

1. INTRODUCTION

The crisis facing coral reefs was only fully recognised during the last two decades. Gradual and chronic stresses have resulted in major losses of coral reefs in areas surrounding large human populations, but the pace of change was slow. Over-fishing and destructive fishing, pollution with nutrients and sediments, coral diseases, mining of coral rock and sand, and coastal developments that modified the reefs were the predominant chronic stresses damaging coral reefs around the world. However, global climate change is now a major threat to the long-term future of the world's coral reefs.

The major El Niño/La Niña Southern Oscillation (ENSO) cycle in 1997-98 resulted in massive losses of corals in the Indian Ocean and the Western Pacific. It was estimated that 16% of the world's coral reefs were effectively destroyed in about 10 months when sea surface temperatures increased considerably and killed corals in many areas, including those remote from damaging human activities.

Then 2005 was the hottest year in the world's recorded history, causing a major bleaching event in the Caribbean without a concurrent El Niño. This year surpassed 1998 and the other 8 hottest years during the past 15 years and further confirms a pattern of global climate change. This report documents the effects of raised temperatures in causing coral bleaching and mortality in the wider Caribbean in 2005 and whether the stressed corals recovered. The report also examines the effects of severe category 4 and 5 hurricanes during 2005 that also damaged coral reefs and other coastal ecosystems. Fortuitously, several of these hurricanes actually protected some reefs by cooling the waters that were causing heat stress. The damage that occurred to reefs in the Caribbean, however, has followed centuries of reef degradation from human activities.

Assessment of climate change effects on marine ecosystems requires a focus on physical observations as well as examining the organisms in the ecosystem. The National Oceanic and Atmospheric Administration (NOAA) of USA is mandated to understand the environment and ecosystem within a changing climate, and use this understanding to improve conservation and management of living marine resources and ecosystems. Thus, NOAA provides products to alert users of the potential for coral bleaching events around the world through satellite and *in situ* observations, forecasts and warning systems. NOAA also works with local and regional managers to quantify the effects of increasing seawater temperatures on coral reefs, and determine ways local managers can mitigate climate change impacts. A partnership was formed with the Great Barrier Reef Marine Park Authority of Australia, the U.S. Environmental Protection Agency, and the IUCN (The World Conservation Union) to produce 'A Reef Manager's Guide to Coral Bleaching', featured in Chapter 10. NOAA and the Department of Interior led an interagency

effort to respond to and assess the 2005 massive coral bleaching event in the Caribbean under the aegis of the U.S. Coral Reef Task Force. The effort also involved many government and NGO agencies, including local partners in Florida, Puerto Rico, the U.S. Virgin Islands, and Caribbean island nations, to assess the impacts of the 2005 mass bleaching event and make recommendations on how to prepare for and address future events.

The marine life and people in the Caribbean depend on healthy coral reef ecosystems and the services they provide, especially for tourism, fishing and coastal protection. The unprecedented and region-wide bleaching event of 2005 has, and will continue to have, far-reaching ecological and major economic implications for the region. UNEP, via the UNEP Coral Reef Unit, assists partners such as the GCRMN in collecting, assessing and disseminating comprehensive and reliable data to decision makers on the status of coral reefs. The Caribbean Environment Programme (CEP) of UNEP provides the Secretariat to the Cartagena Convention on the protection and development of the marine environment in the Wider Caribbean. UNEP CEP works closely with its 36 member governments and other stakeholders to create, harmonize and implement policies, regional cooperation and meaningful actions towards the conservation and sustainable use of coastal and marine resources in the Caribbean, including coral reefs. Local and regional activities are implemented on integrated coastal area management, strengthening of Marine Protected Areas, coral reef monitoring, control of land-based pollution, and promotion of better-practices for fishers and sustainable tourism. UNEP CEP and the Coral Reef Unit acts as the link for these countries into the GCRMN, to assist them in responding to the impacts affecting coral reefs, such as those caused by the 2005 bleaching event.

Since 2006, IUCN has hosted the Marine Working Group on Climate Change and Coral Reefs (CCCR), a widely representative collaborative initiative established with support from the MacArthur Foundation. CCCR provides a mechanism to focus scientific contributions from leading research groups, and synthesize the relevance of resilience to coral reefs and climate change. It seeks to bridge gaps between theoretical science and management application in order to fast-track the development and use of tools to improve the protection of coral reefs under the threat of climate change and interacting or synergistic human threats. IUCN also works extensively with members and partners on developing and applying better practices for ecological adaptation management, including incorporation of best practice climate change resilience principles into the design and management of regional Marine Protected Area networks and capacity building.

WWF is a global conservation organisation that views climate change as a significant threat to coastal ecosystems and livelihoods, and is working to develop adaptation strategies to build ecosystem resilience and improve the ability to cope with a changing climate. Within the Mesoamerican Reef Ecoregion, WWF and partners are working to reduce direct human threats to reefs (e.g. collaborating with agroindustries and local farmers to reduce agrochemical use and working with fishermen on sustainable fishing practices) while concomitantly implementing critical steps towards building reef resilience. Through collaboration with partners, WWF assessed the Mesoamerican Reef System in 2006 to ascertain overall reef status and promote protection of bleaching resilient and resistant reefs. WWF is also working on strategies to build social networks for adaptation, including: improved communication, awareness and public outreach; climate witnesses (for local and international outreach); training and capacity building for WWF staff and local counterparts; and climate change policy recommendations (e.g. Government of Belize adaptation strategy) based on local consultation.

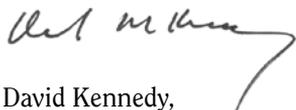
The Intergovernmental Oceanographic Commission (IOC) of UNESCO provides an intergovernmental forum to catalyze and coordinate research on coral reef ecosystems. The IOC sponsors international science required to answer management questions: the causes of coral reef degradation; the global status of coral reef health; the predictions of impacts (both ecological and socioeconomic); and actions to minimize impacts or adapt to changes. The network of 136 Member States is used to communicate the results of these programs to stimulate coordinated action at local, national, and global levels. The IOC sponsors: the Coral Bleaching Working Group of the GEF / World Bank Coral Reef Targeted Research and Capacity Building Project; the Ocean in a High CO₂ World symposium series (assessing current knowledge on ocean acidification impacts on marine ecosystems); the Global Coral Reef Monitoring Network; and has worked recently with UNEP and the Census of Marine Life to report on the vulnerability of deep-sea corals to fishing on seamounts beyond areas of national jurisdiction. They also work with other programs within UNESCO dealing with coral reef issues, such as the Coasts and Small Islands Program and the World Heritage Center's Marine Program.

The emergence of climate change was recognised as an over-arching threat to tropical marine ecosystems at the 3rd International Tropical Marine Ecosystem Management Symposium (ITMEMS) in Mexico, 2006. This meeting was coordinated by the International Coral Reef Action Network (ICRAN) to facilitate discussion and information sharing on coral reef resilience and management, and particularly to communicate climate related challenges for managers (the ICRI statement on climate change is discussed in Chapter 10). ICRAN encourages natural resource management to increase the resilience of coral reef ecosystems through effective implementation of marine managed areas, and the promotion of networks of managed areas. ICRAN is partnering with the World Resources Institute on a global analysis of threats to reefs, including vulnerability of coral reefs and associated communities to bleaching, and the economic impacts of reef degradation.

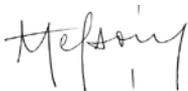
Conservation of coral reefs in the face of increasing global warming will require that all relevant people are informed and encouraged to take remedial action. This is why volunteer and community based organisations like Reef Check and the PADI Foundation are critical to successful action. Reef Check has been working with the GCRMN to monitor coral reefs using a standard method since 1997 and now has teams in over 90 countries. The goals include tracking the impacts of climate change as well as to conserve remaining coral reefs. This important report documents the serious impacts of the 2005 bleaching event in the Caribbean and includes data collected by Reef Check teams in collaboration with NOAA. These data reveal interesting differences in the effects of a major bleaching event on reefs in the Caribbean compared with the Indo-Pacific and provide hope that some reefs may be more resistant than others to temperature stress.

This book collates considerable data and information gathered by NOAA staff, and other coral reef researchers and managers in the Caribbean. These reports will help clarify our understanding of how global climate change is affecting coral reefs and other tropical coastal ecosystems. The final chapter in this book draws on climate change models to attempt predictions in the short to medium-term for the wider Caribbean. This report also illustrates the importance of supporting the GCRMN and partners in monitoring reefs and preparing plans for a warmer world.

We represent organisations that are working towards the sustainable use and conservation of coral reefs around the world, and request that governments, organizations and people actively participate in the International Year of the Reef in 2008 to promote education, research and public awareness about the value of coral reefs and threats to their health. We, and the thousands of people we represent, call on all people to acknowledge that global climate change represents a serious and increasing threat to the integrity of the coral reefs of the world, and seek mechanisms to ameliorate the effects and reduce future impacts. Thus, we are pleased to endorse the GCRMN report 'Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005.'



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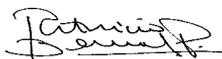
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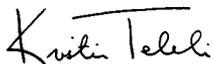
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