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

ANALYSIS REPORT

LARGE MARINE ECOSYSTEMS AND THE OPEN OCEAN

A global Analysis of **Large Marine Ecosystems and the Open Ocean** science and transboundary management

UNEP

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GEF IW:Science Project

Analysis Report of the Large Marine Ecosystems and the Open Ocean Working Group

IW:Science

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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Analysis Report of the Large Marine Ecosystems and the Open Ocean 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.

This report was prepared under the responsibility of the IW:Science Core Partner and Lead Institution of the Large Marine Ecosystem and Open Ocean Working Group:

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Cover photo: A catch from the Guinea Current Large Marine Ecosystem, seafood market in Côte d'Ivoire / *UN Photo, K. Chung*

List of Acronyms and Abbreviations

ACRONYM	MEANING
BENEFIT	Benguela Environment Fisheries Interaction and Training Programme
BEP	Benguela Ecology Programme
BCLME	Benguela Current Large Marine Ecosystem
CRTR	Coral Reef Targeted Research
DLIST	Distance Learning and Information Sharing Tool
DPRK	Democratic People's Republic of Korea
DPSIR	Drivers-Pressures-State -Impact-Response
ENVIFISH	Environmental Conditions & Fluctuations in Recruitment and Distribution of Small Pelagic Fish Stocks
GEF	Global Environment Facility
GloBallast	Global Ballast Water Management Programme
HABs	Harmful Algal Blooms
HCLME	Humboldt Current Large Marine Ecosystem
IW	International Waters
LEK	Local Ecological Knowledge
OFM	Ocean Fisheries Management
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
SAP	Strategic Action Programme

ACRONYM	MEANING
SICOM	Sistema Informático Costero Marino (Coastal Marine Information System)
SIDs	Small Island Developing States
SSME	Sulu-Sulawesi Marine Ecoregion
TDA	Transboundary Diagnostic Analysis
TEK	Traditional Ecological Knowledge
VIBES	Viability of Exploited Pelagic Fish Resources in the Benguela Ecosystems in relation to the Environment and Spatial Aspects
YSLME	Yellow Sea Large Marine Ecosystem
SIDS	**Small Island Developing States**
SSME	**Sulu-Sulawesi Marine Ecoregion**
SPC	**Secretariat of the Pacific Community**
SPREP	**Strategic Action Programme of the Pacific Small Island Developing States**
TDA	**Transboundary Diagnostic Analysis**
TWG	**Technical Working Group**
VIBES	**Viability of Exploited Pelagic Fish Resources in the Benguela Ecosystems in relation to the Environment and Spatial Aspects**
WCPFC	**Western and Central Pacific Fishery Commission**
YSLME	**Yellow Sea Large Marine Ecosystem**

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CHAPTER ONE

Introduction

This report presents an analysis of the science incorporated in the GEF International Waters (IW) Large Marine Ecosystems and Open Ocean projects, set in the context of global water science and with specific emphasis on the emergence of new knowledge. The focus of the analysis is to facilitate comparison between different IW ecosystem types. Results will be used by the Scientific Steering Group to provide added-value generalizations on critical science issues, adaptive management and development of indicators, for use by scientists and managers of GEF IW projects. Toward that end, a common set of questions was addressed by all the working groups. To answer these questions, working group members used the available documentation where possible, but also included their expert knowledge on the ecosystems in question. The questions were:

1.1 Critical emerging science issues.

1. What are the critical science challenges "on the horizon" specific to each ecosystem type?
2. What is the significance of regional and global-scale drivers, in particular climate change, in the genesis of transboundary problems?
3. Describe how understanding and managing multiple causality in a transboundary water context is undertaken?
4. How are variable spatial and temporal scales in IW projects accounted for?
5. What approaches were used to understand/assess the coupling of social and ecological systems?
6. What scientific knowledge is available and/or used to evaluate trade-offs between the response options developed by IW projects? (this question was added at the Macao Project Inception Workshop, January 2010)

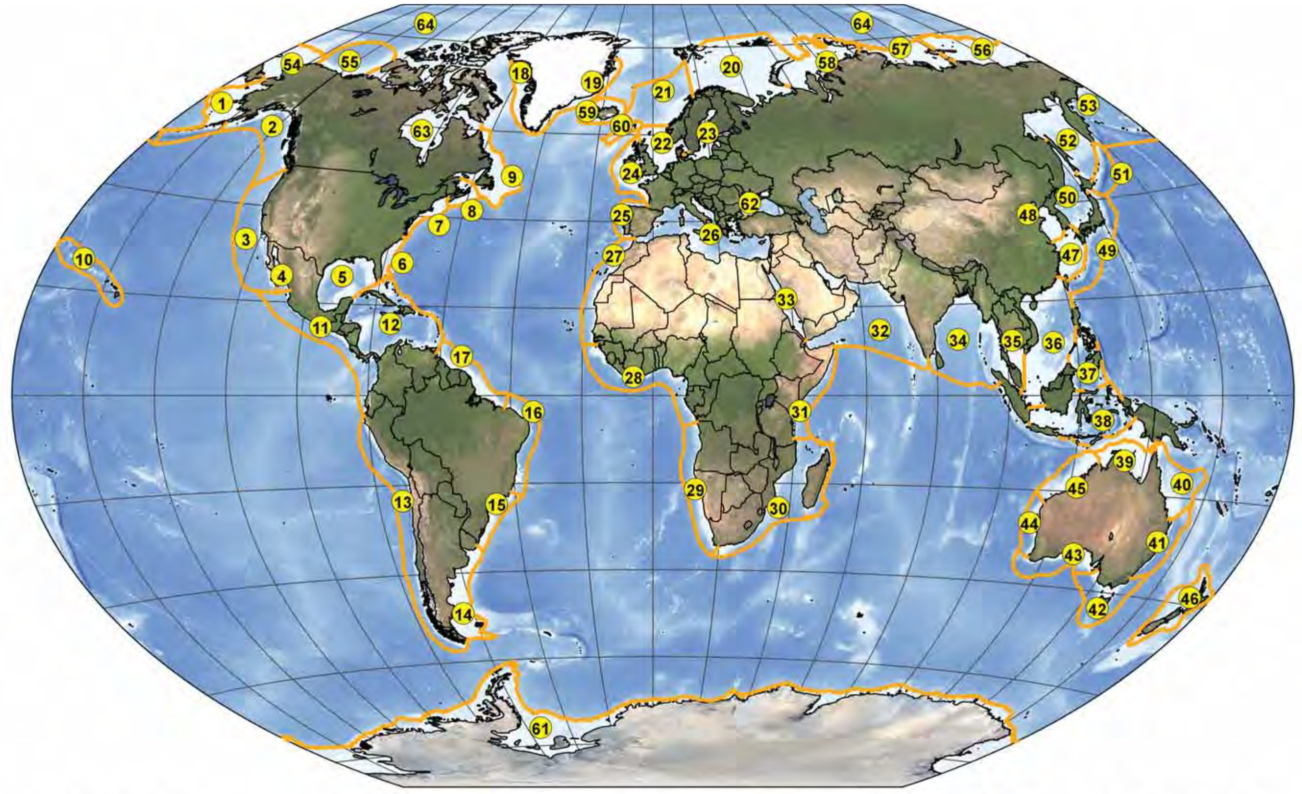
1.2 Development and use of indicators to support the projects.

1. How did the projects help build and implement sound indicators and monitoring strategies to support SAP implementation and/or ultimately assess the achievement of environmental and social benefits?
2. How can we identify effective proxy indicators for use in IW projects?
3. How to make better use of appropriate science and best practices for Transboundary Diagnostic Analysis?

1.3 Application of science for adaptive management.

1. Was engagement of both local and wider science communities utilised in IW projects? If not, how can improvements be made?
2. Is scientific expertise and local knowledge well applied within the IW focal area, particularly in accessing existing baseline information, new findings on methodologies, science breakthroughs and scanning for emerging issues?
3. Identify lessons learned for linking science and policy implementation, including policy formulation and broader governance issues
4. Is adaptive management happening? How to better understand and effectively communicate the scientific dimensions of adaptive management to different user groups?
5. How to better communicate newly-synthesized science knowledge to stakeholders within and external to GEF?

Figure 1 Large Marine Ecosystems of the World



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

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

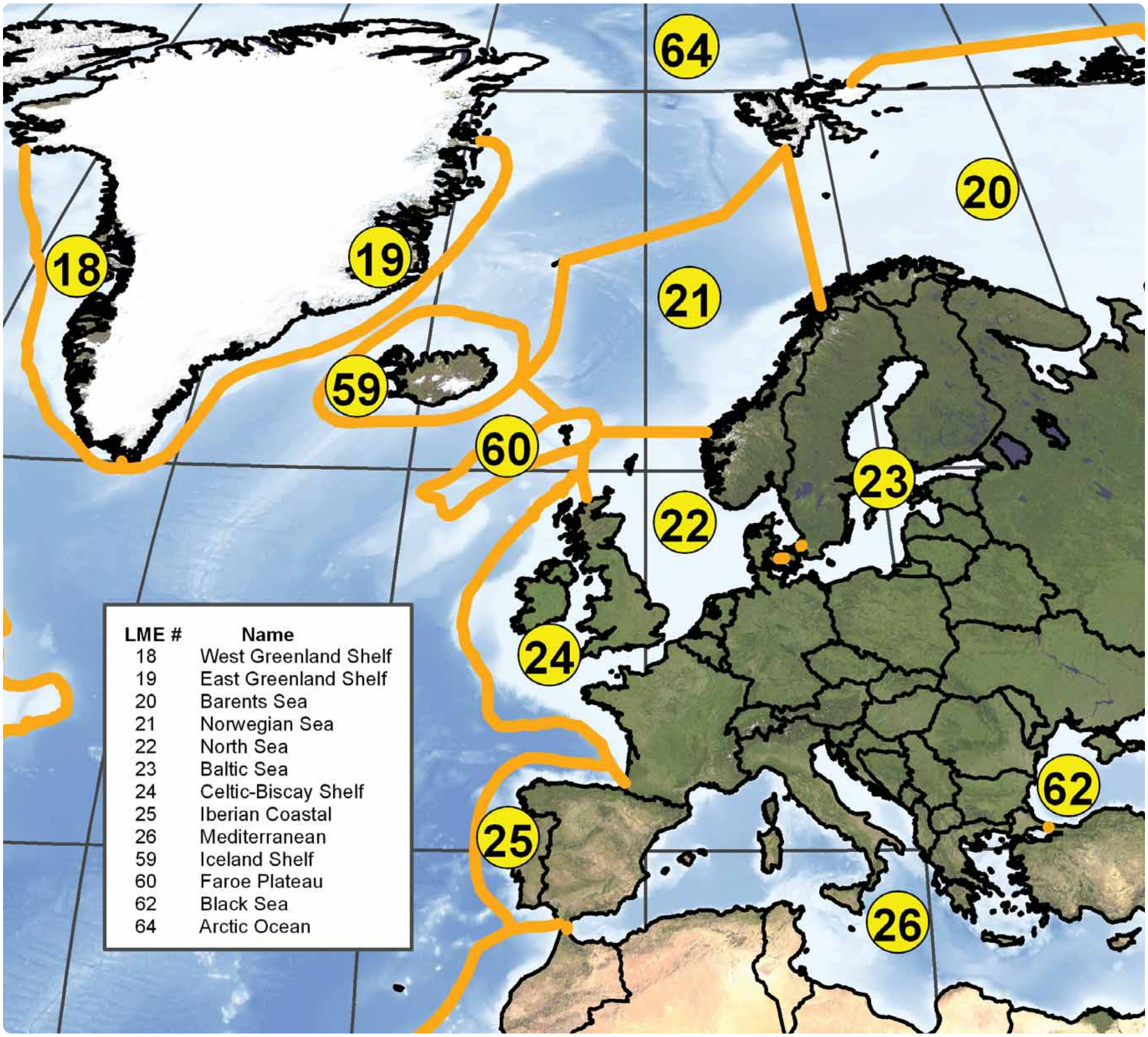
CHAPTER TWO

Methodology

The Large Marine Ecosystem and Open Ocean (LME) Working Group consist of 15 scientists (Figure 1) from Europe (4), Asia (5), South America (2), North America (3) and Africa (1) (Appendix 1). The working group was allocated 52 LME-related International Waters Projects (Appendix 2), which members divided up by area of expertise (Figure 2). The working group met in Macao in January 2010 to divide the 52 projects into those that pertain to coral reefs, mixed fisheries, pelagic fisheries, marine biodiversity, offshore marine-based contamination, and knowledge exchange (Table 1). At the Macao meeting, we used the Baltic Sea as an example to answer the set of questions and to write some generic answers that pertain to most LMEs. These answers were then expanded by the working group (Appendix 3) and updated during the second meeting of the working group in Oban in September 2010. The Oban meeting was attended by nine of the 15 experts, who were for the most part, the experts who engaged with the process, assessed the projects (Figure 4), and participated in the writing of this analysis report.

Coastal use and development impacts both the near and distant marine environment / *Marine Photobank 2009, K. Fuller*

Figure 2 Large Marine Ecosystems of Northern Europe



LME #	Name
18	West Greenland Shelf
19	East Greenland Shelf
20	Barents Sea
21	Norwegian Sea
22	North Sea
23	Baltic Sea
24	Celtic-Biscay Shelf
25	Iberian Coastal
26	Mediterranean
59	Iceland Shelf
60	Faroe Plateau
62	Black Sea
64	Arctic Ocean

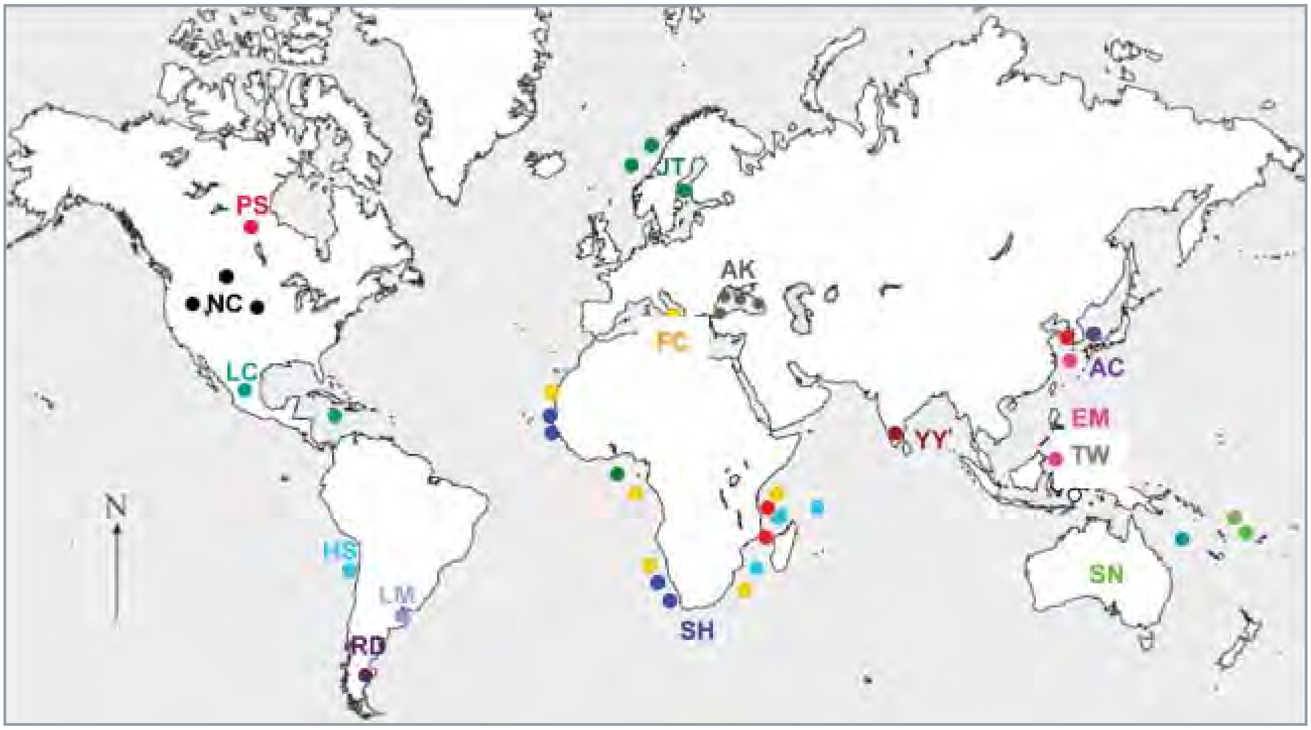
Used with permission from the U.S. NOAA-LME Program Office 2011, http://www.lme.noaa.gov

Table 1 Projects (GEF project #) allocated to the LME group and categories used for analysis. Numbers in red are projects not included in this analysis.

SYSTEM TYPE	CORAL REEFS	MIXED FISHERIES	PELAGIC FISHERIES	BIODIVERSITY ECOSYSTEMS	MARINE-BASED CONTAMINATION	KNOWLEDGE EXCHANGE
Project number	1531	341	530	393	397	2474
	3187	789	1082	584	459	2571
		790	1443	613	610	3339
		884	2131	885	1014	3340
		992		1247	1159	4164
		1032		3523	1202	
		1252		3524	1351	
		1462			1355	
		1909			1542	
		2093			1580	
		2456			1661	
		2574			2141	
		3271			2143	
		3313			2261	
		3314			2263	
		3522			2970	
		3559			3148	

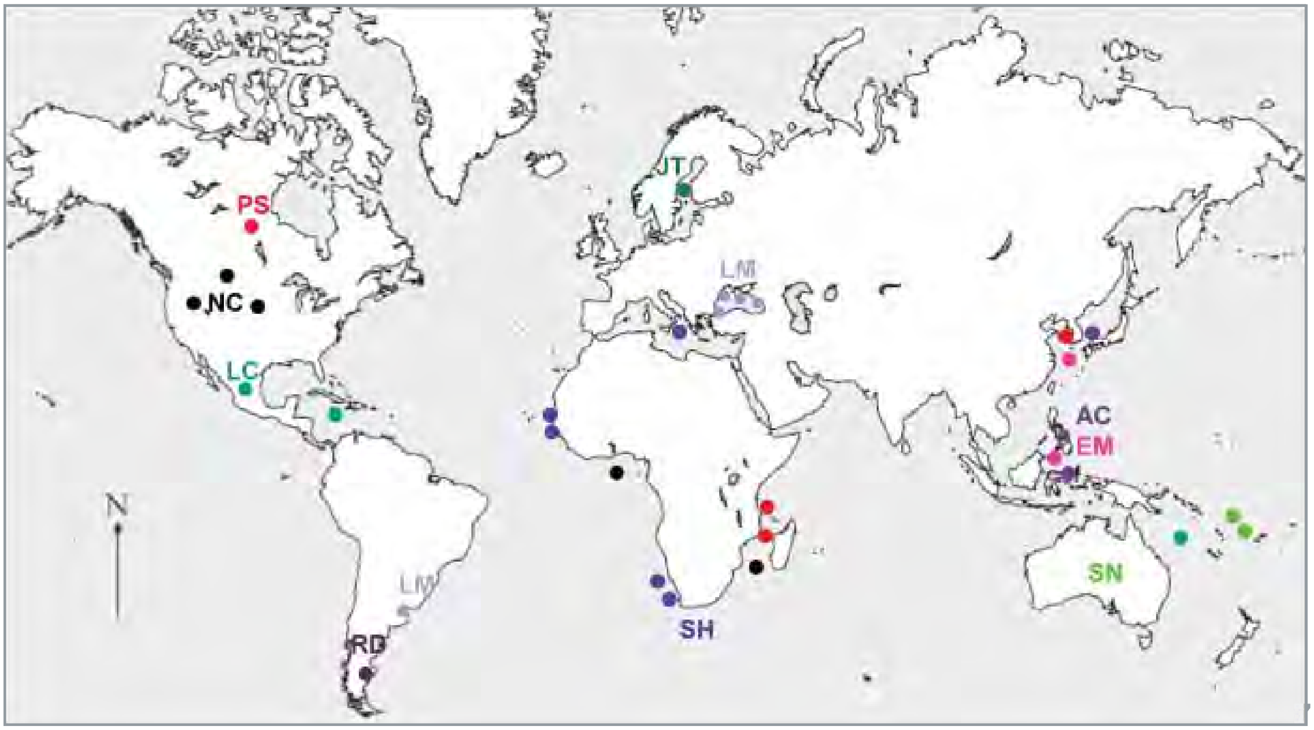
Figure 3 Co-chairs (in blue) and working group members (in red) of the LME working group.

Figure 4 Projects and people selected to undertake the analyses



(PS – Peter Sale, NC – Ned Cyr, LC - Leon Cuahthemoc, HS – Hector Soldi, LM – Laurence Mee, RD – Ricardo Delfino, JT – Jan Thulin, AK – Ahmed Kideys, FC – Frank Chopin, SH – Sheila Heymans, YY - Yugraj Yadava, AC – Annadel Cabanban, EM – Evangeline Miclat, TW – Tonny Wagey, SN – Simon Nicol).

Figure 5 Projects and reviews undertaken and included in this synopsis report (with the names of people who undertook the analysis).



CHAPTER THREE

Results

3.1 CRITICAL EMERGING SCIENCE ISSUES

What are the critical science challenges on the horizon specific to each ecosystem type?

The critical challenges on the horizon for large marine ecosystems and the open ocean were evaluated by analyzing the qualitative scores (high, medium, low, N/A) given to each project synopsis. The three most important issues are actually "on the table" not "on the horizon", and are still unanswered in most of the systems:

1. Eutrophication;
2. Overfishing;
3. Inappropriate coastal development.

In addition, three issues are truly horizon issues, not as yet studied in any detail:

4. Climate change, acidification and atmospheric change;
5. Insufficient recognition of transboundary stocks; and
6. Multiple stressors, tipping points and resilience of ecosystems.

Certain issues were raised when the projects were reviewed (see appendix to this document) including: invasive species and diseases, sustainable management of predatory fish, causes of Harmful Algal Blooms (HABs), nutrient ratio changes, how to reduce fishing effort, illegal, unregulated or unreported (IUU) fishing, illegal immigration of fishers to Europe, inadequate geopolitical frameworks, information on transboundary migration of organisms, impact of improper land-use, and unregulated development. The science needed to meet these challenges will be different for each system and each issue, and needs to be site specific and time specific. Policy-oriented research and science are also important.

On the general issue of horizon scanning, we note that very few projects attempt to look into the future. Design of the TDA approach and the nature of GEF projects themselves tend to take a reactive approach to problems already identified. Given the length of the initial GEF project cycle (from problem identification to SAP implementation), it is often the case that the problems currently being tackled are those identified five years earlier. In some cases, this is perfectly adequate, but it others it is not. In the Black Sea, for example, eutrophication was well recognized as being the major cause of system degradation, but it was not the only cause. A combination of economic collapse in the transition from centrally planned to market economies, along with regulatory actions, reduced the nutrient input to the system. This revealed the secondary causes of degradation: overfishing, habitat destruction and invasive species, none of which had been the focus of GEF intervention. A "systems approach" should have clearly identified these co-factors. Indeed, the Black Sea TDA described them but there was a GEF policy decision to "fix" eutrophication first. There is abundant evidence that such linear logic does not adequately resolve complex problems. In stating this view, we are endeavouring not to be evaluative. In the time since many of these projects were originally developed, scientific thinking has moved toward a systems approach from the earlier linear single cause/effect diagnosis.

The growing human population and increasing demand for seafood worldwide places increasing pressure on the oceans / *A. Dansie*

What is the significance of regional and global-scale drivers in particular climate change, in the genesis of transboundary problems? (To understand this question thoroughly we thought that it was appropriate to reword it to: how important are regional scale drivers in the transboundary projects?)

In addition to climate change, the main drivers include increasing demand for seafood, human population growth, international shipping, globalization energy costs, and global economic drivers such as bad or "ugly" subsidies. All of these are important.

Climate change might sometimes be mentioned in the newer projects, but usually not in projects that commenced in the 1990s and are already finalized. However, some projects, for instance the BCLME (Project 789), Humboldt Current LME (HCLME) (Project 1443), Coral Reef Targeted Research (CRTR) (1531), and the Yellow Sea LME (YSLME) (Project 790), were designed with this driver explicitly included.

Human population growth and global economic effects are almost never included – human population growth is sometimes mentioned (Projects 597, 459), but with a statement that it will not be addressed during the lifetime of the project. Some of the PEMSEA case study sites (e.g. Batangas Bay) responded to the rapid and disproportionate growth of human settlements in the coast, but tended not to examine the wider causes for this phenomenon. In some projects, the impact of human population growth is implicit in the rationale for the project (tuna in the Pacific islands, Project 530) but the consequences are not necessarily dealt with in the project.

We have found little evidence of the impact of energy price hikes and perverse subsidies being considered in GEF projects; these are matters that warrant further investigation. The undesirable global redistribution of species was the key issue for GloBallast (Project 610); the focus was on technical and legal measures to reduce their transport in ballast water.

Suggestion for GEF: Global scale drivers should be included in all projects and their impacts covered in the risk table. If a given risk cannot be mitigated that should be stated. The project documents should state how the project would deal with changes in these drivers and how the risk might be mitigated in the project.

Describe how understanding and managing multiple causality in a transboundary water context is undertaken?

There are different types of causality:

1. Several synergistic impacts on the system such as pollution and warming on coral reefs, for example, where the outcome is not an additive effect of the separate stressors;

2. Global demand for specialized seafood that swamps the capacity of managers either because the product is so valuable that poaching is rampant, or because demand is so intense that fishers at the farthest corners of the ocean are fishing to fulfil the demand;

3. Lack of law for international waters that makes management of resource extraction there more difficult than in coastal waters; here, the lack of legal structures in some cases and/or the inability of legal structures to deal with multiple causality are additional drivers, over and above the drivers of fishing in “owned“ waters.

Examples of multiple causalities from different types of projects are given here:

Mixed fisheries

The multiple causes affecting mixed fisheries were addressed differently among the GEF projects reviewed. In the Baltic Sea (Projects 393, 922, 610, 2261), Senegal (Project 2214), and Canary Island (Project 1909) the multiple causes of the decline of the fish stocks have been studied but the governance regime needed to address has not been tackled. To some extent, the multiple causes of fishery issues were identified in the

Patagonia Shelf Large Marine Ecosystem (Project 459) but an in-depth study is needed, as demonstrated in the following projects. In the Benguela Current (Project 789), South China Sea and Gulf of Thailand (Project 885), and Yellow Sea (Project 790) projects, the multiple-causality of issues was addressed in the TDA and in formulation of the SAP. In the Yellow Sea (Project 790), in particular, environmental concerns were identified and subjected to a causal-chain-analysis to draw out the immediate, intermediate, and root causes for the concerns. The root causes were then prioritized for management.

Marine Biodiversity

Two projects in the South China Sea (Project 885) and the Sulu-Sulawesi LMEs (Project 3524) have addressed multi-causality at all steps in project development and implementation. Socio-economic information was gathered and used in formulating the project and in designing a transboundary response to the environmental issues (e.g., illegal fishing, overfishing, and habitat destruction).

Coral Reefs

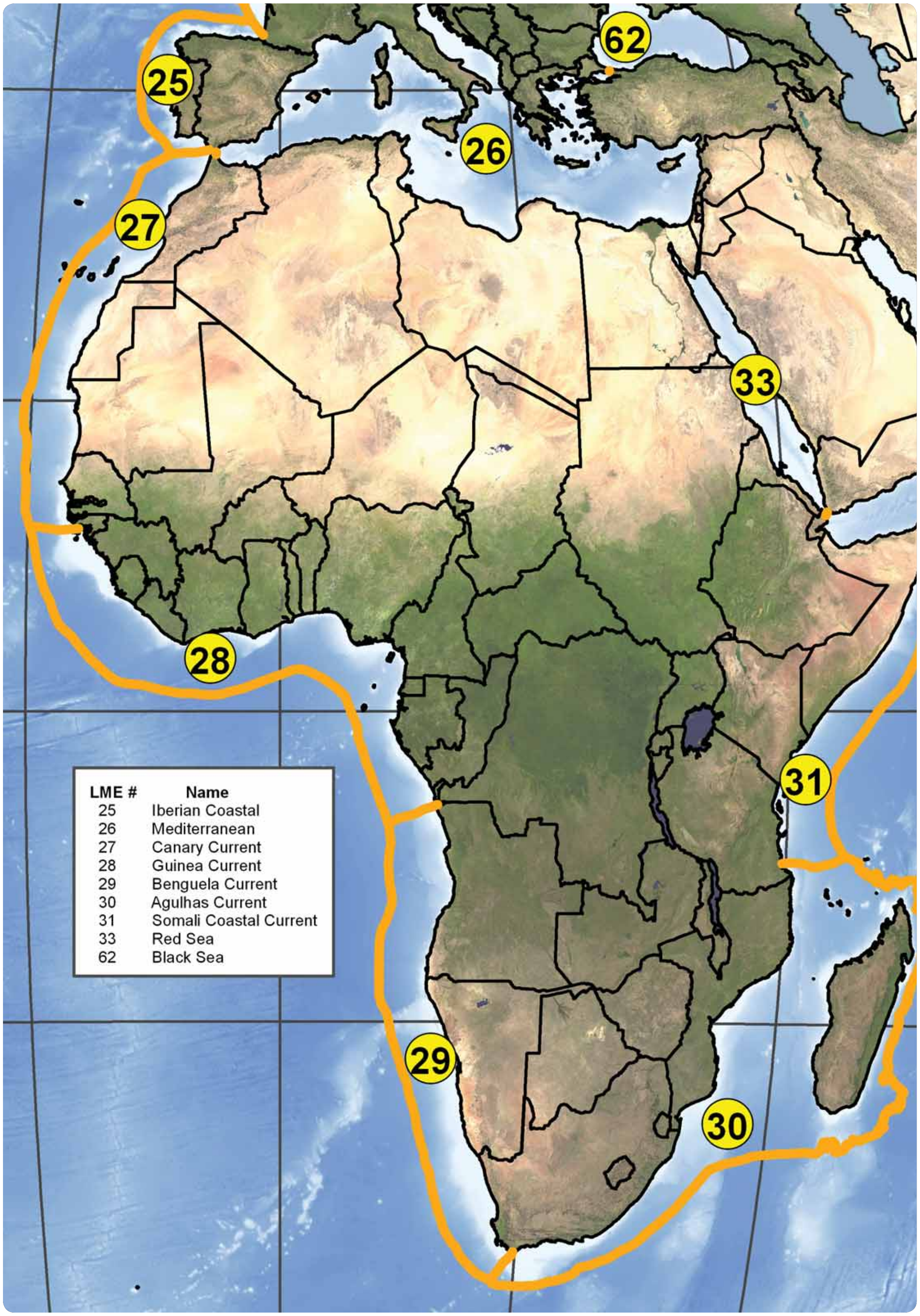
The interacting causes of the phase shift from coral-dominated to algal-dominated ecosystems have been well studied, and there is a reasonable consensus concerning the important role of key herbivores in avoiding this shift from a desirable to a less-desirable state. Although this research did not come out of GEF the projects, the effort to study coral bleaching within the CRTR project did address the interactions among various possible causes of this stress response by corals (Project 1531).

Pelagic fisheries

Management of the international tuna fishery and its related by-catch in the Small Island States of the Pacific was found to be deficient. The Strategic Action Programme for the SIDs (Project 530) identified geographical and functional gaps in management. International management regimes do not adequately cover the fish stocks of the region and there is a lack of capacity or authority in these regimes to manage the fishery and its related by-catch. The project, following the SAP, consisted of two components: Oceanic Fisheries Management (OFM) Project and the Integrated Coastal and Watershed Management Project, which were not interlinked. The SAP, however, was formulated with extensive consultation among stakeholders and it identified “deficiencies in management” at all levels as the root cause of these gaps. These deficiencies in management were linked to many inadequacies in governance and understanding. GEF invested additional funds for implementation of the SAP (Project 2131), particularly the formation of the Western and Central Pacific Commission in the Pacific in 2004 (Project 2131) to address the gaps in management of these large tuna pelagic fisheries.

Offshore marine-based contamination

Figure 6 Large Marine Ecosystems of Africa and the Mediterranean



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Discharge of sediment load from a river into the Caribbean Sea
/ *Marine Photobank, M. Naumann*

Multiple-causality was addressed in the Patagonia Shelf Large Marine Ecosystem (Project 459) and was included in its design and implementation. It was articulated in the TDA, as there was no SAP phase in this project. It tackles the need to better understand and document the specific effects and extent of impacts of anthropogenic activities on the marine environment.

Multiple causality, stakeholder involvement and knowledge exchange

Successive projects in the BCLME (Project 789) have investigated and addressed multiple causality. In the nearshore shelf, habitat destruction can be triggered by offshore diamond mining, oil prospecting and bottom trawling; and there is a lobster fishery that benefits from habitat integrity. The project studied some of these interactions but also brought the relevant stakeholders together at the outset and secured their cooperation. The BCLME DLIST project (Project 2571) brought the science to its users and shared the "lessons learned" by different sectors of society, providing DLIST users with a strong and growing information base relating to the BCLME and its coast. As such, it is useful for understanding multiple causality, but it is not clear if that was the reason the DLIST project was undertaken.

The Patagonia Shelf Large Marine Ecosystem project (Project 459) addressed the need to strengthen the marine resources management capacity of national, provincial, and municipal governments, and help disseminate the information on Patagonia's marine environment generated by the project and available from other sources. One of the project development objectives aimed at building capacity and promoting regional knowledge-sharing about sustainable management of marine resources. There are four key activities developed in this context: the Coastal Marine Information System (SICOM); the matching grants subproject (48 science oriented competitive grants); the inter-calibration of laboratories; and the environmental training for school teachers. The project invested an important amount of time and resources on training programs for government officials and the public in general (54 workshops and more than 1600 participants), and seminars that served as meeting points to exchange the latest knowledge on biodiversity management. All these activities were considered necessary and useful for understanding multiple causality at different governance levels.

Eutrophication, biodiversity and fisheries

There are important relationships between eutrophication and fisheries. Excessive harvesting of predatory fish, for example, can exacerbate eutrophication by increasing the small pelagic fish they prey on, which, in turn, leads to increased predation on zooplankton and an increase in the phytoplankton responsible for eutrophication. This "trophic cascade" has been described for the Black Sea and other regions. Heavy fishing, particularly by destructive trawling, can also destroy habitats and reduce biological diversity, making it difficult for systems to recover. In the case of the Black Sea Recovery Project (Project 2263), GEF Council priorities at the time of project design led to a focus on nutrient reduction and toxic substances only. This was an example of failure to deal with multiple causality that occurred as a result of a central generic decision coupled with regional political unwillingness to deal with overfishing. The Black Sea still does not have a common management regime for fishing, and stocks of predator fish have not recovered despite the clear reduction in eutrophication. Benefits of investment in nutrient reduction are not yet apparent in the fisheries sector. To some extent, this reflects inadequacy in the scientific advice reaching GEF Council, as well as the sectoral nature of the GEF at the time these projects were formulated (IW and biodiversity had insufficient links).

How are variable spatial and temporal scales in IW projects accounted for?

Variable scales are often easier to address with the informal sector, as funding dictates the geographic extent of the project, unless it is part of a bigger programme. Political constraints often limit the spatial scales that a project should work on if it is to capture causes as well as effects. Spatial scales are usually determined by some bio-physical factors, ecological processes, connectivity (e.g. oceanographic features) or shared stocks. Some adjustments are made in view of social science considerations, political constraints, limited funding, or a combination of any of these. GIWA (Project 584) was implemented at the LME scale and expanded the assessment to watersheds because, in many cases, they are a key part of the cause-effect system. Team inexperience, limited funding and poor quality assurance rendered some of the assessments limited in their usefulness to management however. Some of the LME projects included watersheds (e.g. the Baltic Project, Project 922) but, in some cases, the sheer scale of the region made this impractical. In the case of the Black Sea Recovery Project, full coverage was achieved by developing a "programmatic approach" embracing the Danube and Dnieper Basin projects, which shared some common aims and recognised a single downstream objective for nutrient control.

There are also projects that cover smaller spatial scales than originally planned. For example, Yellow Sea LME (Project 790) attempted to do a LME-wide TDA and SAP development. However, the refusal of the DPRK (North Korea) to participate is a political issue, which limited implementation to two of three countries of the Yellow Sea.

The full cooperation of countries is critical if the objective to manage and sustainably use this semi-enclosed LME through the adopted ecosystem-based approach is to be achieved. For various reasons, some projects are limited to implementation in demonstration sites. In the South China Sea (Project 885), political constraints played a major role in limiting spatial scales. Some of the countries participating in the project refused to include contested areas, although the biological and ecological significance of these areas are recognized. Thus, the project was largely focused on demonstration sites within national jurisdictions, though care was taken to ensure scientific understanding of these sites and their relevance to the overall system (a TDA was prepared for the overall system excluding the contested areas). The Sulu-Celebes fisheries project (Project 3524) intended to establish at least two demonstration sites per country, but is limited to one per country due to funding constraints. The funds provided by GEF can provide meaningful contribution only because the project is contributing to a larger, already established tri-national SSME program, which has been developed outside of GEF support. In the Coral reef targeted research project (Project 1531), the choice of sites to run the project depended on the expertise available. It was a political decision to include the centres of excellence – so, overall, it included some countries because of the availability of facilities rather than through a prioritisation of sites by ecological or social characteristics.

Temporal scales are often difficult to account for, as most projects are shorter than the timeframe of the ecological problem that they are supposed to address. This was a major focus of the 2004 IW Program Study, for example, where it was pointed out that many projects were overambitious in trying to achieve change in politically

Women fish sorters separating economically valuable shrimps from the trawl bycatch at Sakthikulangara fishing harbour, Kerala, India / *Marine Photobank, A. Bijukumar*

Figure 7 Large Marine Ecosystems of Latin America

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or scientifically unrealistic timeframes. Regardless of the limiting factors, what is notable among the projects is that final decisions made on scales, temporal or spatial, are guided by a combination of natural science, social science, and legal-institutional and political realities: i.e., Baltic Sea (Projects 922, 610, 2261, 393), Benguela LME (Project 789), Canary Current (Project 1909), Caribbean LME (Project 1032), Tanzanian EEZ project (Project 2456), Patagonia Shelf Large Marine Ecosystem (Project 459), CRTR (Project 1531).

What approaches were used to understand/assess the coupling of social and ecological systems?

Many projects attempted to address the relationship between social and ecological systems. During the TDA process, projects such as the Yellow Sea LME (Project 790) and Caribbean Sea LME (Project 1032) gathered information on both natural and social sciences and made attempts to establish causal links between them. The Benguela Current (Project 789) project included an explicit socio-economic module that made this coupling more deliberate. Workshops, community focus groups and regional working groups were all methods employed to bring together stakeholders using natural and social science. The Baltic Sea (Project 922) and Benguela Current (Project 789) projects went further and included plans for permanent structures, such as Management Advisory Committees for fisheries and biodiversity (Benguela) and a coordination centre for societal impacts of environmental issues (Baltic). These provide a more sustained mechanism for stakeholders to bring social and economic considerations into the natural resource management process.

One challenge is that interdisciplinary approaches such as these appear to be rare at the regional level (not part of the scientific culture), and thus had to be constituted specifically for the purpose of the project. There were frequent difficulties in attracting social scientists with the skills, knowledge and experience to participate in this work. This sometimes led to natural scientists making very superficial social and economic assessments that merely documented well-established trends from publicly available data. There is a clear skill shortage in this area (not only limited to GEF projects) and this should be more widely recognized as a bottleneck to progress. Perhaps mechanisms could be found to improve this situation through providing tools and training. The prevailing attitude, the “we don’t do capacity building”, does not help to resolve the problem.

In some cases, projects claimed social and economic relevance but failed to establish a framework or mechanisms to translate the project’s natural science results into social impacts. GEF should evaluate whether this failure occurs because of the problem of time-scales between the objectives and the possible outcomes. In some cases the countries that should implement the GEF projects restrict what can be done with regards to the coupling of social and ecological systems (i.e. we will not work on fisheries or poverty) and this constrains what can be done in the GEF project.

Suggestion for GEF: If the coupled socio-ecological systems are important, then GEF should do more than give it lip service.

What scientific knowledge is available and or used to evaluated tradeoffs between the response options developed by IW project? (Is science used to give politicians informed choices – are we providing the information for politicians to make the choices?)

There are some examples where the TDA SAP has identified the response options (Black Sea) but it is unclear whether adoption of the SAP into the project implementation has resulted in collection of information that allows the trade-offs between response options to become apparent.

Though not a primary object of our analysis, the Rio de la Plata and its Maritime Front project (Project 613) is a good example of presenting scientific results in a way that promotes discussion on trade offs. The project made a huge effort to assemble scientific information on this area of transition waters between some of the largest rivers in South America and the open South Atlantic. Primary information was gathered in GIS format and some gaps in knowledge were filled with new scientific studies. The whole body of knowledge was finally condensed into a document explicitly written in a language accessible to policymakers. Some of the information was controversial and caused discomfort amongst some stakeholders (e.g. information on the declining fish stocks) but this highlighted the complexities of the management tradeoffs, and some of these are being dealt with in the subsequent GEF intervention (which would not have been possible without the open and rigorous assessment).

Response options used for nutrient reduction in the interventions within the Black Sea Programmatic Approach - a $110M cluster of demonstration projects together with the Black Sea Ecosystem Recovery Project (Project 2663) and its Danube equivalent (Projects 1014,1661) – were an interesting opportunity to test the cost effectiveness of alternative practical approaches to reducing nutrient discharge. To date, we have seen no clear evidence of rigorous and comparative interdisciplinary studies that could facilitate replication of these studies to other systems in the world. In the wider context, it would be useful to establish a GEF database of the cost-effectiveness of pilot and demonstration studies. These would generate considerable added value to GEF investments.

The idea of using science to generate clear management options is desirable – but it is often difficult in the timeframe of a GEF project, which is usually approximately five years. Thus, multiple cycle projects (sometimes in a programmatic approach like the Black Sea: Projects 341, 397, 1014, 1159, 1202, 1351, 1355, 1542, 1580, 1661, 2141, 2143, 2970, 3148) may achieve this, though investment costs are very high. For projects where the causes of identified problems are within a broad catchment, there is a clear difference between the scale of problem analysis (the entire catchment as a social-ecological system) and that of the interventions, which, other than umbrella governance structures, have to be implemented within separate political boundaries. In other words, problem identification should be at a system scale, actions should also be agreed and coordinated at a system scale, but the investments themselves will be defined within national or sub-national political boundaries. The Black Sea programme achieved this by having projects for each country that borders on the Black Sea (Danube - Projects 1014 and 1661; Romania - Project 1159; Rostov - Project 1202; Hungary – Project 1351; Moldova – Project 1355 and Project 1542; Romania – Project 2970; Croatia – Project 3148).

3.2 DEVELOPMENT AND USE OF INDICATORS TO SUPPORT IW PROJECTS

How did the projects help build and implement sound indicators and monitoring strategies to support SAP implementation and/or ultimately asses the achievement of environmental and social benefits?

The processes for development and application of process, stress and environmental status indicators in the GEF projects reviewed were variable. For most projects, process and performance indicators were identified during project development and inception (Benguela - Project 789, Baltic - Project 922, Pacific Islands - Project 530, Canary Current LME - Project 1909, Yellow Sea - Project 790). These indicators are not particularly useful for evaluating science.

The TDA and SAP has been a primary resource for development of stress and environmental status indicators for some projects. For example in the Benguela current (Project 789), indicators of ecosystem health and socio-economics were identified and described in the SAP implementation document. In contrast, the Pacific Islands Oceanic Fisheries Management Project (Project 2131) notes that these indicators are an output of the project and are intended to have a life well beyond the project. It is not clear from the documentation if these indicators have been identified.

Development of indicators during the project is also a feature of the Baltic (Projects 922, 610, 2261, 393). Workshops were held in the early phases of the project to develop these indicators. Phase one of the coral reef CRTR project (Project 1531) was focused on targeted research and the usual data collection activities of science were used to determine results of specific studies. Assessment of the impact of the project on improving understanding within the management community has been informally assessed (questionnaires etc), and significant efforts have been made to communicate results to the management community, with many documents written for the management community rather than the academic community. However it is not clear if indicators were ever formally developed for this project.

In the Viet Nam coral reef project (Project 3187), the intention is to use standard environmental state indicators to evaluate the effectiveness of the management interventions. The indicators were not specified.

Both quantitative and qualitative indicators have been applied. In the Baltic (Project 922), the indicators developed were qualitative, whereas in the Senegalese small-scale fisheries project (Project 3314) and the Tanzanian MACEMP project (Project 2456), key indicators for measuring the success of project activities were quantitative. An important observation from reviewing the GEF documentation was the difficulty in determining how the indicators were developed, implemented and used in evaluation (e.g., Canary Current LME - Project 1909, Sulu-Celebes SFMP - Project 3524, Yellow Sea - Project 790).

An underlying assumption of the GEF approach (Monitoring and Evaluation Indicators for GEF International Waters Projects - Monitoring and Evaluation Working Paper 10, 2002) is that a thorough understanding and description of the baseline data should come through the TDA and objectives through the SAP, leading to formation of project indicators. The review of LME and OO projects indicates that this sequence of events has not always been followed.

There is a further difficulty that underlies some of the issues with development of indicators. The established approach in the GEF is to employ process, stress and environmental status indicators. This differs from the approach used in Europe and other regions that employ the Drivers-Pressures-State-Impact-Response (DPSIR) framework. The two approaches are not directly compatible and this has repercussions for the indicators adopted. We strongly suggest that more work should be done to harmonize these two approaches in order to benefit from the rich research literature emanating from the DPSIR framework.

How can we identify effective proxy indicators for use in IW projects?

To identify effective proxy indicators one needs to identify the assumptions, justify their use, and prove that these indicators are scientifically proven to work: in short, prove the assumption that the proxy defines the appropriate indicator. Proxy indicators should be well vetted and proven – and used with care.

Aquaculture has seen a rapid increase to satisfy seafood demands, salmon pen in Norway / *Marine Photobank, L. Schmeidler*

In general it is not easy to find specific "proxy indicators” in the projects reports, which suggests that the information available is considered explicitly "good" or "good enough" for the managers. This leads to the conclusion that most of the reports lack proxy indicators for both social and economic process. In contrast, most of the reports show that they will follow task- or goals-related indicators, but processes and impact indicators are underestimated. Baseline environmental indicators are common, but local or regional socio-economic proxy indicators are mostly too broad to be useful or to follow the long-term process and the impact of the project. More work is needed on proxy indicators from other fields. They are frequently employed in public health studies, for example, and some of the indicators used in marine protection are, in reality, proxies. An example is coliform counts, which, by themselves, do not reflect exposure to disease (there are some relatively harmless animal sources of E. coli) but are a precautionary proxy for sewage pathogens. There is a particular need for economic proxies given that indicators such as GDP are aggregated within national borders and difficult to interpret on a catchment scale. The same applies to fisheries statistics, and there are major problems in obtaining information on fishing capacity and effort.

How to make better use of appropriate science and best practices for TDA?

To ensure better use of appropriate science and best practices, institutions in the region must be engaged to ensure full “ownership” of the findings and enhance the possibilities for sustaining the outcomes in the future. Though it is often easier to contract skilled consultants to do this, they rarely contribute significantly to local level “buy in” or capacity building. If consultants are used, it is important to check their contacts and experience with current science and the region. There should be quality control from executing agencies to ensure that the people who develop the TDA have the appropriate capacity and knowledge to do the job. Stakeholder consultation and synthesis of unpublished and published information are also important. Explicit inclusion of indicators in the TDA and baseline studies as a result of the synthesis is vital. Serious efforts should be made to peer review the science and TDA, and include stakeholders in the reviewing process. An important step toward ensuring the best possible use of local science would be to establish a multidisciplinary science advisory group or committee for each project, involving key local institutions, academic and public. This will be elaborated further in the next section.

Searching for recyclables in washed up garbage, Thailand
/ *Marine Photobank, K. Kosavisutte*

One tool that is absent from most projects is targeted research. There appears to be (or at least to have been) an unwritten taboo against research. In some cases, however, the preliminary TDA clearly identifies large areas of uncertainty that can only be reduced through a combination of research and monitoring. A case where this was accomplished was in the Black Sea Ecosystem Recovery Project (Project 2263) in which research was employed to assess whether or not the system was recovering and to provide a baseline for subsequent monitoring work. Similarly, some elements of research have been funded in the Benguela Current (BCLME, Project 789) and the Humboldt Current (Project 1443) upwelling systems. In the case of the first BCLME project, the GEF intervention was designed on the back of a major multinational fisheries and ecosystem research project denominated BENEFIT.

3.3 APPLICATION OF SCIENCE FOR ADAPTIVE MANAGEMENT

Was engagement of both local and wider science communities utilized in IW projects? If not, how can improvements be made?

In all these projects, both local and wider natural science communities were involved. Participation of the social sciences is generally low. However, all projects have developed strong participatory processes linked to social science. Presumably all projects include social science considerations, but it is not clear from the documentation reviewed how much was involved, specifically in the Benguela (Project 789) where the project was mainly based on resources, habitats and pollution.

There is a gap in the link between the natural and social systems (anthropic and environmental processes), and the feedbacks between them need to be more explicitly included. GEF projects must work to bridge this gap and improve involvement of the social sciences through inclusion of social science methodologies in the early design of new projects, and development of explicit social and environmental indicators. Specific participation of specialists in social and natural sciences for monitoring and developing of such indicators will also help bridge this gap.

Some projects did set up regional scientific and national scientific advisory boards (Bay of Bengal - Project 1252, South China Sea - Project 885, Benguela LME - Project 789, Baltic - Project 922) and this should be encouraged in all future GEF projects. Participation of social scientists in these boards was quite sparse however.

Is scientific expertise and local knowledge well applied within the IW focal area, particularly in accessing existing science breakthroughs and scanning for emerging issues?

Yes, in most of these projects local science was used. Specifically, when projects are related to more developed countries, international scientists are often also the local scientists. In the Yellow Sea (Project 790), highly qualified scientists working in the area were included in the TDA, and the SAP included scientific findings and assessments from local scientists with international standing. The scientific advisory committee should include both local and international scientists.

In some cases, however, local scientists might be "disregarded" due to the fact that senior policymakers may regard international scientists to have more credibility than local scientists. Sometimes local knowledge is "disregarded" by policy makers, but is taken into account if it is reported by an international scientific expert. In other cases, there may be considerably more knowledge outside the region (coral reef expertise in the UK and Sweden for example). Also, in the Pacific Islands, regional organizations with local science expertise have been engaged, but, on the other hand, local (regionally coordinated) universities have not been engaged particularly well. Occasionally, the first draft of a TDA or PIF is written by a consultant, and has to be reworked to include input from local scientists.

IW projects also do not usually include Traditional Ecological Knowledge (TEK) or Local Ecological Knowledge (LEK) because it is not well documented or considered as "good science" during project development.

Identify lessons learned for linking science and policy implementation, including policy formulation and broader governance issues.

The projects appear to have included international scientific expertise in the formulation of technical activities within the project, although the standard reporting documents do not provide this information, and, in general, the identity of the contributing scientists is hidden. This is perhaps unfortunate, because it makes it difficult to assess the currency of the expertise used. When it comes to the deeper issue of formulating policy and building governance mechanisms, there is little evidence that scientific expertise is explicitly used, or even that the formulation of policy is done in a deliberative way. Administrative structures are built; tried-and-true mechanisms to build consensus and seek agreement are used; and, in some projects, new policy emerges. In general, of course, the five-year timeframe of a GEF project makes it unrealistic to expect much progress in policy formulation and application within the course of a single funding cycle. Further, the usual time delay, when one phase is followed by a gap to prepare and seek approval for the second, creates a significant break in activities that frequently is accompanied by a general collapse of structures and procedures formulated. This impedes the possibility of seamless progress over a series of successive funding phases, to the detriment of achieving long-term goals. Many of the expectations imposed on GEF projects seem unrealistic, given these timing constraints.

Despite these criticisms, there are a few projects that have managed to make real progress over a series of funding cycles (that provide a more realistic timeframe for progress to occur). The Benguela Current LME series of projects is a case in point. It used the science obtained locally (BEP) and internationally (BENEFIT, ENVIFISH, VIBES) as well as the work published in the scientific literature, but, by effective networking among stakeholders, also succeeded in building the Benguela Current Commission, as an effective means to coordinate management across three countries.

Is adaptive management happening? How to better understand and effectively communicate the scientific dimensions of adaptive management to different user groups?

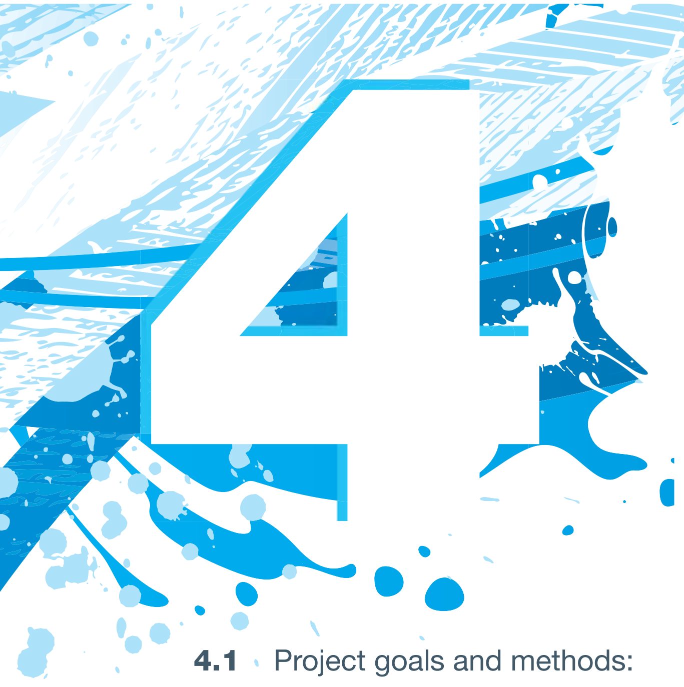
True adaptive management is not well represented in the projects examined, even though adaptive management is probably the only way to generate effective and sustainable improvements in management in regional-scale projects. This failure to observe adaptive management is largely due to the fact that whether or not it is expected by GEF, the formulation of GEF projects, in practice, is more about how to build an effective case for funding than about how to bring about improvement in management and governance. A second reason, of almost equal importance, is that the timeframe of GEF projects is insufficient to achieve more than one or two steps in an adaptive management cycle, and the time delays that are usual during the process of refinancing lead to fall-back or collapse between phases in a multiphase project. While pilot or demonstration projects are a frequent component of GEF projects, and could serve as alternative management trials in an experimental process central to adaptive management, the fact is that these are rarely followed up by adequate monitoring and cross-comparison, which would be essential for an adaptive management approach. If adaptive management is loosely defined as “learning by doing”, the learning component requires data, critical review, and a forum for sharing experiences, both positive and negative. Timeframe constraints, failure of implementing agencies to value monitoring of technical results (as opposed to monitoring of the project), and failure of project design teams to think in terms of adaptive management all contribute to real or potential failure.

How to better communicate newly-synthesized science knowledge to stakeholders within and external to GEF?

The science changes, but managers and stakeholder groups are rarely well connected to the evolution of scientific thinking on topics of relevance to their activities. GEF projects contribute to scientific understanding, build upon current science, and in a few cases make inroads into new scientific or technological understanding. All of this is disseminated through a communication process that involves websites, newsletters, informational brochures and documents, and workshops designed to deliver project results and associated information to stakeholder groups. All projects reviewed showed some evidence of using these approaches, but there is considerable variation in the effort expended, or the proportion of funding allocated to this vital communications task. Further, the effectiveness of transfer and uptake of technical information is rarely monitored. Where projects have resulted in peer-reviewed documents in the primary literature, the transfer of this information to stakeholder groups is rarely well done. The Coral Reef Targeted Research project, which has made a major effort to disseminate new science findings resulting from its activities, has recently posted a Research Compendium on its website. This attractive document does an excellent job of setting out the new science and providing brief descriptions of the more important publications, in a format and style readily accessible to managers and other stakeholders. The project website also has a complete list of peer-reviewed publications, but, due to copyright issues, the articles cannot be downloaded from it. Where purchase by authors of open access to articles is permitted by scientific publishers, an effort by projects to fund this cost could make the science much more available than heretofore. As it is, the lack of explicit information in GEF documents as to which scientists, if any, have been participants, and the usual lack of information concerning peer-reviewed publications on websites or in newsletters together make it almost impossible to search out the full scientific information generated.

Scientific communication should be part of the explicit design in new projects. The vision for the system has to be designed with stakeholder involvement, and there should be a conceptual model that links the ecosystem to that vision. Stakeholders need to be sure that the science will be important to them. Documentation should be in clear language, without “GEF speak” or general jargon. We have seen some good examples of such communication: for example, the popular books written in local languages that have emerged from successive Black Sea projects or the Tropical Coasts journal produced by PEMSEA. It is unclear to what degree these have influenced the policy process, but they may have had a significant impact on young people and future generations.

Phytoplankton blooms in the Black Sea. Increased nutrient inputs into the world's seas and oceans as well as excessive harvesting of fish stocks, which cause a "trophic cascade" as described for the Black Sea, result in increased eutrophication of LMEs / NASA Earth Observatory, 2006 using the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite



CHAPTER FOUR

Conclusions and Recommendations

4.1 Project goals and methods:

- It proved nearly impossible to trace science in GEF projects based on the documentation, given that the internal documentation contains little to none. In terms of the project, the coordinators of the TDA, SAP, mid-term review, and final evaluation should have the science needed to do the review.

    - Most of the science is encompassed in the TDA and if the TDA is poorly prepared (as has happened in some cases where the TDA was conducted by consultants) then it is extremely difficult to know how science can be used to further policy to manage the system. In some cases the extent of the science is not clear from the documentation: that is, while some science was visible we did not know the full extent of what was used. There are some projects where it was done well, such as the South China Sea, Yellow Sea, Sulu-Sulawesi and the Black Sea. Even though these were conducted by consultants, in each case the consultants were from the region. However, in others cases, the science is hard to find. Therefore if the people who put together the TDA were not part of the working group, it was not possible to know what science was included.

    - Sometimes there is a well-prepared TDA but it is not incorporated into the project. It is not necessarily included in the details of what will happen after the TDA is written.

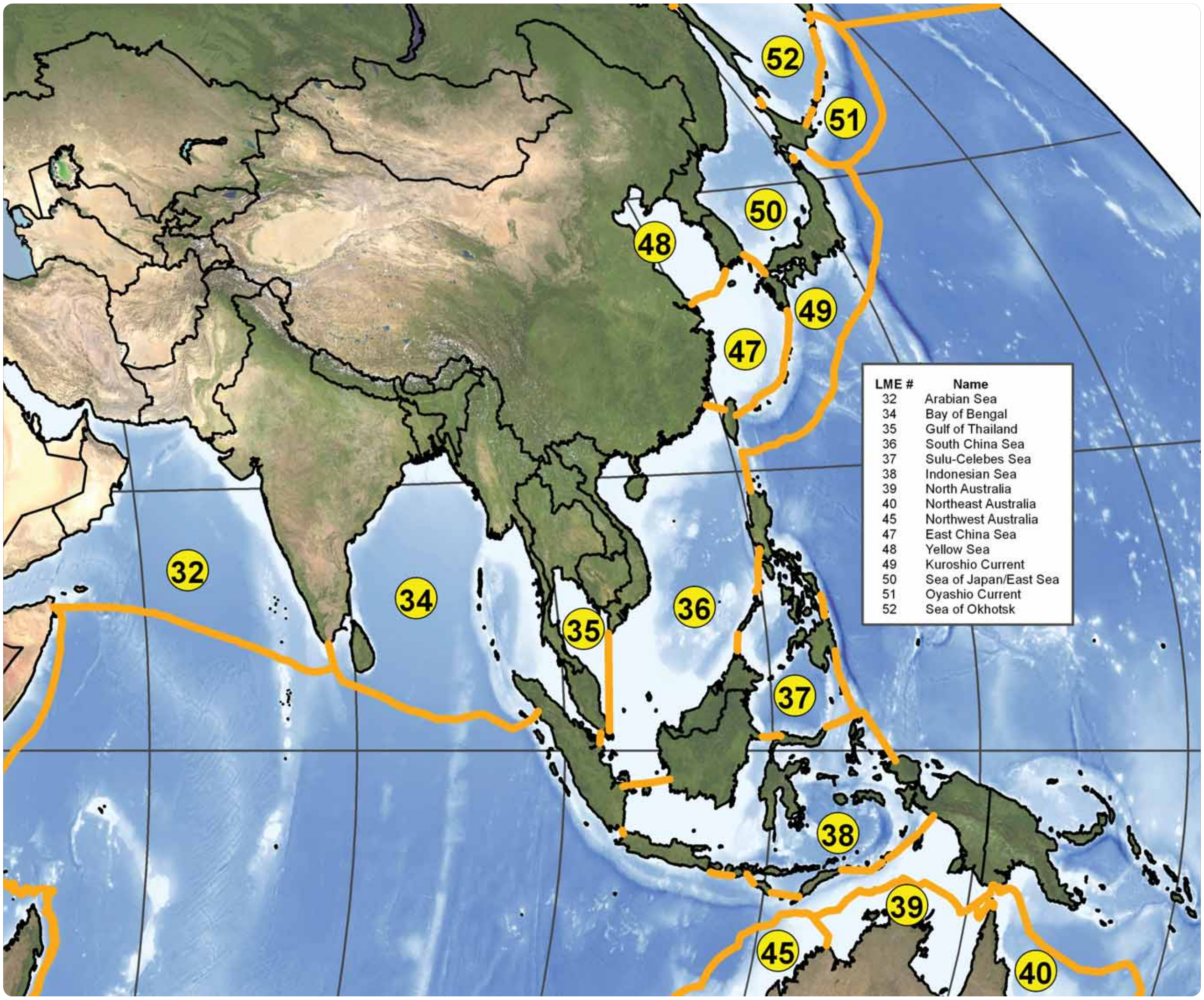
    - The SAP does not have science-into-policy information, and the mid-term review and final evaluation documentation also did not always have the science and policy information needed.

      It is not clear from any of the documentation where the science influenced the policy.

    - **Suggestion to GEF:** There should be a technical science document that sets down all the science used, the scientific findings, and how these influence policy. The mid-term review and final analysis document should also have a section on the science that went into the project and the science that came out of it. This will create a scientific legacy for all GEF projects. GEF should encourage publishing in peer-reviewed literature and uploading citations to the GEF and project websites. For this to happen, GEF needs to overtly fund targeted research, and expect to be mentioned as a funder in the primary literature.

- Barriers to finding information: both before the IW:Science database was constructed — and even now that we have more information — there is still not enough to judge the science. It might have been useful to look at the primary literature but there was not enough time to do that. Nor would finding it be particularly easy since scientists participating in a project are rarely identified in any of the core project documents.

Figure 8 Large Marine Ecosystems of South East Asia



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

Artisanal fishing boats in a Moroccan port / *Marine Photobank, M. Markovina*

4.2 Barriers to achieving goals:

- Diversity (how to compare such diverse projects);
- Investment and policy influence;
- Research should not be a bad word, and GEF should fund research where necessary to reduce critical uncertainties, which is the case in some projects. We note that in more recent projects, where research was needed and clearly identified in the PIF, it was sometimes funded. This is a welcome trend. However, it is not true in all cases. Sometimes science was hidden because the impression is that GEF does not fund research. If GEF funds research for policy implementation, that should be made clear.
- The investment in new knowledge is a core need for these projects, and GEF should invest in new knowledge, given that GEF LME projects cover some of the least understood ecosystems on the planet, and we need to understand and manage human impacts on them.
- **Suggestion to GEF:** There is an assumption that GEF does not fund additional research. This might be untrue, but the general impression is held by some, including the implementation agencies. GEF should clarify their policy on research as there has been a recent high rejection rate of science-based project proposals despite country endorsement.

4.3 The impact of science on policy:

- We have seen limited evidence of the pull through of new science to policy. Most of the issues dealt with have been based upon pre-existing scientific knowledge, sometimes with incomplete understanding. We would expect the impacts of GEF-funded science to be slightly longer term, as they create the baseline for new actions, following the logic of adaptive management. In some cases (e.g., BCLME, Humboldt) the projects are generating knowledge about how whole systems are influenced by climate change and natural cycles so that resource management can be geared to the variability in the wider system, avoiding catastrophic ecosystem collapse.

- **Suggestion to GEF:** GEF should be clear about what the expectation is with regard to the effect of the science in the project on policy; and the documentation should clearly show where the impact on policy was expected (possibly longer term) and where it was shown (possibly within the term of the project). The documentation should reflect how science influenced policy during the course of the project and how it is expected to do so in future.

Based on the analysis report, we make the following recommendations:

1. The three most pressing critical science issues are: 1) climate change, acidification and atmospheric change; 2) life history, ecology and conservation of transboundary stocks; and 3) multiple stressors, tipping points and resilience of coupled social-ecological systems. These should be emphasized in all future GEF funding rounds, and, in addition, there should be a regular review of new issues that might be incorporated (e.g., plastic micro-fibre pollution, "lifestyle" chemicals, deep-sea fishing, seamount habitat conservation, marine renewable energy, and underwater sound).

2. Multiple causality should be incorporated in all future GEF projects and an ecosystem approach should be stressed. Studies of large marine ecosystems should not be regarded as being bounded by the coast; many of the key social drivers are in terrestrial environments (on the coast or within catchments) or may be global in scale.

3. Global scale drivers should be included in all projects and their impacts covered in the risk table. If a given risk cannot be mitigated that should be stated. The project documents should articulate how the project would deal with changes in these drivers and how the risk might be mitigated in the project.

4. Coupled social and ecological systems are important in an ecosystem approach, and natural science results need to be translated into social impacts. GEF should evaluate whether the reason natural science does not translate into policy is (a) the problem of time-scales between the objectives and the possible outcomes or (b) because the countries that should implement the GEF projects work in thematic silos that make it impossible to tackle environmental problems at their social and economic roots (i.e. the same structure will not work on fisheries and poverty).

5. If using science to generate clear management options in an ecosystem context is desirable, problem identification should be at a system scale and actions should be agreed and coordinated at the same scale even if the investments themselves are defined within national or sub-national political boundaries. This requires the use of a "systems science" approach that can work at multiple spatial and temporal scales.

6. An underlying assumption of the GEF approach is that the TDA should develop a thorough understanding and description of the baseline data. Management objectives should be developed within the SAP, together with relevant project indicators. This sequence of events has not always been followed, however. The process differs from the approach used in Europe and other regions that employ the Drivers-Pressures-State changes-Impact-Response framework. The two approaches are not directly compatible and this has repercussions for the indicators adopted. We strongly suggest that more work be done to harmonize these two approaches so as to benefit from the rich research literature emanating from the DPSIR framework.

7. There is a particular need for social and economic proxies given that indicators such as

GDP are aggregated within national borders and are difficult to interpret on a catchment scale. The same applies to fisheries statistics, and there are major problems to obtaining information on fishing capacity and effort.

8. To ensure better use of appropriate science and best practices, institutions in the region should be engaged to ensure full "ownership" of the findings and enhance the possibilities for sustaining outcomes in the future. There should be quality control by executing agencies to ensure that the people who develop the TDA have the appropriate capacity and knowledge to do the job. Stakeholder consultation, joint fact finding, and synthesis of unpublished and published information are also important. Serious efforts should be maintained to peer review the science and TDA, and stakeholders should be included in the reviewing process. An important step toward ensuring the best possible use of local science would be to establish a multidisciplinary science advisory group or committee for each project that involved key local institutions, academic and public.

9. One tool absent from most projects is targeted research. However, in some cases the preliminary TDA clearly identified large areas of uncertainty that can only be reduced through a combination of research and monitoring.

10. To implement adaptive management, GEF projects must work to bridge the gap between social and natural systems and their feedbacks; and improve involvement of the social sciences through inclusion of social science methodologies in the early design of new projects, along with development of explicit social and environmental indicators. Active participation of specialists in social and natural sciences for monitoring and development of such indicators will help bridge this gap. If adaptive management is loosely defined as "learning by doing", the learning component requires data, critical review and a forum for sharing experiences, both positive and negative. Timeframe constraints, failure of implementing agencies to value monitoring of technical results (as opposed to monitoring of the project), and failure of project design teams to think in terms of adaptive management all contribute to real or potential failure.

11. The importance of communicating the science of GEF projects should be explicitly stated, and scientific communication should be incorporated in the design of new projects. Where purchase by authors of open access to articles is permitted by scientific publishers, an effort by projects to fund this cost could make the science much more available than heretofore. In addition, information on peer-reviewed publications should be consistently uploaded to websites and published in newsletters.

12. Communication is vital to achieving stakeholder buy-in. Projects should be designed with stakeholder involvement and a conceptual model is needed that links the ecosystem to the vision. Ultimately, stakeholders need to be sure that the proposed science is, and will be continue to be, important to them.

Coastal reefs and marine life are one of the variants of vastly the 64 Large Marine Ecosystems around the world / *A. Dansie*

IW:Science

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