of conflict often leads to opting out of management through "piracy" actions.

Competition: Self-interest drives all individuals and groups in resource management to compete for advantage. *Scramble competition* exists when people behave autonomously to capture resources in a race against others, a behavior commonly associated with open access resources. *Interference competition* is carried out through strategies that interfere with others' ability to compete, for example through the creation of rules that work to one group's advantage over another (Hirschleifer 1978). In managing the coastal/river basin interface, interference competition is the type most likely to lead to conflict. Interference competition seeks out and exploits weaknesses in institutional structure. It is enhanced by scarcity. Scarcity provides incentives to avoid "equal sharing" decisions in favor of "win-lose" decisions, and in this way contributes to conflict.

Property Rights: Well defined and enforced property rights can help manage the three types of behavior that produce resource conflict. Property rights are bundles of rights to use resources which when well-specified, reduce uncertainty about tenure over resources. Once rights are defined, coordination costs, negotiation costs, scramble competition and interference competition may also be reduced. But property rights are also bundles of *expectations* about rights and responsibilities in the use of resources, and these expectations can come into conflict. Expectation bundles have many strands of historical origins, economic incentives, social organization, cultural values and geographic and ecological context. Although some components of property rights are explicit and legally sanctioned, expectations are implicit, socially defined and informally sanctioned. The dynamic relation between explicit and implicit components must be anticipated if conflict is to be managed.

PRACTICE: THREE CASE STUDIES FROM THE PACIFIC NW U.S.

One hundred and fifty years ago, Euro-Americans began replacing Native Americans as the dominant group in the Pacific Northwest United States. The abundant and productive water resources of the drainage basins, estuaries and coastal seas were major attractions. These resources were rapidly developed into resource-based industries, such as fisheries, timber, irrigated agriculture, and ranching. The huge Columbia River was transformed by the construction of dams and reservoirs to a managed system of hydroelectric production, transportation and irrigation water. Coastal watersheds, estuaries and bays were heavily used for timber, cattle and fish production. Over time, as population growth, resource use, and spillover effects expanded, the resource abundance of the Pacific Northwest was transformed to an abundance of resource conflicts. Three different institutional arrangements in the region illustrate the role played by institutions in managing or failing to manage conflict: watershed councils in Oregon, the Willapa Alliance in Washington, and adaptive management on the Columbia River bordering Oregon and Washington. All three have resource problems and user conflicts at their core. The cases are summarized in light of the three behavioral incentive principles, with particular focus on their ability to manage user group conflicts.

Oregon Watershed Councils: In 1993 the State of Oregon established a Watershed Health Program, and through it created a system of watershed councils. Through the councils, citizens are coordinated with a variety of local, state, tribal and federal agencies in the development of assessments, action plans, and protection activities for watershed ecosystems. Watershed councils are components of the Oregon Coastal Salmon Restoration Initiative of which habitat restoration is an important part (Governor's Natural Resource Office 1997). Because they are organized by watershed, councils cross boundaries of private, state and federal land. The functions of watershed councils are to involve citizens in watershed planning by coordinating communication between watershed interests, preparing and implementing a Watershed Action Plan, promoting basin-wide monitoring of watershed conditions, promoting watershed education, and generating local political and financial support. Councils also provide a watershed-level forum for conflict resolution. To function effectively, a council must integrate across diverse ownership patterns to assess watershed health and develop recovery efforts (Governor's Natural Resource Office 1997).

Because watershed councils are new, they lack an established record of managing resource conflicts. However, several attributes are favorable to conflict resolution. Councils focus on single ecosystems whose boundaries are known. They reduce uncertainty through the incorporation of watershed citizens in the production of scientific information and the conduct of environmental education programs. Property rights to watershed land are well specified. However, some uncertainty exists among landowners about their ability to continue the full range of riparian uses, and this uncertainty may serve as a forcing mechanism for landowners to cooperate through the councils. Uncertainty also exists about the sustainability of council funding, limiting a council's willingness to invest in forward planning. Transactions costs, particularly in the early stages of council formation, have been substantial, and if interests are unable to form common objectives, may remain high (Soscia 1997). The success of a council in resolving conflicts will depend in large part on the management of these costs and on the ability of a council to influence the distribution of transactions costs through its management of interference competition between disparate interests.

The Willapa Alliance: The Willapa Bay, Washington ecosystem, a watershed of 680k acres, includes a bay, a river estuary and forested uplands. The ecosystem produces diverse goods and services including oysters, clams, Pacific salmon, Dungeness crab, timber, mushrooms and other forest products; supports industries such as cranberry bogs, dairy farms, cattle ranches and tourism; and contains a wildlife refuge in its eelgrass and marshlands. Willapa's 19k residents are supported by this resource based economy (Maugham 1995). In 1992, local residents formed the Willapa Alliance, a private nonprofit community-based organization with members from the timber, commercial fishing, aquaculture, seafood processing and tourist industries, environmental organizations, academia, and Indian tribes (Maugham 1995). Its purpose is to build constituencies for local solutions to environmental and economic problems, with an emphasis on coordination between industry, government and environmental organizations. Members of the Willapa Alliance conduct baseline ecological and economic research leading to scientific research policies and plans, and have formed a fishery recovery team. The Alliance has encouraged investment in sustainable activities by working jointly with environmental organizations and with a nonprofit business development organization (Maugham 1995).

The Willapa Alliance has had mixed success in managing conflict. In its early years, an incomplete representation of interests hindered the resolution of conflicts (Hollander 1995) and later, some conflicts over appropriate methods of control of a noxious weed (spartina grass) proved to be locally intractable (Lebovitz and Markham 1997). What has carried the alliance through its conflicts appears to be its organization around the common goal of enhanced economic productivity based on environmental health.. Tenure uncertainty is limited in Willapa Bay through ownership of land and tidelands (DeAlessi 1996). Fact uncertainty is reduced through local participation in the generation of scientific information (Sayce 1997). Transactions costs are minimized through the maintenance of the Alliance as an ongoing coordination and decisionmaking network that explicitly addresses ecosystem effects. The Alliance's greatest strength is probably is ability to cope with interference competition, which, although not removed, has been weakened by the association of environmental improvements with investment in economic activity. Tying investments to ecologically sustainable activities has created a positive feedback for resource stewardship (Maugham 1997).

Columbia River Adaptive Management: The Columbia River Basin has been developed intensively since the mid-1800's. The Basin now includes a diverse network of human activities: fisheries, timber, irrigated agriculture, ranching, and hydropower. At some point in its development "the river died and was reborn as money" (Worster 1985, cited in Volkman and McConnaha 1993). Multiple uses create multiple conflicts, particularly between fish and hydropower and between Indian Treaty fisheries and other fisheries. Development has taken a heavy toll on Pacific salmon as they cross through the Columbia River basin to migrate out to and back from coastal seas and open oceans, passing through multiple management jurisdictions and ecosystems.

The recognition of severely stressed salmon populations, the need for good science, the diversity of competing interests and the need for political support for salmon recovery led in the mid 1980's to the adoption of an adaptive management approach to ecosystem-level restoration of the Columbia River Basin (McConnaha and Paquet 1996). Adaptive management embodies an explicit recognition of the existence of fact uncertainty and the possibility of reducing uncertainty through experimental regulatory action (Holling 1978; Lee 1993). Adaptive management in the Columbia River Basin is unique in a number of dimensions. It encompasses multiple ecosystems that affect the life history of the salmon. It spans many existing institutional layers of local, state, tribal and international governments. It encompasses a diverse range of economic activities important to both local and regional economies. And it attempts to implement recovery for severely damaged salmon stocks (McConnaha and Paquet 1996).

The success with which Columbia River Basin adaptive management has performed in reducing fact uncertainty and coordinating diverse interests is mixed. It's ability to create the critical scientific knowledge needed for recovery has been extremely limited (Volkman and McConnaha 1993). As noted by McConnaha and Paquet (1996), it is easy for decisionmakers to subvert adaptive management's idea of "learning by doing" into a rationale for any action that offers the possibility for learning, allowing management to become captured through interference competition. In addition, the complexity of ecological structure and socio-economic interests in the Columbia River system combined with the perilous state of salmon populations placed a practical limitation on the degree of systematic experimentation that could be conducted (McConnaha and Paquet 1996).

CONCLUSIONS

The three examples illustrate the role played by institutions in managing human behavior for desirable resource management outcomes. The empirical evidence provided by these examples suggests several determinants for institutional success in resolving resource conflicts. At the most general level, institutional arrangements are most successful in containing the conflict-generating components of human behavior when they are able to reduce both fact and tenure uncertainty, manage the effects of scramble and interference competition, reduce transactions costs and maintain equitable distributions of transactions costs. More specifically, the three institutional examples show that the ability to perform these functions depends critically on the full representation of interests, the specification of well-defined management objectives, the existence of external threats that galvanize cooperation, a continuing rather than *ad hoc* decision process, and a cost-effective management structure that ensures benefits of participation greater than costs.

These findings have application to current widespread recommendations for decentralized, community-based, resource management as a mechanism for resolving conflicts. The idea behind community-based management is that communities are embedded within an ecological sphere and that embeddedness counters the worst attributes of individualistic behavior (Hanna and Jentoft 1996). In some cases communities do enhance management through efficiencies of information provision and the effectiveness of social sanctions: the cases of Willapa Bay and the Oregon watershed councils are examples. But other cases, for example the Columbia River, illustrate another dimension to embeddedness that creates difficulties for decentralized management. While ecological resources are embedded in geographic space, most people, at least in developed economies, are not. People are embedded in social and economic systems that extend far beyond eco-regional boundaries, and these nested layers of influence all affect an institution's success in managing conflict.

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THE ROLE OF WATER RIGHTS AND WASTEWATER DISPOSALS REGULARIZATION IN THE RESOLUTION OF STAKEHOLDERS CONFLICTS IN MEXICAN DRAINAGE BASINS

Héctor Garduño, Advisor to the Director General of the National Water Commission, Cda. de Sánchez Azcona 1723 Piso 11, CP 03100, México D.F., MEXICO. Fax (525) 524.11.89, e-mail:@ hgv.internet.com.mx

The 777 mm mean annual precipitation over 2 million sq km of the country's surface produce 450 cu km of renewable surface and groundwater, which should be enough to satisfy the needs of 90 million Mexicans. The equivalent *per capita* mean annual available water of 5,000 cu m is well above international scarcity standards. However, its uneven space and time distribution, along with waste and pollution, is making water with suitable quality for specific uses an increasingly scarce resource[1]. This scarcity explains the multiple conflicts which occur all over the country, specially in dry regions, among uses, users, states and regions.

In particular, the conflicts between drainage basins and coastal seas are due to the former attitude -in Mexico as well as in many other countries- of being proud for not leaving a single drop of water from a river fall into the ocean; as well as to point and non-point pollution.

An estimated annual withdrawal of 209 cu km is distributed among the different uses On the other hand, a reasonably reliable estimate shows that there are almost 300,000 users of national waters[2] in the country.

	Volume (cu km/yr)		Estimated Number of user
	Withdrawal	Wastewater	
Hydropower	122.00	na*	75
Agriculture & livestock	62.50	12.00	122,000
Urban & domestic	15.00	7.30	163,000
Industry & services	7.50	2.05	13,000
Aquaculture	1.30	1.30	1,000
Thermopower (Mostly cooled by sea water)	0.94	3.98	47
	209.24		299,122

*na = non applicable

Table 1. Water uses

[1] Jiménez B.E., Garduño H. and Domínguez R., "Water Availiability in México Considering Quantity, Quality and Uses", paper approved to be published in the Journal of Water Resources Planning and Ma..agement by the American Society of Civil Engineers.

[2] According to the 1917 Constitution all surface and groundwater, except a minor percentage of surface water which originates and stays within a state, are national property.

There are two important reasons to regularize those 300,000 users: to provide them with legal certainty and to have a reliable data base for water resources planning and management. Conflict resolution is already the most important water management activity in the arid regions of the country, but the national Water Commission cannot fully exercise its role as mediator or arbiter while all users in a drainage basin are not regularized. Also, the water rights market -which can help both to improve water allocation and to use it more efficiently-, cannot operate broadly until the regularization process is finished.

Legal Framework

The Constitution of 1917 establishes two basic principles for water use management. The first one states that the only legal way to use national waters is through a concession granted by the Federal Executive. The second, specifies that planning should be coordinated by the Federal Executive with state governments and agreed with individuals. The National Waters Law (NWL) and the Federal Tax Law (FTL) define the three main instruments for water use management: regulatory, economic and social participation.

The objective of the NWL, passed by congress in December 1992, is to contribute to the sustainable development of water resources. It calls for an integral approach of both quality and quantity of surface and groundwater, within watersheds which are considered to be the ideal geographical units for planning, development and management of water resources. Some of its main regulatory features are the requisite of effective and beneficial use for a user to keep his concession[3], the obligation to register his concession in the Water Rights Public Register (WRPR), and his right to claim disagreement with decisions of the National Water Commission (NWC). On the other hand, it gives NWC the right to reserve water for uses of public interest or for ecological reasons. Finally, but probably the most important feature of the law, is that it defines NWC as the sole federal water authority in the country.

The economic instruments are defined also by the NWL, namely the users obligation to pay water levies for abstraction and wastewater disposal, and the possibility of trading water rights, provided no third-party or environmental negative effects are produced. The FTL complements the definition of the economic instruments by making operational the "user pays" and "polluter pays" principles. That is, the tariff for abstraction water levies depends on the specific use and the relative scarcity of the water source; and the tariffs for wastewater disposal levies depend on the pollutants load and on the use and vulnerability of the receiving body.

The participation instruments considered by the NWL are:

- Establishment of watershed councils, as coordination units of federal, state and municipal authorities, as well as water users and all stakeholders. Their main tasks are to participate in planning and development of water resources, as well as in management particularly to cope with scarcity and pollution problems.

[3] According to the law, concessions can be granted with duration from five to 50 years.

- Enforcement of users organizations, mainly through decentralization of irrigation districts and strengthening of water supply utilities.

- Enforcement of social participation in design, construction, financing and O&M of hydraulic infrastructure and water services.

<u>Regularization</u>

Issuance of water abstraction concessions and wastewater disposal permits has been influenced by politics and social pressures all along Mexico's history, as well as limited by lack of information and human, economic and technical resources. This situation, along with a centralized approach to water use management explain why only 2000 concessions and 2800 permits were granted from 1917 to 1992.
One year after the NWL was approved, the Federal Executive issued its by-laws. The first implementation step regarding water use management, was to decentralize water abstraction concessions and wastewater disposal permits to the Sub-director General for Water Use Management, the six regional managers and the 32 state managers. Also, they were all invested with full authority to look after the rest of the water use management functions in their geographic jurisdiction.

By June 1994 it was necessary to design simpler procedures and to exempt users from the payment of titling and registering services, as well as to forgive sanctions to water supply utilities for using water without concession titles (Figure 1). As a result, by March 31, 1997, 46,625 concession titles were registered in the WRPR.

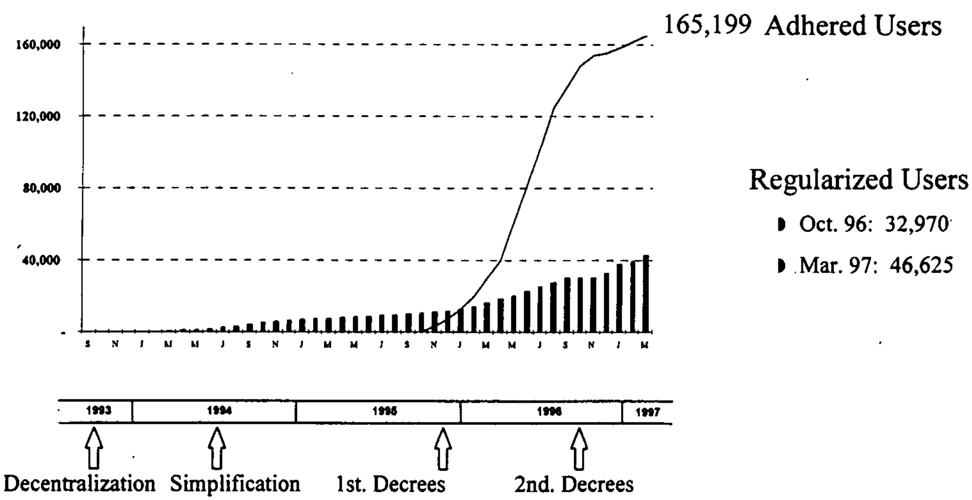


Figure 1. Concession titles for national waters abstraction registered in WRPR

The present administration recognized the priority of regularizing all water abstractions and wastewater disposals by issuing concessions and permits, so the Federal Executive issued three decrees (for agriculture and livestock, industries and services, and water supply utilities) on October 1995, which further simplified procedures; partially or totally condoned levies debts; forgave sanctions for abstracting water without concession title and disposing wastewater without permits[4]; and exempted certain service costs. More benefits were given to agriculture, livestock, aquaculture, water supply users, and micro enterprises than to large enterprises. Moreover, the latter received more benefits if they adhered promptly to the presidential decrees. The result was that after the one year period during which the decrees were in effect, 175,902 of the estimated universe of 300,000, had adhered to them. The capacity of the NWC was not enough to evaluate all those requests and only 20,328 titles were issued. Nevertheless, considering the titles issued prior to the decrees, the WRPR has now 75,596 concession titles. This means 10,000 titles per year as compared with 27 per year during the period from 1917 to 1992, and it also means that with 13% of the estimated users being registered, 71% of the total estimated withdrawal is now controlled.

Taking into account the relative success of the first decrees, the Federal Executive issued three new ones, based on even simpler procedures and, more important, on a different approach which relies on trusting the user and limiting the discretionality of the water authority. All concessions will be issued for a period of ten years.

It is expected that the implementation of the decrees will result, by the end of 1998, in the regularization of most water abstractions and wastewater disposals. The price that will be paid is that by then many watersheds in dry regions will probably be over-concessioned. But one has to recognize that nowadays those watersheds are in fact overexploited in the case of groundwater, and that most surface water users suffer from lack of reliability because of variability of runoff. The ten year period for the concessions will allow for councils, with due representation of water users, to be operational in watersheds all over the country. It will then be feasible to establish water use regulations and programs to reduce water abstractions with the consensus of users, within the participation framework that will be provided by watershed councils.

With regards to wastewater disposals, since the approval of the NWL and also with help of the decrees, almost 3,000 new permits have been issued under the standards in force. But the most important recent achievement is the approval of a single new standard (figure 2) for all industrial and municipal wastewater disposals, which substitutes the former 44 standards. Moreover, Congress has approved reforms to the FTL regarding wastewater disposal permits consistent with the new standard.

[4] However, damage to the environment or human health by toxic wastewater disposals continue to be sanctioned.

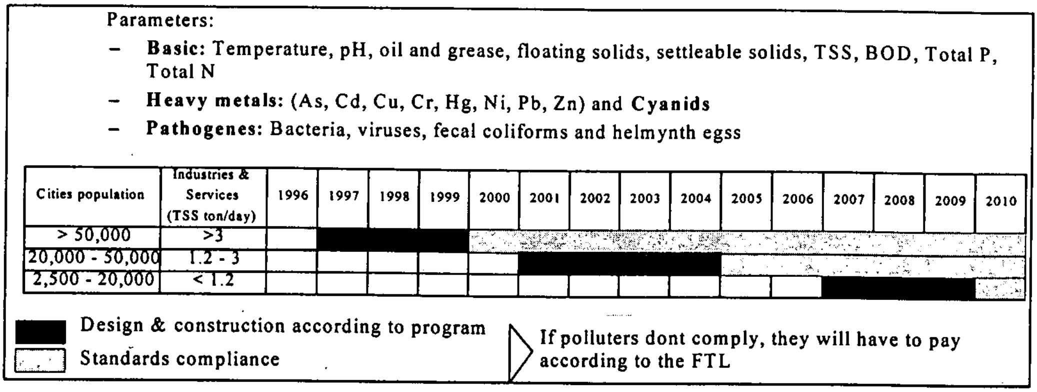


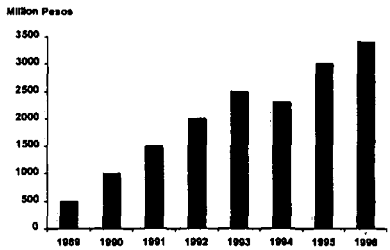
Figure 2. New wastewater disposal standard

Users will have to comply only with the limits established for those pollutants they produce. The new standard takes into account both the use of the receiving body water as well as its vulnerability. It incorporates gradualism (Figure 2), by stating that major polluters must comply on the year 2000, intermediate ones in 2005 and minor ones in 2010. However, existing plants must continue operating according to their original discharge permits or the new standards, depending on the user's will. In case the quality of their discharge exceeds the new standard, they can apply for a bonus. Polluters who exceed in more than five times the limits for any of the parameters of the new standard, have to present immediately a program to improve their wastewater quality. The rest of them, have to present a similar program several years before their target compliance date. If they do, they will be exempted from paying discharge levies during the construction period given they progress according to their programs.

The design of the new standard is such that it is feasible that users comply with it and that the authority will be able to enforce it. Once the watershed councils are operating, it will be up to the users to agree on quality standards for the water bodies within their geographical jurisdiction, and to enforce them in collaboration with NWC.

Water levies collection from 1989 to 1996

The Federal Tax Law considers water abstraction levies according to the kind of water use and to the relative scarcity of the water source, as well as charges for titling and other services, and for irrigation and drinking water provided by the NWC itself (Figure 3). The collected amount has increased yearly in current pesos, with exception of 1994, because in that year the Federal Power Commission obtained an exemption for levies related to hydropower water abstractions and Mexico City didn't pay on time its water supply charges. The yearly income has represented a substantial percentage of the Commission annual expenditures budget. In 1993 it reached 92%. However, in real terms, it has decreased due to inflation. It is interesting to mention that periodic increases in water abstraction levies have induced water savings in industry and a more rational geographical allocation of water demanding activities. Also, the threat to pay wastewater discharge levies to users who don't comply with standards, has induced construction of many treatment plants.



% NWC budget 51 56 50 60 92 75 83 60

Distribution 1996 (% of NWC income)

	Water abstraction	O & M	Waste water discharge	Others
Industry & services	44		3	
Water supply	6	18		
Hydro & Thermalpower	13			
Irrigation	0	4		
Debts	2		4	
Various				6

Figure 3. Evolution and distribution of collected water levies.

The income distribution shown for 1996 is also representative for the other years. From a purely economic standpoint, it could be argued that the structure of water levies induce cross subsidies from industry and services to water supply whose tariffs are substantially less, and to irrigation which is fully exempted from this contribution even though it is responsible for 80% of the consumptive use in the country. A future gradual decrease in these cross subsidies will have to take into account social and political considerations as well as the need to fund with federal money the various programs of water resources development and management.

The NWC income distribution also shows a very low participation of levies collection from wastewater disposal. There are three reasons. One is that industries and municipalities are exempted while they build their treatment plants. Second, the financial weakness of most water supply utilities. And third, insufficient resources for full law enforcement.

Perspectives

Figure 4 shows a program for the next 15 years,_considering that 2010 is the target date for minor polluters to comply with the new wastewater disposal standard. After most water abstractions and wastewater disposals are regularized, watershed councils implemented and the legal framework as well as the water availability and quality database substantially improved, it will be feasible to implement, with users participation, regulations for water allocation and use as well as pollution control. Also, it will be possible then to fully implement water markets which will contribute to a more rational allocation and efficient use of water. It is estimated that this process might take more than ten years, but it is considered that only with the participation of water users and polluters it will be possible to recover hydrological balance in overdrafted aquifers, establish rational rights that take variability of surface water into account, and set up water quality standards for lakes and rivers which may be feasible to reach. Additionally, the participation of users and stockholders related to the downstream coastal seas will be taken into account. In other words, it is the only way to set the basis for water resources sustainable development.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Regularization of water abstractions (10 years concessions)															
Regularization of wastewater disposal permits															
Implementation of watershed councils															
Improvement of water availability and quality database															
Improvement of legal and fiscal frameworks															
Implementation of regulations for water allocation and use															
Improvement of wastewater quality															
Intensive monitoring of water abstractions and discharges															
Capacity building with "user oriented" approach															

Figure 4. A 15 years program.

ENVIRONMENTAL, ECONOMIC AND POLITICAL INTERDEPENDENCE IN THE BALTIC SEA REGION

by

Dr. Stanisława BUKOWICKA[1]

Introduction

The Baltic Sea region is one of the most interesting example of an environmental, economic and political interdependence. It covers north part of Europe and consists of nine countries having long history - over thousand years of development. There was time of war and time of peace. From one point of view you may say that the Baltic Region used to be divided into West Europe and the Eastern Europe. From another point of view you may see the Baltic Region as a zone where the West countries have met the East European countries. Contemporary, we should appreciate that we can enjoy living in peace. However, we need something more - we should collaborate with one another for preserving and improving the marine environment of the Baltic Sea, for increase of our common welfare, for being able to solve our regional problems in a peaceful manner.

The presentation is based on the research conducted at the Institute of International Relations, Warsaw University in 1992-1995 on the Baltic Region. In addition, recent events have been also considered and included if they went in line with the subject. The main research issue was the complex interdependence of environmental, political, economic and social dimensions of international relationships in the region.

The presentation is based on the research conducted on the Baltic Region at the Institute of International Relations, Warsaw University in 1992-1995, Warsaw, Poland. The research work was supported by experience gained while working for the Ministry of the Environment, 1990-1996.

Environmental issues

The key environmental issues in the region there are emission to air and water as well as hazardous substances. While examine the data on land-base pollution load per unit square of drainage basing of a coastal country you will find that Poland is not the biggest polluter, as 99 per cent of Polish territory belong to the Baltic drainage basin. The date on pollution load per unit square of a basin (the Baltic Sea consists of nine basins) indicates which basins are heavy polluted.

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[1] senior specialist at the Ministry of Defence, Department of Infrastructure; Al. Niepodległości 218; PL-00-911 Warsaw, Poland *Phone:* (+48 22) 684 2-102; and Charter Member of the Polish Forum ISO 14000; c/o Centre for Environment & Development; ul. Chmielna 15; PL-00-021 Warsaw, Poland; *Tel./Fax:* (+48 22) 827 00 63

*The views expressed in this presentation are those of the author and should in no way be attributed to the Ministry.

Table 1. Pollution load from inland sources discharged to the Baltic Sea by countries, 1990

	BOD7 000 ton per yr.	Nitrogen 000 ton per yr.	Phosphor 000 ton per yr.
Denmark	63.5	83.4	5.3
Estonia	67.1	59.2	2.8
Finland	151.8	71.4	4.8
Lithuania	193.3	18.6	0.3
Latvia	149.2	94.1	3.2
Germany	25.4	14.4	1.2
Poland	323.6	120.4	14.7
Russia	209.1	80.8	9.5
Sweden	217.0	118.6	5.0
TOTAL	1,400.1	660.9	46.7

source: the author's calculation on the base of Second Baltic Sea Pollution Load Compilation, HELCOM, 1993

Table 2. Pollution load discharged to the Sea by square kilometre of basin - '000 ton

	BOD7 ton per year	Nitrogen ton per year	Phosphor ton per year
Bothnian Bay	2.88	1.07	0.07
Bothnian Sea	2.08	0.67	0.03
Archipelage Sea	0.91	1.03	0.09
Gulf of Finland	10.41	5.11	0.43
Gulf of Riga	8.69	1.05	0.21
Proper Baltic	3.16	0.97	0.09
Belt Straits*	4.46	4.28	0.25
Sund	6.66	5.89	0.75
Kattegat	1.32	2.56	0.09

source: the author's calculation on the base of data from Second Baltic Sea Pollution Load Compilation, HELCOM, 1993

Economic issues

- The economic matter is a foundation of the regional integration process.
- Over 11 per cent of the total world GDP and over 34 per cent of total European GDP comes from the Baltic Sea countries
- On the Baltic drainage are live about 15 per cent of total European population.

The total Gross Domestic Product of the Baltic Sea countries indicates capability of the region. Both the share of population and the share of GDP in the region displays the disparate among the Baltic Sea countries. Performance of joint environmental programs provide excellent opportunities to practice regional co-operation in the field of economy. Moreover, European integration in a framework of the European Union is likely to bring the Baltic Sea region into a quite new more favourable stage. On the other hand the regional co-operation experiences would make significant contribution to the European integration practices.

We would be able to say about common economic interest in the regional co-operation, if each/or most of the Baltic states seen the opportunity to go on profitable either joint enterprises or trade with one another. In what fields might the Baltic "community" bring us benefits?

International trade and common market, particularly the market of environmental protection equipment and devices undoubted make profits. We can also expect benefits from join projects on improve of the environment, first of all marine environment, and benefits from keeping the proper quality of the environment inland.

The other aspect of economic interest in co-operation in the framework of the Baltic "community" is setting both international and state policy that would support start and going on business friendly to the environment. More specifically, while creating policy we do not need to try make people to do the policy, but we ought to make such policy that people would want to do it; be interested in doing it. In general people do that what gives them profits. That is the base rule of the market economy. In other words, the main reason for taking on any economic activity or co-operation is expecting to get gratified profits from that (the exchange). In terms of economics the effective cause of any exchange is but this one.

Otherwise, the very serious chance on developing economic co-operation in the Baltic Sea region are the ecological challenges. Urgent requirement to reduce pollution discharged into the Sea makes the governments to closer collaboration. On the other hand, that is an opportunity to prepare ready market for environmental protection devices and services. The question is who would supply the market. In my view, not only a competition but a real battle for the markets would arise, and that may be a source of serious conflicts between businesses in that region.

Gross Domestic Product

There is a great variety between the Baltic Sea countries in terms of size of the economies and volume of the GDP.

Table 3. Gross Domestic Product in the Baltic Region, 1991

	as % in the Region	GDP $ per capita
Denmark	4,89	25478
Estonia	0,09	1885
Finland	5,36	27527
Lithuania	0,38	2365

	as % in the Region	GDP $ per capita
Latvia	0,28	2304
Germany	54,56	23536
Poland	3,39	1675
Russia	22,20	3220
Sweden	8,84	26652
Region Total	*100,00*	*7366*

source: The Europe World Yearbook 1992, vol.. II, EIU Country Report 1993 No 3,

Trade - geographical distribution

Table 4. Export and Import of Poland, 1992

export to:	as % of total export	*import from:*	as % of total import
Germany	29.4	Germany	26.5
f. USSR	11	f. USSR	14.1
Sweden	2.6	Denmark	2.1
Denmark	2.3	Sweden	1.8
Finland	1.5	Finland	1.1
not listed	53.2	not listed	54.4

source: GUS 1992

Table 5. Export and Import of Lithuania, 1991

export to:	as % of total export	import from:	as % of total import
Russia	56.5	Russia	49.6
Ukraine	11.4	Ukraine	10.4
Bielarussia	8.3	Bielarussia	8.4
Latvia	6.7	Latvia	4.7
Estonia	2.3	Estonia	1.8
Poland	0.7	USA	1.5
Belgium	0.6	Poland	1.5
Germany	0.6	Germany	1.2
not listed	12.9	not listed	20.9
CIS total	*85.1*	*CIS total*	*82.7*
EU	*2.1*	*EU*	*2.8*
Nordic c.	*0.9*	*Nordic c.*	*0.1*

source: Lithuania's Statistics Yearbook, 1992

Table 6. Export and Import of Latvia, 1991

export to:	as % of total export	import from:	as % of total import
Rubel zone:	96.8	*Rubel zone:*	87.2
Russia	54.4	Russia	44.5
Ukraine	12	Lithuania	10.1
Bielarussia	6.9	Ukraine	8.7
Lithuania	5.4	Bielarussia	5.9
Estonia	3.2	Estonia	5.2
dollar zone:	3.2	*dollar zone:*	12.8
Germany	0.8	Germany	1.3
Sweden	0.6	Finland	0.8
not listed	*16.7*	not listed	*23.5*

source: Statistical Yearbook of Latvia 1991, Riga 1992

Table 7. Export and Import of Estonia, 1991

export to:	as % of total export	import from:	as % of total import
Russia	56.5	Russia	45.9
Ukraine	12.9	Ukraine	7.9
Latvia	7.7	Lithuania	6.3
Bielarussia	4.1	Latvia	5.1
Lithuania	3.8	Bielarussia	4.9
Kazahstan	2.5	USA	3.5
Finland	2.3	Uzbekistan	3.4
Uzbekistan	1.8	Finland	2
not listed	8.4	not listed	21

source: The Europe World Year Book 1992, vol. I

Political issues

- ✧ The Baltic region is taken as a peripheral one, but it is involved in global concern.
- ✧ Germany is undoubted European powerful.
- ✧ Russia claims to be a global powerful.
- ✧ Regional co-operation is necessary in order to treat environmental issues of the Baltic Sea in a successful manner.

During the recent fifty years the Baltic Sea countries moved from political isolation through principles of peace existing towards close co-operation to protect the marine environment of the Baltic Sea. Although, the Baltic region is taken as a peripheral one, it is involved in global interests either. For example, Germany is undoubted European power, and Russia claims to be a global powerful. When Poland, probably in the nearest future, and the Baltic states, in a bit further future, join the European Union, the multinational relation in the Baltic Region would turn into bilateral one - between the EU and Russia.

While the discussion on enlargement of the NATO a clear evidence arose that Russia being unable to solve its internal economic and social problems attempts to move them on international level. That would not be favourable for development of the regional co-operation.

The collaboration in the framework of HELCOM might be seen as a proper size of international relationships in the fields of policy, economy, and social or culture. The international co-operation at the regional level is necessary in order to treat successfully environmental issues of the Baltic Sea, because none single state could do it alone. On the other hand, regional level is a life-size of effective joint action - the global approach is too broad and it easy loss less differences which often may sound to the regional community as important ones.

Moreover, political confidence and security play a key role in international relationship. In other words, economic co-operation between the East and the West in the Baltic region was very limited unless these conditions were satisfied.

<u>Perspective on Baltic Europe</u>

- ✧ The regional co-operation is necessary, since none single state can manage to safe the marine environment separately. The regional level is a life-size of effective joint action - the global approach is too broad and it easy losses slight differences which often may sound to the regional community as important ones.
- ✧ The continuously question is how to integrate economic priorities, political circumstances, cultural issues, and environmental requirements in a single concise project. Economic circumstances, political and social mind, and environmental requirements should be carefully considered while developing of any program of protection of the Baltic marine environment if it is due to be performed in a successful way.

In my view, the concept of Baltic Europe faces favourable political atmosphere, currently. More specifically, the Baltic Sea region was a place where the East-West border had proceeded for long time. At present days the situation is pretty different. That gives the chance on making Baltic co-operation closer and resulting in improving of the quality of the marine environment.

WORKSHOP 11:

NGOS: ROLES AND STRATEGIES IN WATER PROTECTION POLICY

Dr Hans Lundberg, Sweden, (Chairman)
Dr Jean-Paul Ducrotoy, UK (Rapporteur)

This workshop illustrated action taken by various types of NGOs to address water management issues and examples were taken from the Baltic Sea, the Seto Inland Sea and Chesapeake Bay. Several aspects of the activity of NGOs were tackled by the nine speakers, including: efforts to combat eutrophication through public participation (F. H. Flanigan), the networking of NGOs to influence the political process at local, national and international levels (E. Frössling), non-governmental educational and training activities (H. Kaya and G. Gross), sustainable development (K. Kusachi), and the role of citizen groups for the management of public land (H. Tenner). Contributions on how journalism can complement the action of NGOs (A. M. Henderson) and on the role of government bodies as catalysts for progress (L. Wenzel) led the workshop to a lively and interesting discussion. It was comforting to see that the focus given to the Chesapeake Bay success story stimulated the audience with interesting contributions from the floor on experiences from various parts of the world, including South Africa. Throughout the discussion, the workshop was aware of the difficulty in using past experiences as guidance for future actions.

In the general discussion, the workshop addressed the following issues:

* NGOs have an essential role in maintaining **public participation** to water management"
* the **concept of NGO** is not interpreted in the same way according to the culture, political and economical framework of the home country. In particular, the economic situation in some developing countries might prevent participation from citizens; environmental issues may appear of less importance to people who are without adequate food, housing or education;
* the **transferability** of the western experience to the third world is far from being obvious;
* in many countries, the existing **local and national NGOs** are weak and need to be better organised and strengthened;
* the notion of **stakeholders** needed further discussion but there was an agreement on the universal difficulties to get and keep up their interest through long periods of time;
* **competition** may occur between green and industry organisations;
* there is a strong need for **scientific information** to be translated and disseminated in a way that it is usable by NGOs and managers;
* an **integrative approach** to the management of watersheds and coastal areas is required.

The audience was composed of participants from developed and developing countries and the problem of the transferability of experiences came frequently during discussions.

It was felt that there was a need to find common themes and forge links between various groups, scientists and policy-makers. But, it was also spelt clearly that the social paradigm was essential in making any collaborative programme successful, including citizens involvement. It was recognised that bottom-up involvement was crucial but that it could only occur if essential needs of populations were met in terms of food, housing, health and education. It was stressed that Overseas Development Aid Programmes, for instance, were instrumental in allowing NGOs to take off the ground.

Participants stressed that it was essential that environmental NGOs be independent from governments in order not only to be able to play a political role in society but also to inform the public and media on environmental issues.

The lack of appropriate mechanisms to translate and use science on a large scale was put into light by the workshop which recognised the importance of the role of the mass media in the process but emphasised the need to develop improved mechanisms to enhance collaboration between universities, industries and NGOs. Solidarity and partnership should be supported by open minded and flexible organisations allowing all parties to be equally participating in the process with a view to achieve sustainable development. The Stockholm Water Symposium (SWS) and EMEC S were recognised as key players in the field.

The role of universities was perceived as very important in facilitating interactions between governmental agencies and the public and in translating scientific studies into policies. But, the workshop also felt that a distinction should be drawn between the mere dissemination of scientific information and knowledge and environmental education. Educational programmes should also be developed to meet the need for new competencies in various scientific disciplines. The problem of the employability of graduates should be tackled and the workshop show interest in the two year programme of the Chesapeake Research Consortium to create jobs of Environmental Management Fellows. It was demonstrated that NGOs can play important roles in training scientific and technical personal by working in the environmental management and protection activities of government agencies. Other comparable experiences were reported from the USA, Japan and Europe and the workshop agreed that the sponsors to the Conference (SWS and EMECS) should be encouraged to be more involved in the future in such activities.

The workshop concluded by recognising that NGOs are to be considered as a resource to be better valued by other users of the environment and official bodies, including governments. A watershed approach to marine pollution appeared very valuable but there was also a strong need for NGOs to better harmonise their efforts.

Finally, the workshop wished to make the following recommendations:

1. the **global network** of local and national NGOs needs to be strengthened

2. **platforms between NGOs and universities** have to be established in order to facilitate the use of scientific information

3. the role of NG0s in **education** should be made clearer and participation made easier

4. scientists, in co-ordination with NG0s, should be encouraged to take a more active part in promoting **integrated environmental management** and adopt an **interdisciplinary approach** to ecological studies

5. the gap in the mechanisms for translating **scientific information** into managerial tools should be addressed and information technology and the mass-media could play an interesting part in the dissemination of the information

6. NG0s position in **developing countries** should be looked into, in the light of potential political changes. in particular, the overlap between CBOs (Committee Based Organisations) and NGOs should be considered

7. structures to bring **knowledge to Third World** countries should be developed by NG0s in conjunction with scientists and universities

8. **governments** should be made aware of the necessity to collaborate with NG0s in an open way and at international level

9. **economic problems** have to be overcome in order to improve environmental awareness of the general public and **attain sustainable development**

10. **funding issues** have to be addressed in order to facilitate the above suggested developments

THE ROLE OF NONGOVERNMENTAL ORGANIZATIONS IN THE CHESAPEAKE BAY PROGRAM

Frances Flanigan, Executive Director, Alliance for the Chesapeake Bay, 6600 York Road, Baltimore, MD 21212, USA

Introduction

A comprehensive and, to date, promising effort to address eutrophication and resource management in the most important estuary in the United States is notable for its technical sophistication, for its intergovernmental collaboration, and for its ambitious public participation program. This paper will present a brief history of the Bay Program and the role the public played in first initiating and then sustaining the Program.

One of the unique features of the Chesapeake Bay restoration program is the role nongovernmental organizations (NGO's) have played. A variety of NGO's have been involved in numerous capacities, from providing education and public awareness programs, to organizing lobbying campaigns, to creating forums to bring diverse points of view together around complex issues. In the Chesapeake Bay Program, NGO's have actually become program partners, receiving grant funds to carry out essential components of the restoration effort.

The media has also played a crucial role in the Chesapeake Bay Program. The media's ability to reach large numbers of people and to make complex and often arcane issues relevant and understandable to the public has been important to securing a broad base of public support.

This paper will describe how several types of NGO's are organized, how they operate, where their money comes from, and how they relate to the Bay restoration effort. It will also briefly describe how the media, particularly the press, has interacted with the Bay Program

Historical Perspective

There is, in the United States, a tradition of public involvement aimed at influencing policy. From the earliest days of European settlement, the democratic foundations of participatory government created continual opportunities for citizens to influence, to shape and to guide the development of policy in countless arenas. The means of involvement and the methods of influencing have varied depending on the issue, the time, and the place. But always, citizens have felt free – indeed, obligated – to make their views known and to organize themselves to most effectively communicate to their elected leaders. The Frenchman Alexis de Toqueville commented in the early 19th century on the Americans' characteristic penchant for involvement in government.

In spite of this tradition of participatory government, the environment as a political issue did not begin to emerge in a serious way until the 20th century. The very abundance of resources, which so marked the American continent, made political activism in the name of environmental protection almost unheard of. The writer Thoreau, the conservationist John Muir, and President Theodore Roosevelt all played key roles in awakening America's appreciation of nature. American journalist Philip Shabecoff described the evolution of American environmentalism in his 1992 book A Fierce Green Fire, in which he catalogued first the efforts to subdue the wilderness and finally the effort to preserve it.

The English essayist Garrett Hardin captured a key aspect of the dilemma of environmental management and stewardship in the United States in his well -known essay " The Tragedy of the Commons." Endless forests, limitless minerals, pure and abundant lakes and rivers, fertile prairies stretching beyond the horizon led, perhaps understandably, to a sense of natural abundance that was early on exploited. The abundance and the wildness of the American continent also led to a strong desire to tame and manage, a desire that early Americans had no difficulty rationalizing as a logical extension of their religious beliefs.

The theme of the Commons essay is that when a resource – the English commons, the Chesapeake Bay – belongs to all, it belongs to no one. The incentive to manage, to steward, to preserve, according to Hardin, is not there when the resource is shared. Each person benefits by extracting something from the commons for himself – and the pattern of extraction continues until the commons has been depleted.

From the vantage point of 1997, one can argue that we have begun to move beyond this short-sighted view of the commons. Perhaps one of the successes of the international environmental movement has been to redefine the notion of commons and to begin to develop workable institutional arrangements for managing it. As recently as the mid 1970's, Hardin's analogy resonated on the Chesapeake Bay, and was instrumental in encouraging politicians and citizens alike to develop a new model of thinking about the Bay as a crucial public resource, and to organize around that model in an unprecedented effort to save the Bay.

The Early Chesapeake Bay Program

When the Chesapeake Bay Program was initiated by Congressional action in 1976, the Environmental Protection Agency faced a huge task for which it was not well prepared. EPA was given a big budget, a broad mission and only ten staff positions. EPA had, as a relatively new federal agency (created in 1970), no track record in dealing with complex regional issues like the Chesapeake Bay. The early organizational efforts were not promising. Staff sent from the EPA regional office in Philadelphia (not in the Bay watershed) were received by the states as outsiders. Public concern was expressed about "another study". Inexperience and lack of a detailed game plan came close to sinking the fledgling study in 1976 and 1977.

Two fortuitous decisions helped the EPA-led effort turn a crucial corner and get on track. First was the invitation to state policy makers in Maryland, Virginia and Pennsylvania to come to the table as partners in the management of the program. Second was the decision to issue a call to area non-profit organizations to make proposals on the design and conduct of public participation activities. The first decision was born of political necessity and led to the establishment of institutional arrangements, which have evolved in the ensuing 20 years into a complex, voluntary and somewhat informal series of committees known collectively as the Chesapeake Bay Program. The second decision was born of a pragmatic acknowledgement that ten staffers could not conduct the work needed to accomplish EPA's objectives. The decision to have public participation activities be conducted by an NGO was actually the first of a series of partnership arrangements that persist to this day and are one of the distinguishing characteristics of the Chesapeake Bay Program.

Among the respondents to EPA's call for public participation proposals was a young organization known as the Citizens Program for the Chesapeake Bay which had been founded in 1971. (The Citizens Program later changed its name to the Alliance for the Chesapeake Bay, and will hereinafter be referred to as the Alliance or ACB). EPA awarded a grant in September of 1977 to this coalition organization, whose mission statement declared that its purpose was to provide a neutral forum for the discussion of diverse ideas and viewpoints, with the objective of developing a management plan for the Bay. The organization's set-up as an umbrella group and its stated goal of facilitation rather than advocacy made it uniquely suited to enter into a partnership with EPA.

Initial tasks included the development of a mailing list of stakeholders and interested citizens; creation of a newsletter and an advisory committee; and development of educational tools to begin the task of engaging the public in discussion of problems and development of alternative solutions. The tasks were standard-issue public participation; the unique aspect of the arrangement was that the NGO was recognized not as a contractor but as a partner who brought credibility to the program. EPA gave to the NGO great flexibility in all aspects of its work, with the result being a fresh approach, the creation over time of a talented staff, and a high level of respect among the public for the work produced by the Alliance.

Today the Alliance for the Chesapeake Bay is a moderately large nongovernmental organization governed by a 24 person board. It has a professional staff of 20, a budget of $1.4 million, and offices in Maryland, Virginia, and Pennsylvania. The Alliance continues to receive substantial grant funds from the Chesapeake Bay Program annually. While these dollars constitute better than half of the organization's yearly budget, they are supplemented by donations, grants, gifts and contracts from a wide variety of sources. In fact, during the first half of 1997, the Alliance was working simultaneously on 40 funded projects. A few representative projects are described later in this paper. For more detail, visit the Alliance's website at http://www. Gmu.edu/bios/Bay/acb/ .

The Role of the Media

The media – both print and electronic – have played a crucial role in focusing public attention on the Chesapeake Bay. The early Bay Program was aided by the media in some unexpected ways. The major newspapers, most notably *The Baltimore Sun*, covered news about the Bay fairly regularly. *The Sun* had a photographer named Aubrey Bodine whose specialty was the Chesapeake and his photographs had for decades been bringing the Bay, its boats, its fishermen, its lighthouses, its quaint isolated towns into the homes of city dwellers. There developed over time an identification with, and an attachment to the Bay which persists to this day and which has provided a strong foundation upon which to build a restoration program.

In the mid-seventies, a young reporter named Tom Horton, fresh from travels in Africa, joined the staff of *The Sun* and assumed the environmental beat. Horton began to cover the Bay with vigor and passion, having grown up on Maryland's Eastern Shore. Horton's stories about the emerging Chesapeake Bay Program, the work being conducted at respected but remote research facilities on the Bay, and the culture of the Bay region were instrumental in acquainting masses of people with complex issues. Horton has since been joined by legions of reporters whose writing about the Bay has been remarkable and prolific.

Horton's early work was seminal. More recently, he has produced five books about the Bay which seem to have deepened their readers' appreciation of the Bay. One, called Bay Country, brought deserved national recognition to its author, and also helped cement the Bay as a fixture on the national political agenda.

The Sun and other major regional papers in Norfolk, Richmond, Annapolis, and Harrisburg have occasionally been joined by the national press: *The Washington Post, The New York Times, The Wall Street Journal,* and *USA Today*, as well as television and radio in turning Bay news into national news. The persistent and in-depth coverage provided by the environmental reporters at all these places has been a major factor in making the Bay Program a high profile effort. In the decade of the 90's, the work of the commercial media has been supplemented and assisted by the award winning publication *Bay Journal* produced by the Alliance for the Chesapeake Bay under the editorship of Karl Blankenship. *Bay Journal* is a small newspaper, which is published ten times per year. Each issue is 20 to 24 pages in length and circulation currently is 40,000. *The Journal* covers a wide array of technical and policy issues and includes in each issue commentary, human interest features, newsbriefs, letters to the editor and a calendar. The publication is provided at no cost to subscribers throughout the Bay watershed and around the country, and can be found on the Alliance's website. The most noteworthy characteristic of *Bay Journal*, aside from its journalistic quality is that while EPA funds it, it is published completely independently by the Alliance. EPA does not review or approve copy, or in any other way exercise editorial control over the publication. This independence, in combination with the quality of the reporting and writing, results in a publication without peer. *The Bay Journal* is probably the most tangible example of the unique relationship between the government-led Chesapeake Bay Program and its non-profit partner, the Alliance for the Chesapeake Bay.

Public Involvement in the Bay Program – A New Paradigm

For twenty years the Alliance for the Chesapeake Bay has received grant funds from EPA to conduct a wide array of public participation activities connected to the Chesapeake Bay Program. Occasionally the Bay Program has proposed a task it wished to have the Alliance undertake – for example, the recent effort to facilitate the work of the Riparian Buffer panel, or the managing of a new program called "Businesses for the Bay". More often, the Alliance has proposed to EPA work that it believed needed to be done or would enhance the Chesapeake Bay Program. Among the many projects developed by the Alliance using grant funds over the years are the citizen monitoring program, the Chesapeake Regional Information Service, BayScapes, the *Bay Journal*, and a long list of workshops, conferences, white papers and fact sheets. A number of these projects have become models to be imitated by other programs in other regions. In fact, the Alliance today is frequently invited to participate in national meetings and requests for information about our projects come regularly.

The Alliance has evolved new models for citizen participation that are promising. The formality of public hearings, written testimony, and rigid schedule driven processes is being supplemented with involvement techniques that engage citizens at the grassroots level. These efforts are resulting in better informed citizens, more partnerships, useful information, and in many cases solutions to problems where before had existed only confrontation. Some current examples may be helpful in describing new approaches being implemented in the Chesapeake Bay Program. These examples directly relate to the Bay Program's goal of reducing nutrients by a measurable amount by the year 2000, and they illustrate the concepts of stakeholder involvement, partnerships, intergovernmental co-operation, consensus-based decision making, and using science as the foundation for public policy. These concepts are crucial to the viability of the Chesapeake Bay Program.

Example # 1: Citizen Monitoring

The Alliance pioneered protocols for citizen monitoring programs that include designing programs based on data needs, recruiting, training and keeping volunteers, providing excellent quality control, and managing, analyzing and reporting on the data. We have written training manuals that are presently in use all over the United States. We have developed and tested techniques for monitoring dissolved oxygen, pH, nutrient concentrations, salinity and clarity. We have trained volunteers to monitor stream quality using biological as well as chemical methods. We have built and tested collectors for wet atmospheric deposition. Monitors have been trained to sample for zebra mussels, to measure stream bank erosion, and to identify areas that meet water quality criteria for submerged vegetation. The citizen monitoring program provides wonderful education to the volunteer monitors, but more importantly, it creates a data base that can be used to characterize river conditions, identify improvements and declines, target areas for remedial action, and supplement the information collected by professionals.

Example #2: Countryside Stewardship Exchange

A novel approach to protection of the countryside was developed in England by the Countryside Commission in the early '80's. Called the Countryside Stewardship Exchange, it was imported to the Untied States about a decade ago and has since been adapted in the Chesapeake region. The exchange is an effective technique for focusing on the unique problems associated with protecting rural villages and landscapes. In the Chesapeake Bay watershed, growth is occurring rapidly, and land is being consumed at an accelerating rate. In addition, most land use planning and decision making is reserved to local units of government, making it difficult to achieve consistent or co-ordinated approaches to protection and conservation. The Countryside Stewardship Exchange pairs local communities with resource professionals from other places for an intense week of assessment leading to a set of recommendations. The local community identifies the issues it wishes the exchange team to evaluate, and then creates a week long agenda of site visits and meetings that enable the team of visiting experts to understand the issues and devise a set of action recommendations. A total of five exchange case studies have been organized by the Alliance and sponsored by the Chesapeake Bay Program to date. The technique has proven to be enormously enlightening for all participants, and has led to some remarkable accomplishments at the local level.

Example # 3: Riparian Forest Buffer Panel

The Alliance recently completed an 18 month task which included the facilitation of the deliberations of a 31 member appointed panel whose job was to make recommendations regarding a policy for forest buffers along the bay's river and stream shorelines. The panel was composed of scientists, state and federal managers, and representatives from agricultural, timber, conservation, development and local government interest groups. The purpose of the work was to provide policy recommendations that could enable the states to stem the loss of existing buffers and accelerate the installation of new buffers. There was a clear desire from the beginning that this goal be achieved without the addition of regulations and in an equitable manner. The Alliance served as the neutral convenor for the panel's meetings; with the advice of the staff we brought in experts who presented a variety of viewpoints; we drafted, redrafted and worked behind the scenes to achieve consensus on a modest set of recommendations. During the course of the panel's deliberations over the 18-month period, we also conducted an extensive outreach campaign to solicit comment on the evolving policy. We wrote and published a white paper, which was widely circulated, and we covered the buffer issue in a series of *Bay Journal* stories. The work of the buffer panel illustrates the preferred approach of the Bay Program to developing policy on emerging issues; it also provides an example of the unique role the Alliance for the Chesapeake Bay plays in the program.

The Public Role in Goal-Setting

The public participation program carried out largely via a partnership with the non-profit Alliance for the Chesapeake Bay has resulted in new models of participation and assured the continuity of the Bay effort. Among the many examples of public input resulting in changed policy, one stands out.

In 1987, the governors of the three Bay states, along with the US EPA, the Chesapeake Bay Commission and the District of Columbia signed the second Chesapeake Bay Agreement. Although an agreement was signed by the same signatories in 1983 at the time of the release of the Chesapeake Bay Study, the '87 Agreement represented the first time all jurisdictions committed to specific actions to restore the Chesapeake. The most notable element of this agreement was the goal to reduce by 40% the nitrogen and phosphorus entering the Bay by the year 2000, and cap inputs at this level thereafter.

The public participation process leading to the signing of the 1987 Agreement indicated a strong desire on the part of the public for an actual numeric target. Many felt that nutrient reductions were not proceeding fast enough without a measurable goal. The target of a 40% reduction in nutrients was the result of this strong political pressure, coupled with some preliminary two-dimensional model runs. To launch an intense public participation effort around the draft 1987 Agreement, the Alliance for the Chesapeake Bay targeted key groups in each jurisdiction, which would be impacted in some way by the Agreement. Alliance staff and board met one-on-one with representatives from these key interest groups, including Chambers of Commerce, agricultural organizations, environmental organizations, boating interests, the seafood industry and civic organizations. Then a series of public meetings were conducted in each jurisdiction. Bay Program staff, state agency and Alliance staff and members of the Citizens Advisory Committee heard comments from the public and all of the interest groups. Well over 1,000 people attended public meetings, with hundreds more speaking up at organization meetings and via written comments. A consistent comment on the draft agreement, which had been published and widely circulated, was that it lacked specificity. Commenters urged agency leaders to add specific, numeric goals and to include due dates. The resulting 40% target was chosen by policy makers in consultation with scientists after the extensive round of public meetings was completed. When the 40% goal was agreed to, some members of the public suggested that it was not high enough, but most recognized the significance of the goal. In fact, numeric goals have since become the norm for the Bay Program which has, since 1987, adopted measurable goals for submerged grass restoration, fish passages, riparian buffer restoration, pollution prevention and a host of other management actions.

Other NGO's in the Bay Program

While the Alliance for the Chesapeake Bay holds a unique position in the program, it is by no means the only player. In fact, the participation of other NGO's with different missions, methods and funding sources is no doubt one of the strengths of this program, although it is also a source of confusion to many.

The largest NGO in the region is the Chesapeake Bay Foundation. Created in 1966, CBF has grown to over 80,000 members, more than 100 staff and a budget of approximately $8 million. CBF is well known for its student education programs. Its staff of technical specialists and lawyers also monitor policy issues, participate in legislative lobbying, and litigate. Under the banner "Save the Bay", CBF has been very effective in providing a citizens advocacy voice in Bay affairs. CBF's budget comes from member dues and contributions, foundation grants and corporate support. CBF has played an important, informal role in the Chesapeake Bay Program. As a very large advocacy organization, CBF opinions and positions on key issues are often important in determining the ultimate outcome of an issue. CBF staff participate in various Bay Program committees, providing both technical and citizen points of view. One of the most effective roles CBF has played has been to prod both the Bay Program and the states to set more ambitious goals, to aim a littler higher. On issues such as wetlands protection and fisheries management, CBF has effectively framed the issues for public debate. Seen by many as extremist, CBF faces a challenge in retaining credibility as a thoughtful player while continuing to serve the vital function of public conscience.

The Chesapeake Bay Trust is a nongovernmental entity chartered in 1985 to make money available to groups wishing to participate in educational activities focused on the Bay. The major source of funding to the Trust is the Chesapeake Bay license plate, a special commemorative plate featuring the Bay's well-known blue heron. The popularity of the license plate – over 700,000 have been sold – has raised $ 7,328,000 for the Trust. The Trust has awarded 2615 grants totalling $6,733,000, and has become a major supporter of small organizations and school projects. The Trust and other grantmaking organizations have played a crucial role in funding educational and advocacy organizations and activities. There are a multitude of river associations, for example, whose vital grassroots work have been supported by grantmakers like the Chesapeake Bay Trust.

In addition, there are a multitude of environmental groups, non-profit trade associations, and educational organizations which all participate to some extent in the Bay Program. Many are represented on the Citizen's Advisory Committee, staffed by the Alliance, which provides advice to the Bay Program. Others sit on Bay Program committees, participate as speakers and resource people in workshops, act as monitors and tour guides, and comment on draft reports and policies as they are developing. Some NGO's adopt a fairly adversarial view; others welcome the opportunity to be involved. There is ample evidence that emerging Bay Program policies have been shaped in consultation with NGO's and interest groups that have helped the Program formulate implementable and sustainable restoration strategies. The Bay effort is, without doubt, stronger because of the active participation of legions of nongovernmental organizations.

Future Challenges

In recent years, conservative thinking in the U.S. Congress has forced a review of the relationship between government and NGO's. At a time when the expectations for what NGO's can accomplish are rising, as was apparent at the President's Summit for America's Future this spring, some are suggesting that government support of non-profit organizations should be reduced. Popular publicly supported NGO's such as public television have been scrutinized, as have more controversial organizations such as the National Endowment for the Arts and the American Association of Retired Persons. Federal law prohibits the use of federal dollars for lobbying activities,; one of the controversies involves whether some large and influential NGO's, such as AARP, have indeed used federal money to support just such activities. Other controversies are more philosophical, focusing on the appropriateness of federal support for programs that some feel are inherently private sector functions. And finally, in an effort to downsize the federal budget, grants to NGO's are among the budget-cutting targets.

In a recent editorial in the *Chronicle of Philanthropy*, Lester Salamon, director of the Institute for Policy Studies at Johns Hopkins University, warned that NGO's "stand at a critical cross-roads." He outlined some of the problems facing NGO's from fundraising to politics, and said "Americans need to come to a consensus about how charities should function and interact with government and business in the years ahead". He urged that "nonprofit groups should mount a serious education campaign to inform the public about what the charitable world does and how it operates, with particular emphasis on the role government plays in supporting it activities."

The role of nonprofits in American society, as in the Chesapeake Bay Program, is vitally important. Perhaps the lessons learned from the Bay Program will be instructive not only to fledgling resource management programs around the globe, but also to those in America who would discourage and dismantle the unique public/private partnerships that are leading us toward the next century.

COALITION CLEAN BALTIC - A NETWORK FOR ENVIRONMENTAL NGO'S IN THE BALTIC SEA REGION

Eva Frössling, Co-ordinator, Coalition Clean Baltic, c/o Swedish Society of Nature Conservation, Box 4625, S-116 91 Stockholm, Sweden

The Baltic Sea is the common sea for over 85 million people living in the nine countries surrounding the sea. The Baltic Sea has a great importance and value in different ways for the people living in this region.

If we want to safeguard the future state of the Baltic Sea environment so that also future generations can enjoy the beauty and life of a healthy sea a profoundly new thinking is required with new behaviours, new lifestyles, new attitudes and new practices. If we just make our business-as-usual a bit greener it will not lead to a real sustainable environmental situation. The economic development must be limited by the ecological capacity of the area. This change will demand a strong political courage, wide partnership and needs to be base on peoples participation.

To be successful this work has to be done on all levels and by all actors in the society at the same time. Everyone is concerned; e.g. ordinary citizens, governments, international organisations, non-governmental organisations, independent sector groups (including business). It is also crucial to have a strong political will, necessary legislation's and other instruments like e.g. economic incentives, taxes etc. as well as governmental agencies and authorities that are implementing the decisions taken.

NGOs have an important role to play in this process contributing with new ideas, giving inspiration and to reach and mobilise the public. The unique strength for the NGOs is the profound local anchoring that they have with the possibility to engage and involve the citizens in the process. A role of the NOGs is also to influence the political process and to watch if the decisions taken by the politicians really are implemented.

CO-OPERATION FOR A CLEANER BALTIC SEA

Coalition Clean Baltic (CCB) was established in February 1990 and is a network of environmental non-governmental organisations in the countries bordering the Baltic Sea. The network was formed as the NGOs saw the possibilities in joining and co-operating on the common goal of protection of the Baltic Sea environment and its natural resources. CCB is a politically independent and non-profit organisation and has 25 member organisations.

CCB strives towards reaching a sustainable development in the Baltic Sea Area and is through its member organisations and secretariat operating in different ways. To create an ecological sustainable society we think it is important to work on different levels and in several ways at the same time and to link the different levels together so we can reach the overall goal.

THE WORK OF CCB

The way in which CCB is working can be grouped in four main categories, namely:

- lobbying
- information, environmental education and other activities to raise public awareness
- support to member organisations
- concrete co-operation projects in the field

Lobbying

Lobbying is an important activity for CCB and we are following and influencing the political process at the local, national and international level.

Concerning the international level CCB is functioning as the joint contact and lobby organisation for the member groups towards intergovernmental Baltic Sea organisations such as the Helsinki commission (HELCOM), the International Baltic Sea Fisheries Commission (IBSFC) and the European Union. CCB has observer status with the HELCOM and all its working groups.

Joint NGO proposals and action plans with demands to the decision makers in the Baltic Sea region are developed and presented.

I will now give an example of one way we are working with lobbying:
Environmental ministers in the Baltic Seas region have decided on the development of an Agenda 21 (Baltic 21) for this region, which should be ready until spring 1998. CCB has got the possibility to participate in the Senior Officials Group (SOG) who are responsible for developing the Baltic 21. We have also participated actively in the negotiations of the Ministerial Declaration. With our support the content of the declaration became a bit more concrete, for example more economic sectors of society were included in the final text and the texts for these sectors were directed towards more concrete actions. I think this is a good example of how NGOs and the governments can co-operate to try to reach the common goal of a sustainable environment.

CCB has also developed an NGO vision for an Agenda 21 in the Baltic Sea Region in order to show what basic principles and actions that we think are needed to create an ecologically sustainable society. This document was presented to the environmental Ministers in October 1996.

Information, environmental education and other activities to raise public awareness

Another important activity for CCB and our member organisations is to increase the public awareness and knowledge in issues concerning the Baltic Sea.

As one step in this work information about environmental problems in the Baltic Sea area and about measures how to address these problems is gathered, distributed and produced.

Another channel we use for spreading information is the CCB Newsletter which is published and issued four times a year.

Support to member organisations

CCB gives its member organisations relevant information about activities (like seminars, conferences, projects etc.) going on in the Baltic Sea region.

Financial and organisational support is given to the member organisations in need of such support so as to help them strengthen their work.

CCB Priority Activities

In order to strengthen our efforts and joint work to restore the marine environment of the Baltic Sea, CCB has chosen five priority areas where we are focusing our activities, namely:

- promotion of ecological engineering - ecological solutions to reduce the load of nutrient to the marine environment
- river watch and river basing management
- protection of the naturally spawning Baltic salmon
- prevention of Harmful Installations
- promotion of sustainable agriculture.

Under each priority activity area a number of projects are carried out. The projects and activities are different in nature and can be grouped under categories like e:g.:

- production of information material
- training and environmental education
- raising of public awareness and campaigning
- drainage area studies
- construction of ecologically sustainable technologies systems for demonstration
- monitoring of water and biota
- river restoration projects
- conferences and seminars.

THE ROLE OF NOGs

To have active NGOs is a part of a democratic society. An important role for NGOs is to analyse the decision-makers, authorities etc. and to inform the public and media when measures are taken that contradicts for a better environment. Environmental NGOs should act as watchdogs for the policies of governments and study in what respect policies and investments really will lead to a better environment. Lobbying governments to implement the declarations they have signed on reductions of pollution's etc. is another important task, as governments usually sign declarations for a better environment, but don't put in too much energy or interest for the implementation.

It is essential to have independent environmental NGOs to keep an eye on the government and on the political decisions taken, but NGOs should not be seen as an enemy to fight - instead it is important to see them as a resource to be used for a better environment. As I have discussed earlier in my paper, one of the roles of CCB is to co-operate with the governments and governmental authorities in order to speed up and improve the environmental solutions for the Baltic Sea.

As I see it an ecologically sustainable society can never be achieved if we don't have a broad and deep acceptance and participation among the people at the local level.

We can take the threatened Baltic Salmon as an example. Even if a crucial step in saving the Salmon would be to take a political decision to have a temporary stop to the fishing of the Baltic Salmon, I think we also must go directly to the fishermen themselves, to involve them and to have discussions with them in order to be really successful especially in a longer perspective. Here the work of the NGOs is crucial as their activities are based on the grassroots level and having extensive experiences of engaging and involving people in environmental work. As being independent organisations NGOs have the unique possibility to act as a link between the local people, authorities and decision makers.

CCB also see the importance of linking different groups of the society to discuss together and to find solutions for specific environmental problems. This approach we are using e.g. when developing river basin management plans in the Baltic States where decision-makers, authorities, environmental NGOs, students, mass-media, anglers clubs etc. are involved. When co-operating we can create an environmentally friendly and sustainable society.

Creating public awareness and increasing the peoples knowledge about environmental issues is big task for the environmental NGOs so as to engage more people in the work for a better environmental situation, e.g. to increase the pressure for a better environmental legislation and a good assortment of environmentally friendly products in the shops.

CREATING INTERNATIONAL NGO NETWORKS

To join forces and create international NGO networks in order to co-operate, co-ordinate activities and to exchange experiences will strengthen the efforts to reach our common goal of a sustainable development.

In order to get strong and effective international networks I see the importance of being aware of the fact that different countries are having different cultures, ways of operating and ways of communicating. To be successful I believe it is very important to be open-minded and flexible so that a common understanding can be reached where all parties feel that they are equally participating in the process. Sadly, this factor is often underestimated.

Finally I would like to end my paper with saying that if we all go together, inspire each other, look for the opportunities and encourage a new and constructive thinking we have all possibilities to reach a sustainable development with a healthy environment!

WORKSHOP 12:

ETHICS AND ENVIRONMENTAL EDUCATION OF THE NEXT GENERATION

Dr Wayne H. Bell, USA (Chairman)
Dr Jack Greer, USA (Rapporteur)

What connects people to their environments? Can we help strengthen this connection - and is environmental education an effective way of doing so? Session leader Wayne Bell opened with these questions, setting the stage for the invited speaker, Professor Richard Collins of the University of Virginia, who provided a powerful introduction to the workshop's themes.

Collins argued that we have come to question some of our basic assumptions about growth, and about where society is heading. He held not only that we should begin to think about sustainable economic and ecological systems, but that "sustainability" should become a foundation word, like "democracy" or "liberty", in our culture. Beyond the economic and physical significance of productive coastal areas, Collins said, we need also to cultivate a reverence for these natural assets as "places", and to do this we need to think not only of carrying capacity, but also of "caring" capacity. The former encompasses sustainability and an area's physical and biological capability to sustain life; the latter includes the emotional, psychological and spiritual significance we attach to place, the feelings and values that lie behind our caring, and our sense of stewardship.

Collins concluded that our goal must be a "civil society". This will depend not on "big answers", but on local actions, including labour unions and community roundtables. He challenged workshop participants to break out of old dichotomies, such as "public versus private". He pointed to land trusts and the Alliance for the Chesapeake Bay as examples of new co-operative approaches. Such approaches do not mean that we will not have anger and debate, he said. Even that discourse is vital.

One session participant, from Singapore, noted that a key word apparently missing was "responsibility". He pointed out, for example, that one cannot simply solve a problem in one place by pushing it somewhere else (to a developing country, for example). Collins agreed, saying that we must solve the root problem in such cases, and not simply push problems from one place to another. This suggests an important role for larger, multi-jurisdictional programs.

The invited young speaker, Anna Kurtycz, spoke of the role of "reflection", choosing an appropriate water word while focusing on the psychological aspects of our relationship to water. Because we tend to take water for granted, we suffer, she argued, from "water blindness", a term first coined by Professor Malin Falkenmark. We need, in short, a new water ethic, and a means of moving from knowledge to action. Whether or not we are "conscious" of our relation to the world depends on communication and reflection. In order to connect with people, and with students in particular, she works with historical and artistic elements of culture. "We must work with water that is close to children", she said. In order to do this, Kurtycz put 44 school children in Mexico in touch with.30 students in France, to exchange drawings and water-related activities. Her "Postal Water Project" effectively created a new sense of place through increased environmental awareness, an important goal for environmental education.

David Carroll, a session participant from the USA, noted how effective children can be in promoting environmental activities, in many instances convincing their parents to begin recycling, for example. He added that a focus on action is essential, and that "just conveying knowledge is not enough".

In his presentation, Frank Hartvelt focused on capacity building, noting that the Dublin and Rio Principles point toward managing water in a holistic way. He pointed to three building blocks for capacity building: an enabling environment; institutional development, including stakeholder participation; and human resources. Seeing capacity building as an "an integrating concept", Hartvelt spoke of working at the regional (e.g., river basin) level, citing several examples from Mexico, Ghana and Mali. He also referenced the Global Water Partnership and the World Water Conservation organization as examples of global efforts. He admitted the difficulty of gaining co-operation between "upstream" and "downstream" stakeholders, and professionals (e.g., engineers and economists) who do not speak the same "language." Capacity building needs to recognize each local sense of place and to integrate these separate locales In an appreciation for broader environmental issues.

A participant from Pakistan noted how difficult it could be to convince leaders to change water allocations, especially in poorer countries, when economics and votes (e.g., from farmers) are at stake.

Philip Reynolds, drawing on his experiences at the United Nations Development Program (UNDP), pointed out that coastal areas are home to some 60% of the world's population and represent a global environmental challenge. He noted that the LTNDP is the largest donor of multilateral aid, and cautioned that a scarcity of resources on land was causing many to turn toward an exploitation of the sea. Current manager of the "Strategic Initiative for Ocean and Coastal Management", Reynolds spoke of the "Train-Sea-Coast" decentralized course, which focuses on the development of local capacity and a co-operative network for sharing information.

The following presentation by Milton Asmus served as an example of the Train-Sea-Coast approach, using the Brazilian coastal zone as a case study. That coast provides a significant challenge, since different local areas represent very distinct ecosystems and varying concerns. They began their approach with a questionnaire, to gauge the concerns of the community, with a 62% response rate. They concluded that they needed to address the whole system: from rivers to the sea. This is another example of how a broader capacity building program can integrate local values into a regional project.

It was pointed out that evaluation of such programs is extremely important. In one case (Kenya) training efforts did not yield anticipated results because managers and the resource management structure were not properly prepared to take advantage of newly trained personnel.

Moving to a focus on the Chesapeake Bay, Robert Magnien addressed the issue of presenting complex technical information to a nontechnical audience. We "monitor" all the time, he pointed out, as when we track changes in the weather. Most citizens, however, do not feel comfortable with the sometimes confusing results of monitoring. Magnien documented with simple and striking visuals how physical, chemical and biological trends can be represented. The graphics make clear, for example, that biological nutrient reduction (BNR) works primarily in warm weather, a point otherwise lost on the public. He pointed out that natural systems can respond slowly to our management efforts, and it is a challenge to improve citizen understanding of this phenomenon. By becoming more involved in tracking the monitoring process - and perhaps participating through volunteer monitoring programs - citizens can increase their sense of attachment to "place" and feel a part of a coastal restoration program.

The session leader pointed out that there is a wealth of information that is often not widely available to educators and others; use of the World Wide Web could help to provide not only data but interpretive syntheses of information as well.

Sunil Shastri, Lecturer at University College Scarborough (University of York), turned attention toward the curricula necessary to provide education and training for future managers and decisionmakers. He pointed out that population growth, industrial development and urban expansion have caused considerable negative impacts in the coastal zone. Education and public awareness, he noted, are central to the commitment required to address these issues. He added that we can "take hope" that earlier environmental management efforts have made a difference, helping to remove the smog from London's air and cleaning the waters of Stockholm. All too often, noted Bell, we stress the negative in eliciting public support.

One of the most important means of reaching the public and affecting the future remains the school classroom. Laura O'Leary (a 10th grade science teacher) described environmental education in Maryland, USA, where a bylaw passed in 1989 required environmental education at all levels of instruction. She has designed and taught a course that emphasizes the watershed as an integrating ecosystem concept, with the Chesapeake Bay as a focal point. O'Leary showed a wetland project at her public school, where a previously soggy piece of land near the athletic field was turned into a flourishing marsh and wildlife habitat. Such projects give students a feeling of accomplishment and a direct investment in the natural environment. In the end, she said, we will preserve only what we love.

Bell noted that school teachers are almost always under-represented in environmental programs. They are a major and largely untapped resource for creating a sense of place among young people.

Working directly with adult citizens, William Roberts of the Virginia Institute of Marine Science, USA, described an initiative to address the awareness and attitudes of people directly affected by wetlands policy. This was accomplished by adapting information and adult courses so that interested persons - specifically wetland board members - could benefit from them, by putting presentations on video, for example, so participants would not be required to travel. In order to show board members the direct impacts on the environment of various practices, Roberts and his colleagues staged field trips, careful to hold them in the evening hours, when working members could attend.

Many of the public's perceptions are based on the way we use language to describe such concepts as "environment" and "place". This was the message presented by Jack Greer, of the Maryland Sea Grant College, USA. Greer used examples from popular literature about the Chesapeake Bay, as well as policy statements from the multi-state Chesapeake Bay Program, to show how language is used in different ways to perform differing functions - functions that may be taken for granted, but are not well understood. He used as an example the goal of a "Bay free of toxics", established by the Chesapeake Bay Program's Executive Council. While cited by many as scientifically unrealistic, the goal is actually more "analogical" than "absolute", and should be read in context as calling for a Bay that functions "as if" it were free of toxic compounds.

Kim Loughran, of Australia, discussed ethics and integrity when reporting on the environment. He noted that newspapers are often locked in the mode of "shock, horror and threat". He pointed out that the world is not the same as it was in the 1960s and 1970s, and that the youth of that period are now often the leaders of today's industry. As an editor of "Tomorrow" magazine, he has traced these trends. He urged that journalists avoid the word "should", and attempt to report environmental stories accurately and dispassionately.

A participant commented that there is still some sense that industry's rules are applied differently in the developing world and the industrialized world. Others argued that companies do not have differing modes of operation in different parts of the world. It became clear from the discussion that many companies still function outside of the local sense of place and so are not viewed as effective environmental stewards.

Darrell Sequeira, an independent consultant from Finland, described the importance of public environmental education, using an example from a mine disaster in Guyana. The accident occurred in August 1995, and resulted from a burst dam, which released some 3.2 million cubic meters of cyanide-laced tailings into the Essequibo River. The area was declared an environmental disaster zone. As an consultant to the United Nations (UNDP) at the time, Sequeira was in a good position to witness the disaster and the public's reaction. According to Sequeira, misunderstanding led to wild speculation, and while the effects of the spill tended to be over-exaggerated, other threats, such as the presence of mercury in the environment, were under-appreciated. Good public environmental education efforts could help remedy this situation, with a goal of "sensible and rational understanding".

Sequeira's presentation brought the workshop full circle, returning to the importance of a "civil society", an "enabling environment", and "an effective public environmental education effort" in preserving the world's irreplaceable watersheds and coastal ecosystems.

SUSTAINABILITY, PLACE, AND CIVIL SOCIETY

Richard C. Collins, Lewis Professor of Architecture, Director, Institute for Environmental Negotiation, University of Virginia, Campbell Hall, Charlottesville, Virginia USA 22903

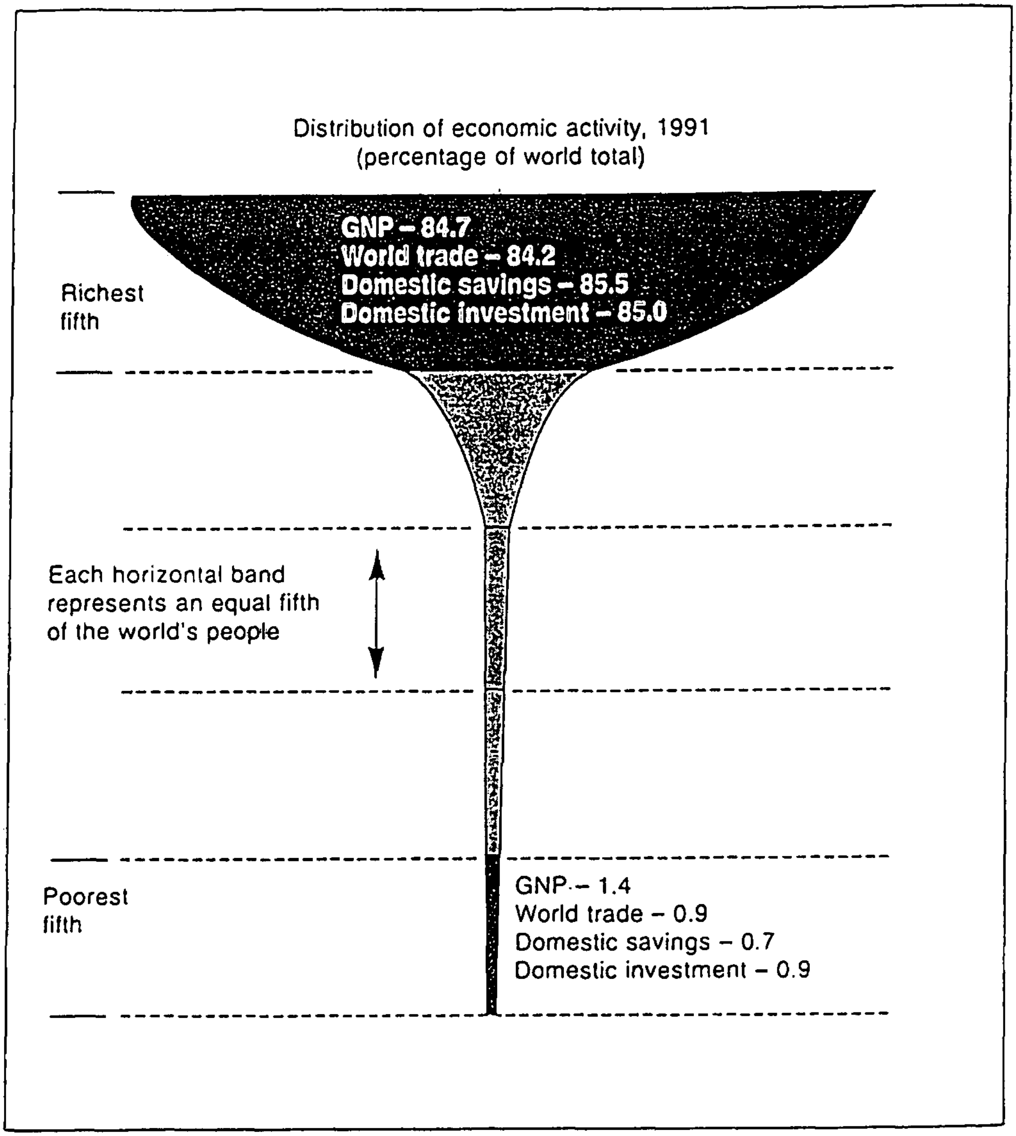
This paper stems mostly from a reflection on my experience in the United States as a mediator in environmental conflicts and as a facilitator of various types of public forums concerned with natural and man-made environments. Although I teach graduate level courses in environmental policy and planning, most of my time is devoted to convening, facilitating, or mediating policy dialogues, or place specific environmental disputes. The Institute for Environmental Negotiation, which I founded in 1980, also participates as a facilitator in community planning processes which may be entitled visioning exercises, alternative future explorations, community design charrettes, growth management options or at the regional level, watershed planning or sustainability roundtables.

I am not an expert in international relations or in international development. Most of my experience has been within the United States. I follow with interest international meetings or activities that have a connection to sustainability. I am aware that sustainability, and its diluted and compromised offspring, sustainable development, has profoundly different meanings depending upon where one sits in the world.

I know that the recent Earth Summit meeting in New York was a major disappointment to many nations and pro-sustainability NGOs. The North-South relationship is the critical axis that must be joined before climate change policies and many other initiatives necessary to sustainability can be realized. Agenda 21 has fared poorly in many respects, but I see promising activities to fix and refine the meaning of sustainability and to operationalize it in diverse settings. I find particularly encouraging the progress made in the sustainable management of the world's forests. The Rio Declaration led to the international Santiago agreements, which in turn led to the Montreal process for protecting temperate and arboreal forests. Now, the certification of sustainable practices is affecting the purchase decisions of homebuilders and others in the U.S. It is worth noting that much of the progress here was achieved by what I will later describe as civil society.

I mention my background because it will acknowledge to the reader some of the limitations of my knowledge about other countries and their environmental and social conditions. I consider myself a critical theorist with practical experience in real settings and with real policy choices and I can only describe what I have observed and experienced in the U.S. I propose to examine and relate three terms whose meaning and interpretation through continuing discourse will shape and affect the potential of my country achieving a sustainable future for itself and for assisting others on their course as well.

There is a story told about a lost traveller on the Northern Neck of Virginia on the western side of the Chesapeake Bay who was trying to find a town located on the eastern side of the Bay. He spotted a farmer and pulled over to ask him directions: He asked, *Graph #1*



Global Economic Disparities.

Taken from Kevin Gallagher's, "Globalization & Consumer Culture," p. 302 in The Consumer Society (eds., Goodwin, et al), Island Press, Washington, DC 1997

"How can I get to Exmore?" The farmer pondered the question at some length and then advised, "If I were you, I wouldn't start from here." That is how every nation or even every place thinks about sustainability. The Chesapeake Bay, Lake Victoria, the Gulf of Thailand or the Baltic all must proceed from where they are, not from where they would like to be ecologically, politically, or economically. Grâph I gives some sense of the disparities among nations in economic terms. These disparities are a broad surrogate for the different locations from which we must start the journey.

Sustainabililty is the key word, and the central organizing concept for our time and for the foreseeable future. To achieve sustainability, all nations will have to acknowledge that no one can move from where we diversely are to where we will diversely be without a recognition that we can only proceed co-operatively. No one nation can get to its destination without the others proceeding to their destination as well. The word "sustainability" derives from its close relation to the concept of carrying capacity and the tragedy of the commons. The tragedy of the commons has become the dominant metaphor for our time; it sets the terms of man-nature relationships which constitute the heart of sustainability. The metaphor of the free-access commons leads to collective tragedy because each cattle owner calculates his own short-term economic interest rather than the long-term community interest in the health of the common resource. The free access commons has become the starting point for much of the politics, economics, and initiatives of sustainable development. Biodiversity, over-cutting, overfishing, depletion of ground water, the pollution of surface water, climate change and other natural disasters have the open-access commons framework.

In spite of the gallery of definitions, one can find for sustainability, the core concept is both threatening and optimistic. It rests on an important assumption: our world has limited resources and the goal of humanity should be to put that issue at the epicenter of the world's quest for a worthwhile future. Essentially this means that there can only be so many people using so many resources without overshooting some limit that portends catastrophe. Sustainability as a noun, rather than an adjective, (as in sustainable development or sustainable agriculture), is the only word with international currency that encompasses the overlapping concerns of ecology, economics and culture. Sustainability serves as the banner of those who are struggling to replace growth with an alternative goal and set of justifying programs. Those who disagree with the assumptions of sustainability, or fear the direction in which it leads, or who fear the political struggle that it portends, want to diminish or compromise the core meaning of the term.

Sustainability is best appreciated as a justifying word that directly challenges the dominance of the concept and word growth. Growth is the almost universal justifying concept and word. But the concept and word growth like sustainability, rest on a metaphor, and the word under careful scrutiny has as many ambiguities of meaning as does sustainability. The value of the word sustainability is in part that it challenges the word growth for dominance as our metaphor for the future. Can you be against sustainability? Can you be against growth? Which is the primary goal and how do you qualify it?

The dominant growth metaphor is the image of the primeval, pervasive forest which the pioneer cuts back and converts to farm fields for growing crops. John Locke, who so heavily influenced the founders of the U.S., uses that specific example in his Treatise on Government. Nature, which constrains man, is forced back as human labor and capital advance human welfare. If growth stems from the optimism of exploiting a mostly unoccupied continent, sustainability is based on the recognition that this view of the world is contradicted by our current plight.

Ihave found at the root of many environmental conflicts competing assumptions about whether the dominant paradigm should be sustainability or continuing economic growth. These discussions produce valuable discourse, advance greater mutual understanding among diverse interests, and serve as a source of creative ideas for innovative action. Although compromise is often seen as the key element in successful public negotiations, creativity flowing from conflict is even more important. A simplistic "win-win" outcome may not easily emerge as negotiators seek to resolve their differences, but increased understanding of the sources of conflict can generate new options and alternatives.

Some have urged that the word sustainability or sustainable development be dropped from our public vocabulary. They maintain that it polarizes a public forum; others claim that it is too ambiguous to provide useful guidance for policy; still others claim that the concept cannot be made operational or measurable and therefore lacks utility.

There is some truth in these claims. You won't find the word sustainability in the Oxford dictionary, which gives you some sense of the novelty of its use. The words sustain, sustainable and sustainably do appear, but each of these words has multiple meanings. These meanings encompass a range that extends from what one can endure; to maintaining a certain rate of activity, but there is no positive reference to its use as a precautionary principle in environmental or economic policy. Interestingly, this authoritative dictionary uses the term "sustainable growth" (which to a true sustainability advocate is an oxymoron) as a type of growth that will assure that "economic stagnation" will not set in. Stagnation, rather than sustainability is viewed as the polar opposite of growth, and sustainable growth is maintaining a rate of economic expansion that can be held relatively constant.

Language and metaphor dominates human consciousness and public policy alike. The central challenge to sustainability as a word and as a concept arises from those who are too literally disposed and are worried about dictionary definitions. But the larger issue is presented by those who resist the strongly normative and persuasive capacity of the metaphor and term. There are those who want to diffuse it's impact, and others want it banished for political advantage. To be sure, there is reason to debate its meaning and implications, because like the words nature, equality, justice or freedom, to apply the term to a particular set of conditions has consequences. Most significantly, if sustainability becomes a central element of the world view of all nations, it threatens the power of other "justifier" words like growth, and the less aggressive but questionable term, development.

Sustainability needs broader public understanding, more effective justification, and pragmatic measurement indicators. Sustainability needs to be used as a noun, nouns are more powerful than adjectives. But sustainable forestry, or sustainable fisheries are good uses of the term, because both acknowledge the possibility of over-exploitation and the consequent natural resource and economic effects. It is most compromised when it is used as the dictionary does: sustainable growth.

Despite the conventional wisdom, the major barrier to achieving sustainability has less to do with understanding nature and natural processes and their limits than it has to do with developing economic and governing alternatives to the currently dominant models. As long as there is in the eyes of the public a correlation of growth with economic improvement and stagnation and poverty with sustainability, there can be no effective modification of our circumstances. There are those like Herman Daly who have provided the basis for a new economic theory of sustainability, but the economy of sustainability is still largely unheard of and ineffective in most government or corporate announcements.

Sustainability, and the economics and institutions which will support it are inhibited by the fact that both the traditional Left and the traditional Right support continuing economic growth. Perversely, the fact that ideological opponents both pursue growth strategies lends weight to the pro-growth positions rather than to support alternative ways of living.

I offer for your consideration the following definition of sustainability: it goes beyond the Brundtland version which is most often cited, and which defines it as the ability "to meet the needs of the present without compromising the ability of future generations to meet their own needs."[1]

"Sustainability is a state of society where an optimum, relatively constant number of people, physical wealth, and natural quality is established and maintained at some preferred level. The population size may vary, the level of general material wealth may change, and natural quality may be subject to variation. But the balance among these factors will emerge from democratic, deliberative choice: the conditions are not forced by some supposed imperative of the economic system."

That is what sustainability stands for: the opportunity for a good life for all without remote forces driven by supposed economic necessity. It is anchored in the fact that the resource base is finite, that the size of the population, and the quantity and character of production and consumption requires a judgment by the diverse communities affected.

As I have said, we all must start from different places and we will all arrive in different places, but none of us can get to a diversely sustainable place if we do not recognize our interdependence. As one person has put it, "sustainability without social justice is possible, (the rich of the earth survive, while the poor perish), but social justice is impossible without sustainability) social justice, that is, to future generations, to whom we will otherwise bequeath a dead planet."[2]

The word "Place" and what it signifies provides my second discourse theme: Place is sympathetic to, and supportive of, the concept of sustainability. If sustainability is mostly about carrying capacity, place is more concerned with caring capacity. The concept of place has a power and identity of its own. As Thomas Kellert has put it, "The erosion and degradation of these connections between people and nature lies at the heart of the environmental crisis along America's coasts, as much as the impact of pollution and habitat destruction does on various economic and health related processes."[3]

Place has no particular ideological baggage, it is associated with neither left nor right. Nevertheless a place-based strategy for the future implicitly challenges economic globalism and unmediated market processes. One who has a strong attachment to place will be more sceptical of unfettered trading than will those who take their cues from neo-market economic theory, or who have confidence in the multi-national corporations and the benefits of their investments and practices. Places in a competitive world market have value principally as they contribute to growth and efficiency. Places perceive their value in the world market as a potential threat to their health and relative autonomy. Locally based initiatives that have considerable place-related value are resisted or opposed because they would limit the international competitiveness of the place. All of us, no matter where our home-place is, have heard these arguments and they often accept the desirability of the proposed change for the place.

Place also provides a counter-balance to the assumption that sustainability and carrying capacity as dramatized by global warming, the attenuation of the ozone layer, the depletion of the world's fisheries or the decline in the world's forests, can only be managed by global governments or by technocratic elites. A concern for place - such as the inland seas that are vital places to those present at this meeting - represents a sensitivity to cultural diversity, social justice, aesthetics, and historic values. A concern for the past and for the culture of place and a search for a better future are not antagonistic. Energetic understanding and recollection are often the basis for sensible initiatives and resource protection.

Caring for place connects human emotion to nature and to culture; it promotes a sense of the whole, as distinguished from the specific environmental media which are often statistic-laden, abstract, and often incapable of providing real meaning to people. Put another way, place is concerned more with the health of the place and new designs for its future, and less with environmental engineering and technical problem-solving."[4]

A concern for Place often translates into sympathy for what are called NIMBYs (not-in-my-backyard). In the U.S., NIMBYs often energize NIMBI (now-I-must-become-involved) reactions as well. From place-based resistance to polluting industries, resource exploitation in forests or fisheries, or challenges to the siting of waste facilities, and to large public works projects such as dams or nuclear plants are generated the alternatives and options that are more sustainable. The conflicts that arise in these place-specific settings generate the public attention needed to publicize the inadequacy and unsustainability of waste disposal practices. NIMBYs must be credited with advancing the growth of recycling, wetland protection, public transit, demand management in water and electric power because of place-based opposition to dumps, roads, reservoirs, and power plants and power lines.

Public identification with the Chesapeake Bay - a very significant place has produced more attention to the population pressures, the concern with soil loss and the excessive use of nutrients, as well as with fisheries and distinctive waterman culture. In Virginia, where I live, concern for the Bay has produced protective programs and public funding that would never have been realized without the connection between these initiatives and that place.

I would recommend to all of you the University of Maryland publication entitled Saving the Seas which contains many of the papers presented at EMECs '93 in Baltimore.[5] In this publication, you will find several articles that provide more and better discussions of some of the topics I have touched upon.

Even the nation is more place-centered than is the multi-national corporation. The term place can flexibly accommodate different geographies, whether of town, sea, watershed or nation. Place has a fixity of space; the world economy endorses mobility. Although one can stretch this too far, one can say that place favors stability, local autonomy, more self-governance, and emotional attachment; while market economics favors mobility, constant change, all commodities caught in universal trade systems, and commodification. Since capital, investment, technology and information is now mobile to an unprecedented extent, national states are increasingly unable to manage either their own economies or to collectively manage this environment either. One major effect felt in most western nations is high levels of unemployment, people requiring public assistance, and declining incomes. Governments are increasingly hard-pressed to meet these responsibilities.

Civil Society is the third concept I would like to briefly address. Civil society includes voluntary, charitable, religious organizations, clubs, unions, trusts, foundations, of diverse interests and purposes. The civil society or civil sector is best understood by distinguishing it from the governmental and market sectors which so dominate our attention.[6] The civil sector is to place and sustainability as the market is to global markets and economic growth. The civil sector supports place, which is fixed in space, while markets support mobility of capital and goods. The civil sector generally provides mediation and support for places and encourages a sense of community.

The polarized debate in the U.S. about the proper role of the governmental and market sectors generally ignores the current and potential contributions of the civil sector as a source of ideas for mediating change, or for providing employment and badly needed services. The civil society or, if you wish, the civil sector offers great promise in providing valuable human services, including jobs, needed ideas, community and environmental improvement and enriching modes of citizen participation and advocacy.

Market and governmental sectors will continue to be important, of course, but the current myopia about the civil society's role must be changed. The Civil Sector in the U.S. is growing rapidly. Historically, the U.S. has been recognized for its community and voluntary associations. Many observers have noted that the U.S. combines an ideology of individualism as in property rights, with a record of community voluntarism and an acceptance of the large corporate organizations that require extensive interpersonal co-operation.

The growing interest in civil society is partly inspired by observing the role these organizations played in opening Eastern Europe to more open societies and economies. In Poland, Hungary and Czechoslovakia, it was the civil sector that stimulated the dialogue and ultimately provided the basis for change. Whether there were unions in Poland, or environmental roundtables in Hungary, these voluntary, mostly democratically governed organizations, proved to be the catalyst that changed the world.

Another reason for the growth of interest in civil society is a concern in the U.S. about the status of public discourse. Politics has become more partisan and negative, it is noted, and there has been an apparent decline in the quality of public deliberations. Environmental and urban concerns have especially stimulated a surge in citizen organizations like land trusts and community participation in planning.

Vaclav Havel says that the strength of civil society is a testimony to the "human spirit" when confronted with apparent deadlock or repression. Interestingly, Havel says that the experiences in Czechoslovakia and elsewhere in Eastern Europe did not prove that socialism was a dead ideology, but that all of the "big answers", including market ideologies, were obsolete."[7]

The role of NGOs (non-governmental organization) in the Rio Conference is well known to you. Around the Chesapeake Bay, there are citizen groups, environmental organizations, producer and user groups that support the Bay and are themselves the source of ideas, programs, and initiatives that contribute to the Bay's health. These same groups work with market and governmental organizations, of course, but without this sector's advocacy, monitoring, research, and education there would be less progress in protecting the Chesapeake Bay. In my own place in Virginia, a regional sustainability council composed of citizens and public officials has engaged churches, farm groups, environmentalists, business sector representatives, and community-based organizations in imagining a sustainable future, and developing new programs as well as public indicators that will provide the broader public with a sense of the community's health. Although I live over 100 miles from the Chesapeake, the sink in my office building has a poster above it that says "The Chesapeake Bay starts here."

Civil society is especially suitable for, and committed to, enriched modes of public deliberation and social learning. Civil society, including charitable foundations particularly, have supported initiatives concerned with the values of place and of sustainability. Much of the activity called environmental conflict resolution or environmental mediation in the U.S, is less an alternative to court-litigation in the legal realm, than a public involvement tool to expand and enrich the governmental policy-making and management process. The civil society contributes especially to consensus-building by its capacity to present a perspective and capacity that avoids the market vs. government regulation polarity.

In the academic and professional journals, one will often find symbols that attempt to visually denote the essential components of sustainability. A popular one is a triangle or pyramid with ecology, economy and social sectors at alternative points. Another is the image of a three-legged stool in which sustainbility is composed of the same three concepts. But if sustainability is to be advanced, it will need four legs, not three.

The fourth leg, the one that converts a stool to a stylish chair is vigorous, public discourse at all levels and on all issues. Sustainability, Place and Civil Society intersect and make possible a form of discourse which is essential to a healthy democracy. We should make sure that a healthy democracy is an integral element of a sustainable future.

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[1] The World Commission on Environment and Development, Our Common Future, p. 3, Oxford University Press, 1987.

[2] Jeremy Seabrook, The Myth of the Market, p. 46, Black Rose Books, Montreal, 1991.

[3] Thomas Kellert, "Environmental Values, the Coastal Context, and a Sense of Place," Saving the Seas, p. 49, eds. L. Anathea Brooks and Stacy D. VanDeveer, a Maryland Sea Grant book, College Park, Maryland, 1997.

[4] Wes Jackson, Becoming Native to This Place, University Press of Kentucky, 1994, offers one of the most eloquent and direct statements of the role that place will play in sustainability.

[5] Saving the Seas.

[6] Jeremy Rifkin, The End of Work, G. P. Putnam, New York, 1995.

[7] Vaclav Havel, "Post-Modern Politics," in Kettering Review, Summer 1992; A New Consensus (USGPO), 1996.

THE ROLE OF REFLECTION PROCESS IN WATER EDUCATION. THE POSTAL WATER PROJECT, A CONCRETE CASE

A. Kurtycz, Co-ordinator of the Environmental Education Branch. Biologist Communication Office of the Lake. A. Postal 5-687, Guadalajara 45042 Jalisco Mexico.

For developed as well as developing countries water's quantity and quality are a fundamental concern nowadays. The adaptation of the water resource to the social demand and the economical development is confronted to the increase of water needs for living and production and to the restrictions of uses due to pollution. Lack of community participation and water blindness is an important cause of water problems. That is why, besides the technical and scientific solution to water problems, the actual water situation requires a more conscious and participative approach. Water needs to be reached, conducted, treated, distributed, but overall it needs to be cared, to be loved. We have entered to a new era of water scarcity and it is imperative, as Postel says (1992), to adopt a new ethic that promotes the efficency and protection of the natural systems. An ethic which makes us accept the obligations and rights that we have towards water, saving when we can and sharing what we have. In this sense environmental education plays an important role.

Unfortunately a global view of environmental education about water, shows us that, in many cases it "has not produced a citizenry that is able and willing to solve today's environmental problems" (Gigliotti 1990, p. 12).

From our point of view, the approach to teach people how to behave in relation to water has left out the personal right of decision, that is reflected in changes of behaviour that are not sustainable. As Gigliotti (p. 9, 1990) says, "environmental education has produced ecologically concerned citizens who, armed with ecological myths, are willing to fight against environmental misdeeds of others, but lack the knowledge and conviction of their own role in the environmental problems". That is why we need to analyse the environmental educational approach to water until today, in order to define the direction we will take in the future.

The educational approach to environment, or in this case to water, is not easy. Even though, information, knowledge of issues and action strategies are determining elements in the process to shape the behaviour towards water, they are not the only ones. Situational factors, action skills, personal experiences and personality factors (attitudes, personal responsability, etc) are important as well and they need to be taken into account during the environmental education process. As Wals says (1994) the concept of nature is the result of our own interaction with the physical, social, and cultural world.

When we teach about water we must take into account the fact that children learn about the resource in their everyday life through a constant information flow, direct perception and interacion with others at school, the family circle and the community. This dynamic can be understood as a communication network, and can be used to improve the environmental education process. As Cullingford (1996) states the information that children have about the environment derives not just from school but from personal observation and from secondary information, such as television, reinforced by anecdotes and opinions shared with families and peer groups. The research of Palmer et al.(1996) shows that, before entering to school, most children have a considerable knowledge about the world around them from many different sources (tv, family and direct experience) and that this knowledge, both accurate and inaccurate, will affect what they learn as they progress through the early years of schooling.

In many cases this learning process about water, as well as the relation with the social physical and natural environment, and the behaviour which evolves as a result, is not conscious. This level of unconsciousness makes it difficult to take the responsability of personal actions into account and to acquire a sustainable commitment towards water. This situation, that can be read as "water blindness", demands from education reflection tools that can help children to make conscious their relation with water and to decide whether they want to change this relationship with the resource or not. We need to use elements that shape behaviour and help children become involved in their own changes (which means a greater commitment) rather than impose the way they have to behave. Enviromental Education must focus on the tools that help the student decide if they want to change their present relationship with water or not.

The Communication Offices of the Lake (OCLA) at Guadalajara, Mexico, was created in 1990 in order to increase public information, organization and participation towards water, especially at the Lake Chapala area (the biggest lake of Mexico) and the city of Guadalajara. Two axis of work were defined in order to achieve its goals: social communication (through the Water and Social Life Project) and Environmental Education. We learned that it was important to use cultural, historical and artistical local elements to deal with water issues.

In the Environmental Education branch, the Office of Communication of the Lake develop different actions with children in formal and informal education. Besides the production of graphic and audio-visual materials, research work is done for a better understanding of the factors that shape behaviour and to develop educational tools and methodologies. We use the communication network between family, community and school as a starting point for the educational activities.

Because we were concerned about the factors that shape behaviour, and the tools that teachers can use to teach about water, in our research work we recognized the reflection process as an important factor to make a sustainable change towards water based on a personal decision. As in our social communication projects, the basic assumption is that concepts, appreciations and conduct cannot be changed from without. The change must be voluntary, from within the individual community, and the tools of self-analysis for this behavioural change must be provided (Escamilla and Kurtycz, 1995).

The Postal Water Project

In November 1996 we started a project concurrently with French and Mexican children. This project, called Postal Water Project, is an example of the research work done by the

Office. It gives an idea of how to develop a reflection process with children as a fundamental step to promote a personal sustainable commitment to water.

Children in each country were invited to bring their knowledge about water in the classroom and to explain to the other children their relationship with water through drawings. The drawings were mailed and, when received in each country, they were used as a source of new information in the process, and as elements for further activities.

The postal exchage between schools (class twining) is an usual activity on environmental education. As Camino (1996) says, this kind of initiatives give the possibility to see the world through others eyes giving an affective, cognitive and emotional openness towards different people, cultures and environments. Cullingford (1996) mentions that the experience of other counties adds to children's growing awareness of their environment.

Looking for the perception of the environment as a planetary issue and the mutual understanding (which is normally the aim of this kind of networking activities on environmental education) leaves out an important aspect that emerge from it: the reflection upon the personal relationship with water. In order to explain to others how our water is, we need to explain it to ourselves, making a conscious relationship.

The action was divided through income and outcome activities. The activities were connected between them by an information flow and were set as a communication system that acts as a frame for the educational process. The actions became important not only by themselves but by the relationship between them.

The income activities, organized in different workshops, used the information about water that children already have. The aim was to construct the new knowledge about water from the structures that already exist. As Palmer says (p 328, 1996) "is critical that school-based education provides ample opportunities for discussion of ideas and beliefs, thus providing appropriate learning experiences which develop positive and accurate understanding". We have to consider that children are not empty vases and that, as Cullingford says (1996), their awareness of the environment and their analysis of it is developed far earlier that their experience of school.

Seventy-four children participated in the pilot project. Forty-four of them, from Mexico, were pupils at the Koala School and the Thirty from France were children from different schools that attend to the public library as an extraschool activity.

At the end of the income activities the children made drawings explaining their own relationship with water to the other children. In this case the exchange worked as a motivator for the outcome activities that were decided by the own children when they got the drawings. The teacher acted just as co-ordinator and facilitator. The French children decide to make a book explaining the activity, to expose the drawings they received at the library and to make a piece of theatre. The Mexican children made new drawings and letters about the experience and they send it to France.

Concluding Comments

Because each person has a different relationship with water, using the communication network and the reflection process as educational tools gives the possibility to have a flexible approach to the topic and address to the particular water conditions that the children and teachers have. As Walls (1996) says environmental education should lead to the development of autonomous thinking. It is in that sense that we must direct our efforts in education. It is not through imposition that we will develop a water ethic in people but through a personal decision.

The communication can be also use for the research on environmental education. It gives the frame for the evaluation process and the information that goes out from the system show us the perception and knowledge that children and teachers have about water.

Even if children had a lot of knowledge about water issues, in most cases there was not a connection between this knowledge and their life. They were more confortable talking about a water that was very far away (they used to talk about the ocean and the sea) than to talk about the water at their homes. There is a consideration that water and the environment's are very far from people and Gigliotti (1990) says people have selectively screened the environmental education message and constructed belief structures to support their own value systems rather than alter their lifestyles to any degree. In this way we have to reconsider environmental education, focusing our effort not only in the transmission of knowledge about water but in the mechanisms to make the relation with the resources conscious. Making drawings for children that are far away is a way to achieve it.

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WORKSHOP 13:

GLOBAL RESOURCE INFORMATION DATA EXCHANGE

Dr Michael Donahue, USA (Chairman)
Dr Sindre Langaas, Sweden (Rapporteur)

The main aim of the workshop was to present and discuss Internet-based information sharing and communication networks dealing with transboundary rivers and water bodies and their drainage basins. Furthermore, additional aspects on how to accommodate flows of data and information for decision making was dealt with. These presentations and discussion in particular focused upon the utility of Geographical Information Systems (GIS) and data visualizations.

Internet based information sharing

Experiences presented in this workshop described various cases in which Internet are successfully being used for transboundary environmental information sharing and communication. Examples were given from the bi-lateral Great Lakes region, the multi-lateral Baltic Sea region, and the tri-lateral Scheldt River basin. The Great Lakes Information Network (GLIN) in North America has evolved very successfully since 1993 as a steadily increasing community of partner organizations in the Great Lakes Region and a web site linking to a continuously growing number of on-line information resources and services, and thereby contributed to improved decision making. The BALLERINA (Baltic Sea Region On Line Environmental Information Resources for Internet Access) has used GLIN as model and has become a very important on-line information broker in the region. The Scheldt case - the REMSSBOT project and information system, currently under development - has a more narrow scope in the sense that it focuses relatively more on data than information.

Time to form an overarching transboundary waters information system, TRAWIS

Given the increasing number of emerging regional Internet based information sharing and exchange initiatives dealing with transboundary rivers, lakes and seas, the workshop strongly supported the proposal for an overarching Internet based global transboundary waters information system, initially named TRAWIS. Such a system should provide key facts or indicators for a large number of transboundary water regions by initially deriving those from existing global GIS data sets, and further provide annotated links to various on-line information resources dealing with the water regions. It was concluded that given the 'decentralised' nature of Internet, this would not replace any on-going major global programmes, but rather support and complement several on-going international efforts.

Communicating, visualizing and presenting data for improved decision making

A number of presentations clearly demonstrated that improved access to information through Internet is only a partial solution to the issue of 'information for decision making'. Other aspects and tools are needed. Some main conclusions resulting from the presentations and discussions were the following:

- It is of great importance to quite precisely know the decision making situation and its information needs to design best possible monitoring systems.
- The decision making value of conventional water quality (and other state of environment) data bases will strongly increase if simplifying indicators are introduced and visualization tools are offered.
- Geographical Information System (GIS) is a tool that should be increasingly more used within the water management community, both for analysis and for visualization.

BALLERINA - AN INTERNET BASED ENVIRONMENTAL INFORMATION CO-OPERATIVE NETWORK AND GATEWAY TO THE BALTIC SEA REGION

Sindre Langaas, Ph.D., BALLERINA network co-ordinator
UNEPIGRID-Arendal, c/o Dept. of Systems Ecology, Stockholm University, S-106 91 Stockholm, Sweden.
E-mail: langaas@grida.no WWW: http://www.baltic-region.net/

TRANSBOUNDARY ENVIRONMENTAL INFORMATION SHARING FOR DECISION-MAKING IN THE BALTIC SEA REGION

The Baltic Sea Region - a transboundary environmental region in transition

The Baltic Sea Region (BSR), here defined as the drainage basin of the Baltic Sea, can be characterised with the following basic facts -

* The world's second largest brackish sea

* Drainage area: 1,745,000 km2, (Sweltzer *et al.* 1996)

* Countries fully or partly within BSR: 14 countries (9 riparian: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Russia; 5 peripheral: Belarus, the Czech Republic, Norway, Slovakia, and Ukraine; Sweitzer *et al.* 1996)

* Population: Around 85 million, of which Poland alone accounts for 37 millions (Sweitzer *et al.* 1996)

The BSR has since the early 1970'ies had extensive environmental co-operation, mainly driven by the increased multiple type pollution to the Baltic Sea and the recognition of these problems as truly transboundary, thus demanding joint solutions (Westing 1989). The establishment of the first Convention on the Protection of the Marine Environment of the Baltic Sea Area in 1974 is a result of this recognition. The convention was the first international agreement to cover all sources of pollution, both from land and from ships as well as airborne. It was revised in 1992.

Until the disintegration of the Soviet Union and the unification of the two German states, the Baltic international environmental focus, as catalysed by HELCOM, was more or less exclusively directed towards the protection of the marine environment and activities on or in the Baltic Sea itself. The breakdown of the Communist regimes around 1990 has allowed for new and expanded activities and initiatives in the region. Of particular importance has been the increased possibilities to explicitly consider various economic and sectoral activities in the drainage basin, both when it concerns joint environmental management activities and exchange of data and information. This has also lead to a flourishment of new region initiatives and networks. See Stålvant (1996) for a quite comprehensive overview of the various actors and initiatives operating on the international level in the BSR.

Another clear trend in the BSR is the increased understanding and recognition of the interconnectedness between economic development and environmental problems. This is influenced by the increased international trend to seek much broader solutions to environmental problems than some decades ago. The concept of sustainable development, as re-invented by the Brundtland Commission in 1987, has been crucial to this understanding. Thus, the various international high-level initiatives started in the BSR this decade have had the broader sustainable/economic development - environment linkage as a starting point when considering the environmental problem issues of the region. Baltic 21 is probably the best and most recent example of this (Kristoferson and Stålvant 1996).

Further, as a consequence of the broadened sustainable development perspective but also for other reasons, terrestrial ecosystem and natural resource issues are now being considered at a BSR level. In these cases the drainage basin delineation of the BSR becomes less relevant. Baltic 21, for example, look into sectors such as energy, industry, agriculture, fisheries, transport and tourism, while regional scientific networks exist for issues like biodiversity (Ingelög *et al.* 1993)

What kind of information for transboundary decision-making in the Baltic Sea Region?

The answer to this question inevitably depends upon the view of the stakeholders of the BSR and their specific on-going (and forthcoming) decision-making processes. Historically, when considering the sharing of and access to environmental information for international, transboundary eco-regions, such as the BSR, the focus has been put on the governmental and intergovernmental bodies and their high-level decision-making needs. In the BSR, such bodies are represented by actors and initiatives such as the Helsinki Commission (HELCOM), the Baltic Seas Fisheries Commission, and the Vision and Strategies around the Baltic Sea 2010 (VASAB 2010) initiative, and their governmental representatives. As an example, the HELCOM Secretariat has as one duty, as specified in paragraph 22 of the 1992 Convention,

> "..i) to receive, process, summarize and disseminate relevant scientific, technological and statistical information from available sources;"

Although not explicitly stated, it is understood that the main target group for the information is the Contracting Parties, i.e.. the BSR governments, to the Convention.

In contrast, the very recent initiative Agenda 21 for the Baltic Sea Region (Baltic 2 1) started in 1996, has taken into account the more recent thinking about public participation and public access to environmental information (Kristoferson and Stålvant, 1996). Such thinking are now firmly recognised in an European context, still in many cases more on the conceptual than on the practical level (UN ECE 1995, Hallo 1997). The foundation for such reasoning is, besides the democratic aspect, the recognition that the actors or stakeholders on the environmental arena basically are individuals, being consumers of goods and services, acting as members of NG0s, being voters, being employees of various types of industries, and so on. Thus, for the individuals to 'think globally (or transboundary) - act locally' require a continuous provision of environmental information to guide in the everyday decisions to be made. In the BSR, humans as consumers, *homo consumus,* can in many respects be looked upon as key stakeholders and determinants for many of the environmental issues of the BSR, including the excessive nutrient pollution to the Baltic Sea.

Given the two extremes of the range of stakeholders and decision-makers in the BSR, the IGOs and the *homo consumus,* it is quite obvious that the scope and extent of possible types of environmental (including natural resources and sustainable development) information is virtually infinite. Thus, the ability of any BSR specific environmental information system to provide **all** the required information to the decision-makers at the low and high levels are impossible to achieve. In most cases, closed or internal spheres of information flow for the various stakeholder groups will have to provide the necessary input to the decision-making processes at both the low- and high levels. In an Internet context, this is commonly being termed Intranet. Yet, some commonalities in information needs can be found when it concerns the interfaces between the various stakeholder groups. These commonalities then can provide a first compromise solution to and practical delineation of the scope and content of a environmental information system to be designed. UN ECE (1995) has defined environmental information as

"..any information on the state of water, air, soil, fauna, flora, land and natural sites, and on activities or measures adversely affecting or likely to affect these, and on activities or measures designed to protect these, including administrative measures and environmental management programmes."

Given the above definition, one possible structural framework for various types of (state of) environmental information when it concerns the BSR environmental issues, is the P-S-R framework, or:

Pressure/Driving force ⇔ State of environment/natural resource stock ⇔ Societal response

This framework is commonly being used in State-of-Environment (SoE) or Sustainable Development reports (see Rump 1996, EEA 1997). The information in SoE reports are often based upon selected quantitative and aggregated indicators. SoE reports are available or under development for most of the countries surrounding the Baltic Sea, but good ones are currently missing for the Baltic Sea and the drainage basin itself (Denisov *et al* 1997). Within the Baltic 21 and the HELCOM, moves are now being taken to provide the BSR community indicator based regional reports. To better address the needs of individuals as stakeholders and actors, it further may be recommended to include environment and human health related issues, such as dietary advice on fish consumption.

Indicator-based SoE reports are typically brief and selective by nature. They ideally should be complemented with more detailed quantitative and qualitative information in both textual and graphical formats about the environmental issues, their pressures or driving forces, the state, distribution and dynamics of the issue or natural resource stock, and the societal and stakeholder responses to alleviate the of the environmental issue. In this context, scientifically and monitoring based information is crucial.

Basic key facts about the BSR, are another type of information needed as a fundamental background information for many decisions to be made. When dealing with international ecological or transboundary regions, the access to such information is neither straightforward nor simple. This is due to the fact that these regions transcends administrative and statistical units (Langaas 1997a). For example, when the 18 billion ECU Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) was elaborated in the early 1990'ies, neither the distribution nor the total amount of population and land cover for the entire and major BSR watersheds were known. It was not until a major research project in 1992 - 1994 created a comprehensive and seamless Geographic Information System (GIS) database of the entire BSR, that such basic facts became available (Sweitzer et al. 1996). Another good example of basic facts is the on-line BASICS statistical database comprising environmental, natural resources and sustainable development statistics about the BSR (Langaas 1997b).

Furthermore, detailed information about the various stakeholders and their different activities to reverse or improve the various (negative) environmental issues, should also be shared. This includes the various international agreements and initiatives at the high level, as well as at the grassroot levels.

BALLERINA - A REGIONAL MODEL OF INTERNET BASED ENVIRONMENTAL INFORMATION SHARING FOR IMPROVED DECISION-MAKING

Introduction

The advent of the Internet and in particular its World Wide Web component has made possible many new and fascinating avenues for environmental co-operation and communication. In fact, the Internet, with its integrated web-like structure, is ideally suited for use in collective efforts to build better communications and foster collaboration among the environmental research and management communities in international eco-regions, such as transboundary rivers and waterbodies and their associated catchment areas, possibly encompassing many Jurisdictions. With its relatively high simplicity (for the end-user) and steadily increasing diversity of tools and services offered to communicate, visualise, present, publish, various types of data and information it has proven to be a most revolutionary tool in Environmental Information Management.

Internet-based information sharing efforts now take place in many parts of the world. The Great Lakes Information Network (GLIN) (http://www.great-lakes.net/) in the bilateral Great Lakes region of North America and the BALLERINA initiative from the Baltic Sea region (http://www.baltic-region.net/) are two examples. The remaining part of this paper will deal with the BALLERINA (BALtic Sea Region On-line Environmental Information Resources for INternet Access). The BALLERINA initiative was proposed as a regional response to chapter 40 of Agenda 21 in 1996 and discussed thoroughly at a workshop held in June 1996. With financial support from the European Environment Agency, the Ministries of Environment of Norway and Sweden and the Swedish EPA, BALLERINA has in 1997 started its operational work. The First Annual BALLERINA Conference with some 80 participants was held in Riga, Latvian in May 1997. This meeting confirmed the great interest in BALLERINA.

BALLERINA aim and objectives

The overall aim of the BALLERINA initiative is to contribute to the sustainable development and thereby to the improved state of the Baltic Sea Region environment, by improving the availability and accessibility of relevant information on Internet for decision-making at all levels.

Main objectives are:

* To bring more substantive and relevant information on environment, natural resources and sustainable development from and about the Baltic Sea region to Internet.
* To make it easier for the increasing number of Internet users to find Baltic Sea region information on environment, natural resources and sustainable development by offering a user-friendly 'top-level' Baltic Sea Region web site - the BALLERINA web site.
* To develop a voluntary personal and institutional network of partners working towards the overall aim of BALLERINA.

The BALLERINA network

Partners

The institutional basis for the BALLERINA initiative is a large number of institutions with a mandate and interest in disseminating or communicating information (in English) on environment, natural resources and sustainable development about the Baltic Sea Region on Internet

* Partnership in the BALLERINA network is voluntary.
* Partners in the BALLERINA network are all those institutions and persons taking an active interest in the development of BALLERINA,
  = by providing pertinent information (in English) on environment, natural resources and sustainable development on Internet,
  = by participating in the Annual BALLERINA Conferences, and taking an active part in the discussion regarding the development of the BALLERINA initiative, or
  = by other means furthering the development of BALLERINA.

The Annual Conferences

The Annual BALLERINA Conferences, of which the first was held in Riga, May 1997, is the main forum for the BALLERINA partners to discuss and express their views concerning the development of BALLERINA. There, the following issues can be discussed:

* Institutional issues including composition of lead parties and advisory board
* The BALLERINA web site
* Joint Capacity Building activities
* Any Other Business

In addition, the Annual BALLERINA Conferences should give ample time for presentations and discussion on various Internet projects, products and initiatives.

Lead Parties

A strong lead party is required to have a dynamic, flexible and competent driving force underpinning the development of the BALLERINA initiative. At the First Annual BALLERINA Conference in Riga, May 1997, UNEP/GRID-Arendal and Stockholm Marine Research Centre were approved as lead parties for a period of three years.

Advisory Board

A BALLERINA advisory board is required to have a limited but competent and supportive group of partner representatives to oversee the development of BALLERINA and to give the necessary guidelines to the lead party in-between the Annual BALLERINA Conferences. As such, a membership in the advisory board can be considered an honourable position and a highly important and substantive function with respect to the aim and objectives of BALLERINA.

The advisory board are composed of 12 persons, representing a wide range of institutional types, from most countries in the Baltic Sea Region, with competence and experiences in the range of activities critical to the success of BALLERINA.

The BALLERINA web site; http:/lwww.baltic-region.net

The first version of the BALLERINA web site was launched on 29 April 1997, and is now continuously being updated. A section of the home page is shown below-

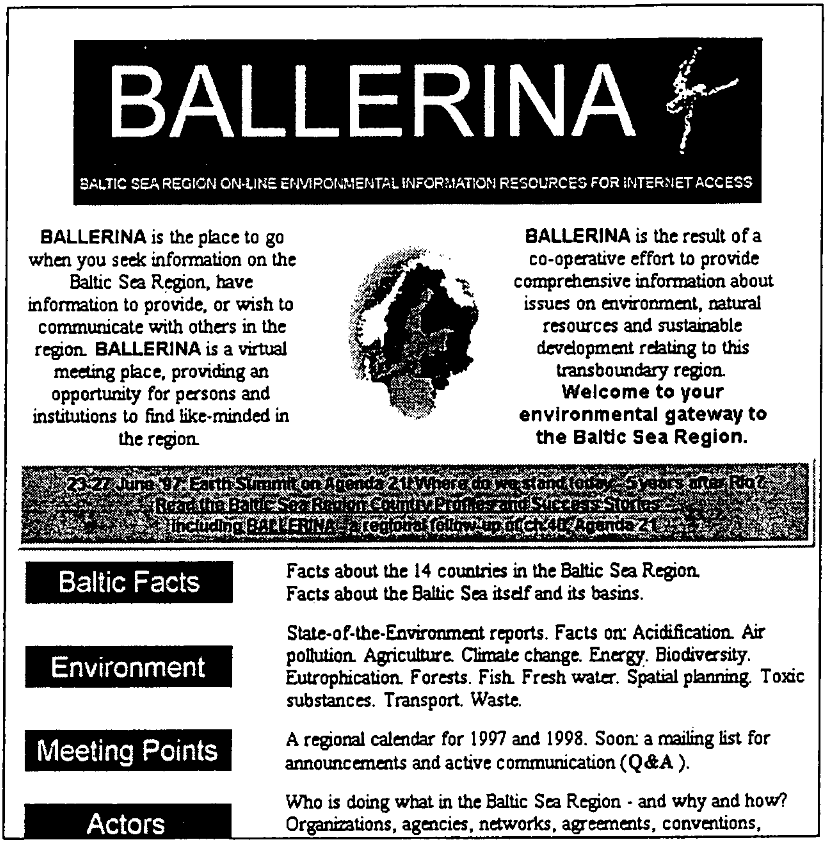

Figure. A section of the BALLERINA home page with some of the entry points to the information found through the BALLERINA web site - http://www.baltic-region.net/

The BALLERINA site offer possibilities to find relevant, internet-available information about environment and natural resource issues through a coherent, well structured, comprehensive and logically built and guiding web site. It aims to function as a well-informed and continuously updated gateway to information of interest in a Baltic Sea Region perspective for a broad spectrum of suppliers and users of information within and outside the region. Several hundred annotated links to web sites in the BSR and elsewhere containing relevant information are found.

The ambition guiding the construction of the BALLERINA web site has been to make it customary for anyone looking for information about environmental, natural resources and sustainable development issues in the Baltic Sea Region first to consult the BALLERINA site and its links to relevant sources. In other words, completeness is a strong ambition.

Furthermore, BALLERINA aims to be a virtual meeting place, encouraging communication and exchange of information and experience between like-minded within the Baltic Sea Region and with people world-wide expressing an interest in the region.

Capacity Building activities

Due to the different levels of capacities among the countries and institutions in the Baltic Sea Region both in publishing material on Internet but also to access on-line information, various types of capacity building activities and efforts are needed to improve this situation. These activities will primarily be targeted the CEE and NIS countries in the region. At the First Annual BALLERINA Conference in Riga, May 1997, the issue was discussed and a comprehensive package of various capacity building activities proposed. Obviously, any proposal concerning capacity building carefully needs to consider the specific needs of the institutions or countries concerned. Some components were:

* Network infrastructure support
* International, national and sub-regional BALLERINA HTML/web site construction training courses, possibly product-oriented.
* National/Regional BALLERINA Web-hotels
* Small equipment grants.
* Grant programs to support on-line publishing of valuable information

CONCLUSIONS

During the 1990'ies, following the disintegration of the Soviet Union and the unification of Germany, and the broadened views upon the interlinkages between (economic) development and environment, major changes have taken place in the joint environmental co-operation and decision making in the BSR. These changes can be summarised in some main points:

* Strong expansion into the drainage basin, when it concerns policy making, implementation and exchange of environmental data and information

* Increased recognition that the pollution to the Baltic Sea needs to be considered and managed in the broad context of sustainable development
* Increased focus upon additional environmental, natural resources and ecosystem issues found in the drainage basin
* A boom in regional initiatives from the grassroot (NGO) level to intergovernmental initiatives

Given these changes, the need for additional kinds of environmental information has expanded considerably compared to the earlier management regime rather strictly focusing upon the monitoring data of the marine Baltic Sea environment.

In response to the increased and changed needs for environmental information among the old and new decision-makers in the BSR, a comprehensive environmental information initiative based upon Internet has been designed. It has been named BALLERINA, which stands for BALtic Sea Region On-line Environmental Information Resources for INternet Access. The objectives of BALLERINA are to

* To bring more substantive and relevant information on environment, natural resources and sustainable development from and about the Baltic Sea region to Internet.

* To make it easier for the increasing number of Internet users to find Baltic Sea region information on environment, natural resources and sustainable development by offering a user-friendly 'top-level' Baltic Sea Region web site - the BALLERINA web site.
* To develop a voluntary personal and institutional network of partners working towards the overall aim of BALLERINA.

Although the BALLERINA network and web site has been operational for a limited time period, it appears to confirm the understanding that Internet is extremely well suited for use in collective efforts to build better communications and foster collaboration among the environmental research and management communities in international eco-regions, such as transboundary rivers and waterbodies and their associated catchment areas.

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THE GREAT LAKES INFORMATION NETWORK: YOUR BRIDGE TO THE GREAT LAKES REGION

Carol Ratza, Communications and Information Management Program Manager and GLIN Director; Paula Mcintyre, Communications and Information Management Project Manager and GLIN Webmaster; Great Lakes Commission, 400 Fourth St., Ann Arbor, Michigan, U.S.A., 48103

Abstract

Communication is the cornerstone of any strategy to promote the sustainable future of large multi-jurisdictional watersheds. To facilitate quick and accurate information exchange, the Great Lakes Information Network (GLIN) links hundreds of agencies and organizations in the U.S. and Canada, via the World Wide Web and other Internet-based communications tools. This highly successful network brings the highest quality data and information directly to decision makers in the public and private sectors with maximum efficiency and minimum content control. The GLIN model identifies three pathways, subject, geographic and administrative, to all information available through the annotated index. New directions for 1997/98 include development of a regional information harvester, a GIS online mapping system, and infusion of the GLIN online resources into the region's classrooms. GLIN is located at http://www.great-lakes.net.

Introduction

Communication is the cornerstone of ecosystem protection and sustainable development efforts in the binational Great Lakes region. The integrated nature of the Internet and information dissemination tools such as the World Wide Web are ideally suited for use in our collective efforts to better manage the complex Great Lakes ecosystem. The key ingredient, however, in using the Internet to foster sustainable development, is not technology, it is people. The Great Lakes Information Network links committed partners, representing all levels of government, universities, business and industry, and the non-profit sector. GLIN partners promote a strong regional economy and healthy environment by working actively online to

- provide access to a wealth of data and information;
- build bridges between the public and private sector; and
- develop and share new technical and decision-support services.

When you visit the GLIN web site, www.great-lakes.net, you'll find that GLIN's content spans a broad range of topics, including environmental quality, resource management, transportation, demographics, economic development, manufacturing, travel and tourism, and much more. Often, new users are surprised that GLIN is not just a 'water information' or 'environmental information' service. We have deliberately designed GLIN's base resources to reach well beyond traditional environmental and natural resources data and information. We believe that fostering sustainable development in large multi-jurisdictional watersheds means building bridges – across national boundaries, and across the interests of the business and industrial users, recreational number of transactions logged anywhere on the GLIN central index totalled more than 40,000 each month.

Over the past three years, the Ameritech grant was augmented with grants from the National Telecommunications Information Administration of the U.S. Department of Commerce; the Great Lakes National Program Office of U.S. Environmental Protection Agency; The U.S. Army Corps of Engineers, Detroit District; Environment Canada; Council of Great Lakes Governors and another large grant from Ameritech. Also, GLIN has secured substantial inkind contributions and commitments for future collaboration from many other Great Lakes partners, including the U.S. Federal Reserve Bank of Chicago, several large universities, and numerous state and provincial agencies. To date, GLIN has received more than $1.3 million dollars in grants and cooperative agreements.

Core services, including index development and population, partner training and help desk, system administration, email list services, program management and fund raising are supplied by a staff of four people at the Great Lakes Commission offices.

Products

GLIN continues to progress toward its intended goal: to provide participants throughout the Great Lakes community with immediate access to regional experts from diverse disciplines, and data and information such. Our products include

- Inventories of socioeconomic and environmental research activities to enhance coordination within the research community and transmit results to policymakers. (Lead Agency: International Joint Commission)

- Air emissions data collected by the Great Lakes states and province of Ontario to assist in Clean Air Act implementation efforts. (Lead Agency: Great Lakes Commission)

- Business and industry statistics, trends and projections to assist economic development strategies. (Lead Agencies: Federal Reserve Bank of Chicago; Northeast-Midwest Institute)

- State, provincial, and federal legislative, regulatory and policy developments affecting Great Lakes interest groups. (Lead Agency: Northeast-Midwest Institute)

- Toxic contaminant and human health effects data to strengthen the binational focus on critical issues. (Lead Agency: U.S. Agency for Toxic Substances Disease Registry)

- Real time lake levels statistics, historical data and trends to assist shoreline residents, businesses and local officials in land-use planning and coastal protection efforts. (Lead Agencies: The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, including U.S. Army Corps of Engineers; National Oceanic and Atmospheric Administration, Great Lakes Environmental

2) Provide one-stop shopping access to a broad range of regional resources, including information, data, news and analysis focused on the region's environmental protection, resource management, economic development, human health issues and more.
Here GLIN provides a regional gateway to the full array of Internet services provided by partner agencies, including World Wide Web; newsgroups; email mailing lists; and file transfer. GLIN continues to develop these services, and is building new tools to expedite this process, including a regional search engine (that works much like worldwide search engines such as Alta Vista) to harvest data and information from GLIN partner servers.

The GLIN philosophy encourages stakeholders in the region to maintain and be responsible for their own data, but to link to similar data and information anywhere in the system. Once a user is online at a site managed by a GLIN partner, the rest of the Great Lakes community is no more than a hypertext link away.

As a cooperative effort, GLIN relies on the commitment and experience of each member agency or organization to enhance network services and provide meaningful data and information to the Great Lakes community. GLIN does not provide quality control or quality assurance of partner data and information. Because we link to the highest quality data sources, we can rely on their internal review and quality assurance. GLIN also relies on participants' interest in coordinating presentation of meaningful data and information to provide a multitude of inter-agency links throughout the system. In fact, our comitment to centralized access and decentralized control is a cornerstone of our success.

3) Foster use of electronic communications tools by groups of scientists, policymakers and others who are collaborating on basinwide projects.
Committee and task force work is a way of life in the binational Great Lakes region. Multi-agency, multi-jurisdictional responses to the issues facing the region require cooperation and coordination at all levels. GLIN helps formally-mandated groups, such as a state/federal task force writing software for toxic air emission estimation, as well as more ad hoc collaborations, such as a group of research scientists and industries sharing information on new pollution prevention techniques. These groups use GLIN to transfer data files, download and test software; hold private email discussions, exchange email, solicit reviews and comments, and set up and mirror web sites to disseminate results to the general public.

History

GLIN development began in May 1993, with funding provided by the Ameritech Foundation. GLIN leadership and administration is provided by the Great Lakes Commission.Technical support is provided by one of the region's Internet backbone providers, CICNet Inc., a cooperative network of the large research universities. The services provided by CICNet have been a key component in GLIN success.

By early 1994, GLIN, online less than one year, had developed a sound framework to provide access to the broadest possible range of data and information and individuals in the Great Lakes region. Growth in GLIN usage has been phenomenal. By July 1997, the and coordinating data delivery with other similar providers. We have moved well beyond this training stage. Now, GLIN is a mature resource; it is frequently the first place that people look for data and information about the region, and partner agencies have integrated Internet-based services into their general operating budgets and work plans.

One of our first efforts was targeted toward demonstrating the advantage of electronic connectivity by providing seamless access to the interconnected environmental, economic, policy and health resources associated with 43 of the region's most polluted shoreline cities, or "Areas of Concern." People responded very positively to our efforts to mirror the complex relationships between stakeholders and data and information sources in these coastal communities with a web of connections linking many of these data and information sources. GLIN's Area of Concern site remains one of the best examples of successful binational online collaboration and information sharing successfully tackling a problem that was just too big to be managed by conventional means of communication.

Beyond this, Internet connectivity has proved useful in many aspects of agency/organization management. Many partner agencies have developed applications that go well beyond our original goals. For example, they use the Internet to help streamline communications between industry and government, thus expediting data transmittals and permit review; sell hunting, fishing and boating permits and licenses; and coordinate with staff in district offices. Thanks to our collective effort to bring the region online for ecosystem management, partner agencies are earning dividends in numerous unexpected ways.

By building upon the well-developed high speed Internet backbone in the region, GLIN merges the wealth of new communications technology at our disposal with the long history of partnership. Although GLIN's most obvious talent has been the development of a vast regional indexing system, GLIN is not just a web site. It is an umbrella information service that helps agencies and organizations a) develop Internet access; b) provide one-stop shopping for high quality Great Lakes regional data and information; and c) develop and share tools to aid collaboration among experts across the region.

There are specific strategic actions associated with each of these objectives.

1) Develop Internet Access.
Here our goal was to bring partner agencies and organizations online with full ability to use Internet services. To this end, GLIN staff and advisory board members traveled to state, federal and non-governmental agencies across the region. After a needs assessment, GLIN provided a host of services including demonstrations for senior management; line staff training; analysis of connectivity requirements and costs; "firewall" seminars; space on the GLIN host server to pilot Internet dissemination of agency data and information; dial-up services; troubleshooting; and, on occasion, help configuring hardware and software and domain name service. This component of GLIN development has been successfully completed. New partners need far less assistance than those who joined GLIN in the early days of 1993-94. Many companies now exist to provide these services; now, we encourage partners to purchase these services from local providers.

users, environmentalists, university researchers and policy makers. You can find just about every kind of environmental or natural resources data on GLIN — and you can also find the latest information on advanced manufacturing competitiveness, great places for a weekend getaway, and economic indicator data including housing starts, motor vehicle production and the midwest manufacturing index. We hope that users who come to GLIN with limited interests, will stay to learn more about our vibrant and beautiful region and our efforts to protect and enhance it.

A New Era for the Great Lakes

The Great Lakes of North America--Superior, Michigan, Huron, Erie and their connecting channels form the largest fresh surface water system on earth. If you stood on the moon, you could see the lakes and recognize the familiar wolf head shape of Lake Superior, or the mitten bounded by lakes Michigan, Huron and Erie. Covering more 94,000 square miles and draining more than twice as much land, these Freshwater Seas hold an estimated 6 quadrillion gallons of water, about one-fifth of the world's fresh surface water supply and nine-tenths of the U.S. supply. Spread evenly across the contiguous 48 states, the lakes' water would be about 9.5 feet deep.

These lakes greatly affect our way of life, as well as all aspects of the natural environment, from weather and climate, to wildlife and habitat. Yet for all their size and power, the lakes are fragile. In the past, this fragile nature wasn't recognized, and the lakes were mistreated for economic gain, placing the ecosystem under tremendous stress from our activities. Today, we understand that our health and our children's inheritance depend on our collective efforts to wisely manage our complex ecosystem.

Over the past 40 years, the Great Lakes Commission, a compact agency of the eight Great Lakes states, has worked with hundreds of agencies, organizations and individuals to create a cooperative environment in which to develop regional answers to the Great Lakes ecosystem's unique environmental and economic challenges. The decades-long effort to build joint commitments to a sustainable economy and protect the Great Lakes Basin ecosystem has developed gradually through meetings, telephone conferences, newsletters and joint projects. This conventional "low tech" approach to what is increasingly a "high tech" challenge is no longer efficient — in and of itself — or cost-effective.

When we first visualized the GLIN network, we recognized that navigating these consultative and collaborative processes into the information age and linking geographically diverse agencies and organizations via a computerized information exchange network was a large, but technologically feasible challenge. In the nearly four years since GLIN came online, we have come a very long way toward meeting that challenge by building a cooperative network supported by a number of public and private funders, by encouraging federal communications policies on both sides of the border and by broad regional interest and commitment.

GLIN has grown far faster than expected. In the first two years of network development, GLIN played an important educational role for the region, GLIN brought Internet experts into agencies and organizations to help educate managers and technical staff on issues as diverse as setting up servers, connecting to the Internet, establishing firewalls, Research Laboratory; Environment Canada; and Canada Department of Fisheries and Oceans)

The GLIN Advisory Board oversees and assists in all aspects of GLIN development and outreach. Membership includes representatives from state, federal, provincial, non-governmental and other organizations.

GLIN Information Infrastructure

GLIN Network Server

The GLIN Network server was established within weeks after the start date of the project in 1993, with the name great-lakes.net coming online in August 1993. It resides at a CICNet high speed (T4) node in Ann Arbor, Michigan. Usage and storage needs are constantly monitored and upgraded when necessary. GLIN services reside on an 167Mhz UltraSPARC with 256MB of RAM, and a Kingston DataSilo rackmounted disk enclosure with contains two 2GB drives and five 4GB drives, all setup with DiskSuite to give approximately 12GB of usable disk space.

GLIN Web Site Organization

GLIN has more than 280 index pages, linking to many times that number of resources at partner web sites. GLIN staff have developed a model that supports two simple principles for use by agencies and organizations serving information via the Web: 1) provide access to the same information from multiple pathways; and 2)provide many interesting links up front; don't bury them.

The GLIN model for information and data dissemination accommodates three different pathways into information: geographic, subject and administrative. Statistics and feedback indicate these pathways are the most likely routes to information that people follow. Examples of these pathways, as implemented in GLIN, include

Administrative: Organizational links are available throughout GLIN. They bring users directly to an agency or organization's home page.

Subject: Our subject links reflect the wide range of topics important to the sustainable development of the Great Lakes region. Subject links are made directly from the GLIN index to relevent data and information files located on the websites of partner agencies.

Geographic: Geographic links are map-based or textual links to information about a locality, lake basin, pollution hotspot, tourist site, or other physical area in the region.

Statistics also indicate that links buried several levels into a web site don't get as much attention. The most frequently hit pages are those linked directly from the home page. As a result, GLIN has been redesigned to provide more link options for people to pursue right from the main pages.

Mailing Lists and FTP

GLIN staff have created and manage several email lists. These include general lists like "GLIN-announce," designed to reach a wide community of Great Lakes interests (more than 500 individuals), and specific lists like "airtoxics," "GLIN-board," "P2Tech," and others that provide direct communication for regional task forces, and specific Great Lakes communities. In addition, the GLIN network server provides the community with an anonymous ftp server for disseminating large documents and software.

A Look to the Future

Here's a look at what we have on the drawing board for 1998, one funded project we are currently working on, and two project ideas that are currently being considered by funding agencies.

Current Development Effort

Currently, GLIN partners are working to create a harvesting mechanism that searches selected machines across the region and interactively harvests information. We have developed an extensive taxonomy that provides the basis for the search, and now have a demonstration online on the GLIN search page. The goals of this effort are to ease information and data access to that subset of data that pertains to our region of the world; to automate many of the tasks of the GLIN web developers; and to provide ready access to data and information stores that are being updated daily.

New Proposals

Online Spatial Data Sharing and Integrated Mapping: Great Lakes GIS Online – Several U.S. and Canadian federal and state agencies have agreed to populate an online library with numerous data sets, including the Great Lakes shoreline, soils, land use and land cover, hazardous waste sites, demographics, watersheds and transportation. The project will also deploy a commercial online GIS application (ArcInfo-based) that makes use of many of these data layers so that visitors to the web-based system can create their own maps. The greatest and most cost-effective benefit that the Great Lakes GIS Online project will provide is institutionalization of a mechanism to build regional cooperation and collaboration in spatial data sharing over the Internet. This proposal was submitted to U.S. EPA, Great Lakes National Program office for consideration.

Cyber City-Schools (C^2S): A Challenge for Great Lakes Cities -- We hope to network K-12 classrooms and community sites from eight cities on the Great Lakes into a new "virtual" learning community, providing them with a learning experience that addresses the the need for an information/multimedia literate citizenry in the 21st Century. The project is intended to engage teams in cooperative learning experiences that use GLIN's real-world data, and to support the production of multiple media products that integrate a wide-range of new and emerging information technologies. It will create, over a five-year period, a network of 200 project sites, connecting schools, mentor schools and agencies and organizations in focused efforts to enhance and enrich student learning.

GLIN Tour

The snapshot of some of the Internet data and information services of GLIN partners provided next is fairly indicative of the state-of-the-art in our partner agencies, and also demonstrates the subject, administrative and geographic pathways through the GLIN universe.

Our GLIN tour brings us from the main GLIN homepage, http://www.great-lakes.net , to a geographic view of the Great Lakes region, and a look at resources accessible by jurisdiction or lake. We'll take a look at the broad range of topics covered in several GLIN subject listings, including environment and economy. And we'll demonstrate the power of coordinated data delivery by moving to a clickable map to access realtime water level data delivered from servers located in several federal agencies in the U.S. and Canada. Then, we'll see how this same information can be accessed from the Administrative pathway. Finally, we'll look at some other GLIN services that go beyond the web, including our email list services for pollution prevention, regional announcements, and partner of the month program.

Accessing GLIN from the Internet

World Wide Web	http://www.great-lakes.net/
Anonymous FTP	ftp.great-lakes.net (pub/great-lakes)
E-mail lists	GLIN hosts several e-mail groups on topics such as pollution prevention, education, air emissions, and the most popular list, announcements concerning the Great Lakes region. To join a GLIN e-mail list, send a message with "help" in the body to the listserv machine, *majordomo@great-lakes.net*

THE INFORMATION CYCLE - A FRAMEWORK FOR THE MANAGEMENT OF OUR WATER RESOURCES

Jos G. Timmerman, MSc, Janneke J. Ottens, PhD, Institute for Inland Water Management and Waste Water Treatment RIZA, P.O. box 17, 8200 AA Lelystad, The Netherlands

Summary

The need for tailor-made information for water management becomes more urgent with growing flows of information, since more data from different disciplines are combined and the exchange of data between organisations increases. Especially, the exchange of information calls for comparability of data. The process of defining a useful information product requires a common framework to support a dialogue between information users and information producers. The information cycle provides such a framework, describing the respective steps in the stream of information gathering. The most important step in the information cycle is the specification of information needs. By specifying the functions and uses of a water body and by defining the use of the information product, the information needs become clear. Indicators are essential in this process.

Introduction

Increasing knowledge of the complexity of processes in water systems has lead to a growing demand for information. Next to this, computers provide numerous possibilities to collect and handle data, thus multiplying the availability of data. Moreover, with the introduction of integrated water management, different aspects of the water system like physical planning, ecology and emissions must be interrelated, each of these aspects bringing about many data to be considered. Nowadays, information users like policy-makers or water managers are loaded with this information, that may or may not be of use to them.

In this situation, there is a call for less information, that is better tailored to the information user. Information should no longer be hidden in facts, tables and statistics, but it should be presented in clear, easy to understand graphs, preferably with colours indicating a good or bad status. The challenge for the information producers, research and monitoring organisations, is to aggregate available data to accessible, actual, integrated and, above all, tailor-made information.

However, a major problem is to make clear exactly what information is needed. Information users tend to pose questions like 'Is this country safe against flooding?' or 'What will be the consequences of dry years for agriculture?' (Hofstra, 1994). On the other hand, the information producer tends to give answers like 'The maximum water level is 34.6 m above mean sea level' or 'pH is 7.8'. These questions and answers reflect different worlds that will have to be linked together through communication.

Need for Communication

Water management is not a matter of countries since running water does not stop at the national border (De Jong and Timmerman, 1997). Therefore, water management should be carried out based on information of hydrological relevant borders of water bodies rather than along administrative borders (UN/ECE TFMA, 1996). This brings about the need for water management organisations to exchange information on common water bodies, thus increasing the flow of information. A complicating factor is that the exchanged information often is hard to compare because of differences in definition of similar conceptions between water management organisations. The additional information from other parts of the water system may therefore be inapplicable to its purpose.

To tackle this problem, water management organisations should find a joint basis for exchange of information, linking common interests into a successful information network. But then again, the problem remains to specify the necessary content of the information exchange. To be able to communicate information, communication on information needs is inevitable. But where to start this communication?

The Information Cycle

To define information networks, information producers and information users of water management organisations involved should jointly specify the information that is needed. As a basis for this discussion, the information cycle (figure 1) has been developed as a common framework. The information cycle describes the process of information production.

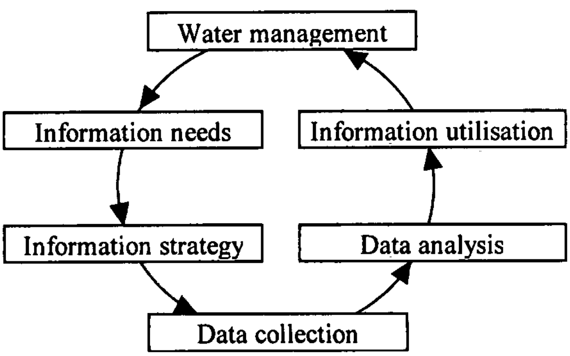


Figure 1 Information cycle (Timmerman and Hendriksma, 1997)

The first and most critical step is to specify the information need. This is the step to identify what information is really needed, but even more important why this information is needed. There are several types of data that may provide information about the same problem. For instance information on pesticides may come from concentration in water or from amount per unit of surface applied by farmers.

Depending on the type and accuracy of the information needed and the purpose for which the information will be used for, one or more of these types of data should be collected.

The next step is to specify how the information will be produced. Depending on what the information will be used for, different strategies in information collection should be used. For instance for policy preparation and evaluation long-term trends are important whereas for operational water management data have to be available on instance (Timmerman and Hendriksma, 1997). Strategies to collect information may be a.o. elaboration of a monitoring network, performing an inventory or calculation with the use of models.

The third step deals with the collection of relevant data. Depending on the strategy used, different activities may be distinguished. For instance in a monitoring network activities are the network design, sample collection, laboratory analysis and data handling (figure 2).

Data analysis is the fourth step in the information cycle. Huge amounts of available data have to be aggregated into clear information. This requires understandable and clearly arranged assessment methods that have to be approved by all parties involved (Timmerman and Hendriksma, 1997).

In the final step, produced information is to be used in water management. Conclusions from the collected information should be discussed in a dialogue information users and information producers to clarify nuances and to take away any vagueness. Next to that, information users should make clear what information has been used and what information has not been used (Timmerman and Hendriksma, 1997). This is to prevent that on the one hand unused information will still be produced in the future and on the other hand information that has been used is not actualised anymore [Timmerman *et al.*, 1996].

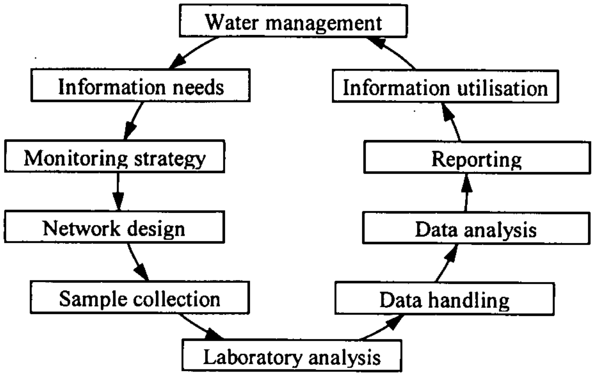


Figure 2 Monitoring cycle (UN/ECE TFMA, 1996)

Usually, at the moment the produced information has to be used, it appears that the obtained information does not satisfy the need. Reasons for this can be:

- Specification of information need is insufficient;
- The information need as specified is not the factual information need;
- The strategy to collect information has not come up with the right information;
- The obtained information generates new questions;
- The situation has changed (by e.g. new policies), causing other information to be needed;
- New methods have been developed, that until recently were not available;
- The information is not presented in a comprehensive format.

Therefore, new information is needed. This (changed) information need must be determined and the process will start from the beginning. Because we have learned from the previous process, this next cycle should lead to better tailored information (Timmerman and Hendriksma, 1997).

Specification of Information Needs

Information is needed for water management and water policy. The essential question is: what information is needed? Information users usually have general questions that have to be translated into data to be collected by the information producers. In different water management organisations, translation of the same question may result in different data. So what is needed is a dialogue between information users and information producers from all water management organisations involved. This dialogue should result in a specification of the issues on which information is needed and the type of information that has to be produced.

To analyse and specify the issues, we have to deal with the triangle of core-elements in water management: functions and use of the water, problems and threats for this use and measures that may be taken (figure 3). A full picture of the problem only becomes clear when the information on all three corners of the triangle have been dealt with. An example: Does sand suppletion (measure) guarantee maintenance of the shoreline as defence line (function) against erosion (problem) [CIW/CUWVO, 1996].

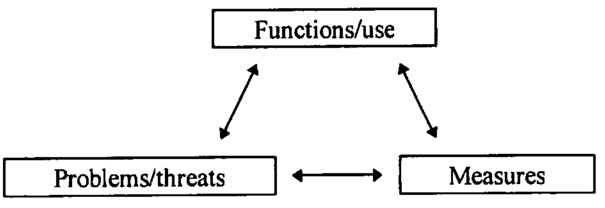


Figure 3 Core elements for water management (UN/ECE TFMA, 1996)

A first, easy, step is to specify the relevant functions and uses of the water. By analysing the requirements for water quality and quantity for each function or use, a first idea of the needed information is obtained. Then, water quality and quantity may be affected by the use of the water. Analysing these effects provides insight in problems that may occur. Other problems, not directly related to functions or uses like sedimentation or erosion, or plans for new developments like industry or waterworks, may be relevant and should be analysed. Finally, there may be a need to evaluate measures taken or information may be needed to be able to evaluate future measures.

Usually, after collecting and analysing data, information producers start to think about how the information should be applied to its purpose. The result is that the information obtained does not match to its purpose. Therefore it is important to specify the use of information while thinking about what information is needed. So the next step in specification of information needs is a division into the necessary information [CIW/CUWVO, 1996]:

- Information for policy evaluation: This information is linked to the policy as defined. The starting point is the existing or desired function and resulting information should show to what extent problems are still relevant and measures have had the effect aimed for.
- Information for policy preparation: Information on future developments is needed. Major sources are experiences, also from other parts of the world, and extrapolation of developments.
- Information for operational water management: Essential is the possibility to react instantly.

Also, the necessary level of detail and accuracy of the information should be specified. By this defining of the outcome of the information system, a better fit will result.

The Role of Indicators

Policy makers and water management bodies face this challenge of managing the complex spatial and temporal cause effect chains in watersheds. Sustainable water management asks for an integrated approach, but different functions and uses of a waterbody may lead to conflicting interests. To be able to manage this complex of interests, proper information is vital. Indicators become increasingly important in providing this information, since their function is communication, simplification and quantification of information on a system. However, indicators are yet not completely accepted or applied in water management. Partly, this might be the result of a general confusion on what indicators are and the lack of knowledge/experience on possibilities and limitations of the use of indicators.

Indicators play an important role in the information system. In specification of information needs, after making a first analysis of the water related issues, indicators can be used to come to a further specification of what information has to be collected. Here we will define an indicator as:

- an observable and measurable quantity/variable/parameter
- representing a phenomenon/(management)process in the environment
- having significance beyond its face value, possibly at a higher aggregation level

For example, in international river basin programs as "Salmon 2000" for the Rhine and the return of the beaver in the Elbe, the return of a popular species is often stated as an objective of ecological restoration measures also to increase the social acceptance of these measures. They represent an aggregation of underlying functional processes.

The use of indicators implies also a implies a specification of the information utilization. The aim of the use of indicators can be:

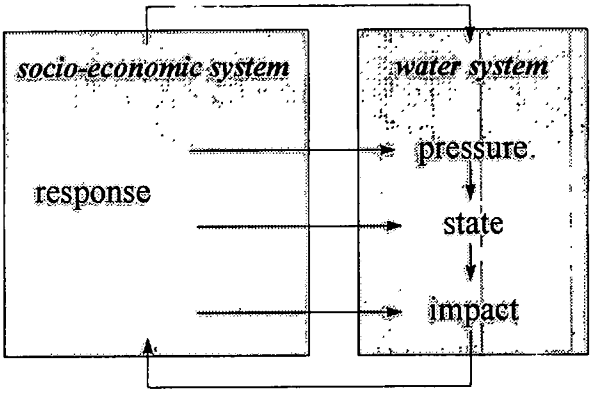
- reporting state of the environment
- evaluation of effectiveness of policy measures
- comparisons between countries/regions or between functions/uses
- communication tool between policy makers, "monitors", and the public

In practice indicators will be a result of a compromise between scientific accuracy, concise informativeness and their use for strategic decision making. Besides application of indicators to aggregate information, also visualization techniques can be used, as tables, diagrams, line charts, and maps.

When using indicators, one has to take into account, that most indicators are constrained to a certain place and time. Its characteristics will depend on:

- spatial scale and geography
- aim (information utilization)
- processes in a system (climatic conditions)

Therefore, rather then recommending the use of certain indicators, we would like to propose a general framework of indicator use/choice, that allows for the development of tailor-made indicators, but also for more compatibility of the outcome. The framework includes issues, functions, uses, target groups, but also parts of the cause-effect chain as pressure, state, impact and response. Like an environmental cycle this so-called PSIR concept includes two objects: the socio-economic system and the water system. The water system consists of three sub-objects: pressure, state and impact systems. The pressure shows that human activities concerning a water system can cause changes in quality and/or quantity of the water, which results in a new state. The impact of changes in the state can influence functions and uses of water. It is likely that there will be "human" response, which aims at a new balance of the water system and the protection of functions and uses. State and impact can be nearly similar; e.a. the impact (sub-object) can be the state (sub-object), that considers the function attached to the water system. The OECD (Organisation for Economic Co-operation and Development) for example combines both together within state.



PSIR-concept
(after van Harten et al., 1995)

As an example, the influence of liquid manure on a groundwater system in relation to the use of groundwater as a source of drinking water is supposed. An indicator for the pressure on the groundwater system, could be the nitrogen load of the soil (kg/ha/yr). The NO3- concentration in shallow groundwater can be selected as an indicator for the state of the system and the impact, the suitability for use of groundwater as a source of drinking water. A response indicator could be the percentage of the total amount produced liquid manure which is processed in a way that is not harmful to the environment.

As stated before, questions within water management are related to the core-elements, functions/uses, problems/threats and measures, of the water under consideration. However, different functions and uses may have conflicting requirements to fulfill. Since most indicators will be linked to functions and uses, they can be a tool to prioritize the different needs or to integrate requirements linked to the different functions/uses and therefore can be very helpful when specifying information needs.

Also, indicators might be helpful in the exchange of information, if the indicators are determined in a harmonised way. For every eco-region, for instance, different indicator species might be chosen, that reflect the same degree of ecological restoration and represent an aggregation of the underlying functional processes. When comparing these indicator species between different eco-regions, they represent a similar degree of ecological integrity/quality.

	pressure	**state**	**impact**	**response**
target groups	hh, ind., agric.			hh, ind., agric.
functions *drinking water supply* *industrial water supply* *agricultural water supply* *Ecosystem* *navigation/transport* *recreation* *hydropower & cooling*				

hh=households
ind.=industry
agric.=agriculture

Framework for indicator selection

International Examples

Recently, a series of pilot projects has been started as part of the work of the UN/ECE task force on Monitoring and Assessment. Its objective is to test the applicability of the UN/ECE Guidelines on Water Quality Monitoring and Assessment of Transboundary Rivers (UN/ECE TFMA, 1996), when setting up new small-scale joint transboundary monitoring programs. A major step in this project is the tailor-made specification of information needs. Defining information needs involves asking many questions until the right questions come up. These questions should be specified further within the framework of the overall water management objectives and should consider the requirements that result from preceding and following steps in the information cycle. Most questions will be related to the specific functions or uses of the water under consideration. However, different functions and uses may have conflicting requirements to fulfil. For transboundary waters an additional complicating factor is the harmonisation of requirements and information needs of all countries involved.

National Information Specification

In 1996, the Dutch Directorate-General for Public Works and Water Management started the project 'Measuring strategy 2000+'. The aim of this project is to develop methods to produce complete information of good quality in an efficient way. One of the activities in this project is to develop a methodology to specify information needs. Some pilot studies in this activity have been carried out. One of the conclusions from these pilot studies was that from different working levels, the people concerned have to be brought together to get a full view of the problem at hand.
Next to this, the fourth national policy document on water management is now under preparation. After summer, the existing national monitoring network will be reconsidered in view of this national policy document, starting with specifying the information needs of national policy-makers.

Conclusions

Integrated water management brings about the need to combine data from different disciplines and the need for water management organisations to exchange data. With these extending flows of information, tailoring of the information product is needed. The information cycle offers a framework as a basis for the dialogue between information users and information producers to tailor information to the needs. Summarising, the main principles of the information cycle are:

1. The information need is collectively agreed upon and related to the information utilisation. This is the starting point for the production of information.
2. The cyclic character guarantees regular evaluation of the gathered information, thus taking care of up-to-date, tailor-made information.

In several projects, the information cycle is being used as such. However, the major challenge is to specify the information needs to such detail that the resulting information producing system will meet the factual information need. Indicators play an essential role in this. A methodology for specification of information needs is under development.

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WORKSHOP SPEAKERS

WORKSHOP 1. AN ECOSYSTEM APPROACH: DRAINAGE BASIN AND COASTAL SEA AS A WHOLE SYSTEM

Large marine ecosystems: Assessment and management from drainage basin to ocean
Mr Kenneth Sherman, USA, Invited speaker

A case study of a specific tool to follow the particulate matter and pollution carried by particles from the Rhone River to the N.W. Mediterranean Sea
Ms Mary-Helene Noël, Japan/France, Young speaker

The southern seas (Aral, Caspian, Azov and Black) under anthropogenic stress conditions
Dr Vladimir Kuksa, Russia

Critical areas and water quality in the agricultural watershed located in the Chesapeake Basin
Mr H B Pionke, USA

Sustainability and regional ecological debt: Watershed ecosystem approach
Dr Irina Glazyrina, Russia

Nepalese concern on ecosystem to regulate highland lowland. Interactive linkage: Regional effort may be both assimilative and productive
Mr Chiranjeevi L Shrestha (Vaidya), Nepal

How can we control the tropic status of coastal environment for maximum sustainable use of the ecosystem?
Professor Osamu Matsuda, Japan

The Seto Inland Sea, Japan - A highly productive and efficient sea
Professor Shin-Ichi Uye, Japan

Review of the balance sheet of nitrogen and phosphorus in eutrophic semi-enclosed seas - Influx of N and P from the outer ocean
Associate Professor Tateki Fujiwara, Japan

An integrated approach to evaluate the role of the macro-zoobenthos on the dynamics of biophilic elements in a tidal estuary in the Seto Inland Sea
Professor Shigeru Montani, Japan

The recent history of the Lake Victoria ecosystem. Euthrophication and biodiversity decline
Mr Robert E Hecky, Canada

Some remarkable ocanographic features of the Gulf of Thailand and their consequences on biogeochemical processes
Mr Anund Snidvongs, Thailand

Impact of the Dniestr River flow on the quality of marine environment of the Black Sea and its reduction
Mr Volodimir Kuznetsov, Ukraine

Biological and hydromorphological processes in the Pregel River estuary (Vistula Bay, Baltic Sea) and human activity in the drainage basin - Interrelations and interdependence
Ms Lena Ezhova, Russia

The role of environmental monitoring in the scientific understanding of temporal changes of nutrient transports in Swedish rivers
Dr Anders Wilander, Sweden

Nutrient species in Lake Edku, an Egyptian coastal lagoon transporting contaminated drainage water to the Mediterranean Sea
Professor Massoud A H Saad, Egypt

Coastal development and pollution impact on the distribution of macro benthic communites along the north western coast of the Red Sea (Egypt)
Mr Mohamed M El-Komi, Egypt

Delineation of onshore and coastal water contamination at some parts of the east coast of India
Dr A Narayana Swamy, India

Pollutant fluxes into a Mediterranean lagoon: Evaluation and minimizing actions
Ms Marie-George Toumoud, France

The interaction between Romania's water management and Black Sea
Mr Octavian Ceachir, Romania

Natural and man made factors effecting Persian Gulf ecosystem
Mr Nasrolhah Kalantari, Iran

WORKSHOP 2. MODELS AS TOOLS FOR ECOSYSTEM UNDERSTANDING, COMMUNICATION, MANAGEMENT, AND RESTORATION

Models and management of the Baltic Sea
Professor Fredrik Wulff, Sweden, Invited speaker

Nested scales of life supporting processes and human justice
Dr Thomas Gumbricht, Sweden, Young speaker

Simulation of transport process of natural and artificial pollutant loadings through river catchment to sea
Dr Shogo Murakami, Japan

An integrated biogeochemical model system for the Baltic Sea - a pilot study
Ms Berit Arheimer, Sweden

Modelling of anoxic conditions formation as an example of the Black Sea
Dr Evgenly Yakushev, Russia

The importance of internal tide and coastal upwelling in the water quality of the estuary facing the ocean
Mr Katsuyuki Abo, Japan

Mechanism analysis to predict "Aoshio" upwelling of anoxic bottom water by the 4-m channel experiment and two-dimensional hydrodynamic-model calculation
Dr Kunio Kohata, Japan

Economic development of coastal area and estuary water quality management in China
Mr Changming Ye, China

The mathematical model of pollutant propagation in the north tidal mouth
Dr Elena Debolskaya, Russia

Some aspects of hydrodynamics in Kursiu Marios Lagoon - the natural "setting basin" for Lithuania's waste water
Mr Alvydas Zibas, Lithuania

Reconnaissance of the Black Sea's ecohydrodynamics by means of an interdisciplinary three dimensional model
Ms Marilaure Gregoire, Belgium

Comparative analyses and seasonal modelling for the regional ecosystems of the Black Sea
Ms Tulay Cocacar, Turkey

Development of ecosystem models in the Seto Inland Sea for fisheries management
Associate Professor Masahiko Sekine, Japan

Water Quality modelling for the environmental management in Chinhae-Masan Bay
Mr Hong-Yeon Cho, Korea

Eutrophication of sea water in the Osaka Bay
Mr Katsuhiko Yamamoto, Japan

Ecological modelling as a tool for coastal zone management of Dokai Bay, Japan
Professor Tetsuo Yanagi, Japan

Study on generation mechanisms of anoxic water body by vertically one-dimensional mathematical models
Dr Kazuo Murakami, Japan

Marine ecosystem models and their application in waste water and coastal zone management
Ms Hanne Bach, Denmark

Integrated management water systems in the basin "Ladoga Lake - Neva River - Neva Bay"
Dr Oleg Macarov, Russia

Application of coupled hydrodynamic-ecological models for environmental management of coastal ecosystem
Dr Ole Krull Jensen, Denmark

Environmental impact modelling of semi-enclosed coastal seas: Three case-studies in Malaysia
Dr Koh Hock-Lye, Malaysia

WORKSHOP 3. MONITORING: A BASIS FOR TRACKING AND UNDERSTANDING FRESHWATER AND COASTAL RESPONSES

Monitoring and interdisciplinary: Understanding the dynamics of coastal and estuarine systems
Dr Bernard Sylvand, France, Invited speaker

Water pollution trends in Guanabara Bay, Brazil
Mr Rodolfo Paranhos, Brazil, Young speaker

Interaction of restoration, management and monitoring of the Chesapeake Bay, USA - the benthic biological monitoring program
Dr Daniel M Dauer, USA

Joint operational environment monitoring and forecast systems for the Gulf of Finland
Dr Juhu-Markku Leppänen, Finland

Relating coastal development to living marine resources and their habitats
Dr James P Thomas, USA

Design of long-term environmental monitoring programs: Approaches taken and lessons learned in the Chesapeake Bay program
Dr Raymond W Alden III and Dr Daniel M Dauer, USA

Temporal limiting nutrient shift caused by river water discharge into the coastal sea of semi-enclosed Hiroshima Bay, the Seto Inland Sea, Japan
Dr Tetsuo Mukai Japan

Pollution loads from land-based sources of Turkish Mediterranean coast and their impacts on the marine environment
Associate professor Aysen Yilmaz, Turkey

Options and strategies for managing fresh water resources in Jordan
Mr Ahmed Ulimat, Jordan

WORKSHOP 4. UNDERSTANDING LONG-TERM CHANGES IN DRAINAGE BASINS AND COASTAL SEAS

Times-scale o nutrient losses from land to sea in the Baltic Sea drainage area
Professor Anders Grimvall, Sweden, Invited speaker

River transport of nutrients to the Baltic Sea
Dr Per Stålnacke, Sweden, Young speaker

Matter-transport with the rivers as an indicator for landscape sustainability
Professor Wilhelm Ripl, Germany

Distortion of thermodynamic equilibrium of watershed coastal seas'ecosystems
Dr Michael A Rozengurt, USA

Retrospect of water quality change in the Yodo River during the last 40 years
Associate Professor Shirou Aya, Japan

Studies of environmental history of the Baltic as recipient and estuary of elemental pollutants
Professor Torbjörn Westmark, Sweden

The long-term changes of water quality and management of pollution load in the Osaka Bay
Mr Hajime Miyazaki, Japan

Impact of a highly polluted river on the pelagic environment of the Bay of Haifa, northern Israel. The case history of the Kishon River
Professor Baruch Kimor and Dr Yossi Azov, Israel

Long-term retention of pollution substances in the bottom sediments of the Avacha Bay and their influence on benthic vegetation
Ms Galina Chuyan, Russia

Heavy metal fluxes of two Baltic river recipients: Sediment studies in the Gulf of Riga and the Curland Lagoon
Mr Birger Larsen, Denmark

WORKSHOP 5. ENVIRONMENTAL IMPACT ASSESSMENT AND VALUATION OF ECOLOGICAL SERVICES

The ecological economic, and social importance of coastal and marine systems
Dr Robert Costanza, USA, Invited speaker

Environmental impact assessment as a tool for the appraisal of pulp mill proposals in Tasmania, Australia
Ms Emma Young, Australia, Young speaker

The Sri Lanka experience of environmental impact assessment and its impact on water management issues
Ms Kusum Athukorala, Sri Lanka

Environmental assessment and control strategies of impact by reclamation
Associate Professor Yoshinobu Kido, Japan

Linking water flows and ecosystems services: A conceptual framework for improved environmental management
Professor Carl Folke and Professor Malin Falkenmark, Sweden, Invited speakers

Interaction between the environment of coastal area and shrimp culture in the north of Vietnam
Dr Do Van Khuong, Vietnam

Aquatic life: Ammunition, not collateral, in the struggle for better water management
Ms Meryl J Williams, Philippines

Economics of natural resources use in Vodokanal, St Petersburg
Mr Felix Karmasinov, Russia

Mangrove forest deforestation, shrimp farming and fisheries development in the Gulf of Thailand
Dr Monica Hammer, Sweden

Valuing environmental benefits - developments in England and Wales
Mr John M Tyson, UK

WORKSHOP 6. CURBING OUTFLOW OF POLLUTANTS FROM DOMESTIC WASTE

Enclosed engineering, enhancing nature's ecological services
Dr William Mitsch, USA, Invited speaker

For a new approach to water drinking promotion in a polluted environment
Mr Kouassi Sébastien Dohou, Benin, Young speaker

The Moroccan experience in the treatment of wastewater
Dr Laila Mandi, Morocco

Towards an ecological approach to sanitation
Mr Uno Winblad, Sweden

The complexity of the management of Lake Victoria catchment basin
Mr E K Mwongera, Kenya

Prosanear - basic sanitation and environmental education program for the low income population - Rio de Janeiro, Brazil
Dr Tereza Rosso, Brazil

Environment and natural resource management in coastal areas of developing countries
Dr Anders Granlund, Sweden

Towards zero impact sewage treatment systems - A integrated approach
Dr Steve Churchouse, UK

The biological wastewater treatment of the future
Dr Wolfgang Dorau, Germany

Dilemma in curbing domestic waste water disposal in South East Asia
Dr P M Sivalingam, Malaysia

Leachate treatment of sanitary landfills using low-cost evaporation technology
Dr Matti Ettala, Finland

Environmental impact from Riga city landfill, Latvia
Dr Anders Rydergren, Sweden

The seawater purification method by effective microbes
Dr Yasunori Kozuki, Japan

New strategic ecological method for preventing the entrophication in the enclosed coastal seas
Dr Machiko Yamada, Japan

WORKSHOP 7. GREENING OF INDUSTRY: CURBING OUTFLOW OF INDUSTRIAL POLLUTANTS

The Baltic Sea year 2008
Dr Curt Nicolin, Sweden, Invited speaker

Collaboration between industry, university and government as a key strategy in achieving cleaner production: Case study of Mauritius
Dr Toolseeram Ramjeawon, Mauritius, Young speaker

An industrial/academic partnership between Salisbury State University and industry on the Delmarva Peninsula
Dr Thomas Jones, USA

Strategic approach to long-term environmental action
Dr Henk Senhort, The Netherlands

Development of ecological sea water purification system with rubble mound
Dr Shuji Miyaoka, Japan

Industrial wastewater cadaster and effects on the central wastewater treatment concept for the city of Adana/Turkey
Mr Clemens Wittland, Germany

Wastewater treatment for pollution abatement in Polish rivers
Dr Bernt Ericsson, Sweden

Use of photochemical methods in technologies of water treatment
Dr Lev L Basov, Russia

A 30-year clean-up from industrial pollution in Lake Vänern, Sweden
Mr Gunnar Persson, Sweden

Sustainable water management at Danfoss
Mr Lars F Jorgensen, Denmark

25 years of experience in improving the water quality of Rhine river by IAWR
Mr Klaus Lindner, Germany

Risk assessment of household detergents in surface waters: Principles, a case study and future state of the art developments
Dr Tom C J Feijtel, Belgium

WORKSHOP 8. NON-POINT POLLUTION: CURBING OUTFLOW OF AGRICULTURE POLLUTANTS AS GLOBAL FOOD NEEDS RISE

Managing water pollution from agriculture in a water scarce future
Dr Edwin D Ongley, Canada, Invited speaker

The impact of forests on water quality in streams draining agricultural lands on the coastal plain of the Chesapeake Bay watershed
Ms Margaret G Mayers, USA, Young speaker

A catchment-oriented and cost-effective policy for water protection
Dr Siegfried Fleischer, Sweden

Managing agricultural nutrients in Maryland's Chesapeake Bay basin
Professor Richard A Weismiller, USA

Eco-farming and sustainable development in an Indian context
Dr Q Zubeeda Banu Quraishy, India

The Water Supply Foundation activities in water pollution control in rural areas of Poland
Mr Maciej Dzikiewicz, Poland

Suspended sediment deposition surveying and modelling in flooded delta of the River Nemunas
Dr Alfonsas Rimkus, Lithuania

Limiting phosphorus loading as solution for water hyacinth erichhornia problem in Lake Victoria
Mr William Kazenga Christian, Tanzania

The use of fertilizers and water quality
Dr Göte Bertilsson, Sweden

Influence of land use changes and climatic fluctuations on runoff and nutrient fluxes in an agricultural watershed
Dr Ülo Mander, Estonia

Minimizing non-point pollution in a world of rapidly growing food needs: Lake Victoria Catchment
Mr Kinya Munyirwa, Kenya

WORKSHOP 10. STRATEGIES AND INSTITUTIONAL ARRANGEMENTS FOR RESOLUTION OF STAKEHOLDER CONFLICTS IN DRAINAGE BASINS AND COASTAL SEAS

Institutions and the Resolution of resource conflicts: Principles and Practice
Professor Susan Hanna, USA, Invited speaker

The role of water rights and wastewater disposals, regularization in the resolution of stakeholders conflicts in Mexican drainage basins
Dr Héctor Garduño, Mexico, Invited speaker

Environmental, economic and political interdependence in the Baltic Sea region
Dr Stanislawa Bukowicka, Poland, Young speaker

Socio-economic and cultural factors of property right regimes and its impact on ecology and environment in Western Ghats, Karnataka, India
Mr A S Shrinidhi, India

Balance of natural and anthropogenic factors in formation of the current Amur River transboundary ecosystem situation
Dr Tatyana Strizhova, Russia

Sustainable water management in Germany
Ms Christine Bismuth, Germany

How has "Biwako Sogo Kaihatsu" worked? The case of Shiga Prefectural Government - Cost allocation system on the downstream local governments for the comprehensive development plan
Ms Kaori Yamamoto, Japan

Are blue whales simply very large cups of coffee?
Mr Colin Green, UK

The role of regional initiatives for management of enclosed seas: The medcoast initiative for the Mediterranean and the Black Sea
Professor Erdal Özhan, Turkey

Guideline for environmental management planning in watershed of tributaries flowing into Seto Inland sea in Hyogo prefecture
Dr Hiroshi Tsuno, Japan

Developing integrated water resources and environmental monitoring information management tools
Ms Cary Gaunt, USA

The ecosystem approach in remedial action planning in the Great Lakes
Dr Amold Gurtner-Zimmermann, Switzerland

Water environment countermeasures in the City of Osaka
Mr Satoro Fujii, Japan

Integrating the management of river basins, coastal zones, and marine waters: The Global Environment Facility's operational strategy
Dr Alfred M Duda, USA

Comprehensive policy making for river and sea: Its social conditions
Professor Masaharu Tsuchiya, Japan

Integrated coastal zone management plans in the Baltics
Mr Lennart Gladh, Sweden

The concept of collective ecological safety for the states of the Baltic Sea
Professor Ludmila Romaniuk, Russia

Assessment of the water systems is a tool of sustainable development of St. Petersburg
Ms Ludmila Tsvetkova, Russia

Coastal zone management of Estonian coast
Mr Toomas Liiv, Estonia

Russian reforms and water quality management
Professor David M Yaroshevskii, Russia

Economic valuation and funding on a watershed-wide basis
Mr Michael Curley, USA

Perspectives of the environment policy in the Danube Basin
Mr Teun Botterweg, Germany

Waste minization program in a small-scale electroplating factory
Assistant Professor Supom Koottatep, Thailand

Marine outfall - A possible solution to stop river pollution?
Dr Yossi Azov, Israel

Technology and policy options for possible energy saving and reduction of exhaust emission in mote vehicles
Dr Jacob Oluiwoye, Australia

WORKSHOP 11. NGO'S: ROLES AND STRATEGIES IN WATER PROTECTION POLICY

The role of non government organizations in the Chesapeake Bay program
Ms Frances Flanigan, USA, Invited speaker

Coalition clean Baltic - A network for environmental NGO's in the Baltic Sea region
Ms Eva Frössling, Sweden, Young speaker

Non-government educational activities on the coast of the Seto Inland Sea
Mr Hideki Kaya, Japan

Handling down from us to next generation, sustainable agriculture which does not pollute water
Mr Ken Kusachi, Japan

Science and journalism: Getting information to the general public
Ms Alexis Henderson, USA

Training environmental professionals by non-governmental organizations
Mr Grant Gross, USA

Developing citizen support for public lands - using corporate partners, volunteers and "friends" groups
Ms Helene Tenner, USA

The role of the federal government in the Chesapeake Bay programme: Catalyst for progress
Mr Peter J Marx, USA

Maryland's tributary teams: An innovative partnership to reduce nutrient pollution in Chesapeake Bay
Mr Lauren Wenzel, USA

WORKSHOP 12. ETHICS AND ENVIRONMENTAL EDUCATION OF THE NEXT GENERATION

Sustainability place, and civil society
Dr Richard Collins, USA, Invited speaker

The role of autoanalysis on water education, the postal water project, a concrete case
Ms Anna Kurtycz, Mexico, Young speaker

Coastal management: The need for dedicated curriculum in higher education
Mr Sunil M Shastri, UK

Chesapeake Bay, ecology, and science education
Ms Laura L O'Leary, USA

Educating local volunteer citizen boards on regulation of the tidal wetlands of Chesapeake Bay
Mr William L Roberts, USA

Challenges in understanding and communicating estuarine monitoring information - the Chesapeake Bay experience
Dr. Robert E Magnien, USA

A capacity building programme for sustainable Water Sector Development
Mr Frank Hartvelt, USA

Train - Sea - Coast programme for human resources development
Mr Philip S Reynolds, USA

Exchange and inter-relationship among the watershed, coastal lagoons, and coastal ocean ecosystems: A train-sea-coast course for the Brazilian coastal zone
Dr Milton L Asmus, Brazil

Understanding coastal seas: Language, environmental science and a sense of place
Dr Jack R Greer, USA

Ethics and integrity - and empathy for industry - when reporting the environment
Mr Kim Loughran, Australia

The Omai goldmine disaster in Guyana. A test case of public awareness and the needs of environmental education
Mr Darrell Sequeira, Finland

Rivers and sea resources exploitation in prehistory on an arid continent - Australia
Mr Hans Bandler, Australia

WORKSHOP 13. GLOBAL RESOURCE INFORMATION DATA EXCHANGE

Ballerina - The internet based environmental information co-operative network and gateway to the Baltic Sea region
Dr Sindre Langaas, Sweden, Invited speaker

Great Lakes information network: Your bridge to the Great Lakes region
Dr Carol Ratza, USA, Young speaker

The information cycle - a framework for the management of our water resources
Mr Jos G Timmerman, The Netherlands

The water dialogue
Mrs Anneli J Schäfer, The Netherlands

Using the internet to support environmental education in universities
Dr Jean-Paul Ducrotoy, UK

Global internet-based transboundary waters information system: Proposed contents and development
Dr Nickolai B Denisov, Norway

Comprehensive environmental management of an urbanized watershed utilizing multimedia geographic information system
Mr Michael S Haire, USA

Integrated water management and remote data access, possibilities of a system based on telematics
Mr Hugo Niesing, The Netherlands

REPORT FROM THE POSTER SESSION

Mr Ulf Ehlin, Stockholm International Water Institute, Sweden

WINNER OF THE POSTER AWARD 1997

Computer graphics for better understanding physical processes in enclosed coastal seas under freshwater influence

Professor K Nakatsuji, Graduate student M Ishizuka, Professor K. Muraoka
Department of civil engineering, Osaka University, Japan

Motivation:
- the content of the poster is relevant to the theme of the symposium
- the scientific content of the poster is of high quality
- it is very efficient in bringing the message to decisionsmakers and the public,
- and it is nicely presented with an excellent graphical design

Two posters for honourable mentioning

Nutrient transformation in established uncultivated zones along watercourses

Ann Fugelsang, Funen County Council, Department of Nature and Water Environment, Denmark

The Chesapeake Bay restoration program: The bentic monitoring program I and II:

Development of restoration goals and an estuarine benthic index of biotic integrity quantifying goal attainment

and

Optimizing temporal sampling strategies using fixed-point stations for long-term trends and probability-bases spatial sampling for status estimates

Daniel M Dauer, J Ananda Ranasinghe, Stephen B Weisberg and Raymond W Alden III

In the jury for the poster award the following persons have participated

Dr Boniface Egboka, Nigeria
Dr Francis Flanigan, USA
Dr Lars Lindblom, Sweden
Mr Peter Nyberg, Sweden
Dr Masataka Watanabe, Japan
Mr Ulf Ehlin, Sweden

We had an extremely difficult task because of the high quality of the poster exhibition, and the many different scientific and other topics delt with. However we all agreed that there is one poster which has somewhat higher qualities then the others and should get the award.

Among the rest it was very difficult to pick out a number 2 and 3. We decided to give a honourable mention to two posters.

PRESENTED POSTERS

BALTIC SEA

- How to reduce nutrient loads to the Baltic Sea - Problems and solutions
- Wetlands to increase nutrient retention and biodiversity

Ms Sofie Adolfsson Jörby and Mr Jan Herrmann, Sweden

Eutrophication state in the Neva Bay and eastern Gulf of Finland by hydrobiological monitoring results
Ms Svetlana L Basova, Russia

Minimizing stormwater pollutant flows from urban areas by source control - Case study: Hammarby Sea Town
Knut Bennerstedt, Sweden

Estimation of the effect of point sources on water quality in the River "Obere Leine", Germany
Mr Arnaud Duine, Germany

Main pollution problems in the shallow Kurshiu Marios Lagoon
Mr Vytautas Dubra, Lithuania

Gulf of Finland: Chemical pollution and biochemical self-purification
Professor Grigori Frumin, Russia

- Full scale example project about establishing wet meadows alongside waterways
- Nutrient transformation in established uncultivated zones along watercourses

Ms Ann Fugelsang, Denmark

Treatment and utilization problems of St Petersburg City waste water sediments
Mr Sergei Gumen, Russia

The Leba Basin restoration project, Poland. Phase 1 - Impact and feasibility studies
Ms Charlotte Gunsell, Sweden

Forest irrigation and urine separation: Design of two systems for waste water treatment with nutrient utilisation
Ms Erica Johansson, Sweden

Pollution of surface waters of Latvia
Dr Inta Klavina, Latvia

Curbing agricultural sources: Minimizing non-point pollution in a world of rapidly growing food needs
Mr Jorgen Krogsgaard Jensen, Denmark

Application of ecotechnological methods for water protection in rural areas in Poland
Dr Jozef Mosiej, Poland

Biological motivation of water level regulation in the large shallow Lake Võrtsjärv, Estonia
Ms Tiina Nõges, Estonia

Response of a natural river valley wetland to supplementary runoff and pollutant load from urban waste water discharge
Mr Peeter Nõges, Estonia

Long-term changes in the Kursiu Marios Lagoon: Eutrophication and phytoplankton response
Ms Irina Olenina, Lithuania

Polders of the Lower Nemunas and the Lower Minija - Positive examples of ecological engineering
Dr Bronislovas Ruplys, Lithuania

Environmental changes, mainly eutrophication as inferred from changes in the diatom species composition from the surface sediments of the Gulf of Riga (Eastern Baltic)
Dr Marie Sakson, Estonia

Retention capabilities and effects of nutrient load reductions in the eastern part of the Gulf of Finland (Baltic Sea) as simulated with biogeochemical model
Mr Oleg Savchuk, Sweden

Environmental management systems in Poland
Dr Stanislawa Bukowicka, Poland

Minimization of non-point pollution in Lithuania
Professor R Tumas, Lithuania

Reflections of human activities in the eutrophication of the Gulf of Riga (Baltic Sea)
Mr Aivars Yurkovskis, Latvia

The Baltic university programme - University cooperation for environmental education in the Baltic Sea basin
Lars Rydén, Sweden

The River Emån project in Sweden and the Matsalu catchment area in Estonia
Mr Bo Troedsson, Sweden and Mr Enn Loigu, Estonia

BLACK SEA

Mixing of river and sea waters at the Danube River nearshore (the Black Sea)
Dr Maria Mikhailova, Russia

CHESAPEAKE BAY

Science, management, and scale: The role of basic research
Dr Wayne H Bell, USA

- The Chesapeake Bay restoration program: The Benthic monitoring program - I. Development of restoration goals and an estuarine Benthic index of biotic integrity (B-BIB) quantifying goal attainment
- The Chesapeake Bay restoration program: The Benthic monitoring program - II. Optimizing temporal sampling strategies using fixed-point stations for long-term trends and probability-based spatial sampling for status estimates

Dr Daniel M Dauer, USA

OTHER AREAS

Water pollution and sustainable development in Hong Kong
Dr W K Yau, Hong Kong

Water resources management in urban areas for water pollution control
Dr Shunsaku Yagi, Japan

Swedish water management research program - towards catchment-based strategies for sustainable resource use
Dr Hans B Wittgren and Ms Anna Blomqvist, Sweden

The plankton of Guanabara Bay, Rio de Janeiro, Brazil: A review
Professor Denise Tenenbaum, Brazil

Managing the sources of pollutants from an urban catchment into False Bay, Cape Town, South Africa
Mrs W S Kloppers, South Africa

Converting metal contaminated sludge to sulphur enchanced biosolids
Dr J Glynn Henry, Canada

Oxygen depression due to the photosynthesized matter caused by the load of nutrition salt from land in the bottom layer of the Sea of Harima
Dr Masakazu Furuki, Japan

Spatial distribution and environmental assessment of the intertidal benthic communities of rocky coasts of the Guanabara Bay
Mr L V Carvalheira, Brazil

River runoff and water level fluctuation of Caspian Sea
Dr Mikhail Bolgov, Russia

Availability of common biological indicator in the lentic and lotic environments for the strategy to prevent the water pollution
Mr Kazumi Asai, Japan

SETO INLAND SEA

Activities and achievement of Osaka prefectural government for conservation of the water environment of Osaka Bay
Mr Yasuo Yagi, Japan

Computer graphics for better understanding physical processes in enclosed coastal sea under fresh water influence
Dr Keiji Nakatsuji, Japan

Long term observation to evaluate biomass and behaviour of Noctiluca scitillans in the Seto Inland Sea
Dr Kuninao Tada, Japan

An environmental/socialogical survey along the cost of Osaka Bay
Mr Shuzo Ozawa, Japan

Movement of terrestrial organic matter in the Seto Inland Sea, Japan
Dr Yasufumi Mishima, Japan

Outline of the investigation for environmental management of the Seto Inland Sea, Japan (IEMS-I)
Mr Tsutomu Ushikawa, Japan

Estimation for the change of bottom sediments in the Seto Inland Sea during last ten years (IEMS-II)
Mr Osamu Nagafuchi, Japan

Quantitative research of macrobenthos in the Seto Inland Sea (IEMS-III)
Dr Kazuhito Murakami, Japan

The change of water quality in the Seto Inland Sea (IEMS-IV)
Mr Takenebu Koyama, Japan

Census data on pollution loadings into the Seto Inland Sea (IEMS-V)
Dr Tohru Seiki, Japan

Distribution of heavy metals and its change in the sediment of the Seto Inland Sea - Case studies on the Sea of Harima and the Sea of Hinchi (IEMS-VI)
Mr Yoshinari Kobuke, Japan

Evaluation of environmental change in the Seto Inland Sea (IEMS-VII)
Mr Yukio Komai, Japan

LIST OF PARTICIPANTS

AUSTRALIA	
Delaney, Jon	Royal Australian Navy, Canberra
Oluwoye, Jacob	University of Technology, Sydney
Young, Emma	Macquarie University, Macquarie
AUSTRIA	
Botterweg, Teun	Vienna International Centre, Vienna
Kling, Walter	ÖVGN, Vienna
Kumar, Ritu	UNIDO, Vienna
Ramsay, Grant	UNIDO, Vienna
Rigola, Miquel	UNIDO, Vienna
Sailer, Hans	Wiener Wasserwerke, Vienna
BAHRAIN	
Akhter, Mohammad Salim	University of Bahrain, Isa Town
BELGIUM	
Feijtel, Tom	Procter & Gamble Eurocor, Strombeek-Bever
Gregoire, Marilura	University of Liege, Liege
Janssens, Jan G	The World Bank, Antwerpen
Kaczmarek, Bernard	French Water Agencies, Brussels
Liebaert, Andre	Europena Commission, Brussels
Lugtmeijer, Kees	European Partners for Environment, Brussels
Olsen, Asger	European Commission - DG XI, Brussels
Woodward, Ian	General Motors Corporation, Antwerpen
BENIN	
Adisso, Pierre	Direction de l'Hydraulique, Cotonou
Dohou, Kouassi Sebastian	Lecrede, Abomey-Calavi
BOLIVIA	
Torrico Vargas, Enrique	Dirrecction Nac de Saneamiento Basico, La Paz
BOTSWANA	
Serumola Oarabile Moanza	Department of Water Affairs, Gaborone
BRAZIL	
Asmus, Milton	University of Rio Grande, Rio Grande
Azulay, Jaime	CEDAE Comp of Water/Sewerage System, Rio de Janeiro
Beekman, Gertjan B	IICA InterAm Inst Coop/Agriculture, Brasilia
Carvalheira, Lucia Vercoŝa	IGEO Depto Oceanografia, UERJ-Universidade do Estado, Rio de Janeiro
Garrido, José dos Santos	Nat. Secretariat on Water Resources, Brasilia
Kelman, Jerson	COPPE-UFRJ, Rio de Janeiro
Paranhos, Rodolfo	UVRJ, Dep. de Biologia Marinha, Rio de Janeiro
Porto, Monica	Brazilian Water Resources Ass, Sao Paulo

Rosso, Thereza Christina	Univ of State of Rio de Janeiro, Rio de Janeiro
Tenenbaum, Denise	Rio de Janeiro State University, Rio de Janeiro
BURKINA FASO	
Compaore, Ouango Athanase	Ministere de l'Environment et de l'Eau, Ougadougou
Zabre, Hado Paul	Ministere de l'Environment et de l'Eau, Ougadougou
CANADA	
Davis, Denis A	Kanata
Hecky, Robert	National Water Research Institute, Burlington
Henry, J Glynn	University of Toronto, Toronto
Ongley, Edwin	Canada Center for Inland Waters, Burlington
Regier, Henry	University of Toronto, Warkworth
Smith, James D	United Nations University, Hamilton
CHILE	
Solanes, Miquel R	UN Economic Commission for Latin America and the Caribbean, Santiago
CHINA	
Dong, Jicheng	National Patriotic Health Campaign, Beijing
Du, Bilan	China Inst for Marine Dev Strategy of State Oceanic Adm, Beijing
Jitjhaturunt, Vathinee	UNICEF, Beijing
Pan, Shunchang	Institute of Environmental Health and Engineering CAPM, Beijing
Wang, Junqi	Chinese Academy of Preventive Med, Beijing
Yang, Guowei	Changjiang Water Resource Commission, Wuhan
Yau, Wing Kwong	Enviro-Chem Engineer & Lab Co, Ltd, Hong Kong
Ye Chang Ming	Chinese Academy of Sciences, Beijing
COLOMBIA	
Pardo-Sanchez, Alvaro	AIDIS- Interamerican Association of Environmental Eng, Bogota
COSTA RICA	
Vargas-Cullell, Jorge	San José
COTE D'IVOIRE	
Djerrari, Fouad	Water Utility Partnership Africa, Abidjan
N'Dri, Koffi	Union Afric des Distrib d'Eau, UADE, Abidjan
CROATIA	
Pavasovic, Arsen	Regional Activity Centre, UNEP-PAP, Split

CYPRUS

Markaris, Argyros	Water Board of Lemesos, Lemesos

DENMARK

Aagaard Jensen, Henning	Vejle County, Vejle
Andersen, Keld	Vejle County, Vejle
Bach, Hanne	VKI, Hörsholm
Bach, Jörn S	Kolding Kommune, Kolding
Bundgård Madsen, Harley	County of Funen, Odense
Harremoës, Poul	Technical University of Denmark, Lyngby
Hörup, Niels E A	Joint Org Danish Private Water Work Solröd Strand
Ipsen, Niels Henrik	VKI, Hörsholm
Jensen, Kurt	VKI, Hörsholm
Jensen, Ole Krull	Danish Hydraulic Institute, Hörsholm
Jönch-Clausen, Torkil	VKI, Hörsholm
Jörgensen, Lars Fredrik	Danfoss, Nordborg
Larsen, Birger	Geological Surv of Denmark/Greenland, Copenhagen
Mikkelsen, Tage	The Princes Award Foundation, Copenhagen
Naranjo, Eugenia	VKI, Hörsholm
Nielsen, Peter Skat	City Engineer's Directorate, City of Copenhagen, Copenhagen
Nörskov Laursen, Sten	County of Funen, Odensen
Olesen, Ulrik Sigvaard	VKI, Hörsholm
Outzen, Solveig	Vejle County, Vejle
Pedersen, Eggert	County of Funen, Odense
Petersen, Dan	Counth of Funen, Odense
Prisum, Jens M	I/S Avedöre Kloakvaerk, Hvidovre
Tellerup, Agnes	Vejle County, Vejle

EGYPT

El-Komi, Mohamed	Nat Inst of Oceanography & Fisheries, Alexandria
Saad, Massoud	Alexandria University, Alexandria

EL SALVADOR

Gough, Jean	UNICEF, San Salvador
Landin, Patric	UNICEF, San Salvador
Mejia, Rafael	Office of Strategic Planning for Housing & Urban Development, San Salvador

ESTONIA

Kull, Ain	University of Tartu, Tartu
Liiv, Toomas	Tallinn Technical Univeristy, Tallinn
Loigu, Enn	Tallinn Technical University, Tallinn
Mander Ülo	University of Tartu, Tartu
Nõges, Peeter	Võrtsjärv Limnological Station, Tartu
Nõges, Tiina	Võrtsjärv Limnological Station , Tartu
Raia, Tiiu	Ministry of the Environment, Tallinn

Sakson, Maire	Geological Survey of Estonia, Tallinn
Seemendi, Sirje	Tallinn Waterworks and Sewerage Municipal Enterprise, Tallinn
ETHIOPIA	
Dulane, Abdirashid	Ministry of Water Resources, Addis Abeba
Edström, Gunder	Sudea, Addis Abeba
Hagos, Mohamed A	Ministry of Water Resources, Addis Abeba
Matiza-Chiuta, Tabeth	IUCN, Harare
FINLAND	
Blomgren, Karl-Erik	Ass of Finnish Local Authorities, Helsinki
Ettala, Matti	Kuopio University Hollola, Kuopio
Kohonen, Tapani	Helsinki Commission, Helsinki
Kremser, Ulrich	Helsinki Commission, Helsinki
Leppänen, Juha-Markku	Finnish Inst of Marine Research, Helsinki
Sandelin, Sirpa	Tampere University of Technology, Tampere
Sequeira, Darrel	Espoo
FRANCE	
Cheret, Ivan	Versailles
Coulomb, René	Lyonnaise des Eaux S A, Nanterre
Dubois, Jean Pierre	BRL, Compagnie de Bas-Rohne, Nimes
Fujikawa, Yoichi	I D I Europe, Paris
Icard, Pierre	Ministère de la Cooperation, Paris
Kosuth, Pascal	Orstrom Hydrologie, Montferrier le Lez
Kurtycs, Anna	Oficina de Comunicacion del Lago, Pontoise
Le Moigne, Guy	World Water Council, Marseille
Naber, Arienne	World Water Council, Marseille
Pochat, Remy	Cemagref, Antony
Potié, Louis	Mediterranean Water Institute, Marseille
Roussel, Pierre	Ministère de l'Aménagement du Territoire et de l'Environnement, Paris
Sylvand, Bernard	Station Marine, Luc-sur-Mer
Szöllösi-Nagy, Andras	UNESCO, Paris
Teniere-Buchot, Pierre-Frederic	Agence de l'Eau Seine-Normandie, Nanterre
Tournoud, M-G	Montpeillier University, Montpellier
GERMANY	
Abdul, Wahib	Marine Geological Inst Indonesia c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Ben, Bunnnarin	D G M of Ministry of Ind, Cambodia c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Bismuth, Christine	FEA Germany, Berlin
Bohnet, Michael	Ministry for Economic Cooperation and Development, Bonn
Buckler, Michael	Energieversorgung Mittelrhein GmbH, Koblenz
Dorau, Wolfgang	Federal Environmental Agency, Berlin

Duine, Arnaud	Inst for Wastewater Engineering and Waste Managment, Hannover
Genschow, Elke	University of Hannover, Sarstedt
Gidarakos, Evangelos	Battelle Germany, Eschborn
Gunasinghe, U D Sandhya S	University of Moratuwa, Sri -Lanka c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Haumann, Helmut	GEW-Werke Köln AG, Köln
Islam, MD Faruqul	Mongla Port Authority, Bangladesh c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Khoy, Khim	Ministry of Industry, Mines & Energy c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Lindenschmidt, Karl-Erich	Technical Univerisity of Berlin, Berlin
Makaoui, Ahmed	Inst Scientifique des Peches Maritim c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Moustafa, Yasser Mohamed	Egyptian Petroleum Res Inst, Cairo c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Nahada, Vuorino Assau	Centro de Investigacas Pesqueiza Apl c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Nair, Maheshwari	National Inst of Oceanography, India c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Nguyen, Van Long	Inst of Oceanography, Nha Trong c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Okon, Timothy John	Inst of Oceanographphy, Nigeria c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Ripl, Wilhelm	Tu-Berlin, Berlin
Robinson, Alpha	Universität GH Paderborn, Höxter
Schriever, Gerd	Biolab Research Institute, Hohenwestedt
Thiel, Werner	Kronos Int Inc, Langenfeld
Trinh, Hai Son	c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Trinh Thi, Le Ha	c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Widodo, Joni	Marine Geological Inst, Indonesia c/o CDG-Course, Inst f Hydrobiologie, Hamburg
Wittland, Clemens	GKW Consult, Mannheim
Wollenzien, Thomas	KFW, Frankfurt

GHANA

Wright, Albert	The World Bank Resident Mission, Accra

HONG KONG

Cheung, Him-Shing	Environmental Protecton Dept, Quary Bay

INDIA

Bhatia, Ramesh	Resourcaes & Environment Group, New Delhi
Chitale, M.A.	Int Commission on Irrigation and Drainage, New Delhi
Chitwadgi, Shreeshail	Bharat Forestry Consultancy, Bhopal
Limaye, Shrikant Daji	Ground Water Institute, Poona-Pune
Narayana Swamy, Addala	Andhra University, Visakhapatnam
Limaye, Shrikant Daji	Ground Water Institute, Poona-Pune

Quraishy, Zubeeda Banu	University of Madras, Madras Chennai
Shrinidhi, A S	ISEC, Bangalore
Varughese, George	Qutub Institutional Akfa, New Delhi

INDONESIA

Helmi	PSI-UNAND, Padang
Koensatwanto, I H	Nat. Planning Dev. Agency, Djakarta
Soenarno	PT Wijaya Karya, Jakarta Timur

IRAN

Kalantari, Nasrollah	Shahid Chamran University, Ahwaz

ISRAEL

Azov, Yossi	Haifa

ITALY

Bernstein, Alberto Giulio	Consorzio Venezia Nuova, Venezia
Klohn, Wulf	FAO, Rome
Walker, Catherine	Australian Embassy, Rome
Wolter, Hans W	FAO, Rome

JAPAN

Abo, Katsuyuki	Nat Research Inst of Aguaculture, Mie
Akagi, Masaaki	Hyogo Prefectural Government c/o International EMECS Center, Kobe
Akao, Takeo	Kaneka Corporation, Takasago
Amano, Aiko	c/o International EMECS Center, Kobe
Asahara, Toshikazu	Harima Town Assembly, Kako-Gun
Asai, Kazumi	Osaka Medical College, Takatuki
Aya, Shirou	Osaka Institute of Technology, Osaka
Dan, Suzuo	Osaka Gas Co, Ltd c/o International EMECS Center, Kobe
Eiho, Jirao	Japan Environment Agency c/o International EMECS Center, Kobe
Enami, Haruhiro	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Endo, Masakatsu	Technology Research Center for Riverfront Development, Tokyo
Fujii, Masaaki	Hyogo Womens Junior College, Kakogawa
Fujii, Satoru	Osaka City Government, Osaka
Fujimoto, Shigeru	Kurodasho Town Office, Hyogo
Fujiita, Tetsuya	Hyogo Pref Town Assembly Speakers Ass, Kobe-Shi Hyogo
Fujita, Toshita	Okawachi Town Office, Hyogo
Fujiura, Kazumasa	International EMECS Center, Kobe
Fujiwara, Tateki	Kyoto University, Kyoto
Fujiwara, Yukio	Tojo Town Assembly, Kato-Gun
Fukushima, Keiji	Tokushima Prefectural Government, Tokushima

Furuki, Masakazu	The Hyogo Pref Inst of Envirnomental Science, Kobe
Furusawa, Shoichi	Coalition of Pref Assembly to Promote International EMECS Act, Kobe
Goto, Aya	Coalition of Pref Assembly to Promote International EMECS Act, Kobe
Goto, Hiroko	Coalition of Pref Assembly to Promote International EMECS Act, Kobe
Goto, Yasuko	Kansai University, Himeji
Hamamoto, Hiromu	Nakayama Alloy Foundry Co Ltd, Fukusaki-Gun
Hanamachi, Kazuo	Tsuna-Gun
Hara, Ginsaku	Marugen Co Ltd, Toyonaka
Hara, Ryosuke	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Hasegawa, Yukiyo	Himeji Red Cross Hospital, Kanzaki-Gun
Hashimoto, Masakazu	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Hasuike, Hiromi	Natan Town Assembly, Mihara-Cho
Hata, Shunzo	Sasayama Town Assembly, Taki-Gun
Hatada, Masao	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Hiramatsu, Shiro	International EMECS Center, Kobe
Hirata, Chie	Hirata Cooking Academy, Hyogo
Hirata, Kyoko	Hirata Cooking Academy, Hyogo
Hirata, Sachiko	Kamigori Junio-High School, Hyogo
Hirata, Sakae	Hirata Cooking Academy, Hyogo
Hirooka, Makoto	Kobe
Hojo, Sadamune	Kubota Corporation, Osaka
Iguchi, Yo	International EMECS Center, Kobe
Imamori, Hideyuki	CRC Research Institute Inc, Osaka
Imanishi, Masayuki	Coalition of Prefectural Assembly to Promote International EMECS, Kobe
Inai, Yukiharu	Koyo Kaikeisha, Takarazuka
Inatsugi, Masahiko	International EMECS Center, Kobe
Isano, Koichi	Kawasaki Heavy Industries Ltd, Kobe
Ishida, Kazuo	Coalition of Prefectural Assemby to Promote International EMECS Act, Kobe
Ishii, Yoshinori	National Inst for Environment Studies c/o International EMECS Center, Kobe
Ishitani, Sakae	Ishitani Shop Co Ltd, Kobe
Itakura, Usaburo	Yachiyo Town Office, Hyogo
Iwaasa, Hiroo	Yabu Town Assembly, Yabu-Gun
Iwai, Katsumi	Mikuniya Corporation, Osaka
Izawa, Masayoshi	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kaihara, Setsuko	Kobe
Kaihara, Toshitami	International EMECS Center, Kobe
Kaji, Junko	c/o International EMECS Center, Kobe

Kajiwara, Hiroshi	Kobe Steel Ltd, Tokyo
Kamamoto, Sadao	Japanese Red Cross Society, Kawanishi
Kamatani, Kenzo	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kaneko, Kumao	Tokai University c/o International EMECS Center, Kobe
Kanto, Masashi	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Kasahara, Kiyoshi	c/o International EMECS Center, Kobe
Kasai, Akihide	Kyoto University, Kyoto
Kashiwagi, Tamotsu	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kashiwagi, Wasaburo	Tsuna Town Office, Hyogo
Katayama, Chisato	Miki Assembly Office, Miki
Katsura, Masaaki	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Kawagoe, Eiichi	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Kawai, Sadako	Hyogo Asako-Gun
Kawamura, Hiroshi	Hyogo Prefectural Government, Kobe
Kawanabe, Akio	Hyogo Int Association, Takasago
Kawasaki, Toshiaki	Hyogo Prefectural Government, Kobe
Kaya, Hideki	Ritsumeikan University, Nagaokakyo-City
Kido, Yoshinobu	Tottori University, Tottori
Kimata, Masayuki	Kobe Municipal Government c/o International EMECS Center, Kobe
Kitamura, Hiroyuki	The Association for the Environment Conservation of the Seto Inland Sea, Kobe
Kitamura, Mizue	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Kitani, Shinji	Amagasaki
Kitaura, Yoshihisa	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kiyomoto, Kosho	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kobayashi, Shigeo	Miki-City
Kobori, Yutaka	International EMECS Center, Kobe
Kobuke, Yoshinari	Hyogo Prefectural Institute of Environmental Sience, Kobe
Kohara, Akira	Chikusa Town Office, Hyogo
Kohata, Kunio	National Inst for Environment Studies, Ibaraki
Komai, Yukio	Hyogo Prefectural Inst of Env Science, Kobe
Kondo, Jiro	International EMECS Center, Kobe
Kondo, Keizo	Hyogo Prefecture Fishery Foundation, Kobe Hyogo
Konishi, Machiko	Konishi Drugstore, Toyooka
Kontani, Eiichi	Environment Bureau, City of Kobe, Kobe
Kotobuki, Susumu	Hyogo Prefecture Fishery Foundation, Kobe Hyogo

Kotoidani, Asako	Sumoto
Koyama, Kazuko	Kobe
Koyama, Takenobu	Wakayama Prefectural Research Center of Environment and Public Health, Wakayama
Koyama, Yoshimi	Yawata Municipal Office, Kyoto
Kozai, Yumiko	International EMECS Center, Kobe
Kozuki, Yasunori	The University of Tokushima, Tokushima
Kumamoto, Nobuo	Hokkai-Gakuen University, Sapporo
Kunogi, Kyoko	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Kuramoto, Naofumi	Hyogo Prefectural Environm Create Center, Kobe
Kuroda, Fujio	Hyogo Prefecutral Town's Association, Kasai
Kuroiwa, Hidetaka	Hyogo Journal, Kobe
Kusachi, Kenichi	The PHD Foundation, Kobe
Kuwagata, Shiro	Ieshima Town Office, Hyogo
Maeda, Katsuhiko	Hyogo Pref Fishery Foundation, Kobe Hyogo
Maeda, Keiichiro	Hyogo Prefectural Government, Kobe
Maeda, Kiyoharu	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Makita, Yoko	c/o International EMECS Center, Kobe
Masahira, Kimiko	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Masuda, Takaji	Kyoto Kansai Manekin Ltd, Kakogawa
Matsuda, Hideko	Nishinomiya
Matsuda, Osamu	Hyroshima University, Hiroshima
Matsui, Saburo	Kyoto University, Otsu
Matsukasa, Seiichi	Clin Hyogo Earthquake Disaster Reconstruction, Ashiya
Miichi, Akira	Otemon Gakuin University, Ibaraki
Mino, Toshiaki	Setokanren, Kobe Hyogo
Mishima, Yasufumi	Chugoku National Ind Res Inst, Hiroshima
Mitsuo, Nobuhiro	Hyogo Pref Fishery Foundation, Kobe Hyogo
Miyadi, Tamiko	Miyady Hospital, Kobe
Miyahigashi, Ichizo	Inagawa Town Office, Hyogo
Miyamoto, Hiromi	Coalition of Prefectural Assembly to Promote International EMECs Act, Kobe
Miyamoto, Yoshiko	Himeji
Miyaoka, Shuji	Obayashi Corporation, Kiyose
Miyazaki, Hajime	Hyogo Prefectural Government, Kobe
Montani, Shigeru	Kagawa University, Kagawa
Mori Katuyuki	Ministry of Int Trade Ind, Sendai City
Mori, Yoshikazu	Hyogo Pref Fishery Foundation, Kobe Hyogo
Mori, Toshiki	Kagawa Prefectural Government, Takamatsu
Mori, Yoshikazu	Hyogo Pref Fishery Foundation, Kobe Hyogo
Mukai, Tetsuo	Hiroshima University, Hiroshima
Murakami, Hitoshi	The University of Tokushima, Tokushima
Murakami, Kazuhito	Okayama Pref Inst for Env Science/Public Health, Okayama
Murakami, Kazuo	Ministry of Transport, Yokosuka

Murakami, Susumu	Hyogo Pref Fishery Foundation, Kobe Hyogo
Murakami, Shogo	Nat Inst for Environmental Sciences, Tsukuba
Muraoka, Kohji	Osaka University, Suita
Nagafuchi, Osamu	Fukuoka Inst of Health & Env Sciences, Fukuoka
Nagahama, Akio	Kobe
Nagata, Jiro	International EMECS Center, Kobe
Nakai, Junko	International EMECS Center, Kobe
Nakanishi, Horioshi	Osaka Institute of Technology, Ube
Nakatsuji, Keiji	Osaka University, Suita
Nakayama, Katsuya	Hirohsima Institute of Technology, Hiroshima
Nakayama, Kenji	Hitachi Ltd, Hiroshima
Nioka, Kamekichi	Hyogo Pref Fishery Foundation, Kobe Hyogo
Niren, Takaai	University of Shiga Prefecture, Hikone
Nishida, Kumiko	Akashi
Nishihara, Yasuo	Kobe
Nishikawa, Kiyoshi	Toa Brush Industry, Kobe
Nishimura, Tomohiko	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Noël, Mary-Helene	Nat Inst for Environmental Studies, Ibaraki
Ogawa, Morio	Hyogo Pref Fishery Foundation, Kobe Hyogo
Oka, Yasue	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Okada, Mitsumasa	Hiroshima University, Hiroshima
Okaichi, Tomotoshi	Tokushima Bunri University, Takamatsu
Okamoto, Makoto	Hiroshima Environm & Health Assoc, Hiroshima
Okawa, Yoshio	c/o International EMECS Center, Kobe
Onishi, Fumio	Hyogo Pref Fishery Fundation, Kobe Hyogo
Onishi, Hideo	Hyogo Environmental Advancement Ass, Kobe
Osato, Chieko	Hyogo Pref Fishery Foundation, Kobe Hyogo
Oshima, Iwao	Oceanographical Consultant Co Ltd, Yokohama
Oya, Yuichi	Daiya Sangyo, Himeji
Ozawa, Shuzo	The People's Alliance to Protect the Env of the Japanese Inland Sea, Akashi Hyogo
Peters, Ruth Koko	International EMECS Center, Kobe
Sakurai, Masaaki	Japan Environment Association c/o International EMECS Center, Kobe
Santiago, Vicente	UN Environment Programme, Kusatsu City Shiga
Sasaki, Kenji	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Sato, Masato	Joman Broader-Based Administration, Kyoto
Seiki, Tohru	Hiroshima Prefectural Inst of Public, Hiroshima
Sekine, Masahiko	Yamaguchi University, Yamaguchi
Shibataki, Toshihiro	c/o International EMECS Center, Kobe
Shibayama, Yuiko	Kawanishi
Shigeta, Misao	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Shikama, Katsushi	Osaka City Government, c/o International EMECS Center, Kobe
Shimadu, Susumu	Shinyo Warehouse/Transport Company, Kobe

Shimatani, Kojiro	Osaka Bay Regional Offshore, Osaka
Shimizu, Koichi	Naka Town Office, Hyogo
Shimizu, Teruko	Water Quality Division, Osaka
Shimizu, Toshio	Nara Prefectural Government Living, Nara
Shiota, Toshio	Hyogo Pref Fishery Foundation, Kobe Hyogo
Suda, Taiichiro	The Kansai Electric Power Co Inc, Osaka
Suematsu, Shinsuke	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Sugimoto, Kyoichi	Goshiki Town Assembly, Tsuna-Gun
Sugita, Satoshi	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Tabuchi, Toshio	The University of Tokyo, Ibaraki
Tada, Kuninao	Kagawa University, Kagawa
Takahashi, Kimiyo	Taki-Gun Hyogo, Taki-Gun
Takahata, Shozo	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Takano, Shigeya	Hyogo Prefectural Governemnt, c/o International EMECS Center, Kobe
Takemoto, Shumei	Osaka Prefectural Government, c/o International EMECS Center, Kobe
Takeuchi, Mitsuaki	Kobe Steel Ltd, Kobe
Takino, Hideo	Setokanren, Akashi Hyogo
Takuma, Kazuki	Suri-Keikaku Co Ltd, Chiyadaku
Tateishi, Yukio	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Teramoto, Takashi	Coalition of Prefectural Assembly to Promote International EMECS Act, Kobe
Teranishi, Hisayoshi	Kobe City
Tsubaki, Kiyoko	Daiichi Life Insurance, Fukusaki-Gun
Tsubakino, Masako	Asako Agricultural Products, Asako-Gun
Tsuchiya, Masaharu	University of Shia Prefecture, Hikone
Tsuda, Minoru	Kobe
Tsuno, Hiroshi	Kyoto University, Kyoto
Uchino, Naoyuki	c/o International EMECS Center, Kobe
Uchino, Tsuneko	c/o International EMECS Center, Kobe
Uenishi, Kenichrio	Ieshima Town Assembly, Shikama-Gun
Uetani, Kozo	City Council, Kyoto
Unisuga, Toshitsugu	The Kansai Electric Power Co Inc, Osaka
Urakawa, Toshikazu	Marusei Construction Co Ltd, Kobe
Ushikawa, Tsutomu	Tokushima Pref Inst of Public, Tokushima
Ushita, Isao	Awaji Civil Engineer/Constr Co Ltd, Mihara-Gun
Usui, Kaszumi	Usui Kosan Ltd, Kobe City
Uye, Shin-Ichi	Hiroshima University, Higashi-Hiroshima
Watanabe, Masataka	Nat Inst for Environmental Studies, Tsukuba
Watanabe, Tadashi	International EMECs Cener, Kobe
Watanabe, Toshiharu	Kansai Gaidai University, Kyoto
Watanabe, Yoshiaki	Japan Environment Agency, Kobe
Yagi, Shunsaku	Setsunan University, Neyagawa
Yagi, Yasuo	Osaka Prefectural Government, Osaka

Yagyu, Toyokazu	Taishi Town Assembly, Ibo-Gun
Yamada, Haruzo	Hyogo Pref Fishery Foundation, Kobe Hyogo
Yamada, Kenzo	Nanko Town Office, Hyogo
Yamada, Machiko	Kitakyushu City Inst of Env Sci, Kitakyushu City
Yamamoto, Kaori	Kobe University of Commerce, Osaka
Yamamoto, Katsuhiko	Osaka Prefectural Government, Osaka
Yamamoto, Teruo	Imada Town Assembly, Taki-Gun
Yamasaki, Takuzo	International EMECS Center, Kobe
Yanagi, Tetsuo	Ehime University, Matsuyama
Yokoi, Satoru	Kagawa Prefectural Government, Takamatsu
Yokoyama, Toru	Japanese Red Cross Society, Nishinomiya-City
Ysohimura, Sadako	Hokkai-Gauken University, Sapporo
Yoshioka, Shuichi	Hyogo Pref Fishery Foundation, Kobe Hyogo
Yoshiwa, Kyoko	Hyogo Pref Fishery Foundation, Kobe Hyogo
Yumoto, Ichiro	Hyogo Pref Fishery Foundation, Kobe Hyogo
Yuri, Masa	Toyooka
JORDAN	
Khatib, Hisham	World Energy Council, Amman
Ulimat, Ahmed	Water Authority of Jordan, Zerka
KENYA	
Bambrah, Gurmeet	Engineering Design Consultants Ltd Int Rainwater Catchment Systems Ass, Nairobi
Doyle, Brendan	UNICEF Esaro Nairobi, Nairobi
Kibaki, Timothy Wakaru	Ministry of Land Reclamation, Nairobi
Langat, Cyprian K	Ministry of Health, Eldoret
Macharia, Peter Mwangi	Ministry of Health, Embu
Melvasalo, Terttu	UN Environment Programme, Nairobi
Munyirwa, Kinya	Osienala, Kisumu
Muthinji, Samuel Kiende	Ministry of Health, Embu
Mwongera, Erastus Kabutu	Ministry of Land Reclamation, Nairobi
Nayaga, Ephabras Njeru	Ministry of Land Reclamation, Nairobi
Rast, Walter	UN Environment Programme, Nairobi
Stower, David	Ministry of Land Reclamation, Nairobi
LATVIA	
Arnts, Raitis	Riga City Council, Riga
Bambe Uldis	Riga Water, Riga
Bebris, Rolands	Ministry of Environmental Protection, Riga
Klavina, Inta	University of Latvia, Riga
Lund, Anders	Riga Municipal Enterprise, Riga
Müller-Karulis, Bärbel	Latvian University, Riga
Prols, Janis	Geo-Konsultants, Riga
Steins, Zigmunds	Riga Water, Riga
Sämite, Indra	Riga City Council, Riga
Vejponis, Raimonds	Environment Board of Greater Riga, Riga
Yuarkovskis, Aivars	University of Latvia, Riga
Zants, Aivars	Riga Municipal Enterprise, Riga

LESOTHO

Kakonge, John O	UNDP, Maseru
Makhoalibe, Sechocha	SADC Water Sector Coordination Unit, Maseru

LITHUANIA

Burokas, Vilius	Kaunas Water Company, Kaunas
Ceringis, Vytautas	Kanuas Water, Kaunas
Devonis, Vitolis	Baltic Consulting Group, Vilnius
Dubra, Vytautas	Center of Marine Research, Klaipeda
Gudavicius, Dainius	Kaunas City, Kaunas
Kytra, Stasys	Kaunas Technical University, Kaunas
Matulionis, Henrikas	City Council, Kaunas
Noreika, Ramunas	Kaunas Municipality, Kaunas
Olenina, Irina	Centre of Marine Reserach, Klaipeda
Orloviene, Viktorija	Kaunas Municipality, Kaunas
Pavilonis, Valdimaras	Kaunas Water, Kaunas
Povilaitis, Arvydas	Lithuanian Univeristy of Agriculture, Kaunas
Ragauskine, Nijole	Kauno Vaderys, Kaunas
Rimkus Alfonsas	Lithuanian Inst of Water Management, Kedainiai
Ruplys, Bronislovas	LZU University, Kaunas
Stonis, Darius	Kaunas Water, Kaunas
Tamules, Henrikas	Kaunas City, Kaunas
Tumas Rimvydas	Lithuanian University of Agriculture, Kaunas
Yla, Juozas	Kauno Vanderys, Kaunas
Zibas, Alvydas	Lithuanian University of Agriculture, Kaunas
Zibiene, Grazina	Lithuanian University of Agriculture, Kaunas

MALAYSIA

Abdullah, Keizrul	Dept of Irrigation and Drainage, Kuala Lumpur
Koh, Hock-Lye	University of Sciences Malaysia, Penang
Lubis, Abdur-Rassaq	Water Watch Asia, Penang
Lum, Ken	Wetlands Intern-Asia Pacific, Kuala Lumpur
Parish, Faizal	Wetlands Intern-Asia Pacific, Kuala Lumpur
Sivalingam, P M	University of Sciences Malaysia, Penang

MAURITIUS

Dookhony, Navin Kumar	Central Water Authority, Port Louis
Reamjeawon, Toolseeram	University of Mauritius, Reduit

MEXICO

Biswas, Asit K	Instituto de Ingenieria UNAM, Mexico
Clark, George Anna	Espacio de Salud, AC, Coernavaca Morelos
Garduño, Hector	Comision Nacional del Agua, Mexico City
Gonzalez, Fernando	University of Mexico, Mexico
Tortajada, Cecilia	Viveros de la Loma, UNAM, Mexico

MOROCCO

Kadi, Mohamed Ait	AGR, Administration de Genie Rural, Rabat
Mande, Laila	Faculty of Sciences Semlalia, Marrakech

MOZAMBIQUE

Nguenha, Antonio	Nat Directorate for Water Affairs, Maputo
Saranga, Suzana da Graca	Nat Directorate for Water Affairs, Maputo

NAMIBIA

Heyns, Piet	Ministry of Agriculture, Windhoek
van der Merwe, Ben	Municipality of Windhoek, Windhoek

NEPAL

Shrestha, Chiranjeevi	Group for Environm Management, Kathmandu

NETHERLANDS

Abd El Khalik, Mohamed A	Drainage Reserach Institute Egypt, The Hague
Agterbos, Roy	Aquatech/Aquatech Asia, Amsterdam
Carmer, Wennmar	Ministry WROM/DGM/IPC, the Hague
De Ruyter van Steveninck, Erik	IHE-Delft, Delft
Diphoorn, Bert	Ministry of Foreign Affairs, the Hague
Hoekstra, Ammo	Ministry of Transport, Public Works and Water Management, Middelburg
Niesing, Hugo	Rykswaterstaat, Middelburg
Onland, Rinus	Media Conslut & Management, Pijnacker
Oudshoorn, C R M	Ministry of Transport, The Hague
Pinkers, Mathew	Ing Inst for Land Reclamation & Improvement, Wageningen
Santbergen, Leo	Rykswaterstaat, Middelburg
Savenye, Huub	IHE, Delft
Schäfer, Anneke	Riza, Lelystad
Senhorst, Henk	Riza, Lelystad
Timmerman, Jos	Riza, Lelystad
Van Damme, Hans	WSS Collaborative Council, La Lisse

NEW ZEALAND

Pyle, Eric	Ministry for the Environment, Wellington

NIGERIA

Adebakin, Eniola	Lifescope Africa, Shomolu Lagos
Egboka, Boniface	Nnamdi Azikiwe University, Awka
Ojo, Godwin Uyi	Environm Rights Action, Ugbowo, Benin City
Ojo, Monday	Lagos State Polytechnic, Lagos

NORWAY

Denisov, Nickolai	UNEP/Grid, Arendal
Gleditsch, Mona	Environm Unit Techn Dept, Oslo
Guldbrandsen, Svenrre	Movar, Rygge
Veberg, Svein	Kronostitan A/S, Fredrikstad

PHILIPPINES

Alejandrino, Angel	Nat Hydraulics Reserach Center, Quzon City
Lincklean Arriens, W I	Asian Development Bank, Manila
Salazar, Roderick	Cebu Uniting for Sustainable Water, Cebu
Williams, Meryl	Int Center Living Aquatic Resource Management, Makati

POLAND

Bukowicka, Stanislawa	Ministry of Defence, Warsaw
Dzikiewicz, Maciej	Water Supply Foundation, Warsaw
Mosiej, Jozef	Warsaw Agricultural University, Warsaw

PORTUGAL

Conde Silva, Maria Conceicao	SMAS de Oeiras e Amodora, Oeiras
Cruz Pinho, Maria Teresa	SMAS de Oeiras e Amadora, Oeiras
Moreira, Eglantina	SMAS de Oeiras e Amadora, Oeiras

REPUBLIC OF KOREA

Ahn, Hee-Do	Korea Ocean Res & Dev Inst, Seoul
Chae, Jang-Won	Korea Ocean Res & Dev Inst, Seoul
Chang, Sun-Duck	Puktong National University, Pusan
Cho, Hong-Yeon	Korean Ocean Reserach & Dev, Seoul

ROMANIA

Ceachir, Octavian	Ministry of Water, Bucharest

RUSSIAN FEDERATION

Antonov, Yuri	Administration of St Petersburg, St Petersburg
Basova, Svetlana	Sevzaphydromet, St Petersburg
Bolgov, Mikhail	Water Problems Institute, Moscow
Chuyan, Galaina	Kamchatka Inst of Zoology, Petropavlovsk-Kamchatskiy
Debolskaya, Elena	Russian Academy of Sciences, Moscow
Ezhova, Lena	P P Shirshov Inst of Oceanology, Kaliningrad
Frumin, Grigori	Inst of Limnology RAS, St Petersburg
Glazyrina, Irina	Inst of Natural Resources of Russian Academy of Sciences, Chita
Iarochevski, David	Water Problems Institute, Moscow
Karmazinov, Felix	SUE "Vodokanal of St Petersburg", St Petersburg
Kuksa, Vladimir	Russian Academy of Sciences, Moscow
Lopatnikov, Victor	Ministry of Foreign Affairs, St Petersburg
Makarov, Oleg	Russian Academy of Sciences, St Petersburg
Mikhailova, Maria	Russian Academy of Sciences, Moscow
Ousanov, Bors	Committee of Economy & Industrial Policy of St Petersburg Adm, St Petersburg
Romaniuk, Ludmila	SRC for Ecological Safety, RAS, St Peatersburg
Tsvetkova, Ludmila	State of University of Architecture and Civil Engineering, St Petersburg

Verakso, Alla	The Branch "Ecocenter" of SUE "Vodokanal of St Petersburg", St Petersburg
Yakushev, Evgeniy	Russian Aacademy of Sciences, Moscow
Zhukova, Ludmila	Association "Baltvod", St Petersburg

SAUDI ARABIA

Alghamdi, Abdulpahman Hamed	K s a Jeddah, Water & Sanitary Dept, Jeddah
Yaghmour, Jamil	K s a Jeddah, Water & Sanitary Dept, Jeddah

SINGAPORE

Rahman, Ausaf-ur	National University of Singapore, Singapore

SOUTH AFRICA

Austin, Aussie	CSIR, Pretoria
Bath, Vincent	Rand Water, Johannesburg
Benya, Lizo	Cape Metropolitan Council, Vlaeberg
Gocini, Tony Malongwana	Cape Metropolitan Council, Cape Town
Hartley, Simon	Dept of Water Affairs & Forestry, Pretoria
Holden, Richard	The Muula Trust, Johannesburg
Kloppers, Wilna	Dept of Water Affairs & Foretstry, Cape Town
Leitsch, Jaqueline	Brooke/Pattrick Publ, Bedfordview
Mjoli, Nozibele	Water Research Commission, Pretoria
Obree, Mark	Cape Metropolitan Council, Vlaeberg
Pelpola, Kalinga U	Dept of Water Affairs & Forestry, Pretoria

SPAIN

Mendiluce, J Martin	Spanish National Committee on Irrigaion and Drainage, Madrid

SRI LANKA

Amarasinghe, Summa R	Lanka Hydraulic Institute, Moratuwa
Athukorala, Kusum	Ass Dev Research Consultants, Colombo
Kondradsen, Flemming	Int Irrigation Management Inst, Pelawatte Battaramulla
Makin, Ian	IIMI, Colombo
Seckler, David	Int Irrigation Management Inst, Pelawatte Battaramulla

SWAZILAND

Brandberg, Björn	Mbabane

SWEDEN

Admassu, Demeke	Uppsala University, Uppsala
Adolfsson Jörby, Sofie	Kalmar University, Kalmar
Adolphson, Tomas	VBB Viak AB/Sweco, Stockholm
Alberts, Tom	Global Water Partnership, Stockholm
Alvendal, Kristina	Stockholm Water Company Board, Stockholm
Andersson, Bengt	Malmö Water & Sewage Works, Malmö
Andersson, Christer	Rust VA-Projekt AB, Stockholm

Andersson, Ingvar	Sida, Stockholm
Andersson, Tomas	Stockholm County Council, Stockholm
Andrejewska, Katarina	SIWI, Stockholm Int Water Inst, Stockholm
Antelius, Claes	Kemira Kemi AB/Kemwater, Stockholm
Arheimer, Berit	SMHI, Norrköping
Arrhenius, Erik	Färjestaden
Arrhenius, Mattias	Årsta
Balmér, Peter	Grynab, Göteborg
Baurne, Göran	Royal Institute of Technology, Stockholm
Berggren, Birgitta	Harladsbogymnasiet, Falun
Berglund, Lennart	Stockholm Water Company, Stockholm
Bergström, Sten	SMHI, Norrköping
Bertilsson, Göte	Hydro Agri, Landskrona
Bjerggaard, Steen	Riga Project, Stockholm Water Co, Stockholm
Björk, Sven	Simrishamn
Björklund, Gunilla	SEI, Stockholm
Björsten, Stig	Stockholm Water Company, Stockholm
Blidberg, Magdalena	Swedish Environm Protection Agency, Stockholm
Blomqvist, Anna	Lindköping University, Linköping
Bodin, Svante	Miljödepartementet, Stockholm
Bondelid, Per	Stockholm Water Company, Stockholm
Bostrand, Lisbet	Sida, Stockholm
Brattberg, Gunilla	Stockholm Water Company, Stockholm
Brismar, Anna	Linköping
Carlsson, Karin	Stockholm University, Stockholm
Carlsson, Leif E	ITT Flygt AB, Solna
Cederwall, Klas	Royal Institute of Technology, Stockholm
Claesson, Eva	SIWI, Stockholm Int Water Inst, Stockholm
Cyon, Stellan	Complan AB, Lidingö
Czarmota, Zbiegniew	ITT Flygt AB, Solna
Dadebo, Elias	Uppsala University, Uppsala
Dahlberg, Alf Göran	SYVAB, Grödinge
Dam, Henrik	ITT Flygt AB, Solna
Digné, Per-Olof	Stockholm Water Company, Stockholm
Drangert, Jan-Olof	Linköping University, Linköping
Edwards, Laura	Global Water Partnership, Stockholm
Ehlin, Ulf,	SIWI, Stockholm Int Water Inst, Stockholm
Eklund, Maj-Len	Stockholm Water Company Board, Stockholm
Elmi Mohamed, Abdullahi	Royal Institute of Technology, Stockholm
Enell, Magnus	ITT Flygt AB, Solna
Engqvist, Anders	Stockholm University, Stockholm
Engström, Eva	Stockholm University, Stockholm
Erickson, Anna	Global Water Partnership, Stockholm
Ericson, Ulf	Ragn Sells Agro AB, Sollentuna
Ericsson, Bernt	VBB Viak AB/Sweco, Stockholm
Eriksson, Kurt O	VBB Viak AB/Sweco, Stockholm
Eriksson, Tor	Sida, Stockholm
Eriksson-Gladh, Lennart	WWF Sweden, Västerås
Falk, Jan	VAV, Stockholm

Falkenmark, Malin	SIWI, Stockholm Int Water Inst, Stockholm
Fallenius, Ulla-Britta	Swedish Environm Protection Agency, Stockholm
Fleicher, Siegfried	Länsstyrelsen i Hallands län, Miljövårdsenheten, Halmstad
Folke, Carl	Stockholm University, Stockholm
Formiga Johansson, Rosa Maria	Laboratoire TMU, Upplands-Väsby
Forsberg, Curt	Uppsala University, Inst of Limnology, Uppsala
Forsell, Lennart	Norrköpings Miljö & Energi AB, Norrköping
Forsgren, Gunilla	Umeå Marine Science Centre, Hörnefors
Forssberg, Brita	Stockholm Water Company, Stockholm
Franzén, Tommy	Coalition Clean Baltic, Stockholm
Frenning, Lars	ITT Flygt Pumpar, Sundbyberg
Frösslind, Eva	Coalition Clean Baltic, Stockholm
Gebru, Tewolde	Ethiopian Embassy, Stockholm
Ghedi, Abdi Jama	Royal Institute of Technology, Stockholm
Goldstick, Miles	SEI, Stockholm
Graham, Phil	SMHI/KTH, Norrköping
Granlund, Anders	Sida, Stockholm
Grimvall, Anders	Swedish Univ of Agricultural Sciences, Uppsala
Grip, Gilla	ITT Flygt AB, Solna
Gräbner, Christer	ITT Flygt Pumpar, Sundbyberg
Gumbricht, Thomas	Royal Institute of Technology, Stockholm
Gunnarsson, Jan-Åke	Stockholm Water Company, Stockholm
Gunnarsson, Per	Stockholms Stadshus AB, Stockholm
Gunsell, Charlotte	VBB Viak AB/ Sweco, Stockholm
Gustavsson, Berthold	Stockholm Water Company Board, Stockholm
Göransson, Bo	Sida, Stockholm
Hagbarth, Ulrika	M-dep, Baltic 21 Secretariat, Stockholm
Haglund, Cecilia	SEI, Water Planet, Stockholm
Hallgren, Lars	SLU, Uppsala
Hallmans, Bengt	SWECO AB, Stockholm
Hamilton, Ian	Stockholm Water Company Board, Stockholm
Hammer, Monica	Stockholm University, Stockholm
Hanneberg, Peter	Environment Protection Board, Stockholm
Hansson, Allan	Tekniska Verken i Linköping AB, Linköping
Hansson, Björn	Swedforest, Stockholm
Hansson, Per	Stockholm Water Company Board, Stockholm
Hedenström, Anna	Stockholm University, Stockholm
Hellström, Daniel	Luleå University of Technology, Luleå
Henriksson, Göran	Stockholm Water Company Board, Stockholm
Herrmann, Jan	Kalmar University, Kalmar
Hjort, Peder	Lund University, Lund
Holmberg, Johan	Sida, Stockholm
Holmlund, Cecilia	Stockholm
Hultgren, Jan	Rust VA-Projekt AB, Stockholm
Hådell, Per	Stockholm Water Company, Stockholm
Håkansson, Bertil	SMHI, Norrköping
Hökervall, Ebbe	Stockholm
Ingevik, Ingemar	City Council, Stockholm

Ivanova, Maria	Stockholm University, Stockholm
Jansson, Bengt-Owe	Stockholm Marine Research Center, Stockholm
Jansson, Ingrid	Swedish Environm Protection Agency, Stockholm
Johansson, Bengt	Sida, Stockholm
Johansson, Catarina	Environmental Protection Agency, Stockholm
Johansson, Erica	Luleå University of Technology, Luleå
Johansson, Iréne	Swedish Natural Sci Res Council, Stockholm
Jonsson, Karin	Global Water Partnership, Stockholm
Jonsson, Åke	Stockholm Water Company, Stockholm
Jordvall, Catharina	Stockholm Water Company, Stockholm
Jordvall, Ulf	Stockholm Water Company, Stockholm
Jönsson, Håkan	University of Agricultural Science, Uppsala
Jönsson, Jörgen	Umeå Marine Sciences Centre, Hörnefors
Kamal, Martin	Nordic School of Public Health GBG, Stockholm
Kautsky, Ulrik	Swedish Nuclear Fuel & Waste Mgt Co, SKB, Stockholm
Kihlblom, Ulf	Swedforest International, Täby
Klaesson, Bengt	Stockholm Convention Bureau, Stockholm
Kleen, Ingrid	SIWI, Stockholm Int Water Inst, Stockholm
Klenell, Markus	Stockholm University, Stockholm
Kristoferson, Lars	Baltic 21, Stockholm
Langaas, Sindre	UNEP/GRIND - Arendal, c/o Stockholm University, Stockholm
Langner, Joakim	SMHI, Norrköping
Larsson, Johan	Urban Hydroinformatics Centre, Stockholm
Liljeberg, Ulrika	Stockholm Water Company Board, Stockholm
Lind, Anna-Greta	Stockholm Water Company Board, Stockholm
Lind, Jan Erik	Purac AB, Stockholm
Lindberg, Anna	SIWI, Stockholm Int Water Inst, Stockholm
Lindberg, Lillemor	Stockholm Water Company Board, Stockholm
Lindblad, Anders	Stockholm
Lindblom, Lars	Stockholm Water Company, Stockholm
Lindén, Olof	Stockholm University, Stockholm
Lindkvist, Torbjörn	SMHI, Norrköping
Linnanheimo, Birgitta	SIWI, Stockholm Int Water Inst, Stockholm
Loughran, Kim	Tomorrow Magazine, Stockholm
Lundberg, Hans	Brottby
Lundqvist, Jan	Linköping University, Linköping
Malmström, Maria	Stockholm University, Stockholm
Martinger, Jerry	Stockholm Water Company Board, Stockholm
Mattsson, Hans	VAV, Stockholm
Midman, Fabia	New World Order Development Forum, Bromma
Moberg, Fredrik	Stockholm University, Stockholm
Morling, Stig	Purac AB, Lund
Nicolin, Curt	ABB AB, Stockholm
Nilsson, Annika	Swedish Environm Protection Agency, Stockholm
Nilsson, David	Urban Hydroinformatics Centre, Stockholm
Nilsson, Jim	Stockholm Stad, Stockholm
Nilsson, Lennart	Int Chamber of Commerce, Stockholm

Nordström, Anders	Stockholm University, Stockholm
Nordström Enkel, Anders	Kemira Kemi AB, Kemwater, Helsingborg
Nyberg, Peter	Stockholm Water Company, Stockholm
Olofsson, Margareta	Stockholm
Olsson, Bengt-Erik	Stockholm Water Company, Stockholm
Olsson, Per	Stockholm University, Stockholm
Pedolsky, Rick	Water Planet, c/o SEI, Stockholm
Pegert, Gunnar	SWF, Stockholm
Peldius, Arnold	Stockholm Water Company, Stockholm
Perers, Jerker	VBB Viak AB/Sweco, Stockholm
Persson, Gunn	SLU, Uppsala
Persson, Gunnar	SLU, Uppsala
Pettersson, Åsa	Stockholm University, Stockholm
Rahm, Lars	Linköping University, Linköping
Renman, Gunno	Royal Institute of Technology, Stockholm
Rennerfelt, Jan	Stockholm
Rey, Jaques	Global Water Partnership, Stockholm
Rockström, Johan	Stockholm University, Stockholm
Romare, Lars	Lars Romare AB, Stockholm
Runnqvist, Jan-Olof	Sida/Natur, Stockholm
Ryan, Thomas	Royal Institute of Technology, Stockholm
Rydén, Lars	Uppsala University, Uppsala
Rydergren, Anders	Sweco, Stockholm
Sandberg, Johannes	Stockholm University, Stockholm
Sandström, Klas	Global Water Partnership, Stockholm
Savchuk, Oleg	Stockholm University, Stockholm
Schubak, Bengt	Stockholm Water Foundation, Stockholm
Seman, Per Olof	VBB Viak AB/Sweco, Stockholm
Sjöberg, Johanna	Global Water Partnership, Stockholm
Sjölin, Karin	Miljödepartementet, Stockholm
Skoglund, Erik	Sida, Stockholm
Skogsfors, Sven-Erik	Stockholm Water Company, Stockholm
Skånberg, Krister	Stockholm Water Company Board, Stockholm
Smolianaja, Tatiana	Stockholm University, Stockholm
Stark, Helena	Stockholm Convention Bureau, Stockholm
Stenström, Thor Axel	Swedish Inst for Infectious Disease, Stockholm
Stocklassa, Claes	Stockholm Water Company, Stockholm
Strömblad, Gunilla	Strömblad & Co Annonsbyrå, Stockholm
Ståhl, Michael	Uppsala University, Uppsala
Ståhl, Peter	ITT Flygt Pumpar, Sundbyberg
Stålnacke, Per	Linköping University, Linköping
Sundberg, Johan	Sida, Stockholm
Sundgren, Margaretha	Sida, Natur/Afrika, Stockholm
Svensson, Torbjörn	Chalmers University of Technology, Göteborg
Söderbaum, Peter	Mälardalen University, Västerås
Tadesse, Zenebe	Uppsala University, Uppsala
Takami, Sachiko	Takami Information Service, Lidingö
Tendaj, Marta	Stockholm Water Company, Stockholm
Tennander, Birgitta	Swedish Institute, Stockholm

Thorén, Ann-Karin	Kalmar University, Kalmar
Tidlund, Annika	Stockholm University, Stockholm
Tilly, Lena	Rust VA-Projekt AB, Stockholm
Torell, Elin	Gothenburg University, Göteborg
Troedsson, Bo	Emå-projektet, Vetlanda kommun, Vetlanda
Trolle, Ingela	Stockholm
Ulmgren, Lars	SIWI, Stockholm Int Water Inst, Stockholm
Wallin, Mats	SLU, Uppsala
Veem, Katarina	Miljödepartementet, Stockholm
Westermark, Torbjörn	Royal Inst of Technology, Stockholm
Westman, Sverker	Stockholm Water Company, Stockholm
Wilander, Anders	Swedish University of Agric Sci, Uppsala
Winberg, Rolf	Sida, Stockholm
Winblad, Uno	Ålem
Wittgren, Hans B	Linköping University, Linköping
Wulff, Fredrik	Stockholm University, Stockholm
Zachrisson, Kaj	VBB Viak AB/Sweco, Stockholm
Åström, Stig	Stockholm Water Company Board, Stockholm
Öhrn, Ylva	Stockholm University, Stockholm
Örvi, Ralf	Stockholm Water Company, Stockholm

SWITZERLAND

Blasco, Delmar	Bureau of Convention on Wetlands, Gland
Fry, Albert	World Business Council Sustain Dev, Conches-Geneva
Giacasso, Pierre	IWSA, Geneva
Gurtner-Zimmermann, Arnold	University of Basel, Basel
Hartmann, Armon	Swiss Agency for Coop & Development, Bern
Kraemer, Dieter	WHO, Geneva
Oppliger, Alain	Inernational Committee Red Cross, Geneva
Rose, Christel	IDNDR, Geneva
Stigson, Bjöarn	World Business Council for Sustainable Development, Conches-Geneva
Warner, Dennis	WHO, Geneva

TANZANIA

Christian, William Kazenga	Ministry of Water, Dar es Salaam
Lobo, Lois	Embassy of Sweden, Dar es Salaam
Mujwahuzi, Mark R	University of Dar es Salaam, Dar es Salaam
Nyirabu, Christopher M	Lake Victoria Env Management, Dar es Salaam

THAILAND

Anukularmphai, Apiehart	Cowrar, Bangkok
Ghooprasert, Wanchai	Provincial Waterrworks Authority, Bangkok
Keola, Keobang-A	Mekong River Commission Secretariat, Bangkok
Koottatep, Suporn	Chiang Mai University, Chiang Mai
Maikland, Pramote	Office of Nat Water Resources Comit, Bangkok
Osathanound, Anucha	Ministry of Foreign Affairs, Bangkok
Ounthouang, Thanousay	Mekong River Commission Secretariat, Bangkok

Piyakarnchana, Twesukdi	Chulalongkorn University, Bangkok
Puncharoen, Porntship	Mekong River Commission Secretariat, Bangkok
Snidvongs, Arnond	Chulalongkorn University, Bangkok
TRINIDAD AND TOBAGO	
Forde, Lester	Water & Sewerage Authority, St Joseph
TUNISIA	
Alouini, Aws	Agronomy National Inst of Tunisia, Mahrajene
TURKEY	
Alparslan, Mustafa	Canakkale Onsekiz Mart University, Canakkale
Cokacar, Tülay	Institutue of Marine Sciences, Icel
Mee, Lawrence David	Black Sea Env Programme, Besiktas Istanbul
Yilmaz, Aysen	Middle East Technical University, Erdemli-Icel
Özhan, Erdal	Middle East Technical University, Medcoast, Ankara
UGANDA	
Mutono, Samuel	Directorate of Water Development, Kampala
UKRAINE	
Kuznetsov, Vladimir	Ukrainian Scientific Center for Protection of Water, Kharkov
UNITIED KINGDOM	
Acreman, Michael	Institute of Hydrology, Wallingford
Bush, Jonathan	Severn Trent Water Int, Birmingham
Churchouse, Steve	Wessex Water Eng Serv Ltd, Bath
Dawes, Michael	Elsevier Science Ltd, Kidlington
Ducrotoy, Jean-Paul	University College Scarborough, Scarborough
Eckford, Tony	Purac, Cambridgeshire
Ferrier, Robert	Macauley Land Use Reserach Inst, Aberdeen
Funaba, Masatomi	Cambridge University, Cambridge
Green, Colin	Middlesex University, Middlesex
Hodges, John	Dept for Int Development, London
Hood Nicholas	Wessex Water Plc, Bristol
Jeffery, Jach	North Surrey Water Ltd, Middlesex
Jenkins, Alan	Institute of Hydrology, Wallingford
King, Henry	Unilever, Bebington
Kondo, Suematsu	Kawasaki Heavy Ind Ltd, London
Mattews, Peter	Anglian Water, Huntingdon
Milner, Sue	National Resource Inst, Chatham Maritime
Oatridge, Jim	Severn Trent Plc, Birmingham
Ramström, Kars-Erik	EBRD, London
Rees, Judith	London School of Economics, London
Shastri, Sunil	Univeristy College Scarborough, Scarborough
Slipper, Michael	Int Water Supply Association, London

Stedman, Lisbeth	Water Services Association, London
Tyson, John	North West Water, Warrington
Wray, Alistair	Dept for Int Development, London

UNITED STATES

Andersson, Thomas	Stockholm Courty Council, Stockholm
Awori, Thelma	UNDP, New York
Bell,Wayne	University of Maryland, Cambridge
Benjaminson, Eric	US Government, American Embassy, Stockholm
Boesch, Donald	University of Maryland, Cambridge
Bouhia, Hynd	Harvard University, Cambridge
Boydell, Robert A	UNDP, Washington
Bras, Rafael	Massachusetts Inst of Technology, Cambridge
Briscoe, John	The World Bank, Washington
Burke, Jacob	United Nations, New York
Carroll, David	EMECS Scientific & Program Committee, Baltimore
Collier, James	District of Columbia, Washington
Collins, Richard	University of Virginia, Charlottesville
Costanza, Robert	University of Maryland, Solomon
Curley, Michael	Finex Limited, Hunt Valley
Dauer, Daniel	Old Dominion University, Norfolk
Donahue, Michael	Great Lakes Commission, Ann Arbor
Duda, Alfred	Global Environment Facility, Washington
Eagleson, Peter S	Massachusetts Inst of Technology, Cambridge
Flanigan, Frances	Alliance for the Chesapeake Bay Inc, Baltimore
Frosh, Brian	Senate of Maryland, Betsheda
Garcia, Luis E	Inter-American Development Bank, Fairfax
Gaunt, Cary	SAIC, Mclean
Gentzler, Keith	Commonwealth of Pennsylvania, Lancaster
Greer, John	University of Maryland Sea Grant, College Park
Gross, Grant	Chesapeake Research Consortium, Edgewater
Haire, Michael	Maryland Dept of the Environment, Baltimore
Hanna, Susan	Oregon State University, Corvallis
Harrison, Verna E	Dept of Natural Resources, Annapolis
Hartvelt, Frank	UNDP, New York
Hedin, Lars	Cornell University, Ithaka
Henderson, Alexis	University of Maryland, Cambridge
Jones, Thomas	Salisbury State University, Salisbury
Kaushik, Surendra	Resources & Environment Group, Briarcliff Manor
Kemp, William Michael	University of Maryland, Cambridge
Kemper, Karin	The World Bank, Washington
Kikawada, Hitoshi	Cheaspeak Biological Lab, Solomons
Kulle, Betsy A	Dept of Natural Resources, Annapolis
Kuylenstierna, Johan	DPCSD, United Nations, New York
Lenton, Roberto	UNDP, New York
Lintner, Stephen F	The World Bank, Washington
Magnien, Robert	Maryland Dept of Natural Resources, Annapolis

Marino, Manuel	The World Bank, Washington
Marks, Jane	USAIO, Washington
Marx, Peter	US Env Protection Agency, Annapolis
Mayers, Margaret	University of Maryland, Flemington
Mitchell, John	Maryland Dept of Environment, Baltimore
Mitsch, William	The Ohio State University, Columbus
Najlis, Pierre	DPCSD, United Nations, New York
Naughten, Kate	Chesapeake Bay Program, Annapolis
Nishida, Jane	Maryland Dept of the Environment, Baltimore
O'Leary, Laura	Jarrettsville
O'Neill, Eileen	Water Environment Federation, Alexandria
O'Neill, Maureen	UNDP, New York
Pionke, Harry	US Dept of Agriculture, University Park
Rapaport, Dave	Vermont Public Interest Res Group, Waterbury
Ratza, Carol	The Great Lakes Commission, Ann Arbor
Reynolds, Philip	UNDP, New York
Roberts, William	Virginia Inst of Marine Sci, Gloucester Point
Rozengurt, M A	Orange County Sanitation Districts, Huntington Beach
Schoenbaum, Thomas	University of Georgia, Athens
Serageldin, Ismail	The World Bank, Washington
Sherman, Kenneth	UN Dept of Commerce, Narragansett
Sorber, Charles	Univ of Texas of the Permian Basin, Odessa
Swanson, Ann	Chesapeake Bat Commission, Annapolis
Tenner, Helene	Water Environment Federation, Annapolis
Thomas, James	US Dept Commerce/NOAA, Silver Spring
Turner, Billy	Water Environment Federation, Alexandria
Wainwright, Barbara	Salisbury State University, Salisbury
Weismiller, Richard	University of Maryland, College Park
Vensio, Elichia	Salisbury State University, Salisbury
Wenzel, Lauren	MD Dept of Natural Resources, Annapolis

VIET NAM

Chien, Bui Trong	Nha Tran Pasteur Institute, Nhatkanga
Do Hong, Phan	Center for Resources Dev and Env, Hanoi
Khuong, Do Van	Institute of Marine Products, Haiphong
Song, Pham	Hanoi

ZAMBIA

Hussen, Adam	Department of Water Affairs, Lusaka
Mutale, Michael	UNDPS, c/o Dept of Water Affairs, Lusaka

ZIMBABWE

Morgan, Peter	Aquamor, Harare
Proudfoot, David	Muuramanzi Trust, Harare
Small, Kenneth	UNDP, Industry Howe, Bulawayo

CO-CONVENERS

Helsinki Commission, Finland
Stockholm Marine Research Center, Sweden
University of Maryland System, USA
National IHP Committee/Swedish Natural Science Research Council
United Nations Environmental Programme, UNEP
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Food and Agricultural Organization, FAO
United Nations Development Programme, UNDP
Stockholm Environment Institute, SEI

FINANCIAL SUPPORTERS

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Stockholm Water Company

MAIN SPONSORS

ITT Flygt
Japan Foundation
PURAC
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RUST VA-projekt
Sida/Swedish International Development Cooperation Agency
SI/Swedish Institute
VBB Viak/SWECO

CONTRIBUTORS

Alfa Laval Separation A/S
AB CDM/Allied Colloids
Hifabgruppen
J & W Bygg
NCC Anläggning Stockholm
NORDKALK
SIAB Anläggning Stockholm
Stockholm Energy Company