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Enhancing the use of Science in International
Waters projects to improve project results

SYNOPSIS REPORT

LAND-BASED POLLUTION SOURCES

A global Synopsis of Land-Based Pollution Sources
science and transboundary management



GEF IW:Science Project

Synopsis Report of the Land-based Pollution Sources Working Group



IW: Science, or Enhancing the Use of Science in International Waters Projects to Improve Project Results is a medium-sized project of the Global Environment Facility (GEF) International Waters (IW) focal area, implemented by the United Nations Environment Program (UNEP) and executed by the United Nations University Institute for Water, Environment and Health (UNU-INWEH). GEF ID Number: 3343.



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Synopsis Report of the Land-based Pollution Sources Working Group

March 2012

This report is written as part of the IW:Science series of reports comprising a Synopsis and Analysis for each of five classes of global transboundary water system: River Basin, Lake, Groundwater, Land-based Pollution Sources, and Large Marine Ecosystems and Open Oceans. The findings and content of the Synopsis and Analysis Reports are then integrated into two IW:Science Synthesis Reports to provide a global water view with regard to *Emerging Science Issues and Research Needs for Targeted Intervention in the IW Focal Area*, and *Application of Science for Adaptive Management & Development and use of Indicators to support IW Projects*. All reports can be found on the IW:Science, UNU-INWEH, IW:LEARN and GEF websites.

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Cover photo: Fishing industry on the coast of India / IOM, Chennai University

List of Acronyms and Abbreviations

ACRONYM	MEANING
ACP	African, Caribbean, and Pacific Group of States
ASSETS	Assessment of Estuarine Trophic Status
CBCM	Community Based Coastal Management
CETPs	Common Effluent Treatment Plant
CM-SES	Coastal and Marine Social-Ecological Systems
DPSIR	Driver, Pressure, State, Impact and Response (Framework)
EECA	Eastern Europe and Central Asia
ELME	European Lifestyles and Marine Ecosystems
GBP	GloBallast Partnerships Project
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities
ICM	Integrated Coastal Management
ICZM	Integrated Coastal Zone Management
IMO	International Maritime Organization
IOM	Institute for Ocean Management
IRBM	Integrated River Basin Management
IWRM	Integrated Water Resource Management
LAC	Latin America and Caribbean
LBP	Land-Based Pollution

ACRONYM	MEANING
LME	Large Marine Ecosystem
LOICZ	Land-Ocean Interactions in the Coastal Zone
MPAs	Marine Protected Areas
MSP	Marine Spatial Planning
OECD	Organization for Economic Cooperation and Development
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
POP	Persistent Organic Pollutants
PPP	Public Private Partnership
PTS	Persistent Toxic Substances
SAP	Strategic Action Plan
SES	Socio-Ecological Systems
SIDS	Small Island Development States
TDA	Transboundary Diagnostic Analysis
UNCLOS	United Nations Convention on the Law of the Sea
WG	Working Group
WIO	Western Indian Ocean
WIOLAB	Addressing Land-Based Activities in the Western Indian Ocean
WMP	Watershed Management Program
WSSD	World Summit on Sustainable Development

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CHAPTER ONE

Introduction

GEF International Waters (IW) projects aim at sustainable management of global transboundary water systems. All IW projects are informed to some extent by science to help realize the objectives of a mosaic of regional and international water agreements. Efforts of the IW:Science project are to recognize, capture, analyze and integrate the scientific findings from these projects and to disseminate them across the IW portfolio and beyond. Through this exercise, IW project scientists and managers will be better informed about broader global water science issues, new methodologies, and science breakthroughs in projects dealing with land-based sources of pollution, and, in particular, emerging scientific challenges. By making such knowledge widely available, GEF-eligible countries could greatly strengthen their scientific capacity and use of science for adaptive management.

1.1 Purpose and Goal of the Synopsis Report

Results from this Synopsis report will address the science base of the International Waters portfolio by integrating social and natural sciences in a systems approach that will strengthen ecosystem-based, adaptive management within IW projects. They will also contribute to stronger, better-validated Transboundary Diagnostic Analyses (TDA) within projects, based on leading-edge science. In particular, the Synopsis report will address:

- Projects that have demonstrated significant and successful scientific components;
- Significant natural and social science findings;
- Unique research, monitoring and assessment issues;
- The role of science within projects;
- The design and use of (local) science networks and scientific advisory bodies;
- Scientific best practices;
- Intended target users; and
- Science/management implications.

1.2 Approach - Methods and Scope

At the first Working Group (WG) meeting in Macau in January 2010, a three-step approach was developed to ensure members follow a uniform strategy to analyze the projects in phases, ultimately producing a Synopsis Report, an Analysis Report, and a Synthesis Report.

The *Synopsis Report* focuses on the scientific basis for Transboundary Diagnostic Analysis of the projects addressing Land Based Pollution [LBP], and on use and quality of indicators for IW monitoring and evaluation purposes on the specific issues, as described in Section 1.1.

The *Analysis Report* provides an overview of the above-listed themes in addition to expanding to address:

- Critical emerging science issues;
- Development and use of indicators to support IW projects; and
- Application of science for adaptive management.


Following production of the Synopsis and Analysis Reports, the Synthesis Report will be prepared by the Co-Chairs of all the Working Groups, by synthesizing findings across the five working group analysis reports.

Method Adopted

A synopsis template was created by all Working Groups and circulated to members. Each group member then used the template to answer science-based questions on the projects they were reviewing by entering them into an online version of the template connected to the IW:Science database. The reports received from the Members were subsequently collated into a single Synopsis Report for the LBP WG.

Scope

The scope is to provide evidence of scientific quality in the IW project portfolio and to assess how proj-



ects are addressing global environmental change processes (including climate change). This exercise has also helped identify gaps and point the way toward a better-informed, ecosystem-based management. The focus of the LBP working group is on “coastal waters” affected by land-based, atmospheric and oceanic influences. Pollution stands in the centre of the assessment but is not the exclusive focus.

1.3 Documentation of Reviewed Projects and Status

Using the IW Science Project Database, a list of documents available under each project was identified and is listed in Table 1. Documentation for a majority of the projects was incomplete (≤ 10), and a few projects are still in the implementation stage, making “lack of documents” a major hurdle to the review process. On the other hand, some projects were exceptionally well documented; thus, this review will focus predominantly on these well documented projects and include relevant information wherever available.

1.4 Keywords in Projects within the DPSIR Framework

DPSI(W)R Framework incorporated in Projects
The Working Group decided to analyze and categorize the projects against the Drivers, Pressures, State, Impact and Response (DPSIR) Framework, highlighting the main focus of each. Promoted originally by the Organisation of Economic Cooperation and Development (OECD) in the early 1990s, this framework has been further developed (e.g. LOICZ) to assist in a harmonized analysis of coastal change processes, their forcing functions, and options for societal response. The framework enables standardized system description

and involvement of social science information. In brief, the DPSIR concept can be summarized as follows (taken from KnowSeas – EU project description: <http://www.knowseas.com/description-of-work/view?searchterm=DPSIR>).

Drivers are largely economic and socio-political (industrial or agricultural development, trade, regulations, subsidies, etc.) and often reflect the way benefits are derived from ecosystem goods and services. Pressures are the ways these Drivers burden the environment (agricultural runoff of nutrients, pollution discharges, bottom trawling, introduction of alien species etc.). State change is a measure (or proxy) of the consequences of Pressures on species or ecosystems. Impacts are measures of changes (the “costs”) to human welfare as a result of State changes; and Response is the way society attempts to reduce Impact or compensate for it.

However, in the design of KnowSeas, which is aimed to inform implementation of the EU Marine Strategy Framework Directive, “impact”, has been replaced by “welfare” — measuring the “costs” to human welfare as a result of State changes. This is designed to avoid confusion as to whether impacts refer to the natural or social system. We appreciate this further development since the underlying system context is one of a social ecological system: i.e., in coastal zones there is an active interaction between humans and nature. For the analysis, we have occasionally used both, impact and welfare. Results of this evaluation are displayed in Chapter 2.

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Table 1 Regional listing of the LBPS projects, status, and available documentation

GEF ID #	PROJECT LOCATION/ IMPL. AGENCY	COASTAL PROJECTS – PROJECT NAME	# OF DOCS.	STATUS
AFRICA				
68	AFRICA-IBDR	Oil Pollution Management Project for the Southwest Mediterranean Sea	2	Completed
533	AFRICA-IBDR	Western Indian Ocean Islands Oil Spill Contingency Planning	8	Completed
2129	AFRICA-UNEP	Demonstrating and Capturing Best Practices and Technologies for the Reduction of Land-sourced Impacts Resulting from Coastal Tourism	12	IA Approved
849	AFRICA-UNEP	Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa (CMEA)	24	Completed
1247	AFRICA-UNEP	Addressing Land-based Activities in the Western Indian Ocean - WIOLAB	46	IA Approved
2602	AFRICA-IBDR	Alexandria Integrated Coastal Zone Management Project - under Investment Fund for the Mediterranean Sea LME Partnership	18	Council Approved
ASIA				
587	ASIA-IBDR	Ship Waste Disposal	2	Completed
2135	ASIA-IBDR	Guangdong-Pearl River Delta Urban Environment	5	Completed
2972	ASIA-IBDR	Liaoning Medium Cities Infrastructure - under WB/GEF Partnership Investment Fund for Pollution Reduction in the LME of East Asia	1	IA Approved
3025	ASIA-IBDR	World Bank/GEF Partnership Investment Fund for Pollution Reduction in the Large Marine Ecosystems of East Asia (Tranche 1, Installment 2) (from November 05 WP) -PEMSEA	11	Council Approved
2188	ASIA-UNDP	East Asian Seas Region: Development and Implementation of Public Private Partnerships in Environmental Investments -PEMSEA	10	IA Approved
3309	ASIA-UNEP	Participatory Planning and Implementation in the Management of Shantou Intertidal Wetland	3	IA Approved
2750	ASIA-IBDR	Ningbo Water and Environment Project - under WB/GEF Partnership Investment Fund for Pollution Reduction in the LME of East Asia	7	IA Approved
2758	ASIA-IBDR	Coastal Cities Environment and Sanitation Project - under WB/GEF Partnership Investment Fund for Pollution Reduction in the LME of East Asia PEMSEA	16	CEO Endorssed
3188	ASIA-UNEP	Demonstration of Community-based Mgt of Seagrass Habitats in Trikora Beach East Bintan, Riau Archipelago Province, Indonesia	70	IA Approved
72	ASIA-IBDR	Gulf of Aqaba Environmental Action Plan PEMSEA	4	Completed
2979	ASIA-IBDR	Second Shandong Environment - under WB/GEF Partnership Investment Fund for Pollution Reduction in the LME of East Asia	5	IA Approved
2700	ASIA-UNDP	Implementation of Sustainable Development Strategy for the Seas of East Asia - PEMSEA	15	IA Approved
396	ASIA-UNDP	Prevention and Management of Marine Pollution in the East Asian Seas - PEMSEA	10	Completed
2454	ASIA-IBDR	World Bank/GEF Partnership Investment Fund for Pollution Reduction in the Large Marine Ecosystems of East Asia (Tranche 1 of 3 tranches) - PEMSEA	12	Council Approved
2576	ASIA-IBDR	Strategic Partnership for a Land-Based Pollution Reduction Investment Fund for the LMEs of East Asia, Tranche 3 - PEMSEA	6	GEF Approved

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GEF ID #	PROJECT LOCATION/ IMPL. AGENCY	COASTAL PROJECTS – PROJECT NAME	# OF DOCS.	STATUS
3223	ASIA-IBDR	Shanghai Agricultural and Non-Point Pollution Reduction project (SANPR) - under WB/GEF Strategic Partnership Investment Fund for Pollution Reduction in the LME of East Asia	30	CEO Endorsed
LATIN AMERICA AND CARIBBEAN (LAC)				
59	LAC-IBDR	Ship-Generated Waste Management	2	Completed
585	LAC-IBDR	Wider Caribbean Initiative for Ship-Generated Waste	2	Completed
1248	LAC-UNEP	Reducing Pesticide Runoff to the Caribbean Sea	78	IA Approved
791	LAC-UNEP	Formulation of a Strategic Action Programme for the Integrated Management of Water Resources and Sustainable Development of the San Juan River Basin and its Coastal Zone (PROCUENCA)	27	Completed
3128	LAC-UNEP	Integrated Water Resources Management of the Sao Francisco River Basin and Its Coastal Zone (GEF São Francisco)	28	CEO Approved
586	LAC-UNEP	Integrated Management of Land-Based Activities in the Sao Francisco Basin	11	Completed
3519	LAC-UNDP	Reducing and Preventing Land-based Pollution in the Rio de la Plata/Maritime Front through Implementation of the FrePlata Strategic Action Programme - NEW	4	IA Approved
613	LAC-UNDP	Environmental protection of the Rio de la Plata and its Maritime Front: Pollution Prevention & Control & Habitat Restoration (FREPLATA) - OLD	9	IA Approved
1426	LAC-UNEP	Development and Implementation of Mechanisms to Disseminate Lessons Learned and Best Practices in Integrated Transboundary Water Resources	7	Completed
CENTRAL ASIA				
2132	EECA-IBDR	Bosnia: Integrated Ecosystem Management of the Neretva and Trebisnjica River Basin - under Investment Fund for the Mediterranean Sea LME Partnership	18	Endorsed
1164	EECA-UNEP	Support to the National Programme of Action for the Protection of the Arctic Marine Environment, Tranche 1	11	Completed
807	EECA	Persistent Toxic Substances, Food Security, and Indigenous Peoples of the Russian North	85	Completed
GLOBAL				
610	Global and Regional-UNDP	Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries (GloBallast)	23	Completed
2261	Global and Regional-UNDP	Building Partnerships to Assist Developing Countries to Reduce the Transfer of Harmful Aquatic Organisms in Ships' Ballast Water (GloBallast Partnerships)	43	IA Approved
3340	Global and Regional-UNDP	Good Practices and Portfolio Learning in Transboundary Freshwater and Marine Legal and Institutional Frameworks	7	CEO Approved
3181	Global and Regional-UNDP	Pollution Reduction through Improved Municipal Wastewater Management in Coastal Cities in ACP Countries with a Focus on SIDS	28	IA Approved
2722	Global and Regional-UNDP	Fostering a Global Dialogue on Oceans, Coasts, and SIDS, and on Freshwater-Coastal-Marine Interlinkages	59	Completed
514	Global and Regional-UNDP	Role of the Coastal Ocean in the Disturbed and Undisturbed Nutrient and Carbon Cycles	57	Completed

The lighthouse projects identified in the end are largely an expression of a reasonable to good science base and underlying documentation.

CHAPTER TWO

Primary issues addressed in the Land-based Pollution Sources Projects based on the DPSI(W)R

Projects of the land-based sources of pollution portfolio cover a wide spectrum of issues ranging from analysis of the present state of the coastal and near-shore environment to the response of provincial and local governments to these broad-based issues. Included are projects on organic agriculture, sewage treatment, water quality monitoring programmes, risk assessments, habitat management, local integrated coastal management, technology and incentive schemes for good practices. As indicated in Section 1.4 above, coastal environmental issues are interdisciplinary and cross-sectoral; thus it was deemed appropriate to structure the findings from the reviewers using the DPSI(W)R Framework. This effort is meant to map projects against land-based and sea-based management initiatives with the purpose of making visible the links between the causes of coastal problems, their effects on the state of the environment, and relevant societal/governance responses. This would also aid in obtaining better clarity of the underlying science involved and the response mechanisms developed through science.

A vast majority (>62 per cent) of the projects pertain to policy responses leading to changes in the DPSIR cycle. A few of the projects have used multiple causality analysis in a GIS context with the advantage of allowing spatial visualization and better integration of different pollution indicators. From the overall review of projects, it is possible to confirm that globally, the highest priority issues of land-based sources of pollution are sewage, agriculture/aquaculture runoff, urbanization-related wastes and runoff, tourism and industry. There are also the issues of mobilization of pollutants through rivers, floods, and cross-border movements of pollutants through and from international waters. Sea-based impacts are included here.

The science undertaken in these projects is a blend of basic and applied science, with the latter more dominant: for example, determination of pollution loads and qualitative evaluation of contaminants discharged, such as use of agricultural pesticides, volume of sewage, dynamics of sediments, solid wastes generated etc. For land-based wastewater discharges and non-point sources, quantification of pollution loads in terms of biological oxygen demand (BOD), nitrogen (N), phosphorous (P) and total suspended solids (SS) loads have been made. Some of the projects exhibit maturity in terms of applying the information from basic science and in using technology (e.g., constructed wetlands, common effluent treatment plants) and policy and governance initiatives (e.g., Putrajaya Declaration, Integrated River Basin Management, Integrated Coastal Management, Public Private Partnerships, Participatory Management and Networking). Development of ecological models, risk assessment studies and use of GIS are all evidence of the diverse use of analytical tools in these projects.



Bauxite residue from nearby industry polluting a pond in 1972, Jamaica / UN Photo, A.F.



2.1 Land-based Activities

Issues concerning “pollution” in these projects are addressed as both “land-based” (Fig. 1a) and “sea-based”. Nearly 42 per cent of the projects reviewed by the Land-Based Pollution Sources Working Group have been successfully completed, with the remainder ongoing. These projects address impacts to the coast, resulting from both point and non-point land-based sources of pollution such as sediments, nutrients, runoff and pesticides. A majority of the projects are aligned toward implementing a local and regional action strategy and, in some cases, to quantifying, characterizing, and prioritizing the land-based sources of pollution to be addressed, based on identified impacts to the coast.

The key goals and objectives of the projects are to characterize past and existing conditions of the coastal ecosystem; quantify and characterize land-based sources of pollution; identify how these sources of pollution impact the coastal waters; develop suitable multi-layered management strategies, including infrastructure development, to reduce impacts of land-based sources of pollution; and to increase public awareness and understanding of the effects of land-based sources of pollution on water quality of the coastal ecosystems.

2.2 Sea-based Activities

Introduction of invasive marine species into new environments through discharge of ballast water from ships, attachment to the hulls of ships, and by way of various other vectors has been identified as one of the four greatest sea-based (Fig. 1b) threats to the world’s oceans¹. Ballast water dumped from a single ship can contain hundreds of species of phytoplankton, zooplankton, larval fish and invertebrates, introducing non-native organisms into the port of discharge. These introduced species are often referred to as exotic, nuisance, alien, or non-indigenous species².

Typically, few organisms are able to survive in new surroundings because temperature, food, and salinity are less than optimal; however, the few that do survive and establish a population have the potential to cause ecological and economic harm. Ballast water control, management regulations and the growing problem of aquatic species carried in ballast water have been explicitly addressed in projects pertaining to sea-based activities.

1 Satir, T. (2008) Ship's ballast water and marine pollution. *Earth and Environmental Science: Integration of Information for Environmental Security*; NATO Science for Peace and Security Series, 2008, 4, 453-463, DOI: 10.1007/978-1-4020-6575-0_30

2 <http://www.pkharbour.org/Ballast%20Water%20Issues.htm>

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Figure 1a Conceptual diagram of major land-based activities in South Asia



Key features

- Large freshwater input
- Forestry
- Marshes
- Temperature (offshore gulf stream)
- Living resources: Crabs, shellfish and fish
- Sand Mining
- Erosion Protection Structures
- Sand Dunes
- Temples

Influencing Factors

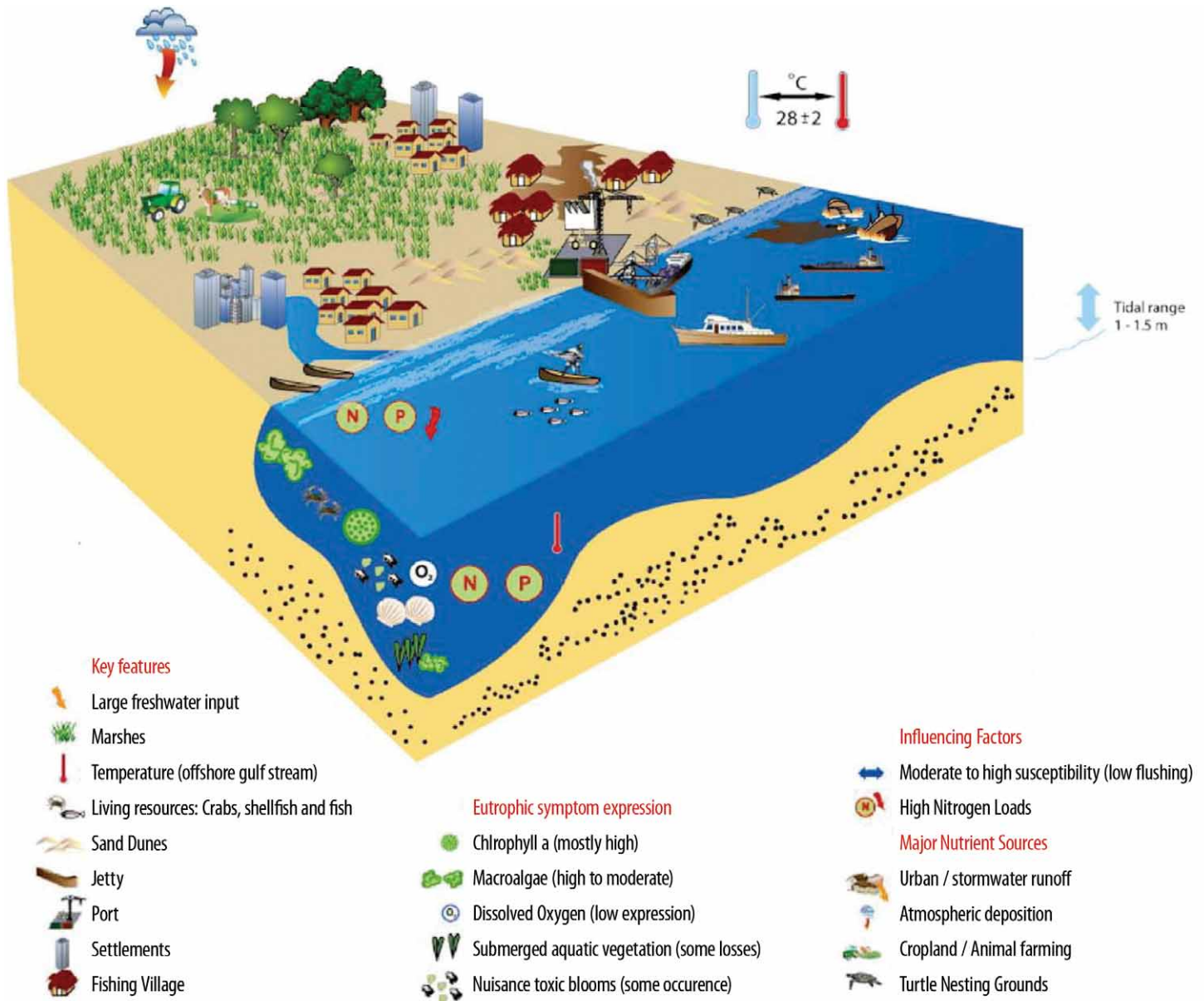
- Moderate to high susceptibility (low flushing)
- High Nitrogen Loads
- Major Nutrient Sources**
- Urban / stormwater runoff
- Waste water discharge
- Atmospheric deposition
- Cropland / Animal farming

Eutrophic symptom expression

- Chlorophyll a (mostly high)
- Macroalgae (high to moderate)
- Dissolved Oxygen (low expression)
- Submerged aquatic vegetation (some losses)
- Nuisance toxic blooms (some occurrence)

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Figure 1b Conceptual diagram of major sea-based activities in South Asia



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Globally, it is estimated that about 10 billion tonnes of ballast water are taken on board ships and dumped each year³. The water taken on board for stabilizing a vessel may contain dormant stages of microscopic toxic aquatic plants, such as dinoflagellates, which may cause harmful algal blooms after their release. Pathogens such as the cholera bacteria have been transported with ballast water. Many varieties of fish, plants, and other animals have all been found in ballast water. Higher rates of species transfer have been attributed to:

- increases in ship numbers;
- increases in the amount of ballast carried per ship;
- increases in the amount of water being transported; and
- increases in ship speeds, with shorter voyage times and higher survival rates of alien species transferred in the ballast water tanks.

All these factors provide a greater opportunity for introduction of non-indigenous organisms in new locations, leading to disastrous consequences for regional ecosystems that contain commercial fish or crustacean stocks or rare and endangered species. Projects considered under sea-based sources of pollution focus on response to threats posed by invasive marine species, technological options for management, and international regulations for prevention of marine pollution in projects concerned with ballast water pollution, invasive alien species etc.

2.3 Institutional dimensions and management

A. Transboundary Issues:

Transboundary issues have been addressed in many of the projects concerning land-based sources of pollution. Countries have begun cooperating on transboundary issues and have a reasonable amount of success has resulted. Direct and indirect benefits are evident from transboundary studies and agreements such as the Gulf of Thailand Oil Spill Contingency Cooperative Agreement signed by Thailand, Cambodia and Vietnam.

Some of the directly relevant obligations and commitments include:

- Promoting regional coordination programmes;
- Ensuring international cooperation by sharing expertise;
- Establishing or increasing regional cooperation in indicator development, monitoring and assessments; and
- Developing mechanisms for transboundary, regional and multilateral cooperation to deal with coastal/marine pollution issues, including exchange of best practices.

Indirectly relevant obligations and commitments include:

- Cooperation in transfer of technology for coastal monitoring, control and management of ballast water, constructed wetlands etc.;
- Promotion of regional cooperation through establishment of joint declaration or memoranda of understanding in applying an ecosystem-based management approach across national borders;
- Cooperation with other regional governments and agencies to address threats and risks to sensitive, vulnerable and threatened marine ecosystems;
- Enhancement of regional cooperation through regional agreements and harmonized procedures;
- Common procedures and formats for data acquisition and reporting on indicators at a sub-regional and regional level;
- Improved regional cooperation in development of indicators; and
- Assistance to developing countries in building capacity to develop and use indicators

In the project reviews, we find an interplay among institutional arrangements, financial development, participation of civil society, and legal and policy dimensions in addressing transboundary coastal and marine pollution. Reviews recognize that results matter more than the means, and achievement of effective transboundary pollution management has to consider technical, social and economic priorities of riparian/regional countries. The reviews also reveal a wide range and variation in institutional arrangements for managing transboundary pollution.

³ [http://www.pkharbour.org/Ballast%20Water%20Issues.htm#The Extent of the Problem](http://www.pkharbour.org/Ballast%20Water%20Issues.htm#The%20Extent%20of%20the%20Problem)

B. Policy Instruments:

Policy instruments refer to tools and measures designed to provide direction to regulators to achieve designated outcomes. Policies are normally created in response to an understanding of issues and their causes, so that policies support actions to solve a problem, such as coral reef destruction, which stems from any one of many causes. Policies supporting coastal management can be grouped into three categories: i) awareness/education, ii) regulatory (limits to access or use), and iii) economic (incentives or disincentives) in relation to local, regional and global scales. Governance incorporates a range of tools including, but not limited to, education, regulation and economic/market oriented instruments. Policies that support global (national and international) pollution management include:

- Trans-national or national integrated coastal management programs;
- Tax or fees intended to fund sewage treatment facilities and collection systems;
- Legal frameworks that provide a basis for regulation of pollution discharge and other impact-generating activities;
- Long-term lease agreements and management rights;
- Education and training;
- Education tools to raise awareness; and
- National, provincial and local laws and ordinances authorizing planning and management of pollution generating activities, etc.

Policies that support localized management mostly revolve around decentralization of authority and provision of resources to local governments and communities; use of the coastal area and integrated coastal management regimes; various types of regulations governing use of an area or the resource; education; and appropriate economic incentives.

C. Management Frameworks (regional, national and community based):

A few of the reviews revealed comprehensive and complex management frameworks. The actual management systems differed from region to region, depending on development trends, conservation needs, tradition, norms, governmental systems and the critical issues and conflicts at the time of implementation of the projects. Legal and institutional frameworks were also developed in a few projects, which have been well implemented

on a regional scale. In most management frameworks, Community Based Coastal Management (CBCM) is recognized as an integral feature of integrated coastal management. The past three decades of coastal development, particularly in Asia, have seen the growing role of participatory approaches and community-based management of local resources. Participatory research is also a means of empowering the community to research its biophysical and socio-cultural environment and to incorporate local knowledge and understanding. This serves as a basis for formulating strategy, resource management and livelihood initiatives, while, at the same time, building confidence in sustaining efforts towards community-based coastal resource management. Some of the projects have demonstrated this management aspect of integrated coastal zone management quite successfully.

D. Public-Private Partnerships:

Public Private Partnership (PPP) has been defined as “a creative and dynamic process of public sector restructuring that improves delivery of services to clients by sharing governance functions with individuals, community groups and other Government entities”. The main idea of PPP is how to address the need for better services to the public at a lower cost. Services should not rely only on the government sector because of relatively higher costs and potential time-consuming and inefficient decision-making processes. There are opportunities for non-governmental and private sectors to take part in delivering some programs and services. Projects that have addressed PPP in their mainstream objectives have emphasized that PPPs can provide effective governance structures for coastal management, but should be carefully implemented. These projects demonstrate that responsibility and authority for resource management can sometimes be achieved through cooperation between government and local resource users. Co-management emphasizes the significant upgrading of community involvement in coastal management process in the context of communities collaborating with local government in management.

E. Networking

Networking is a way of bringing together the scattered expertise of individuals and institutions to help resolve particular problems. The potential usefulness of networking is evident in projects relating to coastal pollution management. Capacity building, training programs and interagency partnerships have been addressed in many of the LBP projects.

CHAPTER THREE

Coastal science and management: A social ecological systems perspective

3.1 Need for social scientific and trans-disciplinary approaches

The Social-Ecological Systems (SES) approach links global, regional and local issues, using case studies as a focus for discussion of national policy and governance approaches, and illustrates how these relate to livelihoods, lifestyles, and coastal and marine resource management. Scientifically, a social-ecological system describes the interaction of humans with nature. Although climate change is a major driving force in global (environmental) change, there are other drivers such as socio-political changes that affect both society and the environment. Recent history has shown that regional seas such as the Black Sea or the Baltic experienced dramatic developments in their environmental conditions, originating largely in policy and market-based variants in drivers in surrounding countries. Whether one deals with fast subsiding coastal cities, such as various Asian Delta Cities, or changes in coastal

biodiversity, stronger signals often come from anthropogenic rather than climate change drivers. In a holistic analysis of this interplay and resulting feedbacks, the key challenge is to conceptualize “social dimensions” in order to inform effective modelling. Future scenarios can then be developed that provide information about likely developments in social choice, global developments, and political and economic systems, including different forms of land and sea use (i.e., addressing the key pillars of governance including value systems). In summary, SES analysis aims to assess the drivers of problems affecting the coastal zone generated through human-nature interactions at multiple levels; and to explore the societal response options towards a more sustainable future. This then feeds into linking governance and science in coastal regions.



Adyar River India / IOM, Anna University



A working definition for social-ecological system (SES) as used in LOICZ includes:

- A bio-geo-physical territory (e.g., ecosystem);
- Associated social agents (stakeholders) and institutions; and
- A particular problem context (e.g., coral, mangrove, sea grass or macro algae degradation, marine pollution, poverty of ecosystem users, climate change).

Obviously, trans-disciplinary research is a useful means of bridging different “world views” and languages of science, policy and coastal users to provide a broader understanding of the complex issues and processes. Natural sciences, social sciences, engineering sciences, and the humanities provide such knowledge. Policy is understood in an abstract sense as a principle or guideline for action in a specific everyday-world context.

In trans-disciplinary research and in boundary organizations, researchers and stakeholders from diverse sectors of society meet and exchange information. Such exchange must take into account that each of the sectors – science, the private sector, public agencies and civil society – organizes knowledge and action according to individual time scales, categories, priorities, etc. We mention this point here because this kind of continued and participatory dialogue and public discourse is a critical element for those projects (inside or beyond IW science) that aim to establish knowledge exchange platforms and science policy interfaces promoting options for sustainable development. Some of the projects reveal different levels of progress in this direction.

A. Ecosystem goods and services initiatives

Our knowledge of ecosystems has increased dramatically in recent decades, but has not kept pace with our ability to alter them. The Millennium Ecosystem Assessment (MEA) assessed the consequences of ecosystem change for human well-being, providing a state-of-the-art scientific appraisal of the condition of and trends in the world’s ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. A critical step in improving the way we manage the earth’s ecosystems is to take stock of their extent, their condition, and their capacity to provide the goods and services we will need in the years to come. Coastal waters are degraded directly by chemical or nutrient pollution, and indirectly when land-use change increases soil erosion or reduces the capacity of ecosystems to filter water. Nutrient runoff from agriculture is a serious problem around the world, resulting in eutrophication and human health hazards in coastal regions, especially in the Mediterranean, Black Sea, and north-western Gulf of Mexico. Water-borne disease caused by fecal contamination of water by untreated sewage is also a major issue.

The Arctic coastal interface is a sensitive and important zone of interaction between land and sea, a region that provides essential ecosystem goods and services and supports indigenous human livelihoods; a zone of expanding infrastructure investment and growing security concerns; and an area in which climate warming is expected to trigger landscape instability, rapid responses to change, and increased hazard exposure. Arctic coasts feature the most rapid global change observed, and they clearly reveal the interacting of local, regional and global interests in exploration and exploitation of energy, mineral and food resources. In scientific terms, Arctic coasts have not, as yet, been subject to explicit and comprehensive interdisciplinary assessments. A first comprehensive

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assessment was published in early 2011 (www.arctic-coasts.org).

The economic value of lost or injured ecosystem goods and services is argued to be the most legally, economically, and ecologically defensible measure of damages. The total ecosystem goods and services deriving from coastal zones worldwide have been estimated to reach almost half of the global total of all ecosystems⁴. However, even today, calculating lost ecological wealth with any precision is an enormous scientific and economic undertaking⁵. Marine vessel, terminal, and harbour operations can generate a range of legal damages rising from liability for response and cleanup costs, damages to private property, and damages to public natural resources. Within ecology and economics, assessment of ecosystem goods and services is a growing area of inquiry. Broadly put, “ecosystem services” refers to the dependence of economic wealth and human well-being on natural systems⁶. While the promise of a cohesive framework for assessing all types of damages is not yet realized, many projects are working toward this goal through more rigorous conceptualization and communication of the links between changes in natural systems and effects on human welfare.

B. Socio-ecological linkages between ecosystems and communities

Specific features of coastal and marine social-ecological systems (CM-SES) include catchment-to-coast and open sea regions (e.g., catchment, lagoon, pelagic, sea bottom, upwelling areas); specific ecosystem types (e.g., coral reefs, coastal wetlands and forests); specific social actors (e.g., fishers, beach tourists), institutions (e.g., UNCLOS, open access, MPAs, Common Fisheries Policies or

Maritime Policies); and problems (e.g., overfishing, marine pollution). Systems operate at varying temporal and geographic scales. They are inter-connected (often across very large distances as a result of human activity), produce surprises (non-linearities), have memory (and learning) and choke points (restricting connectivity), and have emergent properties (such as resilience). The conceptual frame includes the following emergent properties:

- **Resilience:** the ability of a system to absorb disturbances, to be changed and then to re-organize and still retain the same basic structure and way of functioning. Its self-reinforcing dynamics enable sustainable future directions, including emergence of a system’s self-organizing capacity.
- **Vulnerability:** a system’s inability to avoid undesirable change, e.g., climate change; adaptive capacity.
- **Transformability:** a system’s ability to change (switch of a system).

Development and change create “winners and losers” at the national and the local level. Socioeconomic polarization weakens resilience and increases vulnerability. Local rights to participation need to be re-enforced. Irreversible changes require adaptive strategies. This is the case for sea-level rise and disappearing islands, as a result of climate change. Linking of knowledge systems with collaborative learning is needed. Socially, the most marginal local people are also often the most vulnerable, and thus require explicit support. Local coping strategies must be informed by science. Appropriate socio-ecological governance institutions should match ecological scales.

In various, usually local-scale projects (e.g., Indonesian fisheries, Brazilian mangroves), a conceptual framework to address the social dimension in ecosystem/SES management was developed and pretested (<http://www.zmt-bremen.de/Page1179.html>; <http://www.zmt-bremen.de/Binaries/Binary314/MADAM.pdf>). “Social illiteracy” in ecosystem management is still deplorably prominent. In order to actually assess and quantify the social dimensions of human/ nature interaction, therefore, LOICZ, as part of its core research, assembled seven criteria to define them:

1. Population and resource use;
2. Poverty, basic needs and well-being;
3. Equity and justice;
4. Social capital;

4 Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M 1997, 'The value of the world's ecosystem services and natural capital', *Nature*, vol. 387, p. 253.

Boyd, J. (2010). Lost ecosystem goods and services as a measure of marine oil pollution damage. *Resources for the Future Discussion Paper* (<http://www.rff.org>).

5 Barbier, E. B., E. W. Koch, B. R. Silliman, , S. D. Hackery, E. Wolanski, J. Primavera, E. F. Granek, S. Polasky, S. Aswani, L. A.

6 Cramer, D. M. Stoms, C. J. Kennedy, D. Bael, C. V. Kappel, G. M. Perillo, and D. J. Reed. 2008. Coastal ecosystem-based management with nonlinear ecological functions and values. *Science* 319: 321–323.



Rainfall runoff, laden with soil from recent coastal development, brings excess nutrients and contaminants into the marine environment / *Marine Photobank 2008, G. Bergsma*

5. Resilience and adaptive capacity;
6. Participation in management and governance; and
7. Collaborative learning and reflexivity.

Drawing from this rather conceptual research and looking at the portfolio of IW projects, we see various elements addressed or supported that reflect some of these criteria. This indicates that there is a growing, though slow, development to a more thorough consideration of social dimensions in environmental projects. However, not even the “lighthouse” category of project features a comprehensive assessment of the social dimension.

C. Causal Chain analysis

Causal chain analysis aims to identify the root causes of physical and natural aspects and the socio-economic and ecological impacts resulting from prioritized issues and concerns, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. Causal chain analysis has been employed in a few well-studied projects involving the most important causal links between the coastal environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible, and, finally, the root causes that determine

the behavior of those sectors. This analysis has been successfully employed in projects dealing with ICZM, IWRM and IRBM.

D. Transboundary Diagnostic Analysis (TDA)

An important but difficult step in evaluating coastal programs is the formulation of meaningful and measurable criteria for purposes of evaluation. One useful source for deriving evaluation criteria consists of coastal problem statements. Water-related issues, pollution, over-exploitation and habitat modification are concerns of most of the transboundary coastal states. From the reports, it is evident that TDA and Strategic Action Plans (SAP) have assisted in the implementation of a regional action plan in ICZM and IWRM member states by integrating and applying sound management strategies. Implementation of the TDA and SAP has also entailed a number of interventions focused on conservation of biodiversity and designed to obtain national, regional and global benefits. However, TDA has only been partially addressed in the Global Ballast Water projects, although “ballast water” is a major transboundary issue of great regional and global concern. In projects dealing with ICZM, establishment of transboundary Marine Protected Areas (MPAs) are indicators of successful implementation of TDA.

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E. Policy implications

One of the current issues in coastal zone development and management is finding appropriate and suitable ways to decentralize governance. Projects in the LBP group cover a full range of scales from largely global, in terms of drivers, to rather local, in terms of new approaches for waste water management. This highlights the multiplicity of scales that policy has to recognize when responding to coastal socio-ecological change. The projects highlight the fact that to achieve continued success in informing policy, a comparative understanding of a decentralized coastal management process is needed. This can be accomplished by reviewing local and regional projects in a context of global and climate change. Large regional projects such as PEMSEA, or the Ocean communication platforms, point in this direction and aim to build constituency as an enabling platform for sustainable development. Science in this context would likely have been more efficient if it had better informed the potential tradeoffs in time and space that can affect decisions across these scales. So far, most of the projects concentrate on “their” scale and do not make too many links beyond.

To contribute to the shifting of policy in traditional natural resources management frameworks, policy analysis must fully incorporate the concept of compensation for pollution and other damage. Consequences of the distribution of costs and benefits among multiple stakeholders⁷ must also be included. Projects compile existing information to make clear the issues to be considered when formulating ideas concerning approaches to land-based and sea-based pollution issues. However, they do not explore potential tradeoffs, and thus remain focused, to a large extent, on improved understanding of the various processes involved in each of the case studies. Among the lighthouses below, however, there are some with the potential to facilitate future policy development, for reasons discussed above.

7 Turner, K.R., Lorenzoni, I, Beaumont, N., Bateman, I.J., Langford, I.H. and McDonald, A.I. (1998). Coastal Management for Sustainable Development: Analysing Environmental and Socio-Economic Changes on the UK Coast. *The Geographical Journal*, Vol. 164.

3.2 Communicating Science

Different methods of communicating science were employed by different projects. For example, a major effort to update a national assessment of US estuaries was undertaken as part of the National Estuarine Eutrophication Assessment (Bricker et al., 2007). Applications in this assessment include LOICZ biogeochemical modelling, such as ASSETS and typology tools. Also, science communication efforts undertaken in LOICZ are partly reflected in this product. A special volume examines the fit of this research and its implications for the GEF IW operational program (<http://www.loicz.org/imperia/md/content/loicz/science/gef-booklet.pdf>). Projects have displayed a variety of communication strategies best described in the synopsis reports of the individual projects. In summary, those projects aimed at enhancing and maintaining a global dialogue on coastal and ocean issues, as well as those aiming to enhance regional networks and cooperation without greatly reducing national responsibility (e.g. PEMSEA), are largely based on communication. Ballast Water projects have resulted in institutional frameworks to address the issue on relevant scales, and research-based nutrient assessments have motivated development of networks of researchers and coastal users. However, it remains obvious that some of the projects with communication in their objectives seem to have achieved little, and, for the interested reader, it is challenging to find background or information on results. Thus, the strategy for cross-project learning and best-practice communication has huge potential for improvement in this particular portfolio.

3.3 Assessment of response through social wellbeing

As shown above, human/nature inter-relations require a holistic approach, in theory as well as in practice. Multi-level, socio-ecological research is needed to explore the interfaces and feedbacks between global change and local livelihood dynamics in an interdisciplinary way. While there are initial steps evident in some of the projects, generally it seems clear that thorough socio-ecological systems research has not been a focus of these projects. This is not surprising, given that projects emerged before interdisciplinary research concepts had fully evolved. It is promising that some regional projects, namely PEMSEA and its contributing constituents, evolved, to some extent, during implementation and are

now more interdisciplinary and inclusive of social sciences than was the case at their conception.

3.4 Monitoring and assessment in the SES context

Overall, it was observed that monitoring and assessment plans are mentioned in most projects; however, the design for monitoring and assessment is often not specified and relevance to the actual project is sometimes unclear. At the same time, we can see that ecosystems are complex adaptive systems, and their governance requires flexibility and a capacity to respond to environmental feedback. The Socio-Ecological System (SES) approach to natural resource management holds enormous promise towards achieving sustainability. The downside, to date, is still that the complex, adaptive and place-specific nature of human-environment interactions impedes determination of state and trends in SES parameters of interest to managers and policy makers. Usually three things are missing:

1. greater clarity about actual indicators, which can include proxies, such as in the biogeochemical assessment project, land use and cover data, social and economic information, ship traffic and technology (to name a few relevant to the portfolio evaluated);
2. a thorough consideration of temporal and spatial scales on which these indicators are meaningful; and
3. a system for gathering, analyzing, storing, and disseminating data, particularly in traditional trans-boundary projects where a protocol for data sharing across the boundaries is required.

Overall, it seems true to say that, thus far, a monitoring and assessment plan with a well-defined socio-ecological context has not been a primary issue in the projects.



Fisherman Casts Net, Baucau, Timor-Leste / UN Photo, M. Perret

CHAPTER FOUR

Unique “scientific findings” and scientific “best practices”

The majority of coastal environmental problems are so complex in origin that perfect knowledge is an impractical expectation. Most of the projects stress their attempt to build marine scientific and technological capabilities in the field of coastal management to ensure that scientific requirements are integrated into development of national and regional coastal management programmes and plans. In particular, some of the projects promote, through exchange of experiences, development of scientifically-based methodologies, tools and services to assist decision-making processes in the field of sustainable development and management of coastal areas. Projects used a variety of applied scientific assessments: environmental assessments, risk assessments, cause-and-effect analysis, resource assessments and monitoring and evaluation. In general, the cause-and-effect relationships between discharge of sewage and water quality conditions and between dumping of wastes and habitat degradation, for example, were well understood. What is needed now are well-engineered projects sensitive to local environmental conditions and governance capacity.

Science has provided insights into the causes, effects, and solutions to coastal environmental problems and is at the heart of adaptive ocean and coastal management and policy-making. A number of projects have reached a level of experience and maturity where the scientific findings have been translated into cost-effective technological options and sharing of experiences, information, technological improvements, measurable benefits, and effective practices and lessons learned. Some of the high

quality scientific inputs in the projects include:

1. Technological innovations;
2. Demonstration sites;
3. Modelling;
4. Risk assessments;
5. Environmental Impact Assessments;
6. Setting up of guidelines and standards;
7. Use of geospatial clustering for “typology” and development of a nutrient budget model; and
8. Transboundary Diagnostic Analysis (TDA).

Highlights of scientific best practices used in some of the case studies are provided below and are elaborated under a separate heading as “Lighthouse Projects” in Section 7. We have classified “scientific best practices” as a) *technological best practices* and b) *science-outreach*, in order to highlight the major contributions of science to the project and to communication of this science into outreach programmes.



A. Technological best practices

- Creation of an integrated information system (*Case study of Rio de la Plata and its Maritime Front*);
- Environmentally-sound reservoir operation through historic evaluation and modern day modelling (*Case Study: Rio São Francisco Basin*);
- Development of an ecological discharge model to define minimum ecological flows (*Case study: Lower São Francisco River Basin*);
- Application of a calibrated artificial flood model, including a fully documented technical, economical and socio-environmental framework, and a final test of artificial flood and related operation plan;
- Assessment of carrying capacity and valuing ICM (*Case study of the East Asian Seas -PEMSEA*);
- Use of biofilms as a unique procedure for reduction of nutrients in wastewater streams. Use of natural systems such as wetlands for nutrient, POPs, and metal removal may be termed as environmentally friendly (*Alexandria agriculture project*);
- Reporting of new seagrass species-Halophilaspinulosa (*Case Study: Community-based Management of Seagrass Habitats in Trikora Beach*);
- Integrated Coastal Management Demonstration Sites (*Case study of the East Asian Seas - PEMSEA*);
- Integration of ecological and socio-economic indicators (*Case Study: ARCTIC Project*);
- Oil spill contingency plan: a) preparation of a strategy for pollution clean-up and selection of clean-up techniques; b) provision of a well-established stock of equipment for combating oil spills and for dispersing pollutants as well as adequate manpower, both in number and experience; c) provision of sufficient transport equipment to ensure a high level of mobility for pollution clean-up teams; and d) provision of suitable facilities for storage and ultimate disposal of retained pollutants (*Case Study: Oil Pollution Management Project for the Southwest Mediterranean Sea*);
- Environmental impact assessment guidelines to be used for pre-feasibility studies of possible port reception facilities and waste disposal infrastructure;
- Guidelines for control and management of ships' ballast water to minimize transfer of harmful aquatic organisms and pathogens (*Case Study: Ship's Ballast Water management*);
- Clean production technologies and technological options for wastewater management; and
- Transboundary Diagnostic Analysis and Strategic Action Plans.

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B. Science Outreach

Highlights of communication strategies used by various projects include:

- Capacity Building/Training/Workshops
- Monthly bulletins
- Websites
- Key national newspapers and broadcasting networks
- Marine electronic communications
- Scientific publications
- Annual Reports and Technical Reports
- Community awareness
- TDA/SAP
- Contribution Series & Information Series
- Workshops/Conference Proceedings
- Marine Pollution Updates - Quarterly Newsletters
- Program Brochures.

4.1 Lacuna(e) in use of science in projects

In certain projects it is evident that science has been “used” to various extents as a basis to inform governance issues. While there are no path-breaking scientific findings in individual projects, “science” has provided substantial inputs to development of management frameworks, legislations, and policy decisions. In some of the projects, advances in the ways science is used to support public policy decisions are evident. On the other hand, a number of inherent and discordant qualities between the scientific and policy-making processes and between the needs of scientists and resource managers have impeded the ability of science to fully inform decision making. In numerous cases it is not clear to what degree science underlies the project; moreover, communication is not adequately developed.

4.2 Generic framework of scientific themes in LBP using the DPSI(W)R Framework

The primary drivers addressed in the LBP projects are i) agriculture and ii) urbanization and infrastructure development. A vast majority of the projects are response based, which are further classified as:

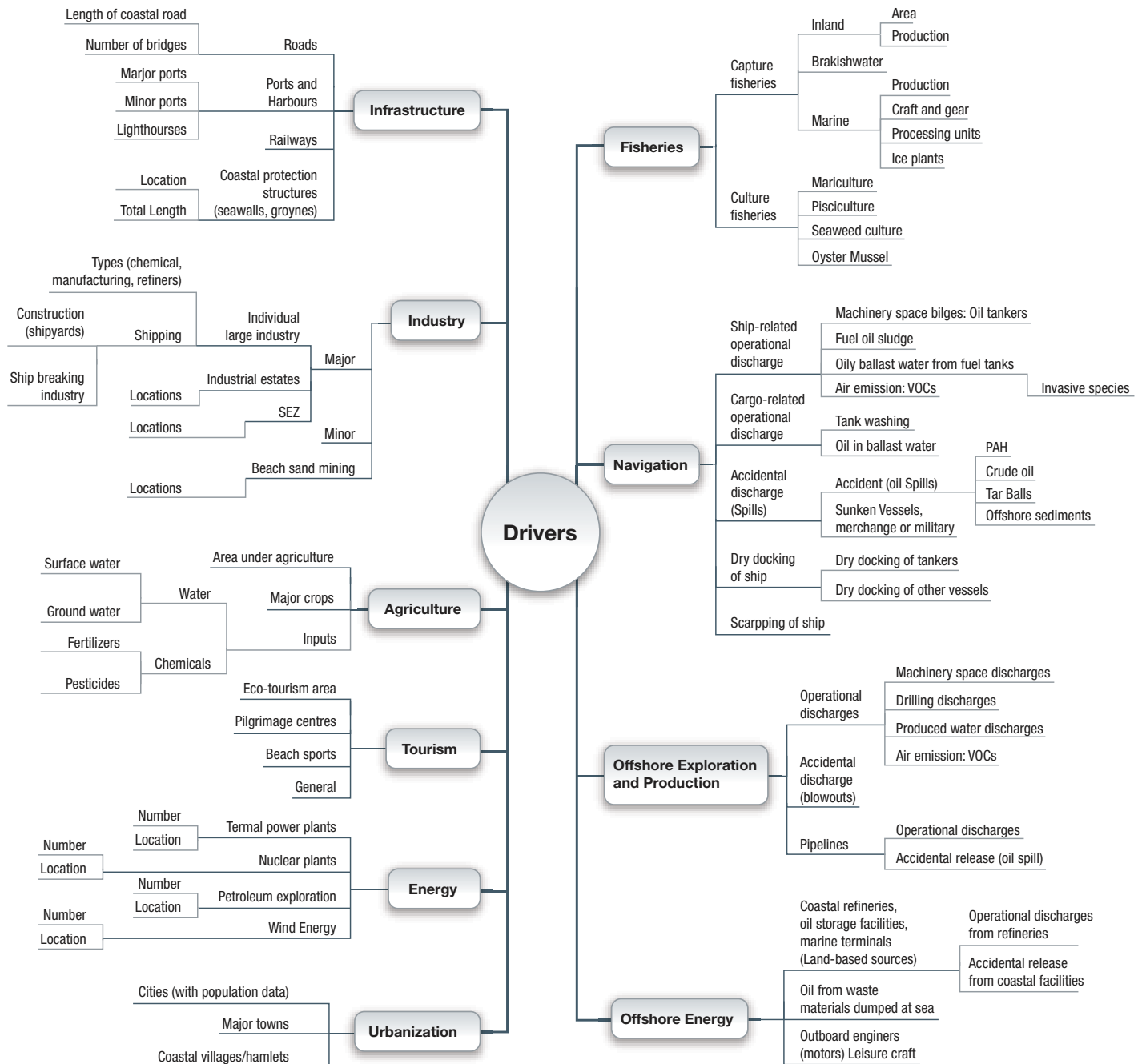
- A. Management response;
- B. Technological response; and
- C. Policy/governance response.

4.3 Output of science in projects

Major scientific outputs in LBP Projects can be classified under the following categories, which are discussed in detail in the synopsis reports of individual projects provided in the Appendices.

- A. Creation of a database in Geographic Information System;
- B. Development of methodologies, guidelines and standards;
- C. Technological innovations;
- D. Demonstration projects;
- E. Transboundary pollution management (coastal and marine); and
- F. Monitoring programs and modelling for building future scenarios.

Figure 2 Generic framework of scientific themes in LBP using the DPSI(W)R Framework



CHAPTER FIVE

Implementation in Policy and Governance Initiatives

5.1 ICZM added value to policy and governance

Policy and legal frameworks in these projects were examined when there was evidence of a particular relevance to Integrated Coastal Zone Management (ICZM), or when they considered management of watersheds. Members of the Working Group aimed to analyze all possible frameworks that interact with ICZM, and those that provide the required range of various interactions required by ICZM. The ways in which ICZM interacts with the respective policy or legal framework and the additional “added-value” ICZM contributes to the policy and governance framework should be considered. A main theme addresses the question of how policy and legal frameworks are able to promote a long-term sustainable use of resources, as opposed to the traditionally rather short-term approach.

5.2 Marine Spatial Planning Initiatives

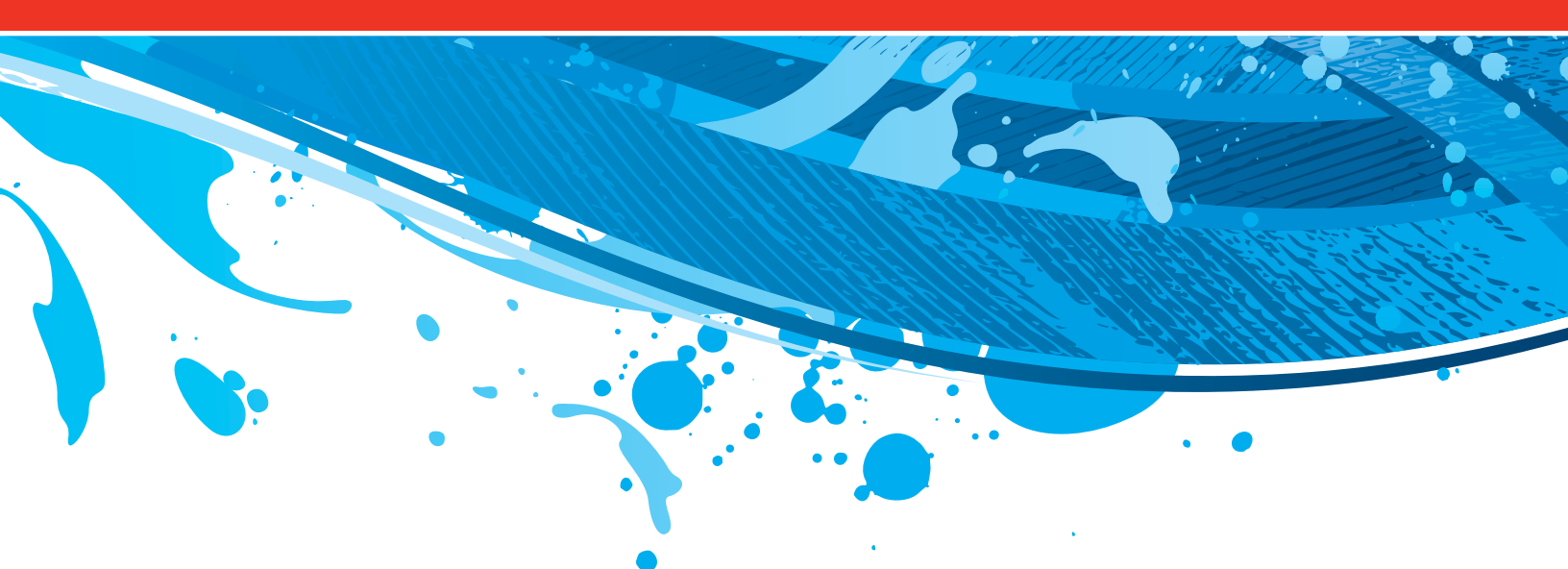
Ecosystem-based Marine Spatial Planning (MSP) is a comprehensive decision-making process employing the best available science and information to address conflicts and organize human activity in ocean spaces, while maintaining ecosystem health, functioning, and services⁸. MSP is a comprehensive, ecosystem-based planning process through which compatible human uses are objectively and transparently allocated, both spatially and temporally, to appropriate ocean areas. The goal is to sustain critical ecological, economic, and cultural services for future generations. As an adaptive process, MSP requires participation and input of stakeholders throughout a plan’s development, implementation,

monitoring, and evaluation. The level of success of an MSP effort largely depends on the quality of stakeholder engagement.

The level of maturity in the use of MSP frameworks in these projects is quite variable. Some state initiatives are now well established, while others are only just beginning. These efforts continue to vary greatly in objectives, approaches, and policy structures. Projects with burgeoning ocean management schemes are looking to more established programs for lessons learned and best practices, as well as a better understanding of what “marine spatial planning” truly means for the future of ocean use and management. LBP projects, as given below, have all highlighted MSP frameworks for coastal and oceanic systems:

1. Sao Francisco River Basin
2. PEMSEA
3. Guangdong Pearl River Delta
4. Shantou inter-tidal wetlands
5. Sub-Saharan Africa
6. Gulf of Aqaba Action Plan
7. SIDS (Small Island Development States)
8. Ballast Water Project
9. PROCUENCA
10. Africa Coastal Tourism project
11. Neretva and Trebisnjica River Basin.

⁸ Marine Spatial Planning Fact Sheet compiled Feb. 2010 by Centre for Ocean Solutions; www.centerforoceansolutions.org



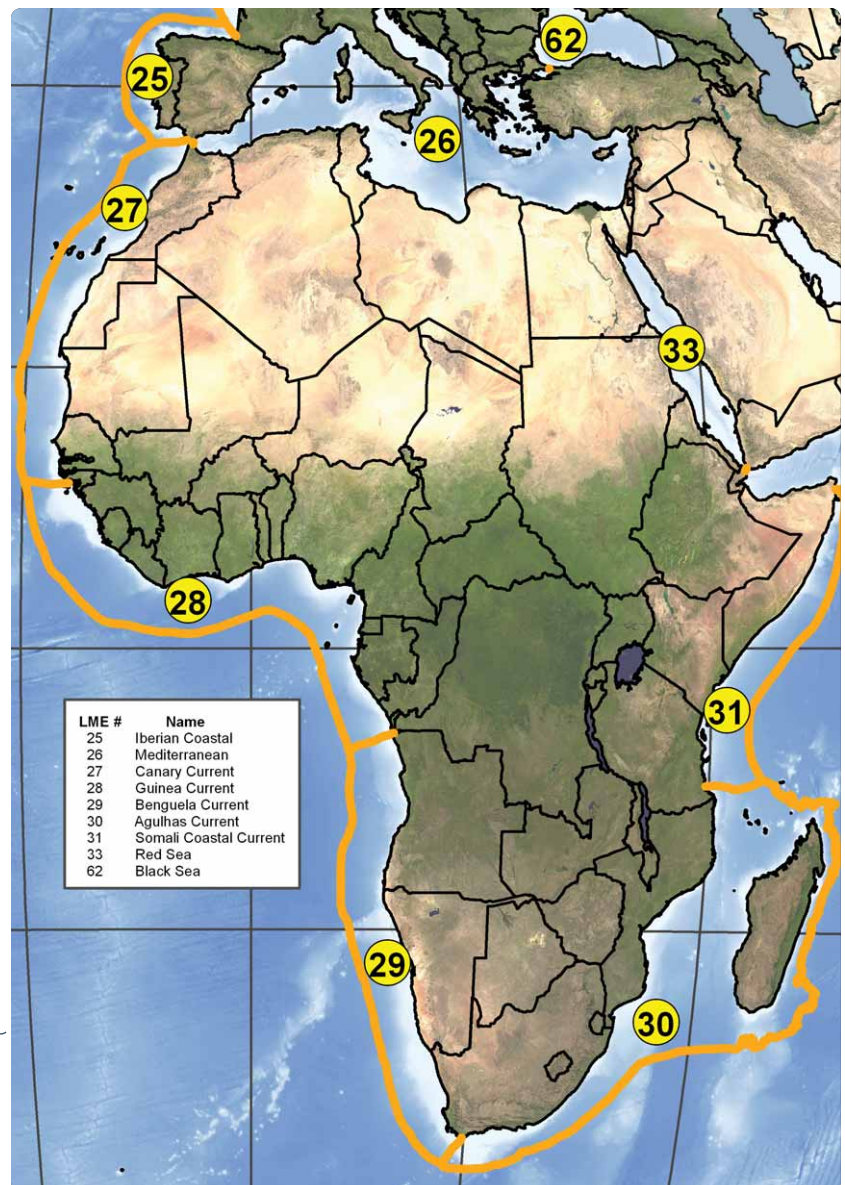
5.3 Public Participation

The need to promote public participation, identify sources of durable financing for coastal and marine pollution management initiatives, and install systems for monitoring and disseminating information to the public about their coastal zone is emphasized in many projects. These are mandated to collect and provide information in appropriate and compatible formats to decision makers at national, regional, and local levels. Most projects have demonstrated the necessity of more transparent planning, by involving the public and by integrating environmental considerations. This will help to achieve the goal of sustainable coastal development. National training and educational programmes, as well as cooperation with neighboring countries, have also been recommended and implemented in many projects.

5.4 Issues concerning “conflict resolution”

Conflict management has been defined by Anderson et al., (1996)⁹ as a multidisciplinary field of research and action that seeks to address the question of how people can make better decisions collaboratively. It is an approach that attempts to address the roots of conflicts by building upon shared interests and finding points of agreement that accommodate the respective needs of the vari-

Figure 3 Large Marine Ecosystems of Africa and the Mediterranean



⁹ Anderson, J., Gauthier, M., Tomas, G. and Wondolleck, J. (1996). Addressing Natural Resource Conflicts Through Community Forestry: Setting the Stage. E-Conference, addressing natural resource conflicts through community forestry. Forests, Trees and People Programme, Forestry Division, Food and Agricultural Organisation of the United Nations. Rome, Italy. 10p.

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ous parties involved. Conflict among stakeholders is prevalent in issues of coastal management, due to the sectoral nature of resource use. Problems exist for stakeholder groups with little experience of complex, multi-sided negotiations. Consideration may be needed as to the actual use of the term “conflict resolution”, as many stakeholders do not recognize they have a problem. For example, a conflict resolution technique has been used in issues related to use of the goods and services generated by San Juan catchment ecosystems through a coordinated program of action conducted jointly by Costa Rica and Nicaragua. In some LBP Projects, conflict resolution techniques have been used effectively for integrated coastal management, coastal and marine pollution related projects.

5.5 Public-Private Partnerships

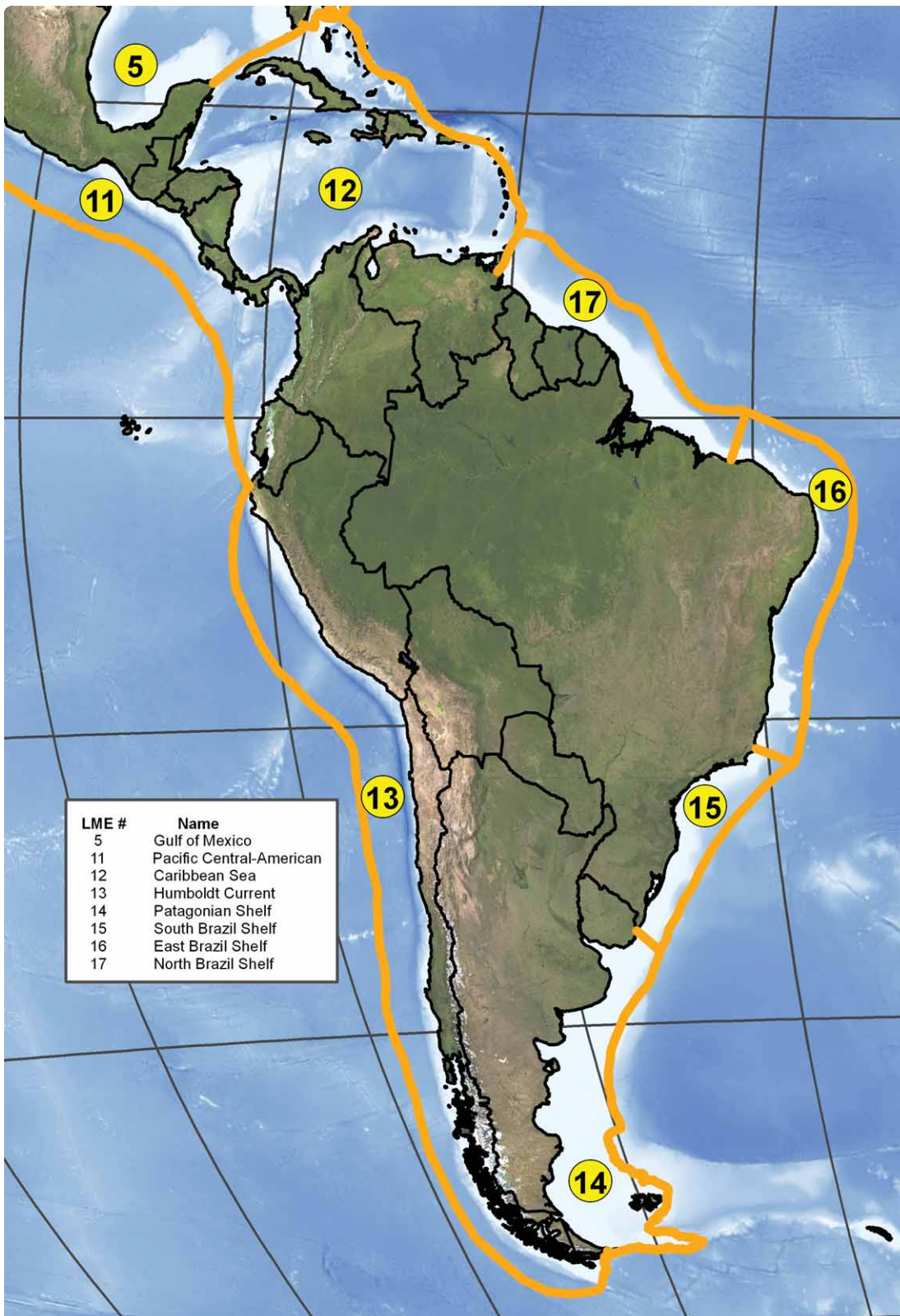
Public private partnerships (PPP), an affiliation between the public and private sector for the purpose of delivering a project or service traditionally provided by the public sector, are becoming increasingly popular as a means to finance and implement integrated coastal man-

agement activities. Public-private partnerships, offer the advantages of private sector dynamism, access to finance, knowledge of technologies, managerial efficiency, and the entrepreneurial spirit. It has been realized that private sector participation in coastal management is not just an advantage but an essential element to achieving sustainability. This concept was used to address major concerns such as enhancement of waste management services; prevention of marine pollution and coastal pollution; development and implementation of coastal environmental facilities and services in pollution prevention; and sustainable use of marine and coastal resources. Due to a paradigm shift, marine pollution management is seen as a responsibility of both public and private sectors and can create investment opportunities. Waste was also seen as a resource. Many projects, dealing with municipal solid waste, agricultural waste, ship and port waste and industrial hazardous waste, have been identified. PPP can improve environmental quality because it improves the chances of projects being successfully implemented, as local government will have the support of the private sector. PEMSEA terminal evaluation, however, seems to be pessimistic about their pilot projects.



Small fishing and tourism boats, Indonesia / A. Dansie

Figure 4 Large Marine Ecosystems of Latin America



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CHAPTER SIX

Lighthouse projects of Land-based Pollution

The broad portfolio of projects assigned turned out to be a rather heterogeneous set of initiatives, featuring various levels of maturity and, more importantly, various levels of success in accomplishing individual objectives. The group decided, therefore, to flesh out a subset of projects that has significance in the context of the synopsis. As regards underlying criteria, we used those that framed the IW science synopsis effort as described in section 1, listed again below:

- Significant and successful scientific components;
- Significant natural and social science findings;
- Unique research, monitoring and assessment issues;
- Role of science within projects;
- Design and use of (local) science networks and scientific advisory bodies;
- Scientific best practices;
- Intended target users; and
- Science/management implications.

This selection by no means implies that these projects are top ranking in all criteria, but they stand out, compared to the rest, in terms of the role of science and the way this is made visible to the reader. Some address a scale that seems appropriate and thoughtful when considering global and regional change; and they are noteworthy because they build constituency toward achieving sustainable development. Above all, the group consensus was that IW GEF projects are first and foremost aimed at improving conditions for humans and the environment affected by a variety of drivers and pressures that often originate elsewhere. This is also reflected in projects involving a multiplicity of agents and institutional dimensions. We have summarized the key features of each of these projects below.

6.1 PROJECT TITLE: East Asian Seas Region: Partnership Investment Fund for Pollution Reduction in the Large Marine Ecosystems of East Asia [Tranche 1, Installment 2]

GEF ID: 3025

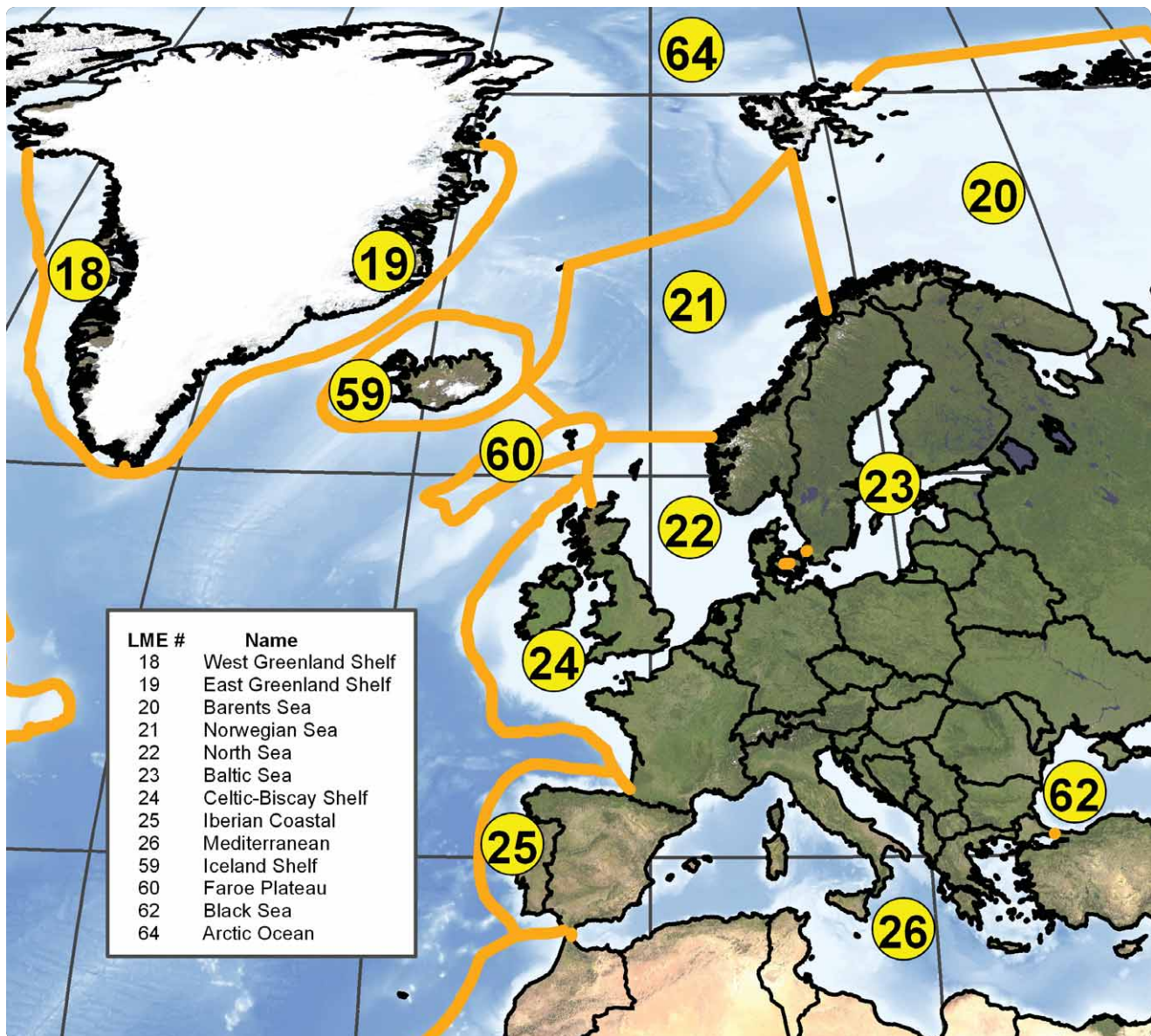
The Partnership for the Management of the Seas of East Asia is a large, multi-component, multi-year program designed to improve the quality of coastal and marine management at the local, national and regional level. The project is based on several key assumptions about threats to large marine ecosystems in the region. The impact of land-based pollution in the East Asia Seas is recognized as having regional and transboundary significance because the ocean is a medium through which pollutants are relatively easily transmitted. Impacts of land-based pollution such as widespread eutrophication, health hazards, and degradation of fisheries and spawning grounds, are felt by all countries in the region. Furthermore, because the seas of East Asia are a major economic resource for the world's demand for fishery and aquaculture products, and a major natural heritage and biodiversity resource for the people of the world, these impacts have global significance.

PEMSEA's research activities are designed to provide scientific inputs to policy and management decisions by:

- Making scientific advice available to project components and activities on an ongoing basis;
- Providing policy support to decision makers and managers by consolidating and “packaging” available scientific information, particularly on transboundary environmental issues of regional implication; and
- Where appropriate, promoting the use of indigenous and emerging technologies.



Figure 5 Large Marine Ecosystems of Northern Europe



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“Significance” may be defined as demonstrating impact of technical analysis on the quality of management decision-making. The five priority management concerns were addressed through various means, depending on the level of information available and the complexity of the issues. While not part of this project, the impacts of trade in marine endangered species were covered as a special issue of tropical coasts. Various topics ranging from trade of marine organisms, to innovative means of conserving key marine species such as giant clams and marine turtles, to implementing an international certification system for a sustainable trade have been covered comprehensively by the papers written by key experts.

A methodology was developed during the workshop, *Valuing Benefits of Integrated Coastal Management*, and proved to be very useful, partly because of its focus on the region’s needs and conditions. Field-testing of the methodology has been conducted in Xiamen and results were presented in a technical report and several articles. Field testing has been proposed for other PEMSEA ICM demonstration sites, and the information generated would be the first of its kind in a region-wide setting. It would also provide the means to convince policymakers and managers to adopt ICM programs.

PEMSEA has organized a number of local integrated coastal management pilot projects at multiple sites in the region. PEMSEA staff organized technical training for management staff in each pilot project, which includes organizing and conducting ecological risk assessment and designing and implementing local GIS projects. In both these technical efforts, there is substantial assistance to local staff, both at the initiation of the projects and throughout the life of the projects.

Project documentation notes that “all sub-projects co-financed by the Fund are required to adopt consistent monitoring and evaluation, replication and information dissemination protocols such that the regional benefits of the Fund could be fully realized. Monitoring and evaluation is conducted in conformity with GEF International Waters guidance against three sets of indicators: those embedded in the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) which are relevant to the Fund, those specifically developed for the Fund, and those developed at sub-project level”.

Mobilization of the Regional Task Force, which provided scientific/technical support to specific sites requiring out-

side assistance, has contributed to strengthening integration of science in project activities. Discussion on the global marine assessment process and discussion of GESAMP-related matters ensured that the region is involved and updated on global developments and linkages, with well-known multidisciplinary scientific advisory bodies, such as GESAMP, established. Most of these focus on output and key environmental outcome indicators. The scientific work was influential regarding specific topics of trade in marine products, socio-economic benefits of ICM, carrying capacity, transboundary impacts, and economic development tradeoffs. Good quality technical analysis, including risk assessment and design of information systems, was also an important component of ICM pilot projects. The program is exemplary as an applied science effort.

6.2 PROJECT TITLE: East Asian Seas Region: Prevention and Management of Marine Pollution in the East Asian Seas

GEF ID: 396

The primary vision of the project is to strike a balance between prevention of marine pollution and economic development in the region. The project targets both local and transboundary marine pollution impacts through participatory management involving the stakeholders.

The role of science in the project can be classified as:

- Ambient water quality monitoring (including standardization of field and laboratory methods);
- Creation of an integrated database composed of a) spatial and temporal databases for ICM, b) a legal information database, and c) an environmental information system for Straits of Malacca;
- Use of modelling to determine transboundary pollution by oil spills and damage assessment; dose response relationship, etc;
- Development of a pollution index;
- Development of tools for assessing natural resources (including extent of damage), risk assessment and risk management;
- Assessment of ecological effects, by exploring measured environmental concentrations for hydrocarbons and hydrocarbon composition, and their impact on the ecosystem; and
- Economic valuation of the coastal marine resources.



Vedaranyam Swamp Salt Fisheries / IOM, Anna University

Highlights of the project are the two “ICM Demonstration Sites” (Xiamen Demonstration Project (People’s Republic of China) and Batangas Bay Demonstration Project (Philippines), and one site that demonstrates transboundary marine pollution, the “Malacca Straits Demonstration Project”, which assesses and manages pollution in the Straits of Malacca. These demonstration projects helped launch efforts in addressing marine pollution problems in the Straits of Malacca and Straits of Singapore.

Success of the regional program can be classified in terms of scientific, management and outreach components. Results from the scientific component are quite impressive with emphasis on GIS and database creation, which is an extremely important initiative serving as a foundation for the various management and outreach objectives. Other highlights of the scientific aspects include environmental impact and risk assessments; monitoring of ambient water quality; economic evaluations of the coastal resources; and development of models and tools.

Management initiatives are captured best in the report(s) in the discussion of the success of the two ICM Demonstration Sites in Xiamen and Batangas; the case study on transboundary pollution management undertaken at the demonstration site of the Straits of Malacca; zoning schemes developed for the Xiamen and Batangas coastal areas; the establishment of a water quality index and standards for the region; and the legislative framework and the ICM framework. All of these are evidence of significant and successful outputs. The project contains documented evidence of “outreach” components by way of newsletters, “Bay Watch” programs organized to create awareness among the local public, and preparation of brochures.

This project has a good blend of natural and social science components, which is important for Integrated Coastal Management and for prevention of marine pollution. Combating transboundary marine pollution, using appropriate tools such as GIS, modelling and risk assessments, is a significant natural science efforts. Various legal measures to prevent marine pollution deserve special mention. Economic analysis of coastal resources, oil spill cleanup costs and zoning of coastal waters are also included.

The social science focus of this project is demonstrated through the various continuing outreach programs and outreach materials. Also, for the first time (as mentioned in the report) participatory management involving various stakeholders has been undertaken. Networking and capacity building in ICM is a unique venture, which is now being taken up by many nations. In conclusion, PEMSEA is a success story, comprehensive in its objectives and successful in its implementation.

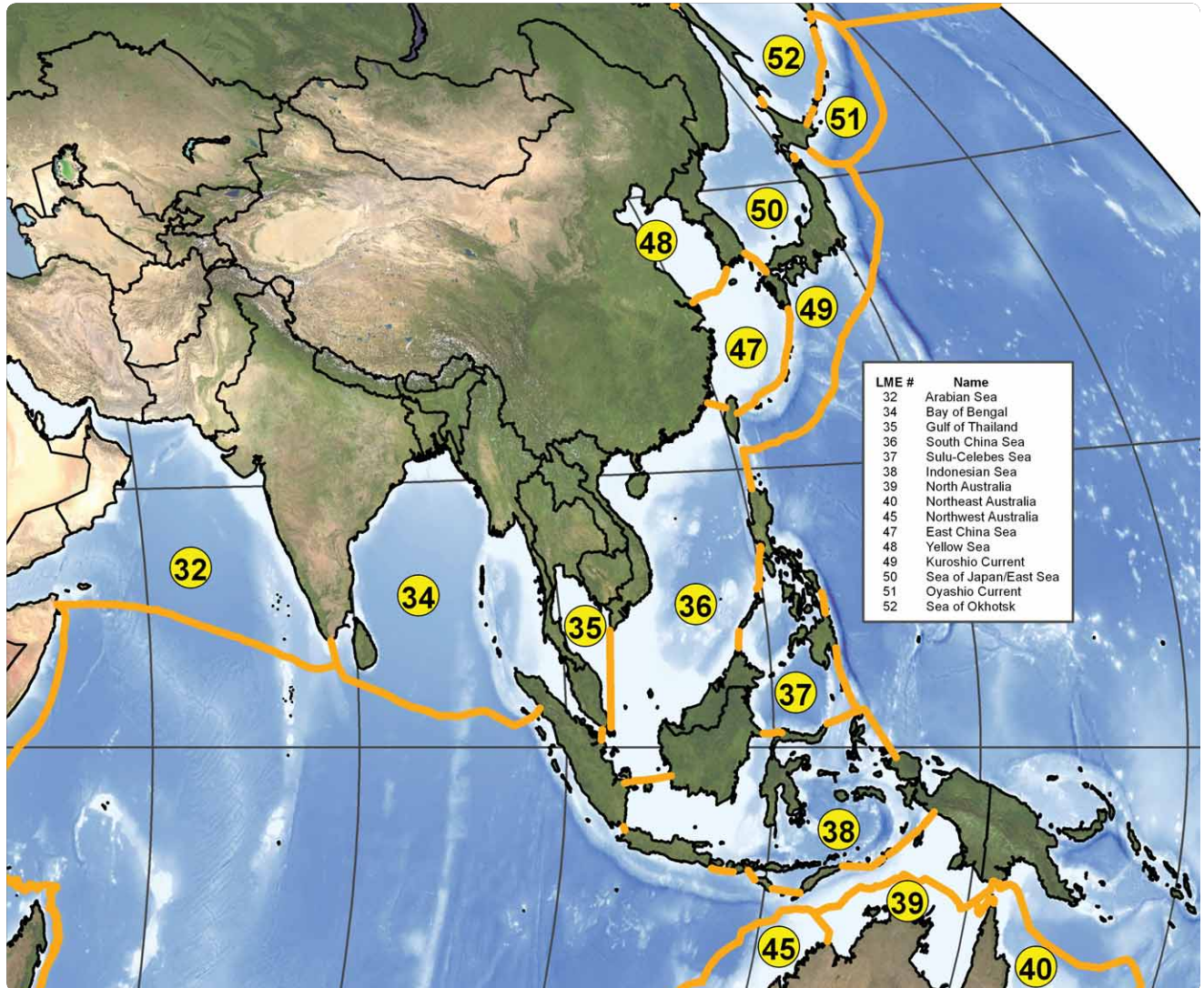
6.3 PROJECT TITLE: Role of the Coastal Ocean in the Disturbed and Undisturbed Nutrient and Carbon Cycles

GEF ID: 514

The emphasis of this project was on gathering a significant number of empirical estimates of C, N and P through workshops and global training, including developing and applying simple models for use in data poor areas. The effort produced preliminary and system-related conclusions on the role of anthropogenic impacts on coastal estuarine metabolism, and gave ini-

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Figure 6 Large Marine Ecosystems of South East Asia



Used with permission from the U.S. NOAA-LME Program Office 2011, <http://www.lme.noaa.gov>

tial indications of implications for coastal seas as source/sinks of carbon. The project developed scientific databases on budgets and a coastal environmental typology that allowed upscaling by means of geospatial clustering. This enabled classification of coastal functioning and metabolism, based on primary data and modeling, and derivation of subsequent estimates of coastal functioning and system response in areas where no primary data were available. Polar regions have not yet been considered. The project aimed to generate/improve the scientific understanding of the role of coastal seas in global

nutrients and carbon cycles, and the impact of eutrophication on local, regional and global scales. It was designed to develop globally applicable methodologies and upscaling tools, and to elaborate on initial findings describing proxies for nutrient fluxes and their dynamics in the water continuum (river to coastal ocean). The relevance of drivers was also a focus. The project has laid a foundation for assessing current and future delivery of coastal ecosystem (estuaries, bays, wetlands, mangroves, deltas, etc.) goods and services, based, for example, on nutrient recycling and maintained flow of water and

materials. This may assist in informing new approaches to improving waste water treatment in urbanized coastal areas, system recovery and restoration, as addressed in various GEF IW projects. The DPSIR framework was adapted to accommodate a harmonized evaluation of drivers, pressures and state changes in coastal systems under consideration. Population density and run off on catchment scale were identified as key controls of nutrient loads, and it was shown that both population density and run-off are major anthropogenic drivers of change. Dissolved inorganic phosphorus and dissolved inorganic nitrogen loads were identified as flux predictors, and additional data and tools required to fully implement up-scaling approaches were noted. Scientific best practices used include methods development, application testing, adaptation, training, building mentor networks; establishing global databases for public access; and use of geospatial clustering for typology. While this project was mainly designed as a scientific effort, it is essential that the results are continuously fed into development of future IW work.

6.4 PROJECT TITLE: Development and Implementation of Mechanisms to Disseminate Lessons Learned and Best Practices in Integrated Transboundary Water Resources Management in Latin America and the Caribbean – “DELTAmericas”

GEF ID: 1426

The project’s objective was to develop and implement mechanisms to disseminate the lessons learned in GEF International Waters-related projects in Latin America and the Caribbean. This included development of a set of mechanisms enabling exchange of information and strengthening of the Inter American Water Resources Network (IWRN), as the main organization to act as a water resources reference for the hemisphere. By focusing particularly on promoting and fostering south-to-south learning, the project was designed to develop capacity to improve water resources management on the catchment and transboundary scale and to share experiences in the region and beyond.

This project aimed to serve Latin American countries through feeding into UN learning efforts: i.e., to assist the International Waters Learning Exchange and Resource Network (IW:LEARN) project, being imple-

mented by UNDP and executed in part by UNEP (IW Best Practices Database); to implement its mandate of helping countries, as part of a global effort to improve communications and outreach. National and local buy-in, thus, was pivotal.

The project could only succeed in providing a mechanism for dissemination of lessons learned if multi-scale and political buy in was guaranteed. The project advanced discussion on how to define best practices and how to deal with participatory approaches, though this has not been documented in a scientific way. Regional activities for strengthening programs to transfer best practices and lessons learned are the basis for this project. Thus, it tried to capitalize on underlying knowledge (including scientific findings) from the portfolio of IW projects in LAC.

One mechanism can be deemed rather successful: the twinning of catchment system projects by exchange of experts. This twinning also included field experiences. It is recommended that this approach become a practice within IW projects (and beyond).

Indicators refer to networking and exchange of information on relevant scales and between relevant institutions to help build an institutional constituency to improve the water management sector. One key indicator is the use and services of the IWRN web-platform for dissemination of results. A recent check indicates that this is not providing significant information. We were unable to access documents during this assessment.

DELTAmericas has succeeded in devising criteria for defining best practices and developing procedures for identifying best practices, as they relate to integrated water resources management. This can be considered a scientific achievement in itself, though not “traditional hard science” but rather focused on institutional dimensions, ownership and a synthesis of existing knowledge on DPSIR-related issues.

Communication with stakeholders seems to have been accomplished, whereas networking and collaboration have room for improvement. In conclusion, this is a very limited project in terms of featuring any concrete science or related publications. Results are networks, communication and institutional constituency-building to deal with transboundary water issues. It appears, however, that there is considerable science on the level of indi-

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vidual IW projects and cases, which will presumably be synthesized and communicated/exchanged through the outcomes of this project.

6.5 PROJECT TITLE: Building Partnerships to Assist Developing Countries to Reduce the Transfer of Harmful Aquatic Organisms in Ships' Ballast Water

GEF ID: 2261

The overall goal of the GloBallast Partnerships Project (GBP) is to reduce risks and impacts of marine bio-invasions caused by international shipping. The specific objective is to assist vulnerable developing states and regions to implement sustainable, risk-based mechanisms for management and control of ships' ballast water to minimize adverse impacts of aquatic invasive species. GBP will expand and build on the successfully completed GEF-UNDP-IMO pilot project.

With the help of tools developed and lessons learned from the pilot project, GBP will expand government and port management capacities, instigate legal, policy and institutional reforms at the country level, develop mechanisms for sustainability, and drive regional coordination and cooperation. The project will enhance global knowledge management and marine electronic communications to address the issue. The partnership effort is three-tiered, involving global, regional and country-specific partners, representing government, industry and non-governmental organizations. Private sector participation will be achieved through establishing a GloBallast Industry Alliance with partners from major maritime companies. Thirteen countries, from six high priority regions, have agreed to take a lead partnering role, focusing particularly on legal, policy and institutional reform. Over 70 countries in 14 regions across the globe will participate, including the six pilot countries whose expertise and capacities will be drawn on for this global scaling-up effort. With the help of tools developed and lessons learned from the pilot project, the GloBallast Partnerships project will expand government and port management capacities, instigate legal, policy and institutional reforms at the country level, develop mechanisms for sustainability, and drive regional coordination and cooperation, ultimately preparing countries for implementation of the IMO Ballast Water Management Convention.

6.6 PROJECT TITLE: Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa

GEF ID: 849

The goal of the project was to assist sub-Saharan countries in achieving sustainable management of their coastal and marine environment and resources. In terms of science in the project design, this was evident in a) design of the causal chain and impact methodology adapted from the Global International Waters Assessment; and b) national reports detailing issues, hotspots, sensitive areas, environmental and socio-economic impacts and causes in the marine and coastal zone of the participating countries. The synopsis report noted that modification of stream flow, with effects on availability, quality and quantity of freshwater, is possibly one of the most important environmental problems that the African continent will have to deal with. Current impacts of the issue are already quite substantive, particularly as regards shoreline changes threatening key productive habitats; projected impacts in the near future may be much greater. On the whole, the open coastline is not as severely stressed as are estuaries, lagoons, bays and semi-enclosed habitats. Analysis of impacts has also demonstrated that the biophysical resource base of the region still holds enormous socio-economic potential.

National reports indicate a major increase in the fishing effort and at the same time a significant reduction in the fishing yield. As the fisheries represent one of the key economic sectors of participating countries, a decrease in present or future catch translates into significant social, biophysical and economic impacts. Finally, though no real impact of climate change could be evidenced in the participating countries, the occurrence of extreme phenomenon or the repeat of "natural" disasters such as flooding should prompt experts to adopt a precautionary approach and examine further the foreseen impacts of the issue, currently not well understood.

Science can assist countries to identify and agree on issues and environmental and socio-economic impacts and causes, which in turn can lead to development of recommendations. Although not a TDA, the project followed the same methodology at the national level and it is confirmed that the level and quality of science included in these reports is sound and the best available. However, as noted, there was a significant gap in socio-



Fishing off Atauro Island, Timor-Leste / UN Photo, M. Perret

economic data, mostly because of limited availability of information and assessments, but also because of the tendency for this and other projects was to include few socio-economic experts on technical teams. All indicators were clearly developed and link to the results of activities.

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6.7 PROJECT TITLE: Addressing Land-based Activities in the Western Indian Ocean - WIOLAB GEF ID: 1247

The broad goal of this project is to address degradation of the marine and coastal environment due to land-based activities in countries bordering the Western Indian Ocean (WIO). The project aims to achieve three specific objectives: improve the information base and develop guidelines and strategies for reduction of stress to the ecosystem by improving water and sediment quality; strengthen the regional legal basis for preventing land-based sources of pollution; and develop regional capacity to maintain sustainable, less polluting development. The information base now available has culminated in a Regional Transboundary Diagnostic Analysis of Land-based Sources and Activities Impacting on the Coastal and Marine Environment.

The project is also implementing nine demonstration projects, which are piloting innovative approaches to addressing the main challenges faced by the region. Several projects focus on application of constructed wetlands for wastewater treatment, a cost effective method of using the natural cleansing capacity of wetlands for treating municipal wastewater, examples of which are the schemes developed in Mombasa (Kenya), Pemba (Tanzania) and Mahé (Seychelles). These projects have been designed to be low cost in construction and maintenance in order to ensure sustainability, while producing significant environmental, social and economic benefits in the region and contributing to MDG and WSSD targets on sanitation. The three projects together will directly improve the living conditions of over 10,000 people by providing badly needed sanitation facilities while achieving international standards for wastewater discharges, and thereby reducing pressure on sensitive ecosystems. All three projects are targeting areas important for tourism, generating important economic spin-offs along the way.

6.8 PROJECT TITLE: Ningbo Water and Environment Project - under WB/GEF Partnership Investment Fund for Pollution Reduction in the LME of East Asia GEF ID:2750

The overall objectives of the project were to reduce land-based pollution along the Cixi coast and the East China Sea, promote replication of innovative low cost wastewater treatment techniques, and encourage coastal zone conservation. The role of science was (a) to demonstrate that wetlands can help in reducing pollutant loads to coastal waters by a number of mechanisms, and (b) to demonstrate that restored and protected habitats of sufficient size may serve as a re-colonization source for the wider surrounding area where marine resources are exploited, as is the case with MPAs. The Cixi City Government designated an existing area in the vicinity of the Ningbo-Shanghai Bridge as the Wetland Center.

The wetland centre will serve as a key area for re-colonization by fish, shrimp and benthos of the surround-



Coastal Erosion, Puri, India / IOM, Anna University

ing, over-exploited coastal zone. At the same time it is intended to develop into an important staging site for migrant birds. Also, this larger wetland is meant to serve as a sink for land-based pollution from the surrounding area. Discharge of effluents from constructed wetlands into the surrounding water bodies and simultaneous reception of drainage water from these waters is possible, but needs a very carefully designed hydrological system.

Development of this project has involved a wide group of local stakeholders in government, as well as NGOs, key research institutes and universities working on pollution and conservation issues in Hangzhou Bay. In conclusion, this project appears to combine two highly relevant concepts (wetlands can treat sewage, and meta-population hotspots can serve the wider surrounding area) to solve a real and practical problem; however, at this stage it is difficult, as yet, to assess the project's effectiveness.

6.9 PROJECT TITLE: **Reducing and Preventing Land-based Pollution in the Rio de la Plata/Maritime Front through Implementation of the FrePlata Strategic Action Programme - NEW**

GEF ID: 3519

The project was developed on the basis of FREPLATA TDA and SAP findings, building very successfully on the solid base of scientific and technical knowledge generated by FREPLATA Project. It will mitigate coastal, land-based pollution (nutrients, persistent toxic substances) threats to one of the leading fluvial and river-marine systems in the world ecosystem, and so reduce pollution export to international waters, generating global benefits. In addition to this, building upon the broad and effective support and networks established during the first GEF strategic project, this project will deliver relevant lessons for upper watershed governance frameworks that can be replicated in other shared watersheds and estuaries around the globe.

The project includes several important pilot projects: 1) development of artificial wetlands at Samboromb Bay to support prevention and reduction of point pollution; 2) governance and integrated management of Santa Lucia wetlands to contribute to prevention and reduc-

tion of diffuse pollution in the coastal areas of the Rio de la Plata; and 3) application of Cleaner Production Approaches in Informal Sectors in the Industrial Tannery Sector in Uruguay

Dynamic stakeholder participation in development of the pollution control proposal, and prioritization of activities and management tools for that purpose, is documented by the reports of bi-national workshops, national workshops and national technical meetings that involved representatives from the public and private sectors, as well as civil society organizations and national/regional projects.

6.10 PROJECT TITLE: **Integrated Management of Land-Based Activities in the Sao Francisco Basin (Coastal Zone Component)**

GEF ID: 586

The main goal of this project is to assist the Government of Brazil to promote sustainable development of the SFRB and its coastal zone, based upon implementation of an integrated approach to management of the watershed and coastal zone. The project will incorporate land-based environmental concerns into development policies, plans and programs for the SFRB for the protection of its coastal zone. Science has been applied through the river basin and coastal zone diagnostic study. The role of science is to provide the sound scientific and technical basis for strategic remedial actions to protect the marine environment from land-based activities identified during the Watershed Management Program process.

Major research components include: (1) quantifying the historical evolution of the river and its estuary since the dams were built; (2) analyzing and modelling the behavior of the river flow and its effect on the transportation of sediments and nutrients under current and forecasted future conditions; (3) determining appropriate (and/or alternative) fisheries management practices; and (4) developing a strategy for environmentally-sound reservoir operation. Major scientific best practices include:

- Quantification of changes in morphology;
- Observation of the sedimentology, oceanography and ichthyofauna at the Sao Francisco River mouth, and in the coastal zone and on the continental shelf;

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- Definition of the minimum discharge requirements at the São Francisco River mouth necessary to sustain the estuarine ecosystems, according to the various water regime changes;
- Identification of the advantage and disadvantages of implementing regularization in the lower São Francisco; and
- TDA and intergovernmental cooperation agreements.

Based on the information and project reports, science provided a spatial and temporal analysis of fluvial fluxes from the Sao Francisco into the coastal zone. Many maps of physical and chemical parameters were developed and recommendations for management have been made.

6.11 PROJECT TITLE: Support to the National Programme of Action for the Protection of the Arctic Marine Environment, Tranche 1

GEF ID:1164

The overall objective of this project was to assist indigenous peoples in developing appropriate remedial actions to reduce the health risks resulting from contamination of their environment and traditional food sources. A secondary objective was to enhance the position of the Russian Federation in international negotiations to reduce the use of PTS, empowering indigenous peoples to participate actively and fully in these negotiations. To enable the Russian Federation and Russian Association of Indigenous Peoples of the North (RAIPON) to increase their involvement in the work of the eight-nation Arctic Council to reduce emissions of PTS, the following objectives were outlined:

- Assessment of the scale of contaminants in the Russian Arctic;
- Impact on the health on local communities;
- Demonstration of the Russian situation in the wider circumpolar context;
- Improvement of management policies to assist the Russian government and NGOs to take remedial actions to reduce health risks resulting from contamination and exposure to PTS.

Science was evident in the collecting of environmental baseline data across the Russian Arctic, via four case study areas with six different case studies, involving six

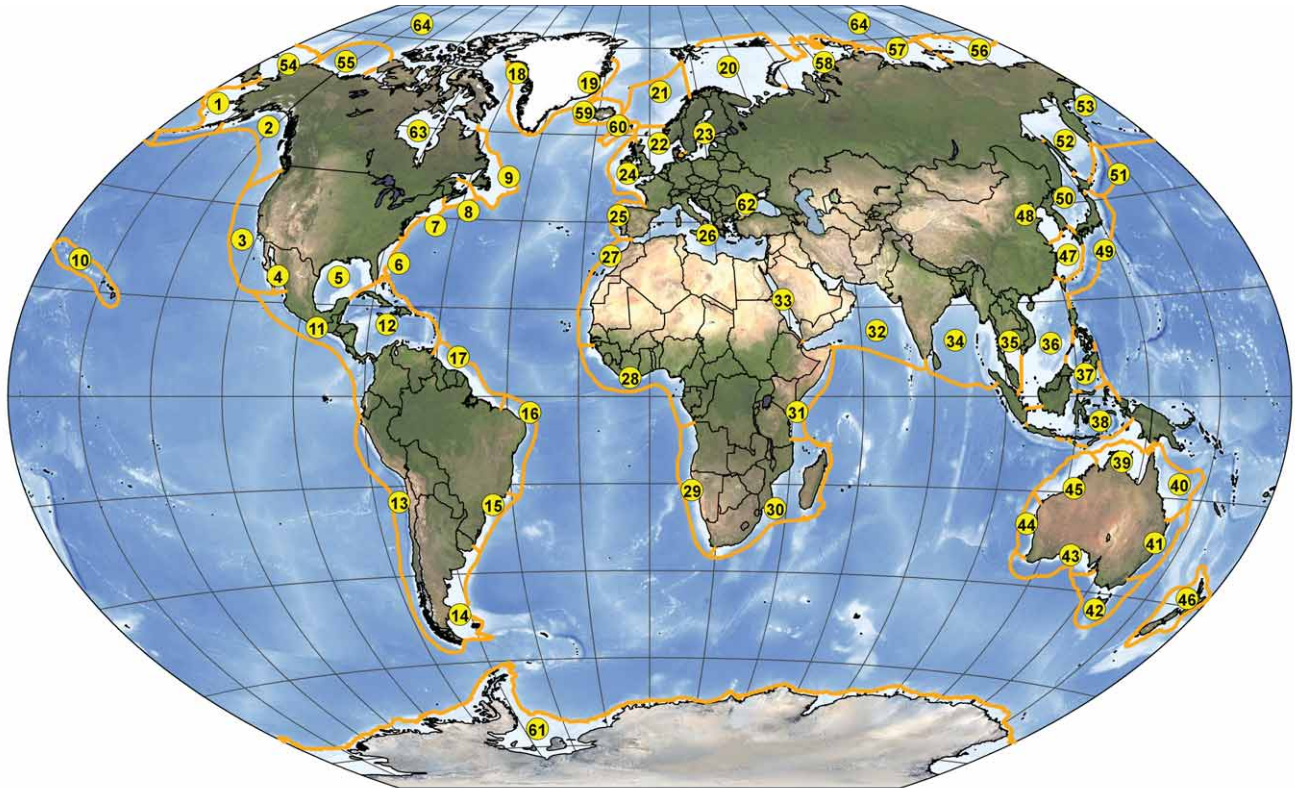
different indigenous peoples covering a wide range of lifestyles within the Russian Arctic. Examples of such data include data to assess long-range transport; to advance modelling; to determine bio-magnification in Arctic food chains; and to determine human health indicators for assessing levels of contamination

Science has a strong role in this project: exploring the issue, highlighting the significance of the findings and the role of air and water-borne transmission, and communicating the findings to decision makers. The project highlighted the importance of integrating ecological science with socio-economic sciences to fully understand the issues and address them appropriately. A multi-disciplinary approach produced outcomes important to adaptive management and policy.



The arctic marine environment / UN Photo, M. Garten

Figure 7 Large Marine Ecosystems of the World



- | | | | | |
|-------------------------------------|--------------------------|----------------------------|----------------------------|-----------------------|
| 1. East Bering Sea | 14. Patagonian Shelf | 27. Canary Current | 40. Northeast Australia | 53. West Bering Sea |
| 2. Gulf of Alaska | 15. South Brazil Shelf | 28. Guinea Current | 41. East-Central Australia | 54. Chukchi Sea |
| 3. California Current | 16. East Brazil Shelf | 29. Benguela Current | 42. Southeast Australia | 55. Beaufort Sea |
| 4. Gulf of California | 17. North Brazil Shelf | 30. Agulhas Current | 43. Southwest Australia | 56. East Siberian Sea |
| 5. Gulf of Mexico | 18. West Greenland Shelf | 31. Somali Coastal Current | 44. West-Central Australia | 57. Laptev Sea |
| 6. Southeast U.S. Continental Shelf | 19. East Greenland Shelf | 32. Arabian Sea | 45. Northwest Australia | 58. Kara Sea |
| 7. Northeast U.S. Continental Shelf | 20. Barents Sea | 33. Red Sea | 46. New Zealand Shelf | 59. Iceland Shelf |
| 8. Scotian Shelf | 21. Norwegian Sea | 34. Bay of Bengal | 47. East China Sea | 60. Faroe Plateau |
| 9. Newfoundland-Labrador Shelf | 22. North Sea | 35. Gulf of Thailand | 48. Yellow Sea | 61. Antarctic |
| 10. Insular Pacific-Hawaiian | 23. Baltic Sea | 36. South China Sea | 49. Kuroshio Current | 62. Black Sea |
| 11. Pacific Central-American | 24. Celtic-Biscay Shelf | 37. Sulu-Celebes Sea | 50. Sea of Japan/East Sea | 63. Hudson Bay |
| 12. Caribbean Sea | 25. Iberian Coastal | 38. Indonesian Sea | 51. Oyashio Current | 64. Arctic Ocean |
| 13. Humboldt Current | 26. Mediterranean | 39. North Australia | 52. Sea of Okhotsk | |

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CHAPTER SEVEN

Summary

7.1 Providing knowledge into ecosystem-based management

Land-based pollution projects, in general, have examined, conceptually and through empirical evidence, how scientific knowledge can be transferred effectively to planning, decision making, and management of coastal marine systems, at different spatial and temporal scales, and in different geographic locations worldwide. Where this has been achieved, there is clear involvement of multidisciplinary groups of researchers, managers, and policy makers whose work is directly relevant to one or more geographic regions. Communication strategies have been developed and implemented to convey the process and outcomes to managers, decision makers, and the public, and to ensure that data and results are archived and accessible to all. The level to which these objectives have been met is variable across the projects.

7.2 How far has knowledge informed implementation and in what form?

Most of the “lighthouse” projects have created a strong knowledge base with inputs from science and management. Due to the transnational and transboundary nature of these projects, regional cooperation has enhanced knowledge sharing and capacity building in many cases. Most of the knowledge has been gained through training and capacity-building initiatives, and through public participation. Frameworks, guidelines and standards have been developed and indicate the robust methodological protocols followed in these projects.

7.3 Balance in terms of natural science and social science inputs

Those projects with a visible scientific background usually have a bias towards the natural sciences. Some of the projects have a fair blend of natural science and social sciences and include the concept of coupled social-ecological systems. Understanding the interactions between coastal zones and environmental change cannot be achieved by observational studies alone, and modelling of key coastal environmental and socio-economic processes is a vital tool. We used the DPSI(W)R Framework to analyze the balance between natural and social science inputs in the projects and assess boundaries and conflicts.

7.4 Does the science involved fit the purpose; are there instruments to gauge success (orders of outcomes)?

In the context of coastal pollution management, evaluation entails assessment of processes, outcomes and effectiveness in achieving goals and objectives, and identification of unintended consequences. Evaluation, together with monitoring, is part of adaptive management, an institutionalized process for continuous learning and adjustment of management activity to improve effectiveness. Evaluation also examines interactions between the “human” and the “natural” environment, as these influence processes and outcomes in ecological and socio-economic terms. Four orders of outcome have been identified and organized into a framework.

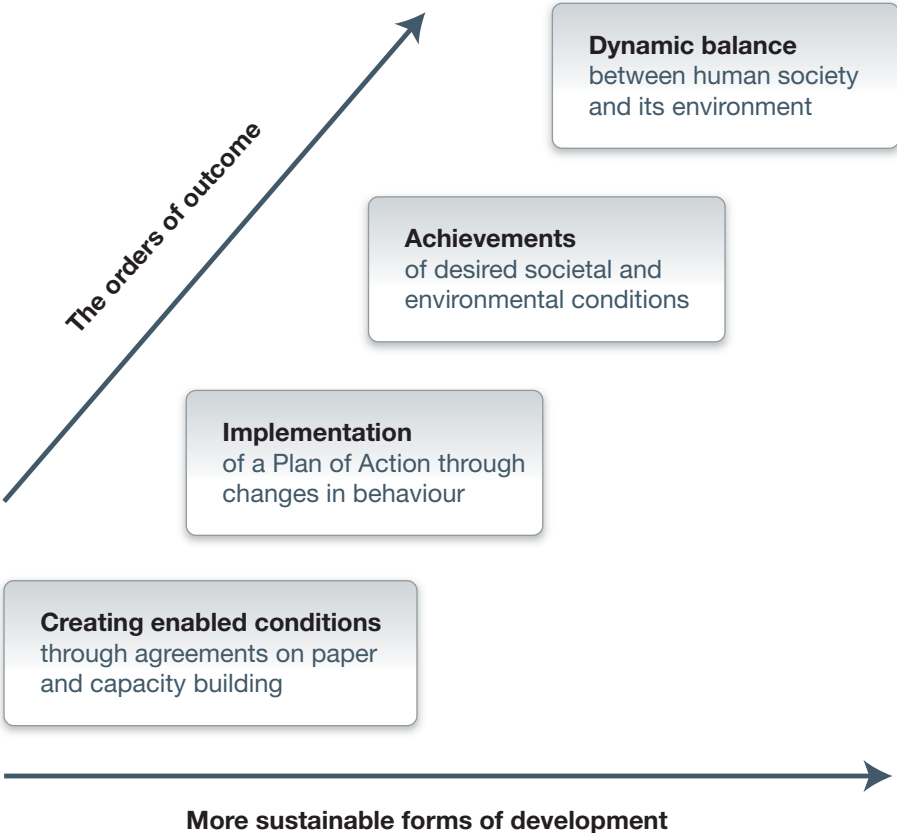
1. Examination of enabling conditions required for successful implementation;
2. Analysis of changes in behavior that occur during implementation;
3. Assessment of long-term environmental impacts and societal benefits; and
4. Evaluation of equilibrium between the environment and human society.



The Orders of Outcome Framework (Fig. 3) is recommended for assessing progress on issues that integrate across coasts and river basins, as it provides guidance on the design of ecosystem-based management initiatives that address both the impact of human activities and the need to sustain or restore the goods and services

generated by healthy ecosystems. To a limited extent, the projects identified major lessons that have emerged from management experiences in the field of coastal and water resources, but further efforts are needed to determine if indeed there has been a measurable change in behaviours.

Figure 8 Charting Progress towards more sustainable forms of development¹⁰



¹⁰ UNEP/GPA (United Nations Environment Programme/Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities). 2006. Ecosystem-Based Management: Markers for Assessing Progress. UNEP/GPA. The Hague: The Netherlands

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