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Assessment and monitoring of climatic change impacts on mangrove ecosystems

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PREFACE

The closely-related issues of greenhouse emissions, global warming and climate change have recently come to the top of the international environmental agenda. In particular, concerns over the problems expected to be associated with the potential impacts of climate change have grown over the past decade and captured the attention of the scientific community, the politicians, decision makers, as well as the private and public sectors. These problems may prove to be among the major environmental problems facing the marine environment and adjacent coastal areas in the near future. Therefore, and in line with Decision 14/20 of the Governing Council on "Global Climate Change", the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of the United Nations Environment Programme (UNEP) launched and supported a number of activities designed to assess the potential impact of climate change and to assist the Governments concerned in identification and implementation of suitable response measures which may mitigate the negative consequences of the impact.

Since 1987 to date, Task Teams on Implications of Climate Change were established for eleven regions covered by the Regional Seas programme: Mediterranean, Wider Caribbean, South Pacific, East Asian Seas, South Asian Seas, South-East Pacific, Eastern Africa, West and Central Africa, the Kuwait Action Plan region, the Red Sea and Gulf of Aden and the Black Sea. Some of these Regional Task Teams enjoy the support of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and other relevant international, regional and non-governmental organizations. In addition, two Global Task Teams on Expected Impacts of Climate Change on Coral Reefs and on Mangroves were established in cooperation with IOC and UNESCO respectively.

The initial objective of these Task Teams was to prepare regional and global overviews and site-specific case studies on the possible impact of predicted climate change on the ecological systems, as well as on the socio-economic activities and structures, based on the climate change models/scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) and widely accepted by the international scientific community.

These overviews are expected to examine at the regional and global levels the possible effects of the sea-level rise and temperature elevations on the coastal, terrestrial and aquatic ecosystems including deltas, estuaries, wetlands, coastal plains, coral reefs, mangroves, lagoons, etc., and to examine the possible effects of climatic, physiographic and ecological changes on the socio-economic structures and activities, and determine the areas or systems which appear to be most vulnerable to the above effects.

The global overviews were intended to account for the above effects on both the coral reefs and mangroves as important, critical and vulnerable ecosystems.

Following the completion of these regional overviews, and based on their findings, site-specific case studies are developed by the Task Teams for areas identified as most vulnerable and needing urgent attention. The results of these case studies should provide expert advice to the national authorities concerned in defining specific policy options and suitable response measures for the protection and sustainable development of these ecosystems.

The work of the Task Team on Mangroves, organized and supported by UNESCO, was completed in 1993 and was led by Prof. Colin Field, who acted as Coordinator of the Task Team. The present report is largely based on the contributions by the individual members of the Task Team, whose cooperation with the Task Team Coordinator is hereby acknowledged and appreciated (see Foreword).

FOREWORD

In November 1991, COMAR (of UNESCO) invited a panel of 16 experts, on behalf of UNEP/UNESCO, to a preparatory task team meeting to consider "the Impact of Expected Climate Changes on Mangroves", in Bangkok, Thailand. The report of the meeting was published by UNESCO (1992a). Subsequent to this meeting, COMAR created a 14-member UNEP/UNESCO Task Team on the "Impact of Expected Climate Change on Mangroves". UNEP, IOC, and WMO had separately recognized the need to focus studies on mangrove ecosystems related to climate change (IOC, 1991).

The first meeting of the UNEP/UNESCO Task Team was held in Rio de Janeiro 1-3 June 1992, and the results were published by UNEP/UNESCO (1992b). The primary role of the Task Team is to advise on the design, development, and organization of the proposed global monitoring of the effect of climate change on mangroves. The Task Team agreed to undertake three initiatives to support its primary objective. These were:

a) to carry out a review of the literature and to prepare an overview of some aspects of expected global change on mangrove ecosystems and the probable affects on the exploitation of the system, with the aim of identifying policy options and suitable response measures.

b) to prepare three specific case studies involving low island, arid coast and deltaic sites. It was considered that these sites would provide a representative range of mangrove habitats and would provide experience of experimental design, data collection and analysis, that would be invaluable for the successful establishment of a long-term mangrove monitoring system.

c) to prepare a position paper on the theoretical and technical basis for data acquisition, experimental design and the analysis of data, including possible modelling approaches, that could be used for the development of the specific case studies and the long-term monitoring programme concerned with mangrove ecosystems.

It became clear after some initial consideration of the tasks that had to be undertaken that the most coherent approach would be to combine the outcome of initiative (1) and initiative (3) and to present the findings as a consolidated report. An initial draft of the report was prepared by a sub-group of the Task Team, consisting of Björn Kjerfve (Convenor), Donald Macintosh, Barry Clough and Sanga Sabhasri, at a preliminary meeting in Phuket, Thailand.

A Meeting of the Task Team in Okinawa, Japan in July 1993, considered the initial draft report and recommended that it be expanded by the addition of further contributions from members of the Task Team. The final report contains a review of the relevant literature, some policy options and the recommended criteria for selecting mangrove monitoring and study sites. The Task Team also recommended that the report be published by UNEP

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Climate Change on Mangroves

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. EXECUTIVE SUMMARY

As mangroves are one of the most prominent coastal ecosystems in tropical and many subtropical areas around the world, it is likely that the impact by climate change on mangroves will have greater economic and social significance, when compared to the effect of climate change on most other coastal ecosystems. Mangrove ecosystems consist largely of trees with life spans of the order of several decades, so that long-term climate change may be gauged by structural and functional responses of mangrove communities. Other tropical and subtropical coastal ecosystems, such as salt marshes and seagrass beds, exhibit more pronounced short-term variability because of seasonal and interannual fluctuations, and turn over too quickly to be useful for gauging climatic change.

The uncertainty and variability of climate change is still much debated and far from universally accepted. The purpose of this report is not to argue whether global climatic change is occurring, but rather to assess the expected type and magnitude of impacts on mangrove ecosystems, if and when global climate change does occur. Coastal ecosystems, including mangroves, are especially vulnerable because of economic and social pressures in addition to their location at land-sea margins.

Mangrove ecosystems cover approximately 15 million hectares globally, with 6.9 million hectares in the Indo-Pacific Region, 4.1 million hectares in South and Central America and the Caribbean, and 3.5 million hectares in Africa. The important communities of plants, animals, and microbes found in mangrove ecosystems are described in the report.

Throughout the world, mangroves have considerable environmental and ecological values as well as providing significant socio-economic benefits to national and local economies and local communities. Mangrove ecosystems, because of their location, are expected to be amongst the first ecosystems to be affected by any global climatic change, in particular from the effects of increasing sea level and changes in wind, wave, current, and storm patterns.

The Intergovernmental Panel on Climate Change (IPCC) scenarios for climate change have been used here as the basis for projecting future trends regarding climate change on mangrove ecosystems and they are presented in Table 4 of the report.

Major responses by mangrove ecosystems to predicted climate changes are estimated as follows:

a) Rise in global mean sea level

It is estimated that the global mean sea level will rise by 6.0 cm per decade as a result of global warming