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Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems

Large Marine Ecosystems
Volume 17

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FOREWORD

The growing risks and impacts of climate change and the accompanying loss of ecosystem services require the world to urgently invest in a new development paradigm. Development, climate change and ecosystem sustainability issues are increasingly interlinked, requiring a rethinking of traditional development assistance in order to remain relevant to human needs.

UNDP has fully embraced the new development paradigm – a unique strategic approach for each economy - to help countries achieve development targets while meeting the needs of their citizens in the face of growing challenges of climate change.

As the UN's global development network, UNDP recognizes the increasing urgency of mainstreaming climate change into sustainable development planning at all levels, linking development policies with the financing of solutions and helping countries move towards less carbon intensive economies. During the present period of global warming, a firm scientific basis is essential to develop options for mitigation and adaptive actions.

The Large Marine Ecosystem (LME) approach recommends a baseline of information at the LME management scale on changing states of productivity, fish and fisheries, pollution and ecosystem health, and socioeconomic and governance conditions. This time-series information provides data to assess the extent of overfishing, nutrient over-enrichment, habitat loss, and progressive rates of surface water warming in LMEs around the globe. Through the GEF's Transboundary Diagnostic Analysis/Strategic Action Programme (TDA/SAP) approach, this LME data set can inform issue prioritization, strategic planning and adaptive management of LMEs towards sustainability.

This volume is a key contribution to advancing LME management in a changing climate. The authors describe the impacts of climate change on LME sustainability in Africa, Asia, and Latin America. Important information is provided on the key role the GEF has played in mobilizing financial support crucial to developing countries committed to carrying forward an ecosystem based approach to sustain LME goods and services. UNDP wishes to express its sincere thanks to the distinguished group of contributors to this volume for their leadership and commitment to sustainable human development.

Yannick Glemarec
Executive Coordinator
UNDP-GEF

INTRODUCTION

The United Nations Conference on Environment and Development (UNCED) convened in 1992 in Rio focused attention on the need for reversing decades of environmental degradation and moving the world toward sustainable development. Follow-on targets prompted by UNCED and the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg included addressing the effects of climate change on the world's coastal areas and ocean ecosystems.

One of the world's international financial institutions, the Global Environment Facility (GEF), was reorganized following UNCED, to provide financial assistance to developing countries committed to environmentally sustainable development. In addition to serving as the financial mechanism for the Biodiversity and Climate Change Conventions, the GEF committed to support efforts to protect and restore the world's most important marine and freshwater transboundary waters systems through its International Waters focal area. Since 1991, the GEF has provided $4.1 billion in grants, leveraged World Bank investments, and co-financing support for projects to recover, sustain, and develop the goods and services of Large Marine Ecosystems (LMEs) off the coasts of over 100 developing countries around the world.

On the occasion of UNCED's 20th anniversary and the 2012 Rio+20 Earth Summit, we are pleased to introduce this volume authored by marine experts engaged in carrying forward GEF supported projects. Their contributions consider the effects of climate warming on the trillions of dollars worth of both market and non-market goods and services provided by LMEs in Africa, Asia, and Latin America.

In the first chapter, Hume and Duda describe the **role of the GEF** in supporting LME projects. The authors focus on the GEF's International Waters portfolio and the distribution of financial assistance provided to over 100 countries participating in LME sustainable development projects around the globe.

The following two chapters examine the relationships among small pelagic fish species and describe how physical forcing controls the strength of upwelling in the Canary Current and the Benguela Current LMEs. Recent effects of climate change are resulting in shifts in distribution patterns of fish populations. For the **Canary Current**, Sambe assesses changes in maximum levels of sardine biomass and observes that shifts in movement of the stocks are in synchrony with wind direction, velocity, and plankton production. For the **Benguela Current**, Hampton and Willemse report on a major shift, likely due to climate change, of pelagic sardine and mackerel fisheries biomass south and eastward, from the coast of Namibia, toward the Cape of Good Hope and beyond.

The **Guinea Current**, like many LMEs, is already stressed by fisheries losses, pollution and the degradation of coastal ecosystems. As a result, project experts are striving to develop a regional management network to sustain the resources in the GCLME. Climate change is an additional stress, especially the expected degradation to coastal fishing communities from sea level rise. The authors review the present problems in the GCLME as well as the projected issues related to climate change. They also discuss mitigation actions and governance mechanisms, most notably the formation of the Guinea Current Commission, to address these threats and promote sustainable development of GCLME goods and services.

The focus of the UNDP-GEF **Agulhas and Somali Current LME** (ASCLME) project has been to acquire scientific data to support policy decisions for the benefit of the nations who rely on the goods and services of both LMEs. Climate change appears to be influencing distribution

patterns of sardine, anchovy, lobster and horse mackerel in the ASCLME. The authors review how the eddies and dipoles affecting the ASLME relate to Western Indian Ocean circulation.

Vivekanandan, Hermes, and O'Brien, reporting observations from the FAO/GEF **Bay of Bengal LME** project, describe the impact of climate warming in producing higher intensity monsoons and lowering salinity levels in the waters of the BOBLME. The resulting increase in thermal stratification could lead to a long term negative effect from lowered primary production and a subsequent decline in fisheries yields.

In the **Humboldt Current LME**, the authors Serra, Akester, Bouchon and Gutierrez focus on climate forcing and how it is changing abundance levels of two small, but extremely abundant pelagic fish species - the anchovy and sardine. The annual production of these species is equal to 20 percent of the world's recent average marine fisheries catch. The authors illustrate the complex interactions between shifting oceanographic regimes and annual levels of fisheries yields in the HCLME.

The **Gulf of Mexico LME** chapter by Mendoza-Alfaro and Alvarez-Torres outlines climate observations for the Gulf of Mexico LME within the context of an ecosystem under stress from overfishing, pollution, nutrient over enrichment, and gas and oil exploration and production. Climate change is creating more intense hurricanes in the GoMLME and this in turn has ramifications for the populations of finfish, shellfish (oysters) and crustacean (shrimp) fisheries. The authors also discuss the impact of climate change and sea level rise on habitats (mangroves, seagrasses) and human populations.

In the penultimate chapter on the **Yellow Sea LME**, Professor Qisheng Tang and Dr. Jianguang Fang review the variable states of productivity and biomass yields under the influence of climate change and anthropogenic forcing. They indicate that in response to overfishing, fishing effort in the Yellow Sea was reduced. In order to replace the loss of capture fisheries in the YSLME, the UNDP-GEF supported YSLME program initiated a pilot project using an innovative integrated multitrophic aquaculture (IMTA) approach. The IMTA technology includes the production of algae (kelp), mollusks (abalone) bivalves (bay scallop), and echinoderms (sea cucumber) to help close the fisheries protein gap, while capture fisheries recover to sustainable levels. Preliminary results suggest that the IMTA pilot should be expanded throughout the YSLME and into other Asian LMEs, where applications could provide job opportunities and food security. The pilot IMTA project proved to be highly energy efficient and optimized the carrying capacity of coastal embayments while improving water quality, increasing protein yields, and, through carbon capture, contributing to mitigation of the effects of climate change.

In the last chapter, Oliver, Widdicombe, and Laffoley outline how increasing levels of carbon dioxide from global climate warming, contribute to **acidification in LMEs**. This in turn limits the calcification process for organisms such as corals, shellfish and calcifying plankton. The authors review how continued acidification of the world's oceans will impact primary production, fisheries and overall ecosystem health. They also consider the socioeconomic effects of acidification in LMEs.

The Editors

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In October 2011, the GEF included an LME climate change workshop during the 6th GEF Biennial International Waters Conference in Dubrovnik, Croatia. In recognition of the excellent quality of the papers presented, a select number of presenters were invited to submit manuscripts for peer review and publication consideration. We are indebted to the authors who patiently, and with considerable diligence and insight, contributed extended analyses first elaborated in Dubrovnik, and now included in this volume. Their names and affiliations are listed on pages vi-ix. We acknowledge the chairpersons of the workshop – Marie Christine Aquarone and Galen McGovern of NOAA for their expert summary of the workshop and archiving of the Power Point materials.

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The Editors