REGIONAL STATE OF THE CORAL TRIANGLE

Coral Triangle Marine Resources: Their Status, Economies, and Management

ADB

CORAL TRIANGLE INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

gef

REGIONAL STATE OF THE CORAL TRIANGLE

Coral Triangle Marine Resources:
Their Status, Economies, and Management

CORAL TRIANGLE
INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

Printed in the Philippines.

ISBN 978-92-9254-528-4 (Print), 978-92-9254-529-1 (PDF)
Publication Stock No. RPT146478-3

Cataloging-in-Publication Data

Asian Development Bank.
Regional state of the Coral Triangle—Coral Triangle marine resources: Their status, economies, and management.
Mandaluyong City, Philippines: Asian Development Bank, 2014.

1. Marine resources. 2. Marine environment. 3. Coral Triangle. 4. Indonesia.
5. Malaysia. 6. Papua New Guinea. 7. Philippines. 8. Solomon Islands.
9. Timor-Leste. I. Asian Development Bank.

Note:
In this publication, "$" refers to US dollars, unless otherwise stated.

Photo credit
Front cover: ADB photo library
Back cover: Oscar Dennis Espenilla

6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
Tel +63 2 632 4444
Fax +63 2 636 2444
www.adb.org

For orders, please contact:
Public Information Center
Fax +63 2 636 2584
adbpub@adb.org

Printed on recycled paper

Contents

Tables and Figures

Tables

Figures

Foreword

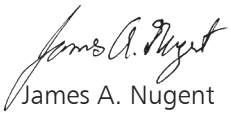
The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (referred to in this report as Coral Triangle Initiative [CTI]) is a partnership of six countries that are collectively home to the most extensive marine biodiversity on earth. While these countries are at varying stages of economic development, all six confront domestic pressures that include population growth, poverty, urbanization, and food insecurity. The latter relates to another characteristic that all six countries share—dependence on fish as a source of dietary protein.

A somewhat positive outcome in this regard is the increase in the size of the fish catch that all six countries have enjoyed over time. That said, the results of several studies indicate that all six countries are perilously close to exceeding the carrying capacity of their demersal and pelagic fisheries. This is reflected in the degree of loss of coral cover in their coral reef ecosystems, which has in turn resulted from numerous factors ranging from use of destructive fishing practices to the negative environmental impacts of economic development in general.

Through its first major CTI technical assistance—Regional Cooperation on Knowledge Management, Policy and Institutional Support to the CTI—the Asian Development Bank (ADB) enabled preparation of this Regional State of the Coral Triangle (RSCT) report. By consolidating and analyzing the data and information contained in the six corresponding country-level State of the Coral Triangle reports, the RSCT report identified the key issues that decision makers must address if sustainable development of the Coral Triangle's coastal and marine resources is to be achieved. Further, the RSCT report summarizes each country's biophysical and socioeconomic characteristics, as well as their institutional framework for governing marine resource use. This in turn helped identify the drivers of the environmental pressures that threaten sustainable development of the Coral Triangle's marine resources. Finally, the RSCT report helped formulate a monitoring and evaluation system for gauging the success of the six CTI member countries in achieving sustainable marine resource management, both individually and collectively.

From a broader perspective, the RSCT report achieved all of the above by fulfilling the three functions of knowledge management—to capture, share, and utilize knowledge. Beyond its thematic limits, the approach taken in preparing the RSCT report can be replicated in other ADB-supported regional cooperation initiatives in line with ADB's overall knowledge management strategy. Often referred to as Finance++, this strategy combines ADB's financial resources and expertise in disseminating knowledge to developing member countries in a manner that maximizes the effectiveness of development aid, thereby accelerating economic development.

ADB remains committed to achieving sustainable development of the Coral Triangle's coastal and marine resources in the long term, beginning with the preparation and publication of this RSCT report. This is true in applying the knowledge generated by the report and the mechanism that the report has helped design to evaluate each Coral Triangle country's progress in addressing the environmental threats that compromise their ability to alleviate poverty.



James A. Nugent
Director General
Southeast Asia Department
Asian Development Bank

Xianbin Yao
Director General
Pacific Department
Asian Development Bank

Acknowledgments

This report benefited from the comments made by the country teams from the six Coral Triangle countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. The preparation of the report further benefited from two regional workshops organized under the Asian Development Bank (ADB) technical assistance—Regional Cooperation on Knowledge Management, Policy, and Institutional Support to the Coral Triangle Initiative—and support from the Government of the United States (US) through the Coral Triangle Support Partnership.

Three external reviewers provided valuable comments and inputs: Angel Alcala (Silliman University Angelo King Center for Research and Environmental Management, Dumaguete City, Philippines); Terry Hughes (Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Australia); and Alan White (The Nature Conservancy, Honolulu, Hawaii, US).

ADB project officers, Pavit Ramachandran, senior environment specialist, Southeast Asia Department; and Marilou Drilon, senior natural resources economist, Pacific Department, provided technical direction and supervision.

Executive Summary

The Regional State of the Coral Triangle (RSCT) provides benchmarks on the biophysical, governance, and socioeconomic attributes of the six Coral Triangle countries, also known as CT6—Indonesia, Malaysia, Papua New Guinea (PNG), the Philippines, Solomon Islands, and Timor-Leste—and the threats, vulnerabilities, and emerging issues in each country and in the CT6 as a collective unit. Using the Driver–Pressure–State–Impact–Response (DPSIR) framework, this report explains the linkages among the higher-level outcomes; and the goals, targets, and actions, which constitute the regional plan of action (RPOA) and the national plan of action (NPOA) of the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI).

Specifically, this report summarizes the status of the biophysical, governance, and socioeconomic attributes of CT6; and highlights the unique social and ecological features of the Coral Triangle, which show the great value of coral reefs and associated habitats. This report further

- establishes a framework for tracking progress of the CTI toward goals set out in the RPOA;
- identifies the information gaps and establishes the status of the coral reefs and associated habitats, fisheries, and food security;
- discusses the relationships of the ecological and social conditions of the CT6 countries; the threats they face; and their corresponding responses to the national, seascape, and regional challenges and opportunities; and
- initiates the linkages between the NPOAs and the RPOA with respect to the desired sustainable development outcomes of (i) conserving the Coral Triangle coral reefs and associated ecosystem functions, goods, and services; (ii) establishing sustainable fisheries; and (iii) improving food security.

The CTI aims to achieve five goals in the RPOA: (i) priority seascapes are designated and effectively managed, (ii) an ecosystem approach to management of fisheries (EAFM) and other marine resources is fully applied, (iii) marine protected areas (MPAs) are established and effectively managed, (iv) climate change adapatation measures are achieved, and (v) the status of threatened species is improving.

Similar to the country State of the Coral Triangle (SCT) report, the regional report is a "living document" that will have to be updated over time as the countries jointly address the various issues confronting them individually and as a group. This first edition of the RSCT report provides baseline data and information for monitoring the countries' progress in achieving the goals and higher-level outcomes of the CTI.

This RSCT report also highlights the CTI's interrelational framework, specifically the state and pressures and the broader context of drivers. This report further discusses how the RPOA is linked to the desired higher-level outcomes of coral reefs, fisheries, and food security (CFF). While the CTI RPOA envisions the attainment of five goals by 2020, the longer-term vision for the CTI are the following: (i) stabilize and/or maintain coral reef ecosystem integrity and services; (ii) improve and sustain fish stocks; and (iii) improve the affordability, availability, quality, and safety of food coming from coastal and marine environments.

The status of coral reefs and associated ecosystems, fisheries, and food security in the Coral Triangle was inferred from data and information presented in the six country SCT reports; and supplemented with information from literature, both published and unpublished.

Overall, coral cover in the CT6 countries had been on a declining trend since the 1980s to the mid-2000s. In the entire Indo–Pacific region, coral cover was recorded from 42.5% during the early 1980s to 22.1% by 2003. In the Philippines, coral cover had declined since the 1980s, while East Indonesia and PNG had stable coral cover from 1984 to 2004. This was the same trend observed in coral cover in the CT6 countries in Southeast Asia and in the Pacific until the late 1990s. The coral reefs in Indonesia, Malaysia and Solomon Islands were in relatively better condition than in the Philippines. PNG and Timor-Leste lack data to evaluate the status of their coral reefs at the national level.

Reef fish biomass values are often not estimated in many parts of the CT6 countries and vary greatly across the CT6. In the Philippines, more than 50% of sites surveyed from 1991 to 2004 showed reef fish biomass of less than 10 tons per square kilometer (t/km^2). Unrestricted areas in PNG had an average reef fish biomass of 12.7 t/km^2, and several reef areas in Solomon Islands reported fish biomass greater than 100 t/km^2.

The extent and status of mangroves and seagrasses at the national level are not fully known for most of the CT6 countries. Research related to these ecosystems has not kept pace with the knowledge and information required to ensure the sustainability of the coral reefs.

Despite the declining health of the reefs, their value remains high. Overall annual net benefits, including tourism and other ecosystem services, are estimated to be no less than $12 billion. Over 120 million people are dependent on ecosystem functions, goods, and services; and their combined contribution to the gross domestic product amounts to $1.2 trillion, with capture fisheries valued at $9.9 billion, representing 10.5% of the global market.

Major drivers common across the Coral Triangle CFF were identified during a regional workshop attended by government officials from each of the CT6 countries: (i) population growth, (ii) cultural challenges, (iii) education, (iv) coastal development, (v) poverty and governance, (vi) demand for fish, and (vii) climate change.

All the country SCT reports identified overfishing and destructive fishing as primary threats to coral reefs. Other major stressors are excessive nutrient inputs and pollution, land and coastal development, and exploitation of threatened species. Consistent with the regional and country SCT reports, *Reefs at Risk in the Coral Triangle* identified overfishing and destructive fishing as the primary threats to coral reefs in the region, followed by watershed-based pollution, coastal development, and marine-based pollution and damage.

The country SCT reports focused mainly on institutional support to the CTI; thus, policies endorsing the CTI and the structure for its implementation are highlighted in the reports such as the composition of the national coordinating committees. Much of the efforts in the CT6 countries appear to be focused on Goal 3, followed by Goal 2. In Indonesia, PNG, and the Philippines, at least two-thirds of their efforts, as articulated in their NPOAs, deal with these two goals. The NPOAs of Malaysia and Timor-Leste also provide for considerable investments in EAFM. Timor-Leste considers Goals 3 and 4 as among its top priorities.

A CTI Index was developed and piloted during the RSCT report and CTI Monitoring and Evaluation Working Group (MEWG) meetings in Jakarta in October 2012. The CTI Index indicates the extent of accomplishment of the five CTI goals without making connection to the higher-level outcomes. The scores for CFF activities in the CT6 countries and in the region averaged 42%.

Nine priority actions agreed upon by the CT6 countries best gauge their progress. Based on the presentations at the Senior Officials Meeting (SOM) in October 2011, the actions were categorized as (i) completed, (ii) in progress, and (iii) not started. An action was deemed completed at the level of the technical working group (TWG) but may or may not indicate a formal endorsement at the SOM. Updates on the status of regional actions were culled from the reports of the TWGs and new reports. All but two of the nine actions had either been started or completed, with the Region-Wide Early Action Plan for Climate Change Adaptation and the Coral Triangle Marine Protected Area System (CTMPAS) framework already completed. Two actions that pertain to Goal 5 had not been initiated.

Many gaps remain in knowledge and information crucial to the strengthening and capacity building of the CTI—processes, systems, and standards are not yet in place for the higher-level outcome indicators. However, opportunities exist for the missing information to be collected by consolidating the monitoring programs of different groups or organizations, and developing protocols to synthesize available fragments of information to arrive at national estimates. The RSCT report allows better transparency for countries to track the progress of their activities (e.g., through the CTI Index). Ways to link these activities had been proposed in the CT6 NPOAs and CTI RPOA, and desired outcomes had been elicited from the DPSIR approach. It is, therefore, suggested that the RSCT be updated on a 3-year basis, as an integral task of the CTI MEWG.

In the next phase of the CTI, 5 major thematic thrusts and 13 action areas are proposed for consideration by the CT6, the Regional Secretariat, and the development partners.

1. Achieve synergies at different governance scales to earn the value-added benefits of overcoming transactional costs (e.g., improving seascapes and operational functions of the CTI as a result of cooperation and complementation)
   (i) Coordinate actions through improved processes, systems, and standards, such as awards and incentive systems for best practices across MPAs and MPA networks and social enterprises;
   (ii) Ensure that benefits from institutional coordination are plowed back to managing ecosystems and their uses through sharing agreements; and
   (iii) Monitor the costs and benefits of cooperative governance to gauge impacts on human and ecological systems; and provide timely response feedback systems, including enabling conditions for social enterprise development.

2. Invest in capacity building and knowledge management to overcome the lack of governance capabilities in CTI systems, processes, and standards (e.g., CTMPAS and EAFM)
   (i) Build the resiliency and capacity of local, national, and regional bodies in planning and implementing the CTI NPOAs/RPOA (e.g., incentives through conditional grants linked to incentives-based progress of capabilities and performance);
   (ii) Understand and apply science-based learning through adaptive research and development learning networks (e.g., Coral Triangle Center, Coral Triangle Initiative–Coastal Learning Adaptation Network); and
   (iii) Organize monitoring and feedback-sharing forums for the regular updating of the country and regional SCT reports at least every 3 years.
3. Exchange resources and engage and empower equitable partnerships
   (i) Establish a Coral Triangle regional investment fund that will rationalize financial and economic support for the CTI; and develop mechanisms that will ensure the sustainability of the CTI, including public–private partnerships; and
   (ii) Improve access of vulnerable coastal communities to available food resources and social enterprise development.
4. Commit to the harmonization of fisheries production targets with biodiversity conservation and food security needs
   (i) Complete red list and critical habitat assessments; and harmonize these at local networks and seascapes, integrating EAFM and CTMPAS (e.g., Sulu–Sulawesi Marine Ecoregion [SSME] and Bismarck–Solomon Seas Marine Ecoregion);
   (ii) Establish safety nets and diversify livelihoods that promote fisher stewardship, such as through conditional cash transfer programs; and
   (iii) Ensure that international and local agreements consider traditional ecological knowledge and wisdom and customary marine tenure through knowledge management and sharing forums linked to regional organizations.
5. Reduce risks and threats through integration of the Local Early Adaptation Plan and the Region-Wide Early Action Plan
   (i) Form regional climate adaptation and disaster risk reduction response programs (e.g., CTI climate research and development sharing exchanges with other regional forums); and
   (ii) Mitigate and minimize threat–transfer effects, such as from illegal, unreported, and unregulated fishing; and transmigration through joint enforcement agreements, such as the SSME learning shared on a Coral Triangle region-wide scale.

These action areas will considered by the CT6 individually as well as collectively by the various technical working groups that are involved in the preparation of the detailed regional action plans. The national action plans and technical working groups will assign responsibilities and budgets.

The establishment of the CTI Regional Secretariat is estimated to cost $3.5 million, and efforts toward attaining the five CTI goals would require $4.9 million. Although these figures seem huge, the total of $8.4 million is less than 1% of the capture fisheries value of the CT6 countries, which was estimated at $9.9 billion in 2007.

Continuing to invest in the CTI is a worthwhile endeavor; and regional cooperation and coordination among the CT6 countries are essential for attaining CTI goals and desired higher-level outcomes.

Abbreviations

ADB	–	Asian Development Bank
BSSME	–	Bismarck–Solomon Seas Marine Ecoregion
CT6	–	six countries of the Coral Triangle (Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste)
CCA	–	climate change adaptation
CCT	–	conditional cash transfer
CFF	–	coral reefs, fisheries, and food security
COASTFISH	–	Sustainable Coastal Fisheries and Poverty Reduction Initiative
CTI	–	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (also referred to as Coral Triangle Initiative)
CTMPAS	–	Coral Triangle Marine Protected Area System
CT-SEA	–	Coral Triangle-Southeast Asia
DPSIR	–	Driver–Pressure–State–Impact–Response
EAFM	–	ecosystem approach to fisheries management
FAD	–	fish aggregating device
FAO	–	Food and Agriculture Organization of the United Nations
FMA	–	fisheries management area
GDP	–	gross domestic product
GHI	–	global hunger index
ha	–	hectare
HDI	–	human development index
INFOFISH	–	Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia–Pacific Region
IOSEA	–	Indian Ocean–Southeast Asia
IUU	–	illegal, unreported, and unregulated
k^2	–	square kilometer
kg	–	kilogram
km	–	kilometer
LEAP	–	local early adaptation plan
LRFFT	–	live reef food fish trade
M&E	–	monitoring and evaluation
MEWG	–	Monitoring and Evaluation Working Group
MOU	–	memorandum of understanding
MPA	–	marine protected area
NEI	–	not elsewhere included
NGO	–	nongovernment organization
NPOA	–	national plan of action

PNG	–	Papua New Guinea
REAP	–	region-wide early action plan
RETA	–	regional technical assistance
RPOA	–	regional plan of action
RSCT	–	Regional State of the Coral Triangle
SCT	–	State of the Coral Triangle
SOM	–	Senior Officials Meeting
SPC	–	Secretariat of the Pacific Community
SSME	–	Sulu–Sulawesi Marine Ecoregion
t/km^2	–	ton per square kilometer
TWG	–	technical working group
TEKW	–	traditional ecological knowledge and wisdom

Overview

The Coral Triangle includes some or all of the land and seas of six countries, comprising Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste—collectively known as CT6. The region has exceptionally high marine biodiversity, harboring 76% of the 798 known coral species (Veron 2000) and 37% of the 6,000 worldwide coral reef fish species (Allen 2008). While the Coral Triangle occupies only about 1.6% of the world's oceans, it covers the largest single coral reef extent of nearly 73,000 square kilometers (km^2) or 29% of the global coral reef area (Burke et al. 2012). Such high diversity and extensive habitat cover and its associated ecosystems help sustain the lives and livelihoods of an estimated 120 million people (Table 1). Fish remains a significant source of food, contributing 14%–19% of dietary protein although there are considerable deficiencies in some countries (FAO 2010).

Table 1 **Population Statistics of CT6 Countries**

Key Features	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste	Total
Population (2009)[a]	231,370,000	27,900,000	6,348,000	92,226,600	515,870	1,039,936	359,400,406
Mean annual population growth rate (%)[b] (2007–2011)	1.4	1.8	2.8	1.8	2.3	2.4	1.7
Land area (km^2)[c]	1,900,000	329,847	460,000	300,000	28,000	14,874	3,032,721
Population density (people/land area [km^2]), (2009)	122	85	14	307	18	70	119
Population living within 10 km of the coastline[d]	64,783,600	8,928,000	1,460,040	43,346,502	433,331	551,166	119,502,639
Percentage of population living within 10 km of the coastline (%)[d]	28	32	23	47	84	53	33

km = kilometer, km^2 = square kilometer.

Sources:

[a] Asian Development Bank (ADB). 2011. *Key Indicators for Asia and the Pacific 2011*. Manila.

[b] ADB. 2012. *Key Indicators for Asia and the Pacific 2012*. Manila.

[c] Country State of the Coral Triangle reports.

[d] Center for International Earth Science Information Network (CIESIN). 2007. CIESIN. National Aggregates of Geospatial Data: Population, Landscape and Climate Estimates, v.2 (PLACE II), Palisades, NY: CIESIN, Columbia University.

In addition to global stressors, significant local and regional anthropogenic pressures have been degrading the coral reefs and associated habitats in the Coral Triangle region. Leaders of the CT6 countries have agreed to work together to safeguard and conserve the ecological function of the coastal and marine environment within the region to ensure the income, livelihood, and food security of their people. In 2009, national and regional plans of action were developed as bases for regional cooperation to implement the five goals of the Coral Triangle Initiative (CTI), as follows:

Goal 1: Priority seascapes designated and effectively managed

Goal 2: Ecosystem approach to management of fisheries and other marine resources fully applied

Goal 3: Marine protected areas established and effectively managed

Goal 4: Climate change adaptation measures achieved

Goal 5: Threatened species status improving

Objectives of the Report

The Regional State of the Coral Triangle (RSCT) report aims to

(i) describe the baseline status of the Coral Triangle region based on the biophysical, governance, and socioeconomic attributes of the CT6 countries; and the threats, vulnerabilities, and emerging issues faced by each country;
(ii) establish a framework for tracking progress made by the CTI to attain the goals set out in the regional plan of action (RPOA);
(iii) identify information gaps and establish the status of the coral reefs and associated habitats, fisheries, and food security;
(iv) discuss the relationships of the ecological and social condition of the CT6 countries; the threats; and their corresponding responses to the national, seascape, and regional challenges and opportunities; and
(v) initiate the linkage actions of the national plan of action (NPOA) and/or RPOA as they are linked to the desired sustainable development outcomes of conserving the Coral Triangle coral reefs and associated ecosystem functions, goods, and services; establishing sustainable fisheries; and improving food security.

The country and regional State of the Coral Triangle (SCT) reports have been recognized by the countries and by the Regional Secretariat as valuable source documents contributing to the monitoring and evaluation (M&E) process. At the back-to-back Monitoring and Evaluation Working Group (MEWG) meeting and RSCT workshop held in Jakarta, Indonesia, on 24 October 2012, an agreement on the articulation of the three higher-level outcomes was reached, with the CTI Interim Regional Secretariat committing to update the RSCT report every 3 years. However, the CTI M&E system still needs further work by the technical working group to be fully endorsed at the Senior Officials Meeting. Thus, the connection between the five CTI goals and higher-level outcomes cannot be explicitly made at this point; and the progress toward attaining the five CTI goals is indicative, based on the CTI Index that was piloted through the RSCT report process.

Scope and Limitations

The RSCT report was conceived to consolidate the status reports of the CT6 countries and provide a regional perspective. Other information contained in available regional reports (Hoegh-Guldberg et al. 2009, Foale et al. 2012, Burke et al. 2012) and publications were used to enrich the insights in the six country SCT reports, and to determine knowledge and capacity gaps in the region (Cabral et al. 2012, 2013). These allowed the identification of priority areas, which could provide value-adding contributions for the next steps, such as knowledge management governance-enabling mechanisms that will enhance the effectiveness of the CTI's M&E process.

The RSCT report was developed based on the Driver–Pressure–State–Impact–Response (DPSIR) framework, which includes the important concerns on poverty alleviation, governance structure reforms, and sustainable development in the CTI. (Specific actions in the countries were not discussed as those are beyond the scope of the report.) The report also recommended the next steps that could assist in linking the outputs to the desired outcomes; or beneficial impacts of stabilizing coral reef ecosystem goods and services, as well as improving fisheries sustainability and food security.

Like the country SCT, the RSCT is a source of data that could be utilized for monitoring the progress of CTI implementation in relation to its goals and higher-level outcomes. However, as it is intended to be a "living document," it needs to be regularly updated to be of value to the Coral Triangle region. As the M&E system of the CTI is finalized and adopted by the countries, the linkages between the goals and higher-level outcomes can be explicitly mapped out. This first version of the RSCT report provides a perspective on the status of the Coral Triangle; and its biophysical, socioeconomic, and institutional attributes. The report presents a preliminary analysis of the progress toward attaining the CTI's five goals through the use of the CTI Index.

Approach and Methodology

To assess the progress in achieving of the CTI higher-level outcomes, the DPSIR framework was used (Figure 1). The DPSIR is a causal framework for describing interactions between society and the environment (Smeets and Weterings 1999); it helps structure knowledge and assesses the causes, consequences, and responses to change in a holistic way (Atkins et al. 2011). DPSIR is a well-established and widely used framework that can be used to support decision making (Tscherning et al. 2012). Aside from establishing indicators, DPSIR is a flexible systems analysis that has been applied to various programs of sustainable development (Carr et al. 2007), describing the state of systems (e.g., Skoulikidis 2009, Rehr et al. 2012), addressing environmental issues (Jago-on et al. 2009), and evaluating impacts of management (Martins et al. 2012, Ojeda-Martinez et al. 2009, Mangi et al. 2007), all of which are relevant to this report.

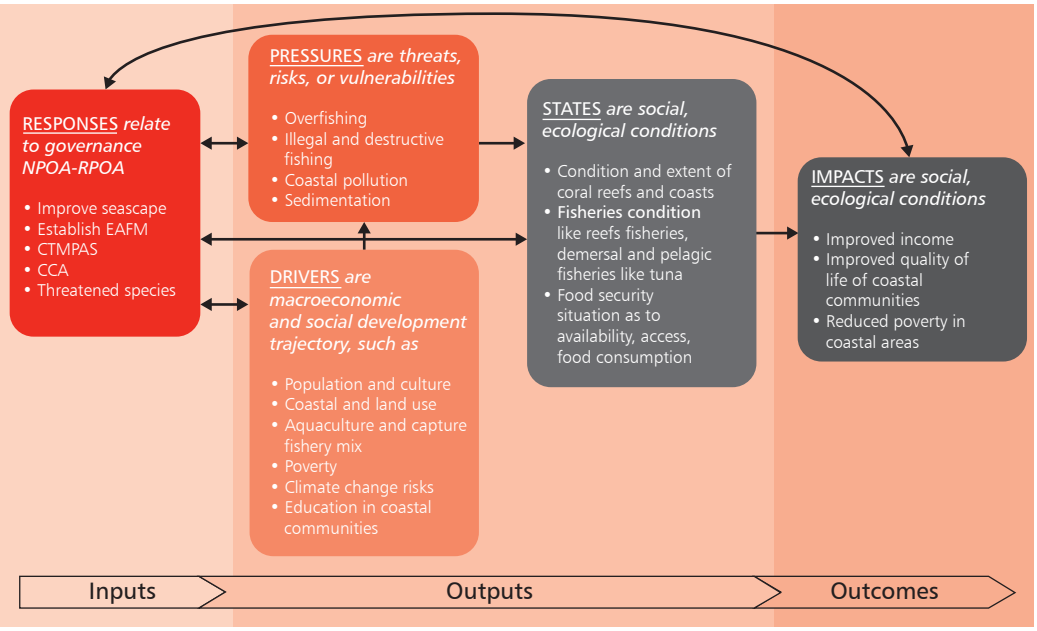
> According to this [DPSIR] systems analysis view, social and economic drivers exert Pressure on the environment and, as a consequence, the State of the environment changes, such as the provision of adequate conditions for health, resources availability, and biodiversity. Finally, this leads to Impacts on human health, ecosystems, and materials that may elicit a societal Response that feeds back on the Driving forces, or on the state or impacts directly, through adaptation or curative action (Smeets and Weterings 1999).

The DPSIR was used to describe the regional ecological and social state of the Coral Triangle by taking into consideration the *drivers* that generate *pressures* resulting in *state* changes that *impact* on human well-being. Through applying the DPSIR framework, it was envisioned that the RSCT report could become a knowledge management tool for identifying *response* gaps and enhancing the plans of the countries to address impediments in achieving higher-level outcomes. Each component of the DPSIR was interpreted in the context of the CTI and the higher-level outcomes (Figure 1, Table 2). Utilizing the DPSIR framework, effective socioecological indicators for good knowledge management, as well as gaps in data, research, and governance, were also identified.

Part of the challenge in the CTI is how to attribute the impacts of the responses presented in the CTI RPOA and NPOAs (e.g., marine protected area [MPA], ecosystem approach to fisheries management (EAFM), and climate change adaptation [CCA] actions). Due to complex feedback chains, the impacts (e.g., improved fish availability, access, and consumption; increased fisheries income; and other benefits to human well-being) are only likely to be achieved following improvements in intermediate outcomes relating to the state of coral reef ecosystems and fishery resources.

The DPSIR provided an analytical approach for linking the various governance imperatives (*Responses*) to the desired outcomes (in terms of coral reefs, fisheries, and food security [CFF]) and the enabling macroeconomic *drivers* (e.g., population, legal and institutional conditions, and social and economic capacity). Matching these with appropriate actions to deal with

Figure 1 **Driver–Pressure–State–Impact–Response Framework to Analyze the Regional State of the Coral Triangle**



CCA = climate change adaptation, CTMPAS = Coral Triangle Marine Protected Area System, EAFM = ecosystem approach to fisheries management, NPOA = national plan of action, RPOA = regional plan of action.

Source: Modified from Chua (2006).

Table 2 **Description of Driver–Pressure–State–Impact–Response Components Used in this Report**

Component	Description
Drivers	Macroeconomic conditions such as population and land use developments; and environmental externalities such as climate change (Chua 2006). Drivers are usually addressed through policy and institutional responses that encompass various social and economic sectors and are beyond the direct scope of project activities.
Pressures	Threats that directly change the state variables. These include issues such as overfishing, runoff, and pollution.
States	Condition of coral reefs and coastal and marine fishery resources in the Coral Triangle according to ecological, biophysical, and resource use variables.
Impacts	Observed and predicted results of changes in the "State" parameters that have implications for human well-being. For the CTI, this refers primarily to food provision and the contribution of coral reefs and fishery resources to food security. However, other "Impacts" resulting in changes in the "State" parameters are also important (e.g., maintenance of biodiversity, coastal protection, cultural and heritage values, recreational values, and others).
Responses	Series of logical activities and actions designed to improve the "State," paving the way for enabling conditions such as policy **drivers** and macroeconomic and social conditions (e.g., population and culture); and to reduce **pressures** (e.g., threat reduction), thereby contributing to meeting the higher-level outcomes. In the CTI context, the RPOA and the NPOAs are considered elements of the "**Response**."

CTI = Coral Triangle Initiative, NPOA = national plan of action, RPOA = regional plan of action.
Source: Authors' definitions modified from Chua (2006) and Smeets and Weterings (1999).

prevailing *pressures* (i.e., improving governance effectiveness through capacity building at different governance scales) required a combination of NPOA- and RPOA-level responses. This approach offered an opportunity to identify value-added benefits and find synergies beyond single country actions. These included bilateral fisheries agreements and other joint actions such as enforcement against illegal and destructive fishing; transparency mechanisms as indicated by the SCT reports; accountability processes like those through NPOA and/or RPOA performance tracking; and incentives such as awards and capacity development. These actions were to encourage both participation and improvement in coordinating mechanisms toward a more inclusive CTI.

Higher-Level Outcomes for the Coral Triangle Initiative

The CTI is more than just the sum of activities and interventions identified in the RPOA and NPOAs. Although not explicitly stated in the RPOA, this multilateral partnership envisions realizing higher-level outcomes on CFF for the region, which could be achieved, partly or fully, through the five goals in the RPOA.

During the CTI MEWG meeting on the review of the RSCT and M&E indicators held in Jakarta, Indonesia, on 22–25 October 2012, the workshop participants proposed higher-level outcomes for the CTI and a preliminary selection of indicators to evaluate these outcomes (Table 3). The indicators were used to guide the description of the status of coral reefs and fisheries and the impacts on food security.

Table 3 **Proposed Higher-Level Outcomes for the Coral Triangle Initiative and Suggested Indicators for Measuring Outcomes**

Higher-Level Outcomes	Suggested Indicators
Coral Reef Ecosystems • Integrity and services stabilized and/or maintained	• Condition of coral reefs • Extent of mangroves and seagrasses • Fish biomass • Extent of coral reef and associated habitats in fully protected areas
Fisheries • Fish stocks improved and sustained	• Change in conservation status (international) of commercially important fish species (coastal and pelagic) • Change in catch per unit effort by gear • Change in species composition relative to trophic level • Change in size distribution by fish species • Change in exploitation status for pelagic and other species
Food Security • Affordability, availability, quality, and safety of food from coastal and marine resources	• Affordability: Income of fishers, prices of fish • Availability: Food sufficiency of fishing households, food consumption of coastal communities • Quality and safety: Contribution of fish to protein requirement, health of fishing communities • Community resiliency or social well-being element: Gini Index and localized downscaled version of Human Development Index

Source: Tetra Tech ARD (2012).

Report Writing Process

The preparation of this report was highly participatory and involved (i) forming a writing team from among the consultants of the Asian Development Bank (ADB) regional technical assistance (RETA);[1] (ii) organizing two regional workshops to seek inputs from, and to engage the country SCT report teams and other key informants; (iii) reviewing the draft RSCT by external and peer reviewers in ADB and by the CTI Regional Secretariat; and (iv) finalizing the report to incorporate comments from the reviewers.

The first regional workshops sponsored by the RETA was held in April 2012 at the ADB headquarters in Manila, back-to-back with the meeting of the MEWG. The second workshop was held in October 2012 in Jakarta, Indonesia, again back-to-back with an MEWG meeting. At the first workshop, the DPSIR framework was introduced, and the country representatives commented on the utility of the approach but the framework was not used in the current versions of the country SCT. In determining indicators for the state of CFF, the workshop participants agreed on those that best represented the three higher-level outcomes of the CTI. At the Jakarta workshop in October 2012, the secretariat took cognizance of the report and agreed to have it updated every 3 years. Furthermore, discussions on the RSCT contributed to the articulation of indicators for the higher-level outcomes for inclusion in the MEWG system.

[1] ADB. 2010. *Technical Assistance for Regional Cooperation on Knowledge Management, Policy, and Institutional Support to the Coral Triangle Initiative* (Supplementary). Manila (TA 7307-REG).

State of Coral Triangle Marine Resources and Their Management

The "state" of coral reefs and coastal and marine fishery resources in the Coral Triangle is defined based on ecological, biophysical, and resource use variables.

Coastal habitats in the CT6 countries show the highest biodiversity values estimated in the world. At least 590 species of corals and 2,057 species of fish may be found in the Coral Triangle (Table 4). The Coral Triangle is also the center of diversity in mangroves and seagrasses. Overfishing, however, has greatly reduced reef fish biodiversity, especially in the Philippines (Nañola et al. 2010).

Table 4 **Biodiversity in CT6 Countries**

Key Features	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste
Number of coral reef fish and associated species	2,057[a]	1,549[b]	1,635[b]	1,658[a]	1,371[b]	1,500[b]
Number of coral species	590[a]	550[a]	514[c]	533[c]	507[c]	514[c]
Number of mangrove species (excluding introduced species)	45[d]	41[a]	43[d]	42[a]	26[a]	12[d]
Number of seagrass species[e]	13[a]	14[a]	7[a]	16[a]	10[a]	7[a]
Number of fish species threatened (2011)[f]	140	64	42	71	16	5
Marine protected areas (% of territorial waters) (2010)[f]	2.0	2.0	0.3	2.5	0.1	6.6

[a] State of the Coral Triangle report of the respective country.
[b] Allen (2008).
[c] Consistent with Hoegh-Guldberg et al. (2009).
[d] Spalding et al. (2010).
[e] Values consistent with Green and Short (2003), and Spalding et al. (2001).
[f] World Bank (2012).

Coral Reef Ecosystems

Proposed Coral Triangle Initiative Higher-Level Outcome:
Coral reef ecosystem integrity and services stabilized and/or maintained

Condition of Coral Reefs

The Coral Triangle harbors the most biodiverse coral reefs in the world coupled with a high endemism of marine organisms (Veron 2009, Allen 2008). Yet, the coral reefs have continually

been threatened by anthropogenic stressors, their already debilitated condition further exacerbated by climate change impacts and extreme natural disturbances (Burke et al. 2011).

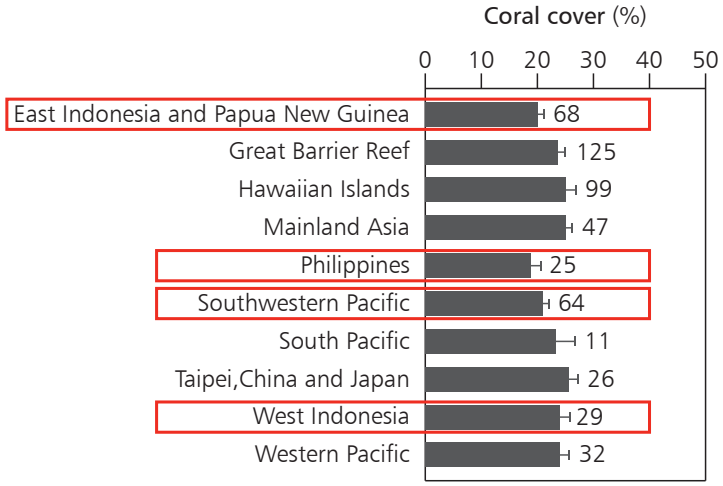
The annual economic net benefits per square kilometer (km^2) of a healthy coral reef in Southeast Asia range from $23,100 to $270,000 (Burke et al. 2002). Considering that the Coral Triangle has 98,177 km^2 of coral reefs, it is estimated that the annual benefits derived from the reef is no less than $10 billion. The annual benefits from coral reef-related goods and services (from tourism, coral reef fisheries, and shoreline protection only) in Indonesia and the Philippines reach $3.3 billion (Burke et al. 2012).

An extensive compilation and analysis of coral reef survey data from published papers, project reports, and grey literature indicated an average of 22% coral cover for the entire Indo–Pacific region in 2003, which was uniform across the region, including the Great Barrier Reef (Bruno and Selig 2007); the Coral Triangle formed a large part of the Indo–Pacific region in their analysis. Over the entire Indo–Pacific region, coral cover had declined from 42.5% during the early 1980s to 22.1% by 2003 (Figure 2). Coral cover in the Philippines has been declining since the 1980s, while East Indonesia and Papua New Guinea had had stable coral cover from 1984 to 2004. This trend in coral cover until the late 1990s had also been noted in the CT6 countries, both for Southeast Asia (Tun et al. 2008) and Pacific island countries (Chin et al. 2011).

More recent reports, however, suggest improvement in the condition of coral reefs in Indonesia, where a general increase in coral cover has been observed in the eastern region of the country from 2006 to 2011 (Table 5) (Giyanto 2012). Reef Check surveys in 2010 indicated relatively high live coral cover (hard and soft corals) for both Peninsular Malaysia (49%) and East Malaysia

Figure 2 **Average Coral Cover in Indo–Pacific Region by Subregion, 2003**

(Means ± 1 standard error)



Note: The subregions belonging to the Coral Triangle (boxed in red) are West Indonesia, East Indonesia and Papua New Guinea, Southwestern Pacific, and the Philippines. Values beside the bars denote the number of reefs surveyed in each subregion.

Source: Bruno and Selig (2007).

Table 5 **Summary of the Condition of Coral Reefs in CT6 Countries**

Country	State of Coral Reefs
Indonesia	• Indonesia's SCT report reported a very stable trend in the percentage of reefs in excellent, good, fair, and poor condition during 1993–2007 (Indonesia SCT). • COREMAP II monitoring reports indicate a general increase in coral cover from 2006 to 2011 (Giyanto 2012).
Malaysia	• Survey of coral reef resources was insufficient, and survey coverage area was not comprehensive (Malaysia SCT). • A comparison of survey results in 1993, 2003, and 2004 showed a general decline in reefs previously with "Very Good" and "Good" coral coverage and a parallel increase in reefs with "Fair" cover (Tun et al. 2008). • Reef Check data in 2010 indicated a 44% average live coral cover (Reef Check 2010).
Papua New Guinea	• "The few survey data for PNG indicate that the reefs are healthy with strong ability to recover from disturbances. However, some coastal reefs show damage from sediment, pollution, and overfishing. There are increasing pressures on reef resources from harvesting, with declines of some species in specific areas. Many reefs, however, are remote with low levels of harvesting. Anecdotal reports and risk assessments indicate that PNG's reefs are affected by pollution and sedimentation, mining, and poor land use practices. High population growth will increase pressure on reefs. PNG has strong legislative mechanisms, but management is limited by a lack of resources, capacity and political will, and ability to access to remote locations." (Chin et al. 2011)
Philippines	• The Philippines SCT made no mention about the status of benthic communities of coral reefs (Philippines SCT). • Out of 424 transects, 57% of reefs surveyed around the country during 2000–2004 had live coral cover (hard and soft corals) ranging from 20% to 40% (Nañola et al. 2006).
Solomon Islands	• A comprehensive survey of coral reefs conducted in 2004 by The Nature Conservancy showed good overall reef health in Solomon Islands, based on 59 fringing reef locations (Turak 2006).
Timor-Leste	• An extensive marine resource survey in August 2012 conducted in the northern coast of Timor-Leste found extremely high biodiversity.

COREMAP = Coral Reef Rehabilitation and Management Project, PNG = Papua New Guinea, SCT = State of the Coral Triangle.

(42%), with an average live coral cover of 44% for the country (Reef Check 2010). In the Philippines, more than half of reefs surveyed between 2000 and 2004 had live coral cover (hard and soft corals) ranging from 20% to 40% (Nañola et al. 2006). Reefs in Pacific island countries are still in good shape with a high capacity for recovery following natural disturbances (Chin et al. 2011).

Although numerous coral reef surveys have already been conducted in the Coral Triangle, large areas of reefs remain to be assessed. Information on the state of the coral reef ecosystems in the Coral Triangle is not regularly collected and consolidated into national reports, except in the Philippines, where data are collected on a biennial basis and reported in *Philippine Reefs Through Time* (Philreefs 2008). However, there are issues as the sites reported changes from one report to another, making it difficult to compare results on the overall status of Philippine reefs through time. Results of coral reef surveys could be compiled from published literature and reports to generate a map of reef health in the Coral Triangle, and identify patterns in the

state of coral reefs as it relates to *drivers* and *pressures* for improved *responses* to enhance coral reef resilience.

Reef Fish Biomass

If coral reef data are sparse and unconsolidated for the CT6 countries, information on reef fish biomass is in a poorer state. Reef fish biomass is seldom collected and reported during coral reef surveys. Many surveys gather abundance data, but do not measure fish size or length to be able to estimate fish biomass. Fish biomass and abundance are more heterogenous and variable than coral cover; hence, generating values at the country level is much more difficult (Bruno and Selig 2007).

In the Philippines, more than 50% of sites surveyed from 1991 to 2004 show reef fish biomass to be less than 10 tons per square kilometer (t/km^2), which indicates that reef fishes are overfished (Nañola et al. 2006). In comparison, although reef fish biomass in Solomon Islands is highly variable across provinces, islands, exposures, and sites, many of its reefs have total fish biomass of at least 100 t/km^2 (Green et al. 2006). Unrestricted areas in Papua New Guinea (PNG) have an average reef fish biomass of 12.7 t/km^2 (Cinner et al. 2005).

Extent of Coral Reefs, Mangroves, and Seagrass Beds

In the Coral Triangle, coral reefs, mangroves, and seagrass beds line over 132,800 km^2 of coastline (Table 6). Coral reefs in the CT6 countries cover a total area of 98,577 km^2. Indonesia has the largest coral reef area at 51,000 km^2, followed by the Philippines at 26,000 km^2. PNG (13,840 km^2), Malaysia (3,600 km^2), and Solomon Islands (3,591 km^2) are in the median range; and Timor-Leste has the smallest area of 146 km^2. Indonesia also has an extensive mangrove cover at 35,337 km^2 and a seagrass area of 30,000 km^2. Timor-Leste has the smallest combined mangrove and seagrass area, which is estimated at 40 km^2.

Mangroves in the Coral Triangle have suffered heavily from unregulated development. Intensive exploitation of mangroves in the Philippines resulted in the decline of their cover. An estimated 337,000 hectares (ha) (75%) of mangrove area have been lost, mostly (278,657 ha or 66%) during 1950–1990 (Samson and Rollon 2008).

Table 6 Physical Attributes and Extent of Coastal Habitats in CT6 Countries

Attributes	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste
Total sea area (km^2)	5,800,000	614,159	3,120,000	2,000,000	1,340,000	…
Total coastline (km)	108,800	4,809	17,110	37,008	4,000	706
Total coral reef area (km^2)	51,000	3,600	13,840	26,000	3,591	146
Total mangrove area (km^2)	35,337	5,750	4,265	2,472 (2005)	650	18
Total seagrass area (km^2)	30,000	…	…	978	100	22

… = data not available, km = kilometer, km^2 = square kilometer.

Source: Country State of the Coral Triangle reports.

Seagrasses remain one of the least assessed coastal habitats in the Coral Triangle. Areal extent of seagrass beds and their quality are rarely monitored. There is no information on seagrass beds area in PNG. A report indicates that 40% of the mangroves and seagrass beds of the CT6 countries have been lost in the past 4 decades (Hoegh-Guldberg et al. 2009).

Fisheries are heavily dependent on coral reefs, mangroves, and seagrass beds, which are considered among the crucial habitats. Gaps of information on their extent and status can distort or delay management decisions.

Fishery Resources

Proposed Coral Triangle Initiative Higher-Level Outcome:
Fish stocks improved and sustained

ADB's technical assistance—Regional Cooperation on Knowledge Management, Policy, and Institutional Support to the Coral Triangle Initiative—conducted the study, *Economics of Fisheries and Aquaculture in the Coral Triangle*, using data in 2007. The study estimated the value of marine capture fisheries in the CT6 countries at $9.9 billion, while marine and brackishwater aquaculture was valued at $1.7 billion.

Although total fish catches[2] have continued to increase in the CT6 countries since 1950 (Figure 3), several studies have predicted that the countries are nearing, or have already exceeded, the critical carrying capacity of their demersal and pelagic fishery resources (Lymer et al. 2010). Indonesia, Malaysia, and the Philippines have been fishing down the food web since the 1950s and catching lower trophic level species based on marine trophic indexes (SAUP 2012). Demersal fish stocks had declined by as much as 20% in Malaysia and 64% in the Philippines since the 1950s until the mid-1990s (Stobutzki et al. 2006). The National Commission on Stock Assessment in Indonesia reported overfishing of demersal fishes in 5 of 11 fisheries management areas (FMAs), and only one FMA was categorized as moderately exploited (MMAF–JICA 2011). In the Philippines, the per capita supply of round scad, dubbed as "the poor man's fish," had declined from 7.2 grams/person/day to 4.4 grams/person/day during 1990–2011.[3]

The fishery resources of the CT6 countries are in various levels of development and exploitation. Overall fisheries development diagnostics identified fisheries in the CT6 as either "developing" or "mature" based on the trends in catch landings (Table 7) (Garcia 2009).[4] National stock assessment programs in Indonesia and the Philippines indicate declines in the catches of commercially important fish species.

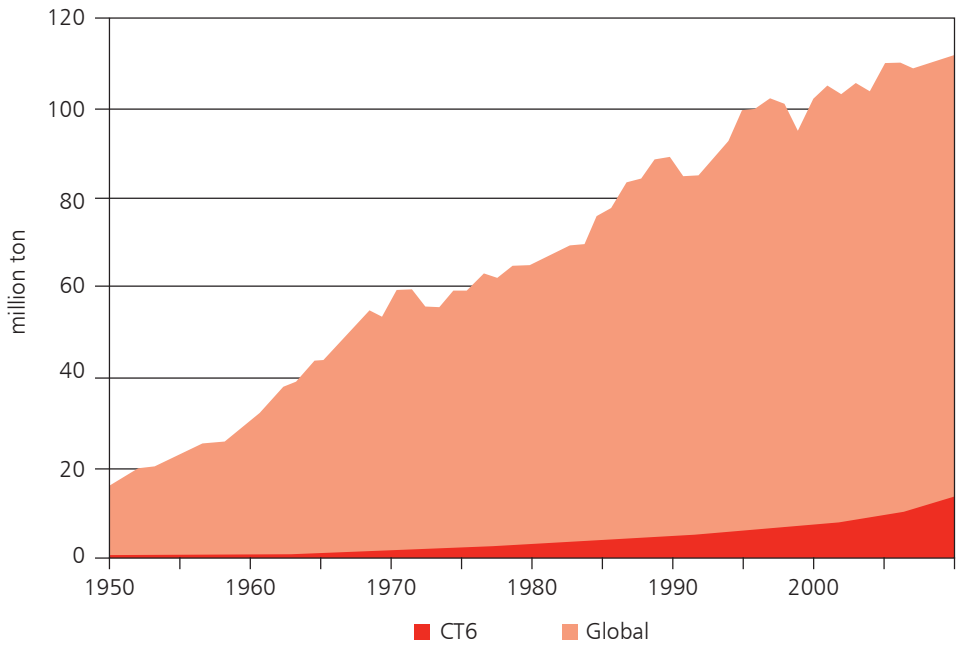
---

[2] It should be noted that fish catch does not necessarily reflect the size of the fish stock.

[3] Bureau of Agricultural Statistics Fishery Supply Utilization Accounts. http://countrystat.bas.gov.ph/?cont=10&pageid=1&ma=I70FCSUA (accessed 13 April 2013).

[4] Fisheries development categories based on Garcia (2009) were (i) Developing = landings increasing regularly and growth rate remains above zero; (ii) Mature = landings have increased and fluctuated, leveling off in the last decade; (iii) Senescent-1 = growth rate shows a clear negative trend and falls below the zero-growth line sometime between 1970 and 1990; (iv) Senescent-2 = shows continuous senescence practically from the beginning of the time series where landings have been decreasing and growth rate has remained negative; and (v) Indeterminate = no trend observed in the landings over time.

Figure 3 **Total Marine Fisheries Production from CT6 Countries, 1950–2010**



Source: Data from FAO FishStatJ (2011).

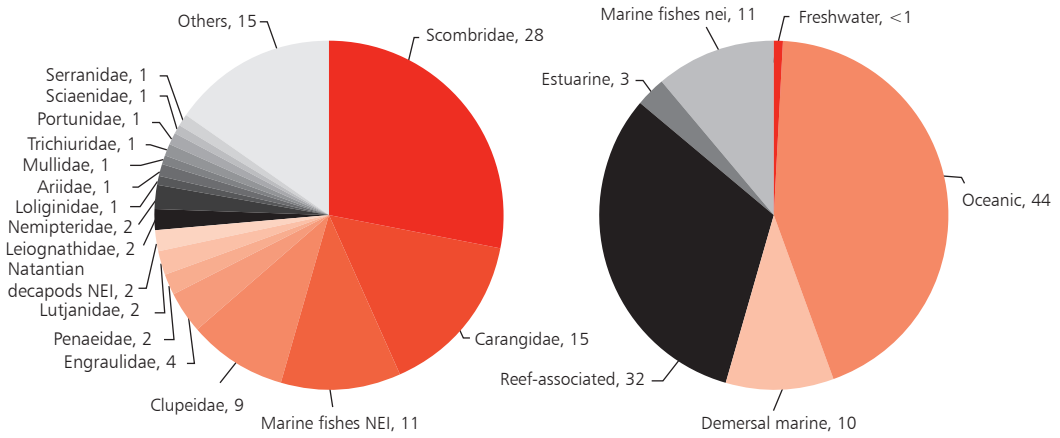
Table 7 **Development Diagnostics of Fishery Resources in Home Areas over the Last Decade**

Country	Total Fishes	Bottom Fishes
Indonesia		
Western	Mature	Mature
Eastern	Developing	Mature
Malaysia		
Western	Mature	Mature
Eastern	Mature	Mature
Papua New Guinea	Indeterminate	Not assessed
Philippines	Developing	Mature
Solomon Islands	Senescent	Not assessed
Timor-Leste	Not assessed	Not assessed

Source: Garcia (2009).

Fishes from the families *Scombridae, Carangidae*, and *Clupeidae* comprise 53% of the total marine capture fisheries production in the CT6 countries in 2009 (Figure 4). A relatively large part of the reported catch is not disaggregated into fish families, i.e., marine fishes not elsewhere included (nei) that accounted for 11% of capture fisheries production in 2009. Of fishes caught in the CT6 countries in 2009, 30% of 2.66 million tons were reef-associated fish

Figure 4 **Aggregate Catch Composition of CT6 Countries in 2009**
(%)



nei = not elsewhere included.

Left: Using FAO Aquatic Sciences and Fisheries Information System (ASFIS) families classification.
Right: Based on habitat and/or ecosystem classification of catches.

Source: Data from FAO Fisheries and Agriculture Department of Statistics and Information Service FishStatJ: Universal software for fishery statistical time series.

and invertebrate families (Figure 4), while 47% were from the family *Carangidae,* comprising various scads, jacks, and trevallies. The total volume of reef-associated fishes and invertebrates would most likely increase considerably if subsistence fisheries are taken into account, and general nei categories are further disaggregated in the landing reports and statistics.

The contribution of fisheries and aquaculture to national economies, in terms of their contribution to gross domestic product (GDP), exports, and employment, varies across the CT6 countries. Fisheries and aquaculture comprise 1.2%–6.8% of the GDP of CT6 countries (Table 8).

Fisheries in the Coral Triangle Pacific countries contribute greater export value compared with the total exports of the countries in the Coral Triangle Southeast Asia. Over the past half century, the percentage contribution of agriculture (including fisheries) to GDP of Indonesia, Malaysia, and the Philippines has been declining to an almost stable level of 10%–15% (Figure 5). On the other hand, it has remained high in PNG and Solomon Islands at 35%–40% of GDP. Fisheries and aquaculture employ at least 4.6 million persons in the Coral Triangle; in 2009, 1.3% of the aggregate population of the CT6 countries or 2.0% of total persons employed in the CT6 were in fisheries and aquaculture.[5] Assuming an average household size of four, 18.4 million people representing 5% of the aggregate population in the Coral Triangle in 2009 were directly dependent on fisheries for livelihood.

[5] Total population for the CT6 in 2009 was 365,394,353, of whom 62.1% were employed (15 years and older). Data from the World Bank: employment to population ratio from http://data.worldbank.org/indicator/SL.EMP.TOTL.SP.ZS and population data from http://data.worldbank.org/indicator/SP.POP.TOTL

Table 8 **Estimated Contribution of Fisheries to National Economies of CT6 Countries**

Countries	Contribution of Fisheries to GDP (2007) (%)	Export Value of Fishery Products to All Exports (%)	**Employment** (number of persons)	
			Fisheries	Aquaculture
Indonesia	2.4[a]	1.9[b]	2,169,279[c]	749,441[c]
Malaysia	1.2[d]	0.4[e]	99,617[f]	…
Papua New Guinea	3.4[g]	10.0[g]	5,114	…
Philippines	2.2[h]	0.9[i]	1,388,173[j]	226,195[j]
Solomon Islands	6.8[g]	12.0[g]	30,000	…
Timor-Leste	…	…	5,718	…

… = data not available, GDP = gross domestic product.

Sources:

[a] Database of Existing Condition on Indonesian Marine & Fisheries. http://www.kkp.go.id/upload/jica/web01/index.html (accessed 25 October 2012).

[b] http://www.kemendag.go.id/en/economic-profile/indonesia-export-import/growth-of-non-oil-and-gas-export-commodity

[c] Data for 2009 from Ministry of Marine Affairs and Fisheries–Japan International Cooperation Agency (MMAF-JICA).

[d] *Status of the Fisheries Sector in Malaysia* (2007). http://www.dof.gov.my/224 (accessed 25 October 2012).

[e] Obtained by dividing the total fish export value for Malaysia for 2007 from http://www.fao.org/fishery/statistics/global-commodities-production/query/en by the total export value of Malaysian commodities (2007) from http://www.statistics.gov.my/portal/download_Economics/files/DATA_SERIES/2011/pdf/03Perdagangan_luar_negeri.pdf (accessed 25 October 2012).

[f] Department of Fisheries Malaysia's 2007 Annual List of Fisheries Statistics. http://www.dof.gov.my/documents/10157/395f0ac9-0363-47c7-ae35-b7f7a62735ad

[g] Gillett (2009).

[h] Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) (2007).

[i] Department of Trade and Industry. n.d. Philippine Merchandise Exports to the World, FY 2006 to 2011. http://dti.gov.ph/uploads/DownloadableForms/BETP%20Stats_Exports%20by%20Product%20Grouping%20FY%202006%20to%202011_25may2012.pdf (accessed 25 October 2012).

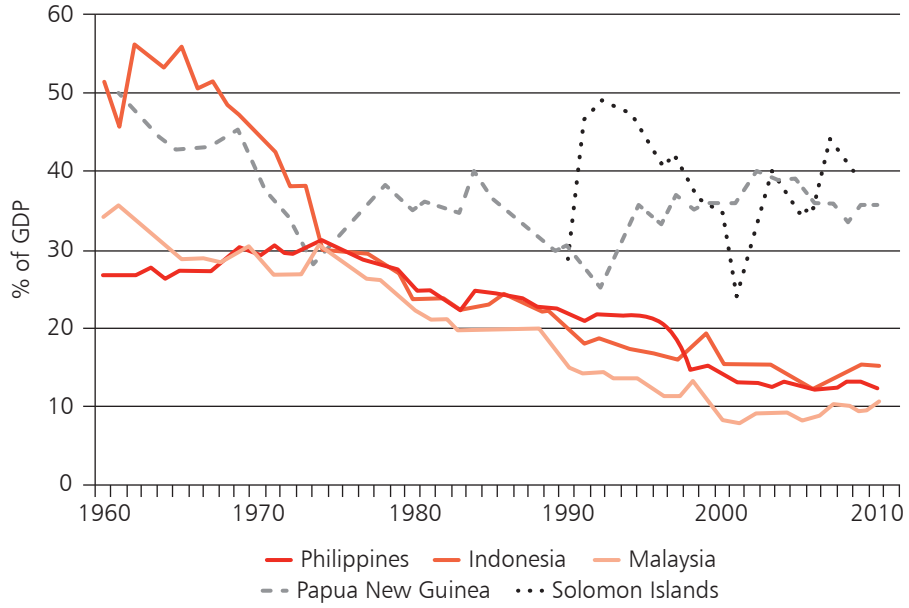
[j] DA–BFAR (2007). Aquaculture employment includes those working in fishponds.

Fisheries Management in the Coral Triangle

CT6 countries are signatories to several binding and nonbinding agreements (Table 9) (Fidelman and Ekstrom 2012). Indonesia, Malaysia, and the Philippines have strong regional ties, as separate from PNG and Solomon Islands (Table 10, Figure 6). Timor-Leste, being a new independent country, is involved in Partnership in Environmental Management for the Seas of East Asia (PEMSEA); and it voluntarily implements the Regional Plan of Action for Responsible Fishing. Of the 19 fisheries-related agreements, 3 have the most memberships from the CT6 countries. Five of the CT6 countries are signatories to the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia–Pacific Region (INFOFISH),[6] the RPOA for Responsible Fishing, and the Asia–Pacific Group of Fisheries and Aquatic Research (GoFAR). All six countries in the Coral Triangle are signatories to the

[6] INFOFISH, whose headquarters are based in Kuala Lumpur, Malaysia, is an intergovernmental organization providing marketing information and technical advisory services to the fishery industry of the Asia and Pacific region and beyond. With the inclusion of Timor-Leste, INFOFISH can serve as a technical support organization for the fisheries of the CTI.

Figure 5 **Value-Added Contribution of Agriculture to GDP of CT6 Countries, 1960–2010**
(% of GDP)



GDP = gross domestic product.
Source: http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?page=1 (accessed 25 October 2012).

Convention on Biological Diversity. Except for Timor-Leste, the other Coral Triangle countries are also signatories to the Convention on International Trade in Endangered Species.

The establishment of the Coral Triangle Initiative (CTI) was very timely given the recognition of the region's importance in global coral reef biodiversity, fisheries, and food security from marine resources. Although it is the first agreement entered into by all CT6 countries, the region has existing multilateral coordination mechanisms, and agreements on fisheries and coastal and marine resource management, albeit initially fragmented. The CTI is an opportunity to synchronize and integrate these arrangements toward more targeted management of coral reefs and fisheries in the region for improved food security and human well-being.

Table 9 Existing Regional Fisheries Institutional and Governance Agreements among CT6 Countries

Arrangements		Institution/Project	Countries Involved					
			Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste
Regional Fisheries Bodies	Regional FMOs	**IOTC**: Indian Ocean Tuna Commission	✓	✓				
		WCPFC: Western and Central Pacific Fisheries Commission			✓	✓	✓	
	Fisheries Advisory Bodies	**APFIC**: Asia–Pacific Fishery Commission	✓	✓		✓		
		FFA: Pacific Islands Forum Fisheries Agency			✓		✓	
		SEAFDEC: Southeast Asian Fisheries Development Center	✓	✓		✓		
Regional Arrangements/Cooperation/Networks/Projects	Scientific Bodies	**INFOFISH**: Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia–Pacific Region	✓	✓	✓	✓	✓	
		NACA: Network of Aquaculture Centres in Asia–Pacific	✓	✓		✓		
		SPC: Secretariat of the Pacific Community			✓		✓	
	Economic Cooperation	**APEC**: Asia-Pacific Economic Cooperation	✓	✓	✓	✓		
		ASEAN: Association of Southeast Asian Nations	✓	✓		✓		Observer status
		PIF: Pacific Islands Forum			✓		✓	
	Fisheries/ Environmental Arrangements	**BOBLME**: The Bay of Bengal Large Marine Ecosystem Project	✓	✓				
		COBSEA: Coordinating Body on the Seas of East Asia	✓	✓		✓		
		CTI: Coral Triangle Initiative	✓	✓	✓	✓	✓	✓
		PEMSEA: Partnerships in Environmental Management for the Seas of East Asia	✓	✓		✓		✓
		SAP: Strategic Action Programme of the Pacific Small Island Developing States			✓		✓	
		RPOA: Regional Plan of Action to Promote Responsible Fishing Practices including Combating IUU Fishing in the Region	✓	✓	✓	✓		✓
		SCS: UNEP/GEF South China Sea Project	✓	✓		✓		
		SPREP: Secretariat of the Pacific Regional Environment Programme			✓		✓	
	Scientific Networks	**GoFAR**: The Asia–Pacific Group of Fisheries and Aquatic Research	✓	✓	✓	✓	✓	

FMO = fisheries management organization; IUU = illegal, unreported, and unregulated.

Note: Prepared by Christine Marie Casal, WorldFish Center, Philippines.

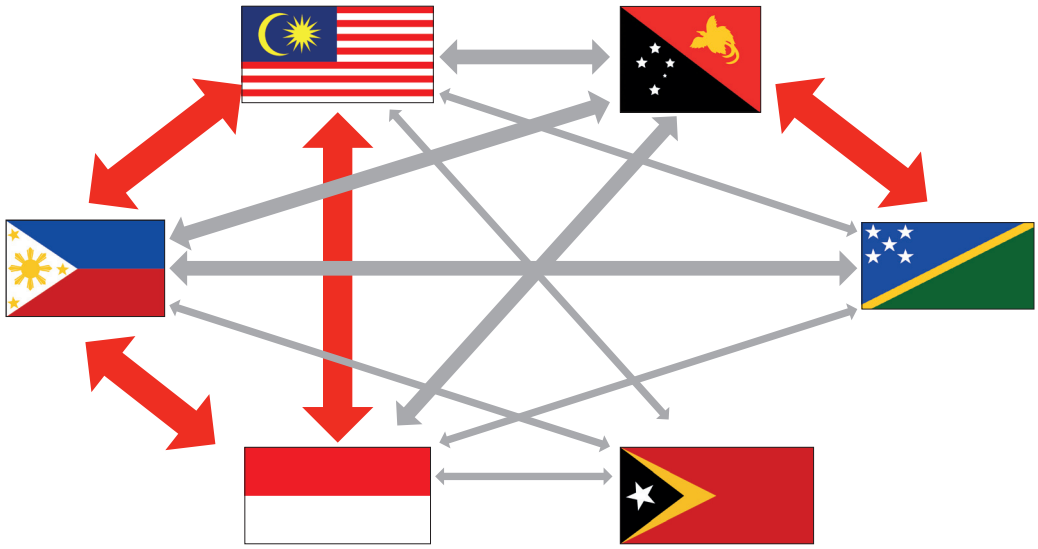
Source: Lymer et al. (2010).

Table 10 **Summary of Multilateral Fisheries-Related Agreements (Binding and Nonbinding) among CT6 Countries**

	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste
Indonesia		13	4	11	2	2
Malaysia	13		4	11	2	2
Papua New Guinea	4	4		5	9	
Philippines	11	11	5		4	2
Solomon Islands	2	2	9	3		
Timor-Leste	2	2		2		
Total	32	32	20	32	17	6

Source: Adapted from Lymer et al. (2010).

Figure 6 **Binding and Nonbinding Fisheries-Related Agreements Signed by CT6 Countries and the Overlaps**



Note: Arrow thickness indicates the number of fisheries agreements existing between countries. Red arrows refer to relationships with more than 11 existing agreements.

Source: Adapted from Lymer et al. (2010).

Drivers of Change in the Coral Triangle

Driving forces are "broad macro socioeconomic issues and processes (natural and anthropogenic) considered as root causes: population, urbanization, natural hazards, transport/trade, agricultural intensification/land-use change, tourism and recreational demand, fisheries and aquaculture, industrial development" (Chua 2006).

During the April 2012 Regional State of the Coral Triangle meeting, seven key drivers of change in the CT6 countries were identified and validated through the consolidated results and analysis of the country State of the Coral Triangle (SCT) reports. These drivers are population growth, cultural challenges, education, coastal development, poverty and governance, demand for fish, and climate change.

Population Growth

Over 350 million people live in the CT6 countries, of which about 120 million live within 10 kilometers (km) of the coastline (Table 1). Of the CT6 population, 90% are in Indonesia and the Philippines—the two countries that have the largest coral reef areas in the region. The Philippines has the highest population density of 307 people per square kilometer (km^2), almost three times the population density of Indonesia (122 people per km^2). Papua New Guinea (PNG) and the Solomon Islands have the lowest population densities at less than 20 people per km^2. The Coral Triangle Pacific countries have relatively smaller populations, with Solomon Islands having 0.5 million and Timor-Leste with 1.0 million. All CT6 countries have had a steady positive population growth rate in 2007–2011 (Table 1, Figure 7).

With limited resources to be distributed to an increasing population and ecosystem functions and services continuing to diminish (Burke et al. 2012), it is likely that the CT6 countries will struggle to meet the demand for resources. In the Philippines, for instance, the high degree of poverty and high population density in coastal communities exacerbate the exploitation of marine resources and the degradation of the local environment (White and Cruz-Trinidad 1998, Green et al. 2003). The sea is an important source of protein and energy for the CT6 countries.

Table 11 Fish Supply and Consumption Statistics of CT6 Countries

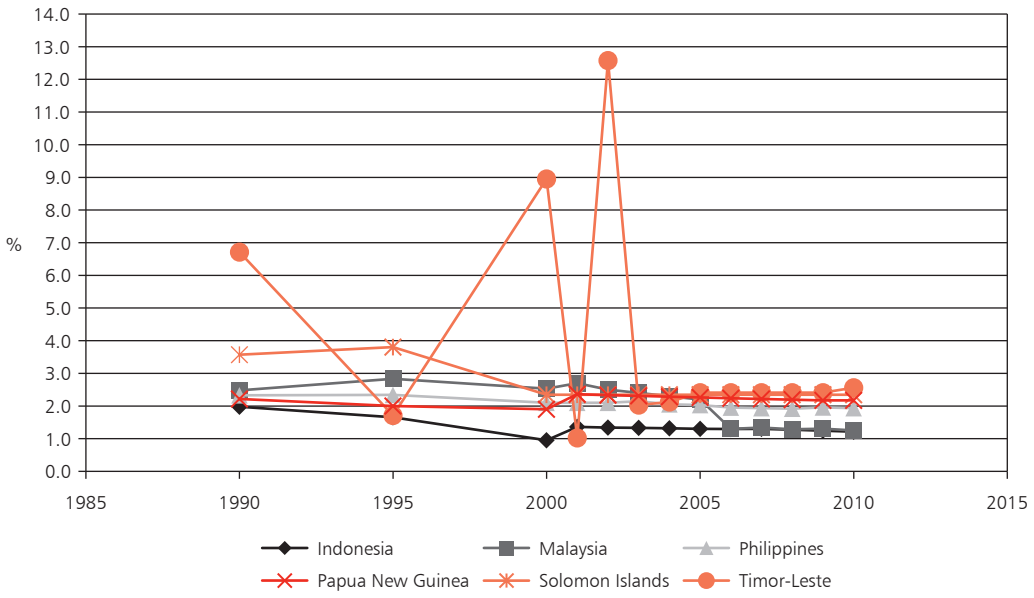
	Indonesia	Malaysia	Papua New Guinea	Philippines	Timor-Leste	Solomon Islands	Asia	Oceania	World
Fish supply (t) (2007)[a]	5,460,553	1,489,953	103,692	3,138,560	4,024[b] (2004)	16,734	75,207,046	868,210	114,026,910
Per capita fish supply (kg/person/year) (2007)[a]	24.3	56.1	16.1	35.4	4.4[b] (2004)	33.6	18.7	25.2	17.1
Fish protein (g/capita/day) (2007)[a]	8.0	17.1	5.2	11.3		11.6	5.1	6.5	4.8
Animal protein (g/capita/day) (2007)[a]	15.3	39.0	40.2	25.3		15.3	23.1	61.9	29.6
Total protein (g/capita/day) (2007)[a]	56.7	77.9	75.5	60.0		52.1	72.5	97.8	77.3
Fish/animal protein (%) (2007)[c]	52.5	43.8	12.9	44.7		75.7	22.3	10.4	16.1
Fish protein as % of total protein supply (2007)[c]	14.1	21.9	6.9	18.9	See note	22.2	7.1	6.6	6.2
Fish consumption (kg/person/year)[c]									
Average, 1990–1992	15.33	48.18		35.41		45.63			
Average, 1995–1997	18.98	55.85		29.93		41.25			
Average, 2000–2002	21.54	60.23		29.20		31.03			
Average, 2005–2007	23.36	51.10	13[d]	32.49	See note	31.03			

g = gram, kg = kilogram, t = ton.

Note: FAO fish protein statistics for Timor-Leste were not presented since they do not coincide with some country reports. Data from Cabral et al. (2013) (supplementary file).

Sources: [a] FAO (2010); [b] FAO (2012b); [c] FAO (2012a); [d] Bell et al. (2009).

Figure 7 **Population Growth Rate of CT6 Countries, 1990–2010**



Source: ADB. *Key Indicators for Asia and the Pacific 2011*. Manila.

However, even at current population levels, food insecurity is already being experienced in the region and will be a greater challenge in the future.[7]

Signs of deficit in fish supply in the CT6 countries are apparent. Protein consumption contribution to the dietary energy requirements of Indonesia and the Philippines is below the recommended level (Cabral et al. 2013). The per capita fish consumption in PNG and in Solomon Islands is currently below the standard requirement to satisfy their present and future dietary protein need (Bell et al. 2009). Fish provides more than 30% of the animal protein consumed by people in the region. This figure increases to more than 50% in Indonesia and Solomon Islands (Table 11). In the Coral Triangle, where 16% of its over 350 million population lives below the poverty line, average fish consumption is about 20 kilograms per person per year (kg/person/year) and higher in coastal communities. In Malaysia, fish consumption is 60 kg/person/year in 2000–2002 but declined to 51 kg/person/yeear in 2005–2007 (Table 11).[8]

Cultural Challenges for Regional Governance

Differences in culture, customs, traditions, development trajectories, and management systems, among others, in subregions of countries in the Coral Triangle Southeast Asia (CT-SEA) and Coral Triangle Pacific (CT-Pacific), could make it difficult to formulate regional policies. For example,

[7] See *Impacts: Benefits to Coral Triangle Coastal Communities* on page 42 of this report for further details.
[8] See ADB final report, *Economics of Fisheries and Aquaculture in the Coral Triangle*,for other statistics and information relevant to this discussion.

countries in these two subregions have different forms or systems of governance in managing their resources. CT-Pacific countries often have established cultural tenure systems, while the majority of fishing areas in CT-SEA countries are de facto open access. Malaysia is an exception as its fishing areas are divided into zones, and fishers are allowed to fish only within their assigned zones. In Southeast Asia, tenurial right arrangements are based on privatization of fishing areas by corporate companies, tourism-based establishments, and housing developments; but in many cases, these arrangements can have negative effects such as the further marginalization of fishers (Cabral and Aliño 2011).

Despite the differences in local and national policies on marine and coastal resource management in the CT6 countries, the Coral Triangle Initiative (CTI) enables the exchange of contemporary and traditional resource management experiences. The challenge lies in harmonizing national and local policies for managing migratory fish stocks (e.g., tuna and small pelagics), turtles, and other endangered marine species. The objective is to see to it that the policies are consistent; and they provide value-adding effects and/or impacts or benefits at various governance levels, and target the full range of stakeholders.

Education

Education is also seen as a major driver of change in CT6 countries. Fishing communities are aware that fishing can be an unsustainable profession, considering the continuous decline in fish catch per unit effort. A survey in the Philippines showed that fishers do not want their children to take up fishing as their primary livelihood, as fishers are aware of the risks and difficulties of the trade; and education is seen as a critical factor for a successful exit from the fishery (Muallil et al. 2011). Education in various forms, including traditional and/or local knowledge, is the link to the stakeholders' propensity to protecting their environment (Kimmerer 2002, Patterson et al. 2009). Awareness of the importance of resources, the link between human action and the state of the environment and/or ecosystem, and the integration of traditional ecological knowledge to management can lead to improvements in the state of natural resources. Women, particularly mothers, play an important role in the food security of households. Women's educational attainment was found to be the single significant factor associated with eradicating children's malnutrition (Smith and Haddad 2000).

Coastal Development

Coastal development is another driver of change in the Coral Triangle (Burke et al. 2012, McLeod et al. 2010). With the continuing industrialization of countries in CT-SEA and the gradual shift of the CT-Pacific to cash-based economies, considerable expansion and development in foreshore areas are anticipated. Mining-related developments and domestic waste management issues in the CT6 countries were identified as emerging concerns during the 26–27 April 2012 RSCT workshop. Regulations toward sustainable mining practices are currently being strengthened in CT6 countries (e.g., the Philippines), although much still needs to be done in this area in many CT6 countries. While coastal development per se is not intrinsically damaging to the environment (e.g., sustainable coastal development such as constructing waste management facilities, regulating activities in the coastal areas, adopting wastewater standards, and

mapping key natural habitats), the lack of governance mechanisms to manage development has resulted in unwanted consequences. For example, spatial and user conflicts, conversion of farmed and mangrove areas, and waste discharges from infrastructure (both housing and industries) in foreshore areas have been contributing to the accelerated decline in the state of coral reefs.

Poverty and Governance

Macroeconomic factors, including poverty incidence and governance, are perhaps the most important drivers of change across the region. Relevant indicators include economic growth (gross domestic product [GDP] at purchasing power parity per capita), poverty (poverty incidence), human development (Human Development Index [HDI] and Global Hunger Index [GHI]), and governance indicators (World Bank's Worldwide Governance Indicators on control of corruption, rule of law, regulatory quality, government effectiveness, political stability, and absence of violence and voice and accountability) (Table 12).

These indicators reflect the socioeconomic and governance sensitivities of the CT6 countries and their ability to cope or adapt to environmental and economic changes. The extreme poverty of the fishers and their high dependence on marine resources make them vulnerable to changes in resources. The governance rating of the CT6 countries is correlated with their poverty condition (Table 12). Malaysia has the highest governance score and the lowest national poverty incidence (3.8%), while Timor-Leste has the lowest governance score and the highest national poverty incidence (49.9%). The GHI combines three equally weighted indicators (undernourishment, child underweight, and child mortality), and is a measure of the countries' food security condition. GHI shows that Timor-Leste is in an "alarming" state while PNG and the Philippines are in a "serious" state (Table 12). Malaysia, on the other hand, has a low GHI score, followed by Solomon Islands. Both have succeeded in improving their food security condition, as their GHI state has been improving since 1990 (Cabral et al. 2013).

Based on CT6 country data on five macro indicators in Figure 8, the economic development of the country (GDP), and improvements in governance and HDI, are all positively correlated. With improvements in economic development and governance come reduction in the level of poverty and hunger.

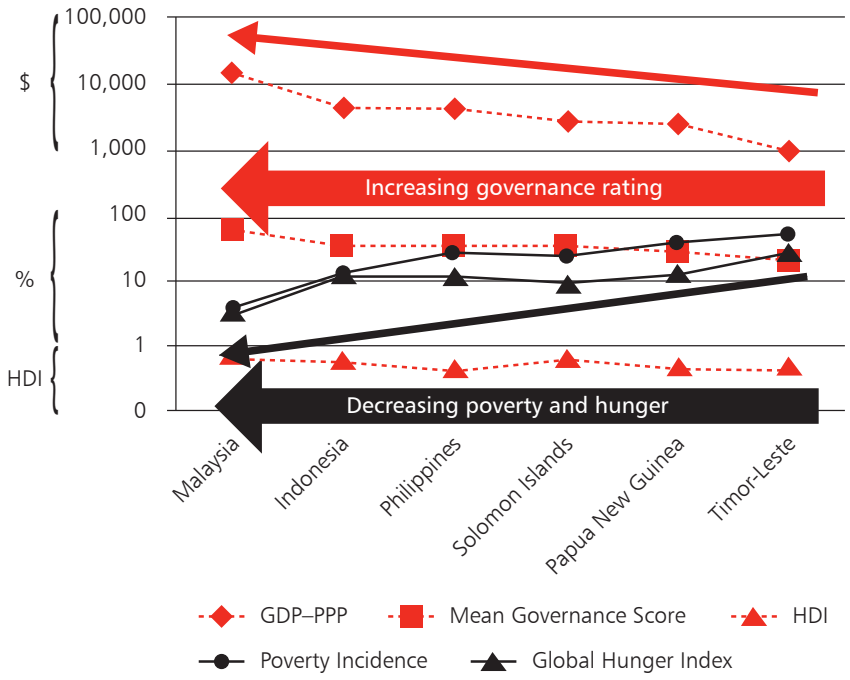
A study using forest ecosystem resources as an indicator found that 26% of the wealth of low-income countries come from environmental wealth compared to only 2% in high-income countries (Hamilton et al. 2005, UNDP 2005). The increase in fishing pressure in several areas in the CT6 countries has resulted in the decline in several fish stocks. Fishers, because of their extreme poverty and high dependence, have resorted to more efficient and often illegal fishing practices. Poverty reduction strategies in the CT6 countries can target the protection, improvement, and restoration of natural ecosystems. However, such strategies cannot be successful without the full cooperation of stakeholders who use and manage the resources. Cooperation can be achieved through education (Patterson et al. 2009); and reduction of vulnerabilities of the coastal communities (Allison and Ellis 2001) through investing in poverty reduction strategies, such as conditional cash transfer mechanism linked to environmental stewardship.

Table 12 Governance and Socioeconomic Status of CT6 Countries

Indicator			Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste
Governance and Human Development Indicators								
World Bank World Governance Indicator (WGI) (Kaufmann, Kraay, and Mastruzzi [2009])		Average percentile of the six WGIs	31.64%	59.23%	26.99%	33.65%	33.20%	20.67%
Mean percentile of the six WGIs	Urgency state	Urgency state	Medium	Low	Medium	Medium	Medium	High
3rd and 4th quartiles (50%–100%)	Low							
2nd quartile (25%–50%)	Medium							
1st quartile (0%–25%)	High							
HDI based on UNDP Human Development Report (2011)		HDI score and rank out of 187 countries	0.617 (rank 124)	0.761 (rank 61)	0.466 (rank 153)	0.644 (rank 112)	0.510 (rank 142)	0.495 (rank 147)
UNDP rating	Urgency state	Urgency state	Medium	Low	High	Medium	High	High
Rank 1–47 : Very high HD	Low							
Rank 48–94 : High HD								
Rank 95–141 : Medium HD	Medium							
Rank 142–187 : Low HD	High							
Socioeconomic Indicators								
Poverty incidence based on the Millennium Development Goal indicators of the United Nations Statistics Division (UNSD)		Poverty incidence	13.3% (2010)	3.8% (2009)	37.5% (1996) 37.0% (2002)	26.5% (2009)	22.7% (2006)	49.9% (2007)
UNSD rating	Urgency state	Urgency state	Medium	Low	High	High	High	High
<10% : Low	Low							
10% to <20% : Medium	Medium							
20% to <30% : High	High							
Over 30% : Very high								
Global Hunger Index (GHI) based on IFPRI and Concern Worldwide and Welthungerhilfe (2011)		GHI	12.2	3.2	10–15	11.5	8.5	27.1
IFPRI and Concern Worldwide and Welthungerhilfe rating	Urgency state	Urgency state	High	Low	High	High	Medium	High
<5 : Low	Low							
5–9.9 : Moderate	Medium							
10–19.9 : Serious	High							
20–29.9 : Alarming								
30 and above : Extremely alarming								

HD = human development, HDI = human development index, IFPRI = International Food Policy Research Institute, UNDP = United Nations Development Programme.
Source: Cabral et al. (2013).

Figure 8 **Relationship between Governance and Economic Growth**



GDP–PPP = gross domestic product at purchasing power parity per capita, HDI = human development index.
Source: Data from Cabral et al. (2012; 2013).

Demand for Fish

The growing demand for fish to feed a rapidly increasing population is putting heavy pressure on coral reefs and other fishery resources in the Coral Triangle. Fish trade in the Coral Triangle is also on the rise. From 2004 to 2008, the value of traded fish increased by 50%, a significant increase that is unsustainable in the longer term. Unmanaged, this poses a threat to all three higher-level outcomes: food security, sustainable fisheries, and coral reef ecosystem function. Of particular concern is the multimillion dollar live reef food fish trade, particularly from Indonesia, Malaysia, and the Philippines. The potential yields of the highly traded grouper species from reefs in moderate condition is estimated at approximately 0.4 tons per square kilometer (t/km^2) (Sadovy et al. 2003). Current yield estimates reach 2 t/km^2 (Muldoon et al. 2009). Increasing demand and high prices for groupers have resulted in intensified extraction. Fish involved in the trade has become, and will continue to be, unavailable and inaccessible to poor families because of high market price.

Climate Change

Sea surface temperature anomalies associated with climate change have led to coral bleaching events in Indonesia, Malaysia, and the Philippines. Climate-related sea level rise is a concern for small, low-lying islands of Indonesia, Malaysia, and the Philippines. Saltwater intrusion has been

observed in many areas of the CT6 countries, affecting mangrove vegetation and aquaculture production. Subsistence fishers in the CT6 countries are particularly vulnerable to the expected changes in weather patterns resulting from climate change. Potential impacts include interruption of livelihoods due to intensified waves and storms and destruction of properties (e.g., boats and houses). Climate change, coupled with severe, immediate local threats throughout the region, underscores the need to build resilient reefs by increasing efforts to curb local stresses (Burke et al. 2012).

Pressures and Threats to the Coral Triangle

In the Driver–Pressure–State–Impact–Response (DPSIR) framework, pressures and threats result from the confluence of various drivers such as population growth, poverty, and increasing pressure on resource use that manifest as state variables.

Pressures and threats are addressed by an integrated, focused, and well-planned mix of policy and institutional responses and ground-level actions that directly eradicate or minimize the pressures. Overfishing and destructive fishing are the most important threats to coral reefs in the CT6 countries; these were identified in the six national State of the Coral Triangle (SCT) reports, as well as in the *Reefs at Risk in the Coral Triangle* report. The other major stressors are excessive nutrient inputs and pollution, land and coastal development, and exploitation of threatened species (Figure 9).

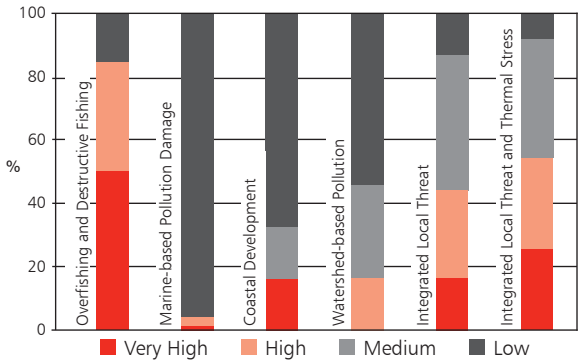
Terrestrial and coastal activities leading to runoff and pollution in the Coral Triangle also need to be addressed. Other escalating threats in the Coral Triangle include the proliferation and expansion of aquaculture and mariculture to meet growing food demands; proliferation of harmful algal blooms; and introduction of invasive alien species through aquarium trade, ballast-water discharges, and other shipping-related accidents. Increasing demand from coral extraction for construction in Indonesia, betel nut chewing in Solomon Islands, and coral mining in Papua New Guinea (PNG) and elsewhere in the CT6 also pose potential direct threats to coral reefs in those countries.

While the *Reefs at Risk* reports provide models of possible risks for coral reefs in the Coral Triangle (Burke et al. 2012), these need to be validated by the countries, as differences may arise between the models and actual status, as shown during a validation workshop in the Philippines. The workshop suggested that there were perceptible reductions of risks, as compared to the *Reefs at Risks* report in Burke et al. (2012), in illegal and destructive fishing scores in large areas of the country where marine protected area (MPA) networks were functional (MSN 2012).

Of the total reef area in the CT6 countries, 44% are predicted to have high to very high risk levels according to the Reefs at Risk models (Table 13). Comparison of in-country local integrated threats show that Timor-Leste has the most number of reefs subjected to high and very high local integrated threats relative to its total reef area (92%), followed by the Philippines (68%), Malaysia (43%), Indonesia (38%), and PNG and Solomon Islands (29%). However, in terms of total reef area, Indonesia and the Philippines together account for 80% of

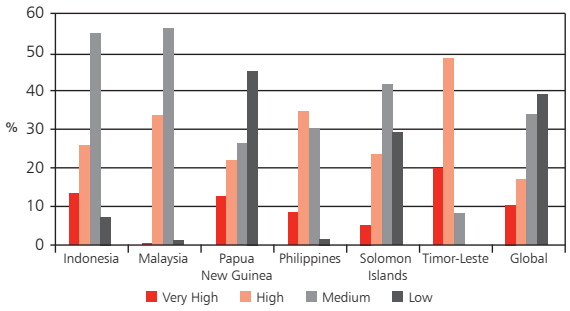
Figure 9 Coral Reefs at Risk from Various Threats in CT6 Countries

(A) Percentage of reefs in the CT6 countries at varying degrees of predicted risks by threat category



Note: Individual local threats are categorized as low, medium, and high. These threats are integrated to reflect cumulative stress on reefs. The fifth column, integrated local threat, reflects the four local threats combined consisting of four local threats—overfishing and destructive fishing, marine pollution and damage, coastal development, and watershed-based pollution. Reefs with multiple high individual local threat scores can reach the very high threat category, which only exists for integrated threats. The right-most column also includes thermal stress during the past 10 years. This figure summarizes current threats; future warming and acidification are not included.

(B) Percentage of reefs with varying degrees of predicted "integrated local threats"



Source: Burke et al. (2012).

reefs in the Coral Triangle under high and very high local integrated threat. Despite their large contribution to high-risk reefs in the Coral Triangle, in terms of reef area, it does not imply that efforts for reducing threats should focus mostly in these two countries. While the escalating threats offer great opportunities for positive social and economic development, their negative environmental impacts, if left unmitigated in a timely manner, will lead to cumulative effects that are more difficult to manage or may even become irreversible (Adora 2009; San Diego-McGlone et al. 2008).

The *Reefs at Risk* reports can provide initial models of possible risks in the Coral Triangle, which need to be complemented by on-site monitoring of coral reef conditions. The Philippines SCT reported that, although reefs threatened by coastal development, overfishing, sedimentation, and pollution increased from 2002 to 2012 (Burke et al. 2002, 2012), reefs highly threatened

Table 13 **Coral Reefs Under High and Very High Integrated Local Threats based on *Reefs at Risk* Analysis**

Countries	Total Reef Area (km^2)	Reef Under High and Very High Local Integrated Threat	
		Area (km^2)	%
Indonesia	39,538	15,009	38.0
Malaysia	2,935[a]	1,254	42.7
Papua New Guinea	14,535	4,161	28.6
Philippines	22,484[a]	15,358	68.3
Solomon Islands	6,743	1,975	29.3
Timor-Leste	146	134	91.8
Total	**86,381**	**37,892**	**43.9**

km^2 = square kilometer.

[a] Statistics for Malaysia and the Philippines do not include certain areas in the South China Sea. For further details on these areas, see Burke et al. (2012).

Source: Data from Burke et al. (2012).

by destructive fishing declined[9] as a result of increased enforcement activities in MPAs and fishery management efforts in several municipalities.

Current Issues in Marine Resource Management

Overfishing and destructive fishing assume varied dimensions across the Coral Triangle. In Indonesia and Malaysia, the increasing occurrence of industrial fishing, poaching, and the use of foreign fleets and employees are the issues highlighted in the country SCT. In the Philippines and in the Coral Triangle Pacific (CT-Pacific) countries, destructive fishing is a major issue; and in Timor-Leste, dynamite fishing is specifically mentioned. In Solomon Islands, destructive fishing occurs even in traditionally managed areas; while in PNG, the main issue is the increasing capacity of smaller, fiberglass boats to fish farther offshore. The information culled from Indonesia and Malaysia indicates that overfishing and coastal degradation are co-variables impacting on each other. Population growth and urban sprawl, and the associated pressures on coastal resources, prevail in all countries. Pressures on coral reef health in the Philippines include recreational activities and anchorage, while coral mining and the use of corals as construction materials are evident in Indonesia and Solomon Islands. Only Malaysia acknowledges that disjointed policies and institutional mandates exacerbate the management of conflicting land uses and their impacts on the coastal environment. A listing of specific issues confronting the CT6 countries is provided in Table 14.

The Philippines has reported signs of overfishing based on the maximum sustainable yield since the late 1980s, especially in small demersal and small pelagic fisheries. National information

[9] Based on the results of the MPA Support Network Threat Assessment Workshop held in 2012; and participated by various scientists, researchers, nongovernment organizations, and environment officials in the Philippines.

Table 14 Threats in CT6 Countries Reported in the Country State of the Coral Triangle

Country	Overfishing, Destructive Fishing, and IUU Fishing	Threatened Coastal Habitats, Excessive Nutrients, Pollution, and Other Threats (HABs and IAS)	Threatened/ Endangered Species
Indonesia	• Increasing industrial fishing activities, IUU fishing, and unsustainable fishing practices and fisheries bycatch in certain FMAs • Accidental catch by fishing gears threatening dolphins and whales	• (i) Illegal fishing activities; (ii) land-based pollution; (iii) coral mining for development material and sedimentation; (iv) seagrass threats from human activities; (v) mangrove threats due to unsustainable forest practices, land conversion and/or reclamation (for agriculture, aquaculture, mining, industry, port expansion, urbanization, tourism, and infrastructure development), coastal pollution from oil spills, and domestic and industrial wastes; and (vi) rareness or extinction of many coastal and marine species due to the destruction of critical coastal habitats and overfishing • Pollution due to discharge of untreated wastes into coastal areas from households and aquaculture activities; and large proportion of domestic sewage discharged directly or indirectly via rivers to the sea without proper treatment due to low level of sewage treatment • Negative impacts for IAS observed but no proper documentation • Invasion of water hyacinth impacts on part of lake and river areas, disturbing the habitats of freshwater organisms and reducing the area for freshwater aquaculture	Turtles, dolphins and whales, dugongs, humphead wrasses, and others (mollusks, corals, and crustaceans)
Malaysia	Encroachment of vessels into restricted zones, increasing use of foreign employees, increase in bycatch, dredging activities in estuaries, destructive fishing methods, land-based pollution and coastal mega developments, and changes in the availability of fish supplies	• Disjointed and fragmented legislations governing coastal habitats; land-based activities, land- and/or marine-based pollutants, sewage and industrial nutrients, fisheries activities (trawling), and recreational activities; lack of treatment for sewage in east coast islands; natural causes bringing about coastal erosion; marine turtles threatened by fisheries bycatch, direct poaching, habitat destruction and marine pollution, migratory nature, long-term harvesting of marine turtle adults and eggs; and inadequate institutional arrangements • Threats due to environmental effects, wastes from cage culture, farm escapees and invasive species from ballast water, genetic pollution and disease and parasite transfer, habitat modification; and threats that include human fatalities, and economic losses to both natural fisheries and cultured species • Global warming causing rise of sea temperature, resulting in bleaching of corals affecting many coral areas in Malaysia	Marine mammals, sea cucumbers, humphead wrasses (live reef fish trade in the Asia and Pacific region)
Papua New Guinea	Population growth and methods of fishing; and easy access to distant or protected fishing grounds by outboard-powered engines and fiberglass boats	• Effects of weather patterns, runoff from heavy rainfall; habitat degradation and loss of foraging and breeding areas through impacts associated to illegal fishing practices and IUU fishing; and lack of research and monitoring	Freshwater dolphin, dugong, three of marine turtles and three of freshwater turtles, all tuna species

continued on next page

Table 14 *continued*

Country	Overfishing, Destructive Fishing, and IUU Fishing	Threatened Coastal Habitats, Excessive Nutrients, Pollution, and Other Threats (HABs and IAS)	Threatened/ Endangered Species
Philippines	Impacts of overfishing and, to some extent, destructive fishing practices on coral reefs evident in the biomass of reef-associated fish; and increasing live reef food fishery	• Industrial development, ports and recreation, harvesting of fuelwood, construction, and charcoal; increase in coastal populations, built-up areas, and urbanization; coastal tourism; coral reef degradation through anchorage and landing facilities, saltwater intrusion, increasing traffic noise, and congestion; inappropriate land use practices; irresponsible mining practices; deforestation and illegal logging activities; improper waste disposal; and overstocking and fish kill, toxic chemicals, increasing demand in trash fish, alteration of physical environment, eutrophication from aquaculture, environmental impacts of culture of species, harmful algal blooms, and invasive species • Climate change adding to the extent of coral bleaching and may be causing frequent occurrences of algal blooms owing to adverse impacts on other resources	Marine turtles, whale sharks, humpback whales, and Irrawaddy dolphins
Solomon Islands	Destructive fishing practices involving both traditional and modern methods	• Natural disasters; coastal development (tourism development projects); coral mining and use of corals to build seawalls; seaward extensions of land and artificial islands; and domestic pollution, logging, and industrial-scale plantations • Low threat from aquaculture and/or mariculture, recent Marovo fish death due to HAB, and IAS from ballast water • Intrusion of freshwater lenses in atoll islands	Turtles, dolphins, dugongs, and whales
Timor-Leste	Evidence of overfishing in 2003; greater concentration of blast fishing craters along Laivai to Mehara transect, with some of the craters relatively recent as a result of IUU from Indonesian vessels; illegal fishing causing significant losses to Timorese economy	• Population growth, land degradation, inadequate infrastructure to supply water and remove sewage, urbanization, water and air pollution, intensified use of natural resources in the surrounding areas, and loss of agricultural and vegetated land due to urban sprawl • Low threat from aquaculture, and no record of HABs • Changes in weather pattern (prolonged drought, extended rains)	Three tree species, four birds, three mammals, and one butterfly specie

FMA = fisheries management area; HAB = harmful algal bloom; IAS = invasive alien species; IUU = illegal, unreported, and unregulated.
Source: Derived from a consolidated analysis of the *State of the Coral Triangle* country reports and authors' analyses.

has shown high incidence of very low fish biomass that implicates overfishing as a problem (Nañola et al. 2006). A significant decline in reef fish biodiversity in the Central Visayas region, historically known to contain the highest concentration of coral reef fishes in the world, has been observed at around 2% per decade (from 1970 to 2010) (Nañola et al. 2010). On the other hand, Indonesia and Malaysia reported overfishing concerns in the late 1990s. The national SCT reports include little information on the composition of fish assemblages today or in the recent past because of the paucity of large-scale data.

There has been a reported decrease in destructive fishing in many areas in the Philippines during 2002–2012, but the incidence of destructive fishing continues to be higher than anywhere else in the CT6 countries. The Indonesia SCT does not have an explicit account on the status of destructive fishing, but the most recent *Reefs at Risk* report showed considerable overfishing and destructive fishing indications in some areas (Burke et al. 2012).

Coastal development is perceived as an escalating issue for coral reefs, especially since it can profoundly affect habitat features (e.g., sedimentation from mining activities in the Philippines and PNG). Land-based pollution from poor land use is a growing concern in Indonesia. Coastal tourism, which entails the conversion of foreshore areas to varying degrees, has been seen to cause beach erosion in some areas of Indonesia, Malaysia, and the Philippines. On the other hand, there is no ongoing large-scale tourism development in Solomon Islands, although some areas are being mined for construction materials. Human settlements and poor agricultural practices pose an increasing risk to the coastal and marine resources in Timor-Leste and elsewhere in the CT6 countries.

Inappropriate land use practices such as deforestation and agrochemical loading, and coastal pollution from mining, are becoming major concerns in the Philippines. Coastal, maritime, and shipping industries, and the increase in urban sprawl and agricultural areas, have contributed to increasing pollution problems in Indonesia, Malaysia, and the Philippines. Domestic pollution and logging are long-standing concerns in the Pacific island countries such as Solomon Islands. Other sources of pollution in marine environment are wastes from rapidly growing human coastal communities and poor drainage systems from inadequate infrastructure. Improper waste disposal and poor practices in coastal tourism also pose additional threats to the coral reef ecosystem.

Overfishing, destructive and illegal fishing practices, and habitat conversion (e.g., for aquaculture and tourism) threaten many coastal and marine species in Indonesia and the Philippines. Marine turtles and marine mammals, such as dugong and humpback whale, are threatened in all the Coral Triangle countries. The Irrawaddy dolphin (*Orcaella brevirostris*) is particularly threatened in the Philippines. Large long-lived reef-associated fish, such as the whale shark (*Rhincodon typus*) and humphead wrasse (*Cheilinus undulatus*), are also considered threatened in Indonesia and the Philippines.

Escalating Issues in Marine Resource Use

Improper practices in aquaculture and mariculture, which may result in fish kills and eutrophication, are causes for concern in Indonesia and the Philippines. Emerging issues in Malaysia include habitat conversion, possible genetic pollution diseases, and parasite transfer. Mariculture is considered a low threat in the CT-Pacific countries, although there is current interest in the expansion of mariculture and aquaculture in Pacific island countries.[10] Invasive species associated with aquaculture have also been documented in Indonesia and the Philippines. Harmful algal blooms have been recorded in Indonesia, Malaysia, and the Philippines, with some cases even resulting in human fatalities. While there are no records of fish kills in Timor-

[10] RSCT Workshop in April 2012.

Leste, they have been noted in Marovo in Solomon Islands. Impacts of ballast water discharge have been observed in Malaysia and in Solomon Islands.

Other Issues

Fisheries transboundary issues on straddling stocks (e.g., tuna), shared stocks (e.g., small pelagics), and highly migratory threatened species (e.g., turtles, dugongs, and sharks) are major concerns not only in the Coral Triangle region but in the entire western and central Pacific Ocean. These issues are primarily discussed on overfishing in each of the countries. Issues concerning bêche-de-mer management have been documented in PNG and Solomon Islands. Marine turtles, such as the leatherback and green turtles, are important iconic species for the seascapes of the Bismarck–Solomon Seas Marine Ecoregion and the Sulu–Sulawesi Marine Ecoregion.

Responses: Progress in Implementing the National and Regional Plans of Action

The CT6 countries link their national plans of action (NPOAs) with those of the regional plan of action (RPOA). Their approaches illustrate how their country actions can contribute to, and be amplified at, the RPOA. The five goals of the Coral Triangle Initiative (CTI) addressed in the plans of action are the following:

Goal 1: Priority seascapes designated and effectively managed

Goal 2: Ecosystem approach to management of fisheries and other marine resources fully applied

Goal 3: Marine protected areas established and effectively managed

Goal 4: Climate change adaptation measures achieved

Goal 5: Threatened species status improving

The three countries in the Coral Triangle Southeast Asia—Indonesia, Malaysia, and the Philippines—prepared NPOAs, which are consistent with the structure of the RPOA. On the other hand, the Coral Triangle Pacific countries—Papua New Guinea, Solomon Islands, and Timor-Leste—established their own priorities. For example, the Timor-Leste NPOA highlights ecosystem approach to fisheries management (EAFM), marine protected areas (MPAs), and climate change adaptation (CCA) consistent with their own priorities. Meanwhile, the Solomon Islands NPOA is based on a platform of Community-Based Resources Management Plus (CBRM+), which is an adaptive management that incorporates food security, ecosystem approach to resource management, and vulnerability and adaptation planning. Instead of articulating the goals, four crosscutting themes guide the NPOA implementation in Solomon Islands: (i) support to and implementation of resource management efforts, (ii) policy and legislation, (iii) data and information needs, and (iv) communication and raising awareness.

The establishment of MPAs and the promotion of marine mammals as attractions for the ecotourism industry target Goals 3 and 5 of the CTI. In relation to CCA, Malaysia has completed the Region-Wide Early Action Plan for Climate Change Adaptation (REAP–CCA). Other related plans in the context of the CTI and the NPOA are either being implemented or have already been completed (e.g., National Coastal Zone Physical Plan for Peninsular Malaysia, 2010). Goal 5 is pursued through the implementation of national laws and participation in international conventions such as the Convention of Migratory Species. Malaysia is a party to the Memorandum of Understanding (MOU) on the Conservation and Management of Marine Turtles and their

Habitats in the Indian Ocean–South-East Asia (IOSEA Marine Turtle MOU) in September 2011. Support to Goal 5 has also entailed the introduction of turtle excluder devices to trawl fishers in Sandakan, Malaysia. Further support is embodied in a joint initiative of Malaysia and the Philippines to establish the Turtle Islands Heritage Protected Area, which also addresses Goal 3.

In terms of progress toward attaining the CTI goals, most of the efforts in the CT6 countries appear to be focused on improving MPA effectiveness (Goal 3), followed by those related to EAFM (Goal 2). In Indonesia, Papua New Guinea (PNG), and the Philippines, at least two-thirds of their NPOAs deal with these two goals. Malaysia and Timor-Leste have considerable investments in EAFM, and Timor-Leste also considered CCA (Goal 4) and MPA management among its top priorities.

Indonesia

In Indonesia, actions toward achieving Goal 1 include the establishment of priority seascapes: Anambas–Natuna–Karimata and the Bird's Head of Papua in 2010. Based on Indonesia's report to the Seventh Senior Officials Meeting (SOM 7) in October 2011, six seascapes have been identified: Karimata Strait, Lesser Sunda, Makassar Straits and North Sulawesi, Gulf of Tomini, Bird's Head of Papua, and Banda Sea. Harmonization of seascape plans with the fisheries management areas (FMAs) and local spatial plans is reported as a next step. As for the Sulu–Sulawesi Marine Ecoregion (SSME), there has been reported progress in establishing MPA networks based on turtle corridors. Additionally, Indonesia is co-implementing the Sulu–Sulawesi Seas Sustainable Fisheries Management, 2010–2014, which includes the Transboundary Diagnostics Analysis for Sulu–Sulawesi waters and is funded by the Global Environment Facility and the United Nations Development Programme.

To address Goal 2, actions include the following: (i) further development and implementation of effective regulations for optimizing FMAs; (ii) enforcement of legislation and regulations pertaining to illegal, unreported, and unregulated (IUU) fishing; (iii) capacity building and support for large-scale enterprises; (iv) development of an integrated coastal fisheries community to achieve sustainable fisheries and monitoring; and (v) control and surveillance of tuna fisheries.

Indonesia's report to SOM 7 highlights the following EAFM achievements:

(i) Prepared a ministerial regulation concerning ship registration in the Regional Fisheries Management Organization;
(ii) Completed the zoning regulation on the use of fishing gears in FMAs or *wilayah pengelolaan perikanan*;
(iii) Implemented the National Program for Poverty Eradication in Marine and Fisheries Sector and introduced an integrated approach to support small-scale fisheries, actions envisioned under the Sustainable Coastal Fisheries and Poverty Reduction Initiative (COASTFISH) program, which the RPOA touts as the poverty reduction component of CTI;
(iv) Developed a certification scheme for fisheries best practices (capture, aquaculture, and processing); and
(v) Tuna tagging and revitalization of tuna fisheries through capacity building, field monitoring, processing, and investment in a cold chain system.

Goal 3 actions have resulted in nearly 2 million hectares (ha) increase in MPAs from 2009 to 2011, and the designation of the 1.2 million-hectare Marine Recreational Park of Anambas Islands. Marine curriculum development and capacity building were also highlighted as achievements of the CTI. For Goal 4, a strategic CCA research is aimed at reducing climate change threats to coral reef ecosystems. Coral observations using Compact Airborne Spectrographic Imager sensor have started in Tanibar Island, and plans are being developed to study carbon dioxide variability and its relation to the blue carbon concept.

Public awareness campaigns have also begun in earnest in Maluku, Maluku Utara, Nusa Tenggara Barat, Papua, and Sulawesi. To address Goal 5, efforts include the identification of coral curio for trade and review of the protection status of the Napoleon wrasse. The Minister of Home Affairs has produced a government circular to manage the ban on trade in sea turtles. To implement the NPOA for sharks, Indonesia has begun the inventory and distribution of sharks and initiated action on shark protection.

Malaysia

Malaysia is one of the lead countries in the SSME program, which has made good progress toward Goal 1. Efforts to address Goal 2 include the implementation of EAFM through the SSME program; and the enforcement of laws, including the Wildlife Protection Act, 1972 and the Fisheries Act of 1985, which guide the management of fisheries and the protection of marine mammals. A fisheries initiative launched in conjunction with the National Agro-Food Policy (2011–2020) in January 2012 is aimed at achieving the higher-level outcome of better food security.

For Goal 2, Malaysia has started the assessment of small pelagic fish in Semporna, and plans are under way to declare a closed season in Tun Mustapha National Park. Kota Marudu is also being primed as a CTI model site, where several actions are occurring, including the farming of sea cucumbers and mangrove resource management.

Papua New Guinea

The NPOA of PNG was launched during the Secretariat of the Pacific Regional Environment Programme Council Meeting in Madang in 2010. The country has been active in addressing Goals 1 and 5, being a partner in the Bismarck–Solomon Seas Marine Ecoregion (BSSME) and the Leatherback Turtle Conservation Program. Large-scale marine areas were designated as priority seascapes across territorial and archipelagic waters in PNG to serve as the geographic focus for major investment and development in the country. Seascape investment plans for priority seascapes have been completed, along with arrangements for sequencing investments in line with PNG's Vision 2050. PNG has also joined the Arafura–Timor Seas Programme.

However, PNG does not have specific policy and legislation that address EAFM (Goal 2), although there are draft policies on fish aggregating devices (FADs), community-based management, and MPAs that complement and support EAFM. The report to SOM 7 (2011) also mentioned community training in EAFM principles and the deployment of FADs in certain provinces.

At the moment, no large-scale MPA exists in PNG, but there is a large wildlife management area in Western Province called Maza WMA, which focuses on the protection of turtles and dugongs (Goal 5). The Kimbe Bay Marine Management Area is a network of 11 locally managed marine areas (LMMAs) that contribute to Goal 3. Five communities in West New Britain Province completed community engagement processes and their management plans, and signed conservation agreements with their local governments to manage and protect their marine areas. Further, the West New Britain provincial government delivered banana boats to the four LMMAs to support their community biological monitoring and surveillance to keep poachers away.

CCA (Goal 4) is pursued through hazard-based approaches, which address coastal flooding events, for instance. There are also efforts to set up early warning systems, protect coral reefs, conduct vulnerability assessments, rehabilitate mangroves, and engage in provincial consultations. Vulnerability assessment has been conducted in the Central Province and in project sites by respective nongovernment organizations (NGOs). The report to SOM 7 outlined various activities in support of Goal 4, as follows:

(i) Set up technical working group (TWG) as part of the Pilot Program for Climate Resilience process to carry out vulnerability assessment in selected areas of PNG;
(ii) Conduct the course on CCA for Coastal Communities and Training of Trainers hosted by PNG at March Girls Resort, with 24 trainees from national and provincial governments, NGOs, and community-based organizations of PNG and Solomon Islands; and the participants now preparing to implement individual country plans;
(iii) Construct a dry seawall in Tubuserea Village, Central Province, with guidance provided on techniques for constructing seawalls for coastal defense;
(iv) Conduct a national mangrove workshop on 11–12 May 2011 and prepare a draft plan for a national community-based mangrove planting program; develop a mangrove planting manual; and identify and select pilot sites for demonstration activities; and
(v) Set up coastal early warning system through text messaging to give communities early notice about extreme weather and climate-induced events.

In pursuit of Goal 5, PNG signed the IOSEA Marine Turtle and Dugong MOU in September 2010. In addition, a dugong pilot project was launched in the Western Province, where a larger activity on assessment of dugongs, marine turtles, and associated habitats is already taking place.

Philippines

To attain Goal 1, the Philippines has designated two priority seascapes (SSME and the West Philippine Sea [also known as South China Sea][11]); and has developed implementation plans for the three subcommittees of the SSME, as well as Transboundary Diagnostic Analysis Tool. Goal 2 has been pursued by drafting national policies on EAFM (i.e., policy for tuna management), live reef food fish trade (LRFFT), and monitoring of tuna catches and small pelagics (e.g., sardines). In its report to SOM 7, the Philippines discussed the start of new projects, including the Regional Fisheries Livelihood Project and Livelihood Partnership Program toward Sustainable Tuna,

[11] In the context of the Regional State of the Coral Triangle, West Philippine Sea (also known as South China Sea) shall be used analogously and coterminously throughout this report.

while completing a policy and market study on *dulong* fishery. Contributions to Goal 3 are the (i) assessment of locally established and managed MPAs by the Marine Protected Area Support Network, (ii) establishment of 10 MPAs under the National Integrated Protected Area System, and (iii) increase in the number of marine key biodiversity areas in marine biogeographic regions.

NGOs are currently conducting a nationwide assessment of MPAs using the MPA Management Effectiveness Assessment Tool in preparation for the October 2013 MPA Awards—*Para El Mar*. The Coral Triangle Support Partnership (CTSP) under Conservation International–Philippines provided a grant to the University of the Philippines Marine Science Institute to develop the nationwide MPA database. A Sustainable Coral Reef Ecosystems Management Program was implemented covering nationally declared MPAs of 1.7 million ha in line with Goal 3.

For Goal 4, the Philippines adopted the CCA framework in 2010, and CCA plans have been conducted in Dumaran and Taytay in Palawan Province. There have also been initiatives to conduct vulnerability assessment and climate change-related research in nearshore habitats with the United States CTI Program supporting two sites—the Verde Island Passage (VIP) and Sablayan Municipality in Occidental Mindoro Province. The VIP-wide mangrove mapping was completed and communicated to the local governments as input for CCA. The CCA plans have also been prepared for Sibutu and Sitangkai in Tawi-Tawi Province and in Dumaran in Palawan Province. The Remote Sensing Information for Living Environments and National Tools for Sentinel Ecosystems in the Archipelagic Seas Program (2009–2011) built partnerships among national government agencies, local governments, academe, and other local stakeholders to pursue such work.

Monitoring of threatened species was initiated to address Goal 5. Mechanisms (e.g., payment for ecosystem services) have been identified to generate funds for assisting national and local governments in implementing activities to achieve NPOA goals. Capacity building programs, such as mentoring of state colleges and universities within CTSP geographic focus areas, are also being undertaken.

Solomon Islands

To address Goals 1 and 3, Solomon Islands has prioritized the BSSME by signing the MOU in 2006, declaring a transboundary partnership among Indonesia (Papua), PNG, and Solomon Islands. The Solomon Islands LMMA was established to coordinate the management of marine resources, addressing Goal 3. In addition, the National Biodiversity and Strategic Action Plan and other pieces of legislation, such as the Protected Areas Act 2010, guide the declaration and management of protected areas. In its report to SOM 7, Solomon Islands cited its progress in implementing the Protected Areas Act through a series of implementing regulations, and by articulating the community-based coastal resource management model to expand its geographic coverage.

There are no confirmed policies and regulations that are directly related to EAFM (Goal 2); but some principles of the approach are reflected in the Fisheries Act (1998), in fisheries regulations, and in the management plans for specific resources. The Ministry of Environment, Climate Change, Disaster Management and Meteorology (formerly the Minister for Environment, Conservation and Meteorology) and the Ministry of Fisheries and Marine Resources are the

lead agencies for actions to implement Goal 4. A regional action plan was developed to provide guidance in the conservation of the endangered leatherback turtle in the BSSME, thus contributing to Goal 5. The action plan engages Indonesia, PNG, and Solomon Islands in the conservation of the leatherback through information sharing, data exchange, and research.

Timor-Leste

Timor-Leste established baseline data, key policies, and legislation to support fisheries and protected area management as support for Goals 2 and 3. Establishing MPAs and building the capacity of relevant stakeholders to design, manage, and monitor these protected areas contributed to the achievement of Goal 3. Timor-Leste reported the implementation of an integrated coastal marine spatial plan for MPAs in Jaku Island, which is an action identified under Goal 2, Target 2 on improved income, livelihoods, and food security. An initiative for Goal 4 is the creation of a Climate Change Information Center to house historical data and information on climatic conditions and climate change impacts, and to function as a learning hub for communities. An assessment of threatened species is being done, and fisheries policies and management plans for the proposed MPA network are being developed to address Goals 2, 3, and 5.

Regional Priority Actions

Nine priority actions agreed upon by the CT6 countries are the best gauge of progress in the region. At the SOM 7 in October 2011, the actions were categorized as (1) completed, (2) in progress, and (3) not started. An action was deemed completed at the level of the TWG but may or may not indicate a formal endorsement of the SOM. Updates on the status of regional actions were culled from reports of the TWGs and new reports.[12]

All but two of the nine actions have either been started or completed (e.g., the Region-Wide Early Action Plan for Climate Change Adaptation [REAP-CCA] and the Coral Triangle Marine Protected Area System [CTMPAS] framework) (Table 15). Likewise, the *Seascapes Guidebook* has been completed, with copies circulated during SOM 7, although it lacked endorsement of the Seascape Working Group.[13] A draft of a common regional framework for EAFM has been completed and awaiting endorsement and adoption. An implementation road map, which includes issues on illegal, unreported, and unregulated (IUU) fishing and LRFFT, has also been prepared.

The CTMPAS framework and action plan have been endorsed by SOM 8 in November 2012 in Kuala Lumpur, Malaysia, for final review by the national coordinating committees before full implementation. One of the highlights of the MPA Regional Exchange held in Solomon Islands in March 2013 is the readiness of the countries to nominate regional flagship sites. Regional Action 5, which focuses on building capacity for effective management of MPAs, is in progress in Malaysia, the Philippines, and Timor-Leste. They are likely to adopt the MPA Effectiveness

[12] CTI. http://www.coraltriangleinitiative.org/ and http://www.coraltriangleinitiative.org/news
[13] Conservation International. 2011. *The Seascapes Guidebook: How to Select, Develop and Implement Seascapes*. http://www.conservation.org/publications/Pages/seascapes_guidebook.aspx

Table 15 Progress in Implementing the Coral Triangle Initiative Regional Plan of Action

Plan of Action No.	Goal/Target/Action	Status
1	Goal 1 (Seascapes), Target 2 (Marine and coastal resources within all "priority seascapes" are being sustainably managed) Action 1: Adopt a general "model" for sustainable management of seascapes	Completed, awaiting formal endorsement by the Seascape Working Group
2	Goal 2 (Ecosystem approach to fisheries management [EAFM]), Target 1 (Strong legislative, policy, and regulatory frameworks are in place for achieving an EAFM) Action 1: Collaborate to develop a "common regional framework for legislation and policy" that would support EAFM; and drawing on this, strengthen regional and national legislations, policies, and regulations	Completed, awaiting endorsement by the Eighth Senior Officials Meeting
3	Goal 2 (EAFM), Target 1 (Strong legislative, policy, and regulatory frameworks are in place for achieving an EAFM) Action 2: Improve enforcement of illegal, unreported, and unregulated fishing through greater collaboration	In progress
4	Goal 3 (Marine protected areas [MPA]), Target 1 (Region-Wide Coral Triangle Marine Protected Area System [CTMPAS] in place and fully functional) Action 1: Jointly establish the overall goals, objectives, principles, and operational design elements for CTMPAS centered on priority MPA networks	Completed
5	Goal 3 (MPA), Target 1 (Region-Wide CTMPAS in place and fully functional) Action 3: Build capacity for effective management of the CTMPAS	In progress
6	Goal 4 (Climate Change Adaptation [CCA]), Target 1 (Region-Wide Early Action Plan (REAP) for CCA for the nearshore marine and coastal environment and small island ecosystems developed and implemented) Action 1: Identify the most important and immediate adaptation measures that should be taken across all Coral Triangle countries, based primarily on analyses using existing models	In progress
7	Goal 4 (CCA), Target 1, Actions 3 and 4 (blended): Complete and implement REAP for CCA and conduct capacity needs assessments and develop capacity programs on CCA measures	Completed
8	Goal 5 (Threatened Species), Target 1 (Improve the status of sharks, sea turtles, seabirds, marine mammals, corals, seagrasses, mangroves, and other identified threatened species) Action 3: Complete and implement Region-Wide Sea Turtles Conservation Action Plan	Not yet started
9	Goal 5 (Threatened Species), Target 1, Action 5: Complete and implement a Region-Wide Marine Mammals Conservation Action Plan	Not yet started

Source: Various reports and communications of the Coral Triangle Initiative technical working groups.

Assessment Tool model applied and tested in the Philippines, while the other countries have adopted commonly used protocols for assessing management effectiveness.

Through regional exchanges,[14] representatives from the CT6 countries and development partners developed the CTI REAP–CCA, which serves as a framework for building coastal community resilience by

(i) providing a regional outlook on climate change issues and early actions to guide national and subnational planning and implementation,

[14] One in Indonesia (Ancol, Jakarta, in October 2010) and one in Solomon Islands (Honiara, in April 2011).

(ii) promoting an integrated approach to CCA that achieves the dual objectives of sustainable development and risk reduction,
(iii) supporting collaboration among institutions to share data and knowledge and to report on progress, and
(iv) identifying possible financing mechanisms to support implementation of early actions.

The SOM 7 adopted the document, thus completing Regional Action 7.

Coral Triangle Initiative Index

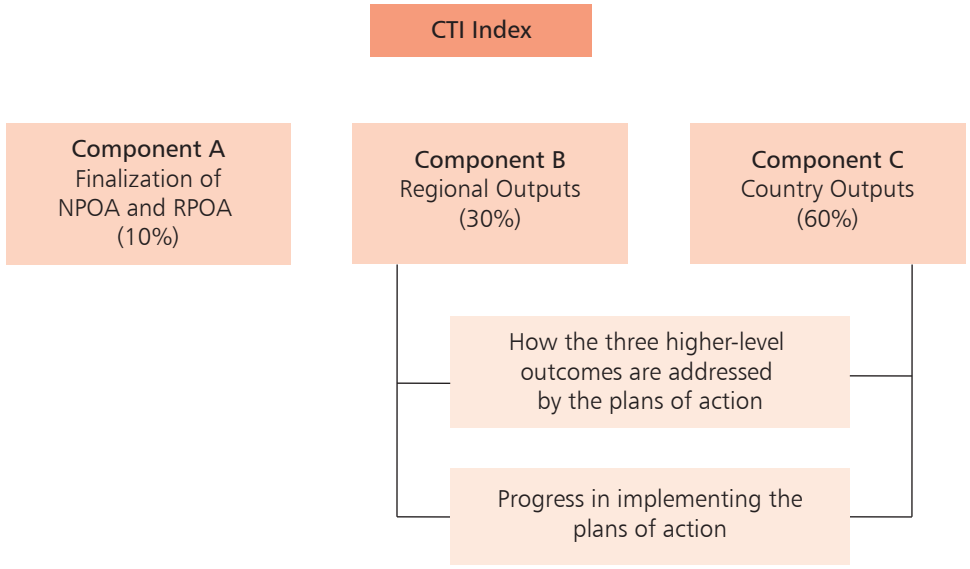
To determine the progress of the countries working individually and jointly in the Coral Triangle region, a CTI index was developed and piloted during the regional State of the Coral Triangle report and Monitoring and Evaluation Working Group (MEWG) meetings in Jakarta in October 2012. The CTI Index was the only method that attempted to measure progress against the three higher-level outcomes; its methodology and implementation can be improved. Its usefulness in this report is to expose the method to stir interest and propose improvements. The three higher-level outcomes are sustained coral reefs ecosystem and its services (outcome 1), established sustainable fisheries (outcome 2), and attained food security (outcome 3).

Three indexes for CTI were proposed for (i) coral reefs, (ii) fisheries, and (iii) food security. These indexes measure the progress of the CTI in performing actions identified in the RPOA and NPOAs; and these are broken down into three components (Figure 10):

(i) **Development of national and regional plans of action.** A score of 10% is automatically provided as the minimum level of attainment as a result of success in drafting, finalizing, and agreeing on the principles of the CTI and its goals and actions. At the baseline, a score of 10% is assigned.
(ii) **Progress of implementation in the region.** A score of 30% is assigned to regional progress. Scoring is subjected to a two-stage process. Regional experts, such as thematic group members, development partners, and the CTI Secretariat, were asked to participate in the scoring. MEWG indicators are used as proxies of the goals–targets–actions to facilitate analysis.
(iii) **Progress of implementation in each country.** A score of 60% evaluates individual country progress in implementation, with each of the CT6 countries contributing a maximum of 10%. Scoring for each country is based on a two-stage process. The first stage determines how each of the country priorities are perceived to contribute to the three higher-level outcomes. Users are asked to rate how each of the goals contribute to the three outcomes, i.e., as being low, medium, or high. The second stage is an assessment of implementing actions in the NPOA as completed, started, and not started. This scoring system gives importance to the status of implementation and assumes that completion of action contributes to the overall goals. Furthermore, there is a tacit understanding that the priority actions of each country contribute in one way or another to the three outcomes of coral reefs, fisheries, and food security (CFF).

The method is an affirmation of the RPOA and NPOA. First, by assigning a minimum score of 10 points, the method gives credence to the work already done in finalizing and complying

Figure 10 **Components of the Coral Triangle Initiative Index**



CTI = Coral Triangle Initiative, NPOA = national plan of action, RPOA = regional plan of action.
Source: This study.

with the programs of action. Theoretically, the scores should move upward as progress with the RPOA and NPOA is achieved. The indicators for CFF should move in tandem. If this does not happen despite successful completion of actions in both the RPOA and NPOAs, adjustments can be examined by looking at the assignment of weights, and can be made by introducing or amending the actions. This could mean that the plan, which guides actions, is unable to align with the higher-level outcomes or, alternatively, respond to threats.

A total of 15 CTI experts, with 4 from the region, filled out the score sheets. The scores for CFF yielded an average of 42%, with minimum variance (Table 16). The method can be improved further by expanding the sample size and improving the weights. As the monitoring and evaluation (M&E) system is developed, the index can be computed by a third-party expert who can verify the progress in relation to the M&E indicators.

Table 16 **Coral Triangle Initiative Index Scores**

	Coral Triangle Initiative	Regional	Indonesia	Malaysia	Papua New Guinea	Philippines	Solomon Islands	Timor-Leste	Total
Points	**10.00**	**30.00**	**10.00**	**10.00**	**10.00**	**10.00**	**10.00**	**10.00**	**100.00**
Coral Reefs	10.00	12.56	3.73	3.85	3.00	4.62	4.83	…	42.58
Fisheries	**10.00**	**12.01**	**3.96**	**3.86**	**2.53**	**4.62**	**4.67**	…	**41.65**
Food Security	10.00	12.47	4.30	4.14	2.00	4.69	4.83	…	42.44

… = data not available.
Source: Coral Triangle Initiative Index Methodology developed and tested by ADB technical assistance for *Regional Cooperation on Knowledge Management Policy, and Institutional Support to the Coral Triangle Initiative* (TA 7307-REG).

Impacts: Benefits to Coral Triangle Coastal Communities

The desired higher-level outcomes of the Coral Triangle Initiative (CTI) are (i) maintaining coral reef ecosystem functions, goods, and services; (ii) improved fisheries stocks; and (iii) better food security. Achieving these outcomes requires an understanding of the drivers that shape the viability of the specific targets and goals. It is thus essential that governance capacity and benchmark conditions are assessed to track the effectiveness of responses. One challenge that needs to be addressed is whether the responses, such as the regional plan of action (RPOA), will result in positive ecological outcomes, in terms of stabilization of coral reefs and in improved fisheries and food security, leading to benefits to society in general.

Social and Human Development Benefits from Maintaining Ecosystem Functions, Goods, and Services

Coral reefs and the associated coastal ecosystem perform important functions—coastal protection, fisheries production, recreation, education, and generation of livelihood—benefits that can be derived from implementing governance actions contained in the RPOA and in the national plans of action (NPOAs). Climate change adaptation (CCA) actions to implement the Local Early Adaptation Plan and the Region-Wide Early Action Plan are expected to contribute to coastal protection against extreme events and coastal erosion.

Monitoring the extent of effective coastal zone management could minimize risks to people residing in coastal areas. Monitoring can be further translated into the valuation of coral reefs, where estimates of economic and social benefits for a coral reef area may be derived (Cruz-Trinidad et al. 2009). A greater understanding of how coral reefs are able to provide protection from the effects of sea level rise and coastal erosion could motivate coastal communities to become stewards of their coastal habitats (Villanoy et al. 2012). Timely actions that are implemented effectively at various governance scales would have profound impacts on a significant proportion of at least 120 million people living within 10 kilometers of the coast in the Coral Triangle region (Cabral et al. 2012, 2013).

The outputs of the RPOA activities include agreements on the implementation of the Coral Triangle Marine Protected Area System, and strengthening and sustaining management effectiveness in specific geographic focus areas. Assessing the outputs would redound to

improved ecological conditions and lead to increasing social and economic benefits, like improved fisheries production and fishers' incomes. The CTI monitoring and evaluation indicators for measuring the progress of CTI implementation in relation to the expected impact and higher-level outcomes, as agreed during the Monitoring and Evaluation Working Group workshop held in October 2012, are presented in Appendix 1. It should be noted that this report treats the three outcome statements as being at the same level, as originally formulated by the CTI.

Social and Economic Benefits from Sustainable Fisheries Ecosystems

Interrelated governance responses embodied in the RPOA, such as improving the effectiveness of marine protected areas (MPAs) and establishing ecosystem approach to fisheries management (EAFM), would lead to improved conditions of fisheries stocks in coastal and pelagic areas. Improved MPA effectiveness and EAFM at the local level (e.g., reef fisheries), at the seascape level (e.g., sardines), and at the regional level (e.g., agreements on tuna and live reef food fish trade [LRFFT]) would eventually contribute to the overall improvement of fisheries stocks. In turn, these would lead to improved fishers' incomes and help to alleviate poverty and enhance human well-being. The study by D'Agnes et al. (2010), despite its inherent limitations in quasi-experimental research design, illustrated the importance of looking at ecological and social outcomes. Linking the status of reef conditions with associated fish biomass estimates offers a means to determine parameters for MPA no-take zones, and demonstrates the benefits of spillover to fisheries (Abesamis and Russ 2005).

Fish visual census surveys have also been used to illustrate an initial approximation of allowable biomass catch and projections related to overall maximum sustainable yield (MSY). Although there are real concerns in using MSY estimates, trends detected should still be regarded as a wake-up call (Licuanan et al. 2008). Challenges encountered, including those associated with regulating overfishing and reversing fisheries decline when moving toward sustainable fisheries, have been highlighted by many authors at the local and eco-regional scales (Lachica-Aliño et al. 2009, Pauly and Chua 1998, Pauly and Christensen 1993). Various levels of interaction between small-scale municipal and commercial fisheries and reef relationships with tuna stocks (Allain et al. 2012) suggest the importance of understanding the fisheries social and ecological systems and dealing with them at various governance levels.

Improved Food Provisioning and Contribution to Food Security

The Food and Agriculture Organization of the United Nations (FAO) (2011) defines food security as a condition "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life."

A recent evaluation of national vulnerability of fisheries, reef management, and food security to climate change in 27 countries, including the countries in the Coral Triangle Southeast Asia, found that Indonesia was most vulnerable to climate change with a rank of 1, the Philippines with a rank of 5, and Malaysia the least vulnerable (Hughes 2012). In the Pacific, a study of food security, based on required protein consumption, found that the current per capita protein consumption of Papua New Guinea (PNG) is below the required level to support the consumption and needs of its people. The same study showed that per capita protein consumption in Solomon Islands is within the boundary of the required level to support consumption but will inevitably experience hardship in meeting the demand for fish (Bell et al. 2009).

A new assessment of coral reefs, fisheries, and food security (CFF) in the CT6 countries found that all of them, except Malaysia, have urgent food security concerns (Cabral et al. 2012). Malaysia heavily relies on imports of fish to support the consumption and needs of its population, which makes it susceptible to fluctuations in the supply of fish from other countries.

Food security has multiple definitions and is defined by the FAO as composed of three pillars:

(i) availability of consistent and sufficient quantities of food,
(ii) access or the capacity to obtain appropriate and sufficient foods, and
(iii) consumption or appropriate use of basic nutrition and food preparation.

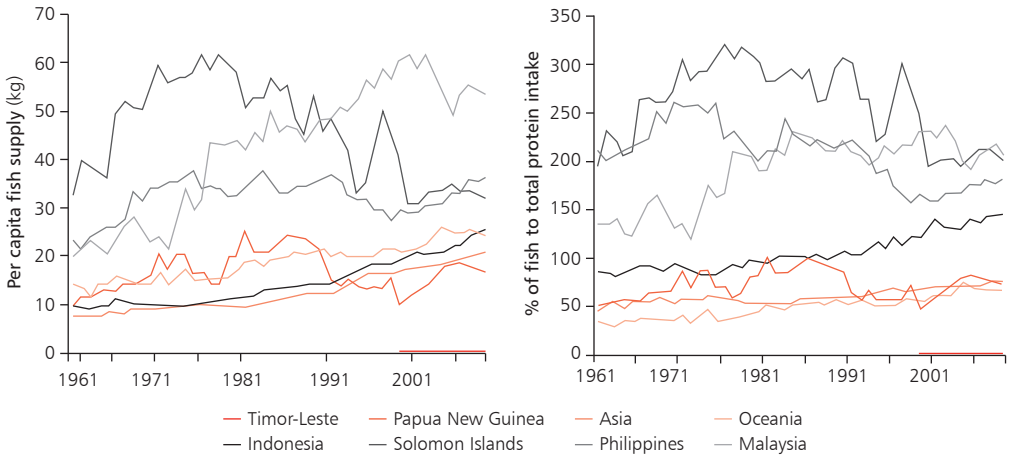
The Secretariat of the Pacific Community (SPC), in conjunction with the Commonwealth Scientific and Industrial Research Organisation, analyzed the food security condition of 15 Pacific island countries. It involved four traditional food security pillars: (i) adequacy, (ii) availability, (iii) stability, and (iv) utilization (SPC 2011).

Adequacy means "enough food on a consistent basis, either through local production or imports or food assistance from outside sources" (SPC 2011).

Adequacy. Fish and aquatic invertebrates are important protein sources for most countries in Asia and the Pacific. Production from both capture and culture fisheries continues to rise in all CT6 countries, although the rate of growth of capture fisheries has been slowing down while aquaculture is rapidly increasing. Per capita fish supply in Indonesia, Malaysia, and the Philippines in 2009 remained above the average values for Asia; and has been increasing since 1961, with Malaysia showing the fastest rate of increase (Figure 11). This is also true for Solomon Islands compared to the Oceania average. However, PNG and Timor-Leste have per capita fish supply values below the average for Oceania; and for Timor-Leste below the average for Asia. Per capita fish supply for Solomon Islands increased from 1961 to the mid-1970s, but started to decline thereafter. Recent estimates for Solomon Islands reveal a per capita fish supply similar to the early 1960s, while PNG's per capita fish supply has fluctuated by 10–20 kilograms (kg) over the last 48 years.

Following the same trend as the per capita fish supply in Indonesia and Malaysia, the importance of fish as a protein source has also been increasing in both countries (Figure 11). In contrast, despite the increasing per capita fish supply in the Philippines, the relative contribution of fish to total protein consumption of Filipinos has been declining. In PNG and Solomon Islands, the

Figure 11 **Per Capita Fish Supply (*left*) and Percentage Contribution of Fish to Total Protein Intake (*right*) in CT6 Countries, Asia, and Oceania, 1961–2009**



kg = kilogram.
Source: FAO (2010).

pattern of fish contribution to total protein consumption reflects the same temporal pattern observed for their per capita fish supply, indicating direct consumption of fishery resources by the population.

Availability means "the ability of households and individuals to acquire food" (SPC 2011).

Availability. Fresh fish is still the primary source of protein for the Coral Triangle population, although the contribution of meat is continually increasing. Based on the country SCT reports, the annual average fish consumption is currently 13 kg/person in PNG and 31 kg/person in Solomon Islands. FAO data (2012) show Malaysia as having the highest annual per capita fish consumption among the CT6 countries at 51 kg/person, followed by the Philippines at 32 kg/person. However, although fisheries resources are an important source of protein in the CT6 countries, the contribution of fish protein to the dietary energy requirement in Indonesia, PNG, the Philippines, and Solomon Islands is below the recommended 10%–12% dietary energy consumption (FAO 2012; Cabral et al. 2013).

Stability means "resilience of food supplies to external shocks, such as natural disasters" (SPC 2011).

Stability. Growth in fish exports from the Coral Triangle region of 50% in 2004–2008 is remarkable but unsustainable. Malaysia has a significant negative trade balance in fish export. Predicted declines in fish and food supply may increase market prices of these commodities and may limit access to these foods.

Utilization means "requiring that people are healthy enough to process the food internally, and have adequate safe water and sanitation and food hygiene and child-care skills" (SPC 2011).

Utilization. Estimates of undernourishment in the CT6 countries comprise 13% of total population or 46 million people, with more than 60% coming from Indonesia (Table 17). On the Global Hunger Index, Indonesia, PNG, the Philippines, and Timor-Leste registered from serious to alarming numbers, albeit improving, except in the case of Timor-Leste (Table 18).

Table 17 Poverty and Undernourishment in CT6 Countries

Country	Population, 2009[a]	% of Population below National Poverty Line[b]	Undernourished in the Population (2005–2007)	
			No.	%
Indonesia	231,370,000	13.3 (2010)	30,078,100	13.0
Malaysia	27,900,000	3.8 (2009)	558,000	2.0
Papua New Guinea	6,348,000	37.0 (2002)	1,650,480	26.0 (1995–1997)
Philippines	92,226,600	26.5 (2009)	13,833,990	15.0
Solomon Islands	515,870	22.7 (2006)[c]	56,746	11.0
Timor-Leste	1,039,936	49.9 (2007)	322,380	29.5
Total	**359,400,406**		**46,499,696**	**12.9**

Note: The general trend for the proportion of the undernourished in the population is declining in the region, and this value is potentially higher than its value for 2005–2007.

Sources: [a] ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; [b] Millennium Development Goals. United Nations Statistics Division; [c] Solomon Islands National Statistics Office and United Nations Development Programme Pacific Center Suva, 2008.

Table 18 Global Hunger Index in CT6 Countries, 1990–2009

Country	1990	1996	2001	2009	Status
Indonesia	18.5	15.5	14.3	12.2	Serious yet improving toward a moderate level
Malaysia	9.0	6.7	6.6	3.2	Transition from moderate to low level
Papua New Guinea	17.1	17.2	…	…	Serious with condition improving based on the trend in the percentage of undernourished population and under-5 mortality rate
Philippines	19.9	17.5	14.1	11.5	Serious yet improving toward a moderate level
Solomon Islands	…	…	…	8.5	Current state is moderate
Timor-Leste	…	…	26.1	27.1	Alarming level

… = data not available.

Note: Global Hunger Index (GHI) is computed as (Undernourishment + Child underweight + Child mortality)/3; GHI: low (<5); moderate (5–9.9); serious (10–19.9); alarming (20–29.9); extremely alarming (30 and above).

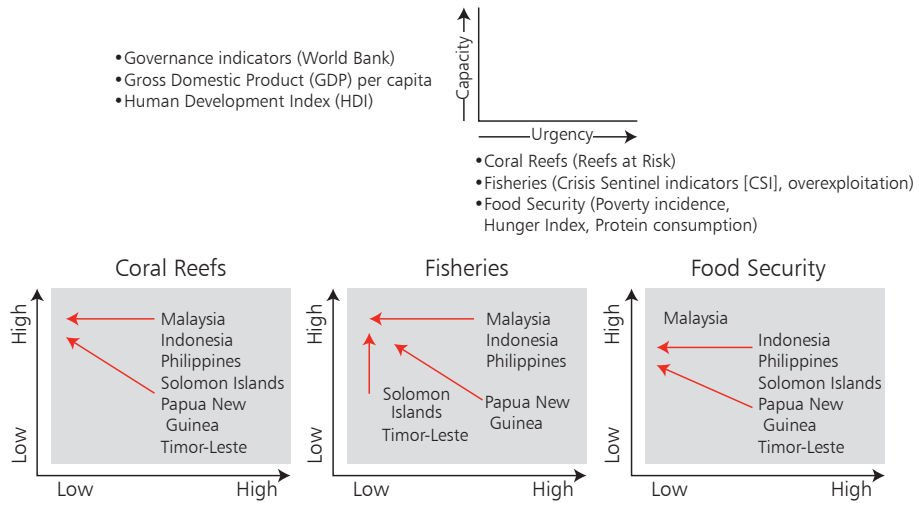
Source: International Food Policy Research Institute (IFPRI), Concern Worldwide, and Welthungerhilfe (2011); Cabral et al. (2013).

Improved management of coral reefs and associated ecosystems will help maintain coastal integrity and improve fisheries stocks, resulting in better affordability, availability and quality, and safety of food from coastal and marine ecosystems. Better food security is expected to result from the RPOA at the local level such as LRFFT guidelines and conditions that include incentives linked to good practices in fisheries management, and better market arrangements such as reducing asymmetry of information of fish food and other alternatives. At the seascape level, investments in cooperative prevention of illegal, unreported, and unregulated fishing; and fair fisheries trade promoting affordability and food safety through joint agreements will contribute to improved food security. At the regional level, agreements on tuna conservation and incentives, through social enterprise development and public–private partnerships to minimize overexploitation and unfair trade practices, could help in equitable allocation of benefits in the value chain.

Relationships of Ecological, Social, and Governance Conditions

In all the CT6 countries, there is an urgent need to address climate change threats and the resultant degradation of coral reefs, the associated ecosystem in relation to different governance and socioeconomic conditions, and consequent variable development paths (Figure 12). For example, Timor-Leste will require transcending governance and socioeconomic barriers to address the urgent needs of habitat degradation. In contrast, Malaysia is the least vulnerable among the CT6 countries, as a result of its capacity to address habitat degradation and unsustainable fishing concerns and their impacts on food security. In Solomon Islands,

Figure 12 Socioeconomic and Environmental Governance Capacity of CT6 Countries Utilizing Gross Domestic Product at Purchasing Power Parity per Capita



Note: HDI and governance indicators are used as proxies to address coral reefs, fisheries, and food security issues in relation to the urgency of the issues.

Source: Modified from Cabral et al. (2012).

overfishing is less of a concern, but food security is of relatively high urgency; and habitat degradation is an emerging concern. Indonesia and the Philippines have similar moderately high capacity, but both urgently need to address overfishing, habitat degradation, and food security issues. PNG has a moderate socioeconomic and governance capacity but with an urgent need to reverse habitat degradation, overfishing, and food insecurity trends. In general, there is a need to reduce the vulnerability of the CT6 countries by increasing their capacity in good governance; and by introducing socioeconomic incentives, such as knowledge management, capacity development through improved regional cooperation, and learning processes and standards of good practices.

Information Gaps and Gap-Filling Recommendations

The Driver–Pressure–State–Impact–Response (DPSIR) framework employed in analyzing the state of the Coral Triangle made use of information and data presented in the national State of the Coral Triangle (SCT) reports, which were assumed to be official statistics provided by the respective national agencies. Summaries from the national SCT reports highlighted gaps in information and data needed to evaluate the progress toward the higher-level outcomes based on baseline conditions described in the SCT reports.

A gap analysis of the data and information needs in the CT6 countries was undertaken to understand the linkages between the target outputs in the national plans of action (NPOAs) and the higher-level outcomes of conserving coral reefs, establishing sustainable fisheries, and attaining food security.

Gaps in Information and Data for Tracking the State of the Coral Triangle

Information needed to track the progress of implementing the Coral Triangle Initiative (CTI) Regional Plan of Action (RPOA) and NPOAs is being set up by the CTI Monitoring and Evaluation Working Group (MEWG). The RPOA monitoring and evaluation (M&E) indicators have been selected, consulted with the national and regional CTI secretariats, and presented in great detail in documents developed by the MEWG (Appendix 1).

Countries have yet to implement the CTI M&E system; but once they do, it will be possible to obtain an objective report on the status of implementing the CTI RPOA and NPOAs—if the countries adopt and/or adapt the regional indicators to fit their national actions.

Using inputs from the country SCT report, the status of the Coral Triangle countries was reevaluated from the perspective of the CTI higher-level outcomes. The biophysical and socioeconomic conditions of the coral reefs and associated habitats and fisheries were assessed based on the information provided in the country SCT and validated during the regional State of the Coral Triangle (RSCT) workshops. Higher-level outcome indicators were proposed, and the information available for each country and for each indicator was provided by the participants at the RSCT workshop.

Gaps in Indicators for Coral Reef Ecosystem Integrity

For the higher-level outcome of "improved coral reef ecosystem functions, goods, and services," the following indicators were suggested by the participants at the RSCT workshops: (i) condition of coral reefs, (ii) extent of mangroves and seagrasses, (iii) fish biomass, and (iv) extent of coral reefs and associated habitats in fully protected areas.

Linkages between social benefits and changes in ecological and socioeconomic conditions derived from governance will need to be better articulated along with the required capability-building support. It is not surprising that the national SCT reports do not present a comprehensive and extensive description of the status of the countries' coral reefs. The CT6 countries have available information on the extent of their coastal habitats and some evaluation of the habitat conditions. However, the overall countrywide conditions are not well elucidated in the SCT. There is limited information on the condition of the coral reefs, coral reef fish biomass, and the extent of coral reefs and associated habitats within fully protected areas relative to the total extent and condition of coastal habitats (i.e., coral reefs, mangroves, and seagrasses). Some of the numbers presented in the SCT report also cannot be reconciled with other figures estimated from other studies or even the estimates of the Coral Triangle Atlas team. The six country SCT reports value for the extent of coral reefs but not for mangroves and seagrasses.

It is crucial to examine the extent and condition of the reefs and adjacent coastal habitats and how they change over time to determine whether reefs are healthy or resilient amid the threats and/or whether they are responding well to the intervention or management actions, if any. Filling the data gap on the condition of coastal habitats requires that monitoring programs are in place at strategic areas to characterize the conditions that will enable the CT6 countries to adjust their responses based on the broad, national coral reef ecosystem state changes. In addition, the ecosystem functions, services, and goods related to these habitats would need to be described in relation to their uses (e.g., coastal protection, recreation, tourism, and others) and users (e.g., human settlements, export, and trade value of products). While all CT6 countries have yet to mainstream coral reef M&E in overall government planning and programming, coral reef monitoring is being done by scientists, nongovernment organizations, underwater diving volunteers, and even local governments at a good number of sites in the Coral Triangle. A national reef monitoring program can be developed based on these ongoing small-scale or subnational-scale assessments through consolidation and standardization. A good example of such effort is done in the Philippines through the biennial State of the Coasts reporting, where the national status of coral reefs is consolidated from studies done in various parts of the country by different groups. However, this has yet to be institutionalized and formally adopted by the national government.

Gaps in Indicators for Fish Stock Improvement

For the higher-level outcome of "improved and sustained fish stocks," the following indicators were suggested by the participants at the RSCT workshops: (i) change in conservation status of commercially important fish species (coastal and pelagic), (ii) change in catch per unit effort by gear, (iii) change in species composition relative to trophic level, (iv) change in size distribution by fish species, and (v) change in exploitation status of pelagic and other species.

Fisheries production is monitored in the CT6 countries, although the Coral Triangle Pacific countries are only starting to develop their national fisheries statistics. Malaysia's annual fisheries statistics are the most detailed and most accessible (through the Department of Fisheries website). The Philippines also regularly publishes its annual fisheries statistics via the website of the Bureau of Fisheries and Aquatic Resources, but long-term changes are not analyzed extensively. Indonesia's fisheries statistics are mostly in Bahasa Indonesia, although general production data are available from the Ministry of Marine Affairs and Fisheries. However, the indicators proposed for the higher-level outcome require additional information not often collected through regular fisheries statistics. Fishing effort is severely lacking in most fisheries statistics. This limits standardized comparisons of production changes that take into account the increasing effort, which often accompanies the maintenance of fisheries beyond the maximum sustainable yield. A huge gap in the fisheries statistics of the CT6 countries, however, pertains to small-scale and subsistence fisheries, which are mostly associated with coral reefs and other coastal habitats.

Analysis of spatial relationships of harvest rates and fishing grounds need to be refined, and require independent fisheries monitoring (i.e., productivity-based measures, fish census, and experimental fishing designs). The heterogeneous nature of fisheries, especially coastal fisheries associated with habitats, requires spatially explicit data, currently limited in national fisheries statistics. Although changes in catch and trophic composition have been identified as a more appropriate indicator, only a few countries collect this information and are able to analyze it in the context of evaluating sustainable fisheries production. Many countries in Asia and the Pacific report a large proportion of their catches as "marine/freshwater fish not identified elsewhere" (Lymer et al. 2010)

Gaps in Indicators for Food Security from Marine Sources

For the higher-level outcome of "improved food security," the following indicators were suggested by the participants at the RSCT workshops:

(i) availability or food sufficiency of fishing household inferred from food consumption of coastal communities;
(ii) quality and safety of food fishes in terms of contribution of fish to protein requirement and the health of fishing communities;
(iii) affordability of fisheries products including income of fishers and price elasticity; and
(iv) community resiliency or social well-being element, such as the Gini index and localized downscaled version of the Human Development Index.

Among the three higher-level outcomes, measuring the proposed indicators for food security is the most difficult, at least for traditional stakeholders and partners of fisheries management and conservation. These data are not presented in the country SCT report, except for some small details (e.g., average fisher incomes).

It should be noted that the CTI MEWG included the increase in income of fishers among the RPOA indicators. Available data on national fish and seafood consumption are not reported in most of the country SCT reports. On the other hand, these are reported in other sources (e.g., Food and Agriculture Organization [FAO], World Development Indicators, Millennium Development Goals, and others), and can be adopted as part of or linked to the fisheries

ecological monitoring system in the countries. Information on the availability and accessibility of marine-sourced produce is also lacking. This information can help managers prioritize fisheries and develop ancillary industries. Thus, dialogues with the relevant economic planning and social welfare agencies, as well as health and nutrition organizations in the CT6 countries are necessary, as is the mainstreaming of coastal and environmental governance in local and national institutions, with participation of relevant stakeholders. It is imperative to inculcate a CTI ethos and culture locally, but with a regional–global perspective, as part of the efforts of community-based organizations.

Information on the value chain for important fisheries (e.g., tuna, live reef food fish trade [LRFFT], and other high-value invertebrates) is also needed, along with the social behavior of fishers on costs and expenditures and income from fishing and other livelihood sources, to address issues related to food poverty.

Gaps in Achieving Higher-Level Outcomes

The use of the DPSIR framework for summarizing the state of the Coral Triangle enables a stakeholder to see the bigger picture, and to contextualize the efforts presented in the CTI RPOA and NPOAs. To assess the state of the Coral Triangle from the perspective of the higher-level outcomes, the actions identified in the country SCT reports were extracted and categorized according to their scope: national (by Coral Triangle country); seascape (Sulu–Sulawesi Marine Ecoregion [SSME], Bismarck–Solomon Seas Marine Ecoregion [BSSME]); and regional (beyond the scope of the current priority seascapes or encompassing the entire Coral Triangle region).

However, given that the country SCT reports contain information mostly up to the seascape level only, regional actions were identified from documents available at the regional CTI Secretariat, particularly the CTI regional working groups. Laws and policies stated in the national SCT reports prior to 2009, when the CTI was adopted, were excluded unless specific actions after 2009 pertaining to its implementation were mentioned. The resulting matrixes, presented in Appendix 2, revealed action gaps at the national, seascape, and regional levels.

Higher-Level Outcome 1: Coral Reef Ecosystem Integrity and Services Stabilized and/or Maintained

National-level actions. Sustaining coral reefs and ecosystem services is being achieved in the CT6 countries primarily through establishing and managing marine protected areas (MPAs). Indonesia, Malaysia, Papua New Guinea (PNG), and the Philippines have advanced networks of functioning MPAs. There are several MPA effectiveness assessment tools and national coral reef monitoring programs in Indonesia, Malaysia, and the Philippines. An incentive system for the best-managed MPAs is in place in the Philippines, where awards are given every 2 years. Coral collection and export are banned in Malaysia and the Philippines, while Indonesia and Solomon Islands continue to collect and export corals. All countries, except Timor-Leste, are working on climate change adaptation (CCA) plans and programs.

Seascape-level actions. The SSME has networks of MPAs within smaller corridors, and a larger network of protected areas established for marine turtles. Fisheries management interventions

initially focused on addressing threats to the marine turtle populations in this region. Connectivity studies have been conducted to inform possible ecologically connected MPAs within the seascape, but no seascape-wide MPA network plan has been prepared. In the BSSME, PNG and Solomon Islands signed an agreement for the conservation of leatherback turtles.

Regional-level actions. The CTI MPA Working Group has conducted studies and released guidelines on establishing MPA networks that integrate fisheries, biodiversity, and climate change objectives in the design. A regional-level MPA effectiveness assessment tool is also being developed from existing tools in the region. The Coral Triangle Marine Protected Area System will help provide the governance process systems and standards that will improve the effectiveness of MPAs to achieve the higher-level outcome of stable coral reef integrity, goods, and services. A series of training on Local Early Adaptation Plan for climate change have been conducted in the CT6 countries.

Identified gaps. Corals continue to be extracted and exported from some of the CT6 countries, thereby directly impairing coral reef ecosystem services, especially if extraction rates are high. Timor-Leste requires basic habitat information and possibly identification of important marine areas for protection and conservation. MPAs within seascapes are not yet been networked and plans for seascape-wide MPA networks have not yet been developed, except for a relatively recent development (2011–2013) in the Philippines on networking of MPAs along the West Philippine Seascape (also known as South China Sea). While countries are monitoring their MPAs and, to a limited extent, the condition of coral reefs and other habitats, there is very limited socioeconomic monitoring of MPAs and coral reef uses, particularly on the costs and benefits of MPAs to affected communities. There is also no regional climate change monitoring and information exchange, although this has been identified as a target in the CTI RPOA.

Recommendations. Some recommended actions for the CTI to sustain and improve coral reef ecosystems and services are as follows:

(i) Reduce the impact of coral extraction on coral reefs by exploring coral farming strategies to supply the traditional betel nut for chewing in Solomon Islands,
(ii) Evaluate the social and economic costs and benefits of MPAs and CCA,
(iii) Address threats that are beyond MPAs (e.g., marine-based pollution, sedimentation, watershed-based pollution, and others), and
(iv) Develop regional-level incentive systems for good practices in MPA network management.

Higher-Level Outcome 2: Fish Stocks Improved and Sustained

National-level actions. The CT6 actions to establishing sustainable fisheries focus primarily on enforcing the laws to curb and halt illegal fishing practices and prosecute those who continue to do so. The Philippines reports a 10% decline in the threat from destructive fishing based on a reevaluation of the *Reefs at Risk* threat values. Vessel registration is implemented in Indonesia, Malaysia, and the Philippines. However, incorporating subsistence fishers in the national registration systems remains low. In the Philippines, municipal fishers' registration is not consolidated or compiled at the national level. Hence, estimates of the number of fishers, boats, and total effort exerted on fishery resources are critical gaps for evaluating fisheries sustainability. Effort regulation, such as limiting the number of permits and licenses for fishing, is being implemented only by the Coral Triangle Pacific countries. Malaysia implements buyback

schemes for certain fishing gears; while Indonesia and Malaysia both implement fishing zones or fisheries management areas, and the Philippines has initiated fisheries management units. All of the CT6 countries provide support to local fishers. Indonesia provides subsidies to the fisheries sector. The Philippines employs a conditional cash transfer (CCT) scheme that provides conditional cash grants to extremely poor households, including fishing households, to improve their health, nutrition, and education, particularly children aged 0–14.

Seascape-level actions. The SSME's fisheries management intervention initially focused on addressing threats to the marine turtle populations in this region. The Turtle Islands Heritage Protected Area represents an important milestone of cooperation among Indonesia, Malaysia, and the Philippines. More recently, the three countries started conducting studies to evaluate the small pelagic fisheries in this region and the options for improving the stocks following declines in population. In the BSSME, circular hooks have been adopted to reduce bycatch of marine turtles.

Regional-level actions. The CTI regional working group on ecosystem approach to fisheries management (EAFM) is preparing a "common regional framework for legislation and policy." It would support EAFM, which will be accompanied by an 8-year (2012–2020) road map for implementation in the CT6 countries. There is no regional action yet on the LRFFT, which is being addressed currently by the EAFM technical working group (TWG).

Identified gaps. At the national level, linking support to fishers (e.g., subsidies and CCT programs) with conservation and sustainable fisheries targets can add value to these initiatives; and result in long-term benefits to fishing communities, and not just to individual households. In seascapes, comprehensive, direct, and coordinated fishing interventions are still lacking beyond the marine corridors. Regional-level actions of the CT6 countries are still being planned and developed using an EAFM framework through a regional TWG.

Recommendations. The CT6 countries are linked by ecological, socioeconomic and trade, and governance arrangements that provide numerous opportunities for regional collaboration. In addition to efforts related to adopting EAFM as a framework for making their fisheries sustainable, a few other regional actions can be undertaken to complement these activities. These include the following:

(i) Harmonize production targets with conservation and food security needs, since most countries do not have concrete targets for their fisheries except to increase fish production and make full use of marine resources for economic development, and the targets for fisheries production and development can be improved by considering food needs and balancing these with conservation goals.
(ii) Develop incentives and disincentives for accountability of other countries to comply with other regional agreements.
(iii) Link local and national incentives to CTI goals and targets, e.g., use of subsidies on fishers practicing responsible fisheries or adding sustainable fishing practices as a condition for CCT programs.
(iv) Enhance the use of traditional ecological knowledge and wisdom to improve compliance and success of regional cooperation.
(v) Develop and implement standards, certificates, and incentives for good practices in live reef fishing and fisheries in general.

(vi) Develop and provide market trade incentives or premiums for fish sold by fishing communities adhering to good and/or sustainable fisheries, such as the application of EAFM.
(vii) Increase the participation of countries in a rule-based regional fisheries arrangement, since the boundaries of the CT6 countries are porous when it comes to fisheries but bilateral agreements for access to fishing grounds exist. This will most likely increase in the future as stocks in heavily exploited fishing countries continue to decline. Regional agreements need to be put in place this early to ensure that such events become opportunities for cooperation instead of dispute.

Higher Level Outcome 3: Affordability, Availability, Quality, and Safety of Food from Coastal and Marine Resources Improved

National-level actions. Only Indonesia, Malaysia, PNG, and the Philippines have specified actions in their country SCT report to address food security issues. Indonesia has started implementing a Sustainable Coastal Fisheries and Poverty Reduction Initiative (COASTFISH) program to empower fishing communities and develop small-scale fisheries. Malaysia launched a National Agro Food Security Program in January 2012. The Philippines provides livelihood diversification options for fishers, and is developing aquaculture and ecotourism as poverty alleviation measures for coastal communities. PNG is following suit with the development of aquaculture for food security.

Seascape-level actions. No seascape-level actions relating to food security have been identified in the country SCT reports, aside from ongoing fisheries-related activities.

Identified gaps. Addressing and improving the contribution of marine resources to food security are gaps. It is the least addressed higher-level outcome in the CTI. It is implicitly addressed through improvement of fish availability (i.e., improving fish stocks through EAFM), but not explicitly addressed in terms of accessibility (e.g., measures to make fish more affordable). Aquaculture has also been noted as an important intervention for addressing fish scarcity from capture fisheries, but it is not included in the CTI RPOA.

Recommendations. Some actions to sustain and improve food security from marine sources in the CTI include the following:

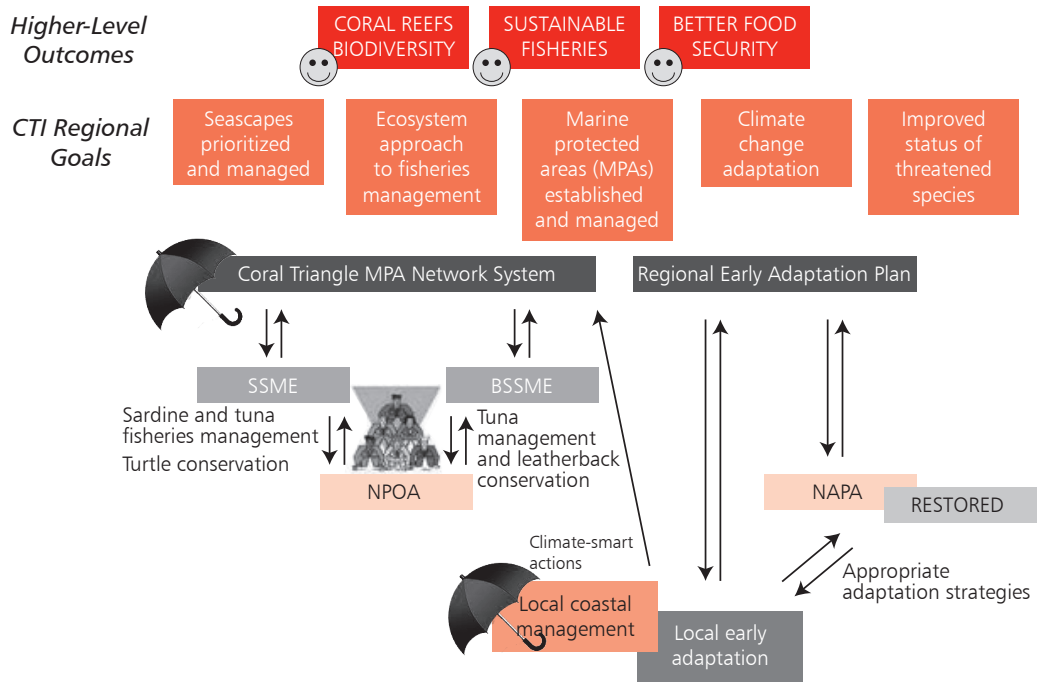
(i) Monitor the contribution of fisheries to food security, and
(ii) Diversify livelihood options to increase the ability of fishers and local communities to access fish.

Summary and Conclusions

Summary

The Driver–Pressure–State–Impact–Response (DPSIR) framework shows the governance responses of the Coral Triangle Initiative (CTI) in contributing synergistically to the attainment of the five CTI goals, and eventually to the overall achievement of the higher-level outcomes of coral reefs biodiversity, sustainable fisheries, and better food security (Figure 13).

Figure 13 **Indicative Linkage of the National and Regional Plans of Action**



BSSME = Bismarck–Solomon Sea Marine Ecoregion; CTI = Coral Triangle Initiative; NAPA = National Adaptation Program of Action; NPOA = national plan of action; RESTORED = Restoring, Enhancing, Sustaining, Threshold maintaining, Organizing management bodies, Resiliency building, Effective management and Disaster risk reduction; SSME = Sulu–Sulawesi Marine Ecoregion.

Note: RESTORED are strategies for climate change adaptation.

Source: Aliño (2012).

The RSCT report can also be used to track changes in social and ecological *states* within the CT6 countries and within the context of *drivers* and *pressures* prevalent in the region, which could help adjust the *responses* to more effectively achieve expected *impacts*. Regular reporting can provide valuable input to the feedback mechanisms of the CTI Monitoring and Evaluation Working Group (MEWG).

The regional plan of action (RPOA) and national plan of action (NPOA) provide value-added contributions:

(i) regional cooperation and complementary action and coordination;
(ii) accelerating progress of the interconnectedness of ecological outputs and outcomes leading to beneficial social impacts in the CT6 countries;
(iii) overcoming transactional costs by enhancing effectiveness in governance systems through adaptive management processes, systems, and standards; and
(iv) monitoring and evaluation, and response and feedback mechanisms through the Coral Triangle Marine Protected Area System (CTMPAS) and integrated with ecosystem approach to fisheries management (EAFM) that can scale up to seascape and region-wide levels and continue the learning-by-doing process.

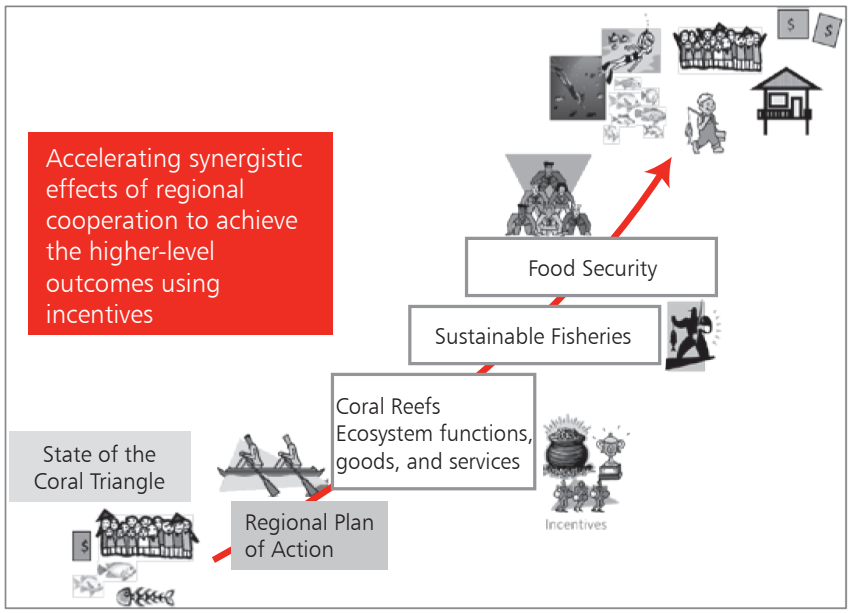
The present region-wide governance of the social and ecological arrangements in the Coral Triangle is at its incipient stage, with the interim secretariat hosted by Indonesia. Various bilateral and seascape agreements have been forged at the seascape level, such as the Sulu–Sulawesi Marine Ecoregion (SSME) and the Bismarck–Solomon Sea Marine Ecoregion (BSSME), which provide the opportunity for integration and synergy region-wide through the RPOA. Furthermore, existing fisheries agreements are important staging areas to accelerate progress in linking coral reef conservation, sustainable use of ecosystem goods and services, and improved food security.

The RPOA and/or NPOA also complement existing international agreements, such as the Rio agreements including the Convention on Biological Diversity. These have, in turn, contributed to the regulatory and institutional framework of the CTI. Considerable headway has been achieved in setting up foundation mechanisms through the CTMPAS and in initiating local early adaptation plans (LEAPs), which upon consolidation into the national adaptation program of action, could contribute to the broader Region-Wide Early Action Plan (REAP). Planned regional sharing forums on tuna fisheries and live reef food fish trade (LRFFT) should also include discussions on incentives to motivate cooperative agreements and minimize conflicts. In addition to seascape investment planning, integrating threatened species concerns within the CTMPAS is also being considered. Interrelated actions outlined in the NPOAs can be scaled up into joint bilateral and multilateral agreements facilitated by the RPOA, as shown in Figure 14.

These cooperative arrangements will contribute to the higher-level outcomes of stabilizing coral reef integrity, establishing sustainable fisheries, and improving food security for the region's population. Synergistic positive effects are expected to achieve accelerated impacts by helping build resiliency of social and ecological systems through incentives such as capacity building of good governance systems through the CTMPAS, REAP/LEAP, and sharing forums that lead to fisheries agreements such as for tuna and LRFFT.

These efforts will help reduce negative impacts and eventually make positive contributions to society as a whole. The engagement and capacity development of various Coral Triangle

Figure 14 **Illustrative Schema of Desired Accelerated Synergistic Effect Resulting from Coral Triangle Initiative Regional Cooperation**



Source: Aliño (2012).

stakeholders in the implementation of CTI actions, and tracking their progress through the CTI MEWG, will pave the way for attaining outputs and outcomes, including benchmark databases and knowledge management systems. Regular updating of the RSCT (e.g., every 2–3 years) with the help of knowledge management integrators (as part of the CTI MEWG system) will promote informed, science-based decisions and actions to support adaptive management. Incorporating incentives to reward good practices will help sustain motivation and encourage participation. The need for good coastal governance to achieve intermediate ecological outcomes, such as stabilizing and maintaining coral reef functions and ecosystem services, is gradually being recognized (McLeod et al. 2012, Burke et al. 2012).

Having and understanding a region-wide approach, linked to national and global priorities, are crucial in realizing the desired higher-level outcomes and their beneficial impacts to human and natural communities.

The CTI has already put in place the fundamental elements espoused in the five goals of the RPOA. Linking governance activities have yielded significant outputs in marine protected areas (MPA) and formulation of climate change adaptation plans. Despite challenges to the CTI, initial contributions have planted seeds of hope in the functional working groups in place (e.g., MPA, CCA Technical Working Group, and the State of the Coral Triangle [SCT] reports knowledge integrators). These groups not only provide a core cadre of people in the Coral Triangle, they could also initiate the social marketing process necessary for local and national efforts to yield benefits for biodiversity conservation and human well-being. The improvement of ecological conditions in many MPAs, such as Apo Island and Tubbataha in the Philippines,

has shown that small and large protection efforts could result in ecological resilience and social and economic benefits among concerned stakeholders. Translating this into a regional impact could be explored in the next edition of the RSCT.

The preparation of the RSCT is a process that engages the CT6 countries in consolidating National CTI Coordinating Committee inputs and analyses, which are based on changing conditions of socioecological systems and governance responses (e.g., RPOA/NPOA) within the context of existing drivers. Monitoring and evaluation indicators and the monitoring process are useful in eliciting the linkages between these interactive components.

Opportunities can be derived from the drivers to broaden partnership arrangements at various governance levels, such as among sectors and external players and forces that include donors and markets. These opportunities can be expanded through incentives, like agreed standards for recognition and tax credits that promote good governance processes and systems. For example, a certification system with conditions based on public welfare standards may be developed to encourage the private sector to engage responsibly through social enterprises in the marine aquarium trade. The system may install standards, such as no–take areas based on fish densities, as well as grow-out procedures where certified organisms are provided premium prices. Such governance systems may be applied in various modes for the CTI goals, such as in transboundary fisheries for shared and highly migratory stocks like tuna.

Other examples are region-wide fisheries management systems or sharing forums to reach agreements on good practices, guidelines, protocols, and standards. Diversifying opportunities for livelihood options (e.g., the Sustainable Coastal Fisheries and Poverty Reduction Initiative [COASTFISH]) minimizes threats, and provides the bridge between the governance input *responses* and the *drivers* that lead to improved ecological conditions. In the community, the strategy would enhance livelihood, capacity to access food, and overall well-being. These interactions and processes may also be replicated as governance responses in the climate change context. The outputs (e.g., LEAPs, REAP, and national adaptation program of action) and outcomes (e.g., hectares of restored mangroves and protected coral reefs) result in social and economic benefits. These include those derived from the capacity of healthy coastal ecosystems to help prevent coastal erosion and minimize the impacts from strong waves, thereby protecting human communities and preventing the loss of lives and properties.

Conclusions

Five major thematic thrusts, and 13 suggested actions are put forward to enhance the links between the NPOAs and RPOA to the desired outcomes, and contribute to the achievement of the five CTI goals and three higher-level outcomes. The following are proposed for consideration by the CT6 NCCs, nodal departments, technical working groups, Regional Secretariat, and the development partners in the next phase of the CTI:

1. Achieve synergies at different governance scales to earn the value-added benefits of overcoming transactional costs (e.g., improving seascapes and operational functions of the CTI as a result of cooperation and complementation)
   (ii) Coordinate actions through improved processes, systems, and standards, such as awards and incentive systems for best practices across MPAs and MPA networks and social enterprises;

(iii) Ensure that benefits from institutional coordination are plowed back to managing ecosystems and their uses through sharing agreements; and
(iv) Monitor the costs and benefits of cooperative governance to gauge impacts on human and ecological systems; and provide timely response feedback systems, including enabling conditions for social enterprise development.

2. Invest in capacity building and knowledge management to overcome the lack of governance capabilities in CTI systems, processes, and standards (e.g., CTMPAS and EAFM)
   (i) Build the resiliency and capacity of local, national, and regional bodies in the planning and implementing the CTI NPOAs/RPOA (e.g., incentives through conditional grants linked to incentives-based progress of capabilities and performance);
   (ii) Understand and apply science-based learning through an adaptive research and development learning networks, such as the Coral Triangle Center and the Coral Triangle Initiative–Coastal Learning Adaptation Network; and
   (iii) Organize monitoring and feedback-sharing forums for the regular updating of the country SCT and RSCT reports at least every 3 years.
3. Exchange resources and engage and empower equitable partnerships
   (i) Establish a Coral Triangle regional investment fund that will rationalize financial and economic support for the CTI; and develop mechanisms that will ensure the sustainability of the CTI, including public–private partnerships; and
   (ii) Improve access of vulnerable coastal communities to available food resources and social enterprise development.
4. Commit to the harmonization of fisheries production targets with biodiversity conservation and food security needs
   (i) Complete the IUCN Red List of Threatened Species and critical habitat assessments and harmonize these at local networks, the seascapes integrating EAFM and CTMPAS (e.g., SSME and BSSME);
   (ii) Establish safety nets and diversify livelihoods that promote fisher stewardship (e.g., conditional cash transfer programs); and
   (iii) Ensure that international and local agreements consider traditional ecological knowledge and wisdom and customary marine tenure through knowledge management and sharing forums linked to regional organizations.
5. Reduce risks and threats through the integration of the LEAPs and REAP
   (i) Form regional climate adaptation and disaster risk reduction response programs (e.g., CTI climate research and development-sharing exchanges with other regional forums); and
   (ii) Mitigate and minimize threat transfer effects, such as from illegal, unreported, and unregulated fishing; and transmigration through joint enforcement agreements, such as the SSME learning shared on Coral Triangle region-wide scale.

The establishment of the CTI Regional Secretariat is estimated to cost $3.5 million, and efforts toward attaining the five CTI goals would require $4.9 million. Although these figures seem huge, the total of $8.4 million is less than 1% of the capture fisheries value of the CT6 countries, which was estimated at $9.9 billion in 2007. Continuing to invest in the CTI is a worthwhile endeavor, and regional cooperation and coordination among the CT6 countries are essential for attaining the CTI goals and desired higher-level outcomes.

Appendix 1

Coral Triangle Initiative: Coral Reefs, Fisheries, and Food Security Monitoring and Evaluation Indicators

IMPACT: Improvement in the affordability, availability, quality, and safety of food coming from coastal and marine resources

- Affordability: Income of fishers, prices of fish
- Availability: Food sufficiency of fishing household and food consumption of coastal communities
- Quality and safety: Contribution of fish to protein requirement, health of fishing communities
- Community resiliency or social well-being: Gini index and localized downscaled version of Human Development Index

OUTCOME 1: Coral reef ecosystem integrity and services stabilized and/or maintained

1.1 Consider the number of target beneficiaries and established institutions that have benefited or been capacitated by the establishment of first governance level, together with the people whose incomes increased, e.g., from ecotourism, or reduced costs derived from disaster risk reduction and climate change adaptation

1.2 Diversified livelihood options through social enterprises and public–private partnership (PPP), blue carbon trading, conditional cash transfer, and ring fencing

1.3 Change in condition of coral reefs leading to increased biomass and keeping up with sea level rise and wave surges to estimate benefit in coastal protection (see Villanoy et al. 2012, Cruz-Trinidad et al. 2011)

1.4 Extent of mangroves and seagrasses

1.5 Fish biomass

1.6 Extent of coral reefs and associated habitats in fully protected areas

OUTCOME 2: Fish stocks improved and sustained

2.1 Consider the number and proportion of target beneficiaries directly benefiting from improved catch in relation to costs of actions

2.2 Households and people with improved income from sustainable fisheries

2.3 Fair trading and market arrangements due to social enterprises leveraged and PPP

2.4 Diversified livelihoods leading to resiliency from shocks in markets and better shifting options (Muallil et al. 2011)

2.5 Change in conservation status (international) of commercially important fish species (coastal and pelagic)

2.6 Change in catch per unit effort by gear

2.7 Change in species composition relative to trophic level

2.8 Change in size distribution by fish species

2.9 Change in exploitation status for pelagic and other species

continued on next page

Table A1 *continued*

Coral Triangle Initiative: Coral Reefs, Fisheries, and Food Security Monitoring and Evaluation Indicators				
Goal 1: Priority seascapes designated and effectively managed	**Goal 2: Ecosystem approach to management of fisheries and other marine resources fully applied**	**Goal 3: Marine protected areas established and effectively managed**	**Goal 4: Climate change adaptation measures achieved**	**Goal 5: Threatened species status improving**
• Number/area (square kilometer [km^2]) of priority seascapes under continuous improved management	• Percent change in average income (fishing and non-fishing) of coastal households, by profession, compared to baseline • Percent change in poverty and food threshold of coastal households, by livelihood, compared to baseline • Stable price of fish • Percent contribution of fish to protein requirements • Change in conservation status of tuna and live reef fish • Number and area (in km^2) of locally managed areas for live reef fish trade	• Percent/area of total marine habitat in Coral Triangle region in marine protected or managed areas • Percent/area of each major marine and coastal habitat type in strictly protected "no–take replenishment zones" • Percent/area (in km^2) of marine protected areas under "effective" management	• Percentage of local governments that have integrated climate adaptation into local governance plans and actions • Area (in hectares) of mangroves protected, managed, and restored	• Number of threatened species with improved status (to be decided by the Coral Triangle Initiative [CTI] as a body or by a forum designated by the CT6 countries according to the IUCN Red List of Threatened Species criteria assessment or other criteria to be determined by CTI)
• Number of priority seascapes designated with investment plans • Value (in US$) of funding secured per type of fund source • Coordinating body for each "priority seascape" established to guide, monitor, and track efforts in the seascapes	• Number of policies and regulations promoting ecosystem approach to fisheries management (EAFM) at regional and national levels with regulatory framework and budget allocated for their operationalization • Number of projects and programs addressing EAFM • Number of policies and agreements by CT6 countries for the management of tuna • Number of countries adhering to markets and/or certification standards of tuna fisheries agreed upon by CT6 countries	• Coral Triangle Marine Protected Area System (CTMPAS) Framework developed and adopted by CT6 • Percent and/or area of marine protected and/or managed areas included in CTMPAS	• Number of new policies or agreements adopted at the regional, national, and local levels that are in compliance with international agreements on threatened species • Area of protected marine habitat that contributes to conservation and protection of threatened and endangered species	• Number of new policies or agreements adopted at the regional, national, and local levels that are in compliance with international agreements on threatened species • Area of protected marine habitat that contributes to conservation and protection of threatened and endangered species

continued on next page

Table A1 *continued*

Coral Triangle Initiative: Coral Reefs, Fisheries, and Food Security Monitoring and Evaluation Indicators				
Goal 1: Priority seascapes designated and effectively managed	Goal 2: Ecosystem approach to management of fisheries and other marine resources fully applied	Goal 3: Marine protected areas established and effectively managed	Goal 4: Climate change adaptation measures achieved	Goal 5: Threatened species status improving
	• Number of policies and agreements and/or legislations adopted on live reef fish trade among CT6 countries to decrease the level of destructive fishing practices linked to the trade • Number of countries adhering to markets and/or certification (live reef fish and ornamental fisheries) agreed by CT6 countries			
• Priority seascapes designated and effectively managed • "Priority seascapes" designated, with investment plans complemented and/or sequenced • Marine and coastal resources within all "priority seascapes" being sustainably managed	• EAFM and other marine resources fully applied • Strong legislative, policy, and regulatory frameworks in place for achieving EAFM • Improved income, livelihoods, and food security of people in coastal communities across the region • Effective measures in place to help ensure sustainable exploitation of shared tuna stocks, with tuna spawning areas and juvenile growth stages adequately protected • More effective management and more sustainable trade of live reef fish and reef-based ornamentals achieved	• Marine protected areas established and effectively managed • Region-wide CTMPAS in place and fully functional	• Climate change adaptation measures achieved • Region-wide early action for climate change adaptation plan for the nearshore marine and coastal environment developed and implemented • Networked national centers of excellence on climate change adaptation for marine and coastal environments established and fully operational	• Status of threatened species improving • Status of sharks, sea turtles, marine mammals, and other identified threatened species improved

Note: As presented at the Jakarta Monitoring and Evaluation Working Group (MEWG) formal meeting on 24 October 2012, and endorsed by the MEWG "with provisions for modification by the respective thematic working groups going forward as needed."

Source: Modified from Tetra Tech ARD (2012).

Appendix 2
Actions Related to Coral Triangle Initiative Higher-Level Outcomes

Country	National	Seascape	Regional
A. Actions Related to Maintenance/Stabilization of Coral Reef Ecosystem Integrity and Services			
Indonesia	• National marine protected area (MPA) system initiated • Potential distribution of ornamental trade identification and mapping • Coral reef monitoring • Capacity building • Public awareness program on climate change adaptation (CCA)	**Sulu–Sulawesi Marine Ecoregion (SSME)** • Network of MPAs in corridors (i.e., Philippines) • Tri-national agreement on Turtle Islands Heritage Protected Area (TIHPA) • Connectivity studies to inform networks of MPAs • Formation of tri-national committee for SSME • Production of action plan for the SSME threatened species, sustainable fisheries, and MPAs	**Coral Triangle Marine Protected Area System (CTMPAS) 2020** • Study on integrating fisheries, biodiversity, and climate change objectives into MPA network design in the Coral Triangle • Evaluation of possible MPA effectiveness tools for possible region-wide application **Coral Triangle Initiative–Climate Learning Action Network** • Training on Local Early Action Plan for CCA in CT6 countries • Region-Wide Early Action Plan for CCA • Regional and international treaties to support biodiversity conservation initiatives (e.g., Convention on International Trade in Endangered Species, Convention on Biological Diversity, etc.) **Gaps:** • No socioeconomic monitoring of MPAs and coral reef uses • No regional climate change monitoring and exchange
Malaysia	• New MPAs established • State of the Coast reporting • Marine mammals in the ecotourism industry promotion • Ban on coral exports • Coral reef monitoring • National coastal vulnerability index developed		
Philippines	• Improving the management of National Integrated Protected Area (NIPAS) and local MPAs • Evaluation of MPA management effectiveness • Increase in the number of marine key biodiversity areas in the marine biogeographic regions • Ban on coral exports • Destructive fishing practices reduced by 10% (2002–2012)		

continued on next page

Table A2 *continued*

Country	National	Seascape	Regional
	• Coral reef monitoring • Vulnerability assessment tools developed and implemented • Climate change research programs (e.g., Resilient Seas Project) • Promoting incentives for best-managed MPAs • MPA support network established • Ongoing State of the Coast reporting		**Recommendation:** • Joint research on monitoring for climate change
Papua New Guinea	• Implementation of community-based climate change adaptation • Establishment of MPA network in Kimbe Bay	**Bismarck–Solomon Seas Marine Ecoregion:** • Signing of memorandum of understanding (MOU) for the conservation of leatherback turtles (Papua New Guinea; Solomon Islands; and West Papua, Indonesia)	
Solomon Islands	• Establishment of Solomon Islands locally managed marine areas to coordinate management of marine resources • National Adaptation Programme of Action for climate change drafted • Recommendation on equity of benefits from the trade of corals and plowing back of fees to enhance coral reefs • Gap: Application of total economic value framework to coastal ecosystems because of the ongoing shift to a cash-based economy		
Timor-Leste	• Marine parks established and starting to be networked • Introduction of payment for ecosystem services • Gaps: Climate change preparedness programs and baseline data • Collection including habitat mapping		

continued on next page

Table A2 *continued*

Country	National	Seascape	Regional
B. Actions Related to Improvement and Sustainability of Fish Stocks			
Indonesia	• Fisheries resource management areas established • Reporting of illegal, unreported, and unregulated (IUU) fishing through involvement of other fishers • Sustainable Financing Working Group for MPA management initiative established in 2011 • Monitoring, control, and surveillance system for tuna fisheries established • Sustainable Coastal Fisheries and Poverty Reduction Initiative (COASTFISH) initiated • Subsidies provided to fisheries sector	**Sulu–Sulawesi Marine Ecoregion:** • Seascape integration into Indonesia's Fisheries Management • Application of turtle excluder devices • Signing of MOU on Indian Ocean–South East Asia marine turtle protection • Protection of TIHPA by Indonesia, Malaysia, and the Philippines • Initial transboundary diagnostic analysis on shared stocks (e.g., small pelagics) • Research on small pelagics • Enforcement of laws	**Current Actions:** • Developing the CTI "common regional framework for legislation and policy" that would support ecosystem approach to fisheries management (EAFM) • Developing a road map to implement the "common regional framework for legislation and policy" that would support EAFM **Gaps:** • No regional action on the live reef fish food trade (LRFFT) • Total allowable catch for live fish • Implementation of IUU standards • Rationalizing the use of fish aggregating devices (FADs) in relation to national and global targets and standards for sustainable fisheries • Absence of a regional vessel monitoring system • Absence of quota on LRFFT • International agreements to take traditional ecological knowledge and wisdom into consideration • Regional actions to provide safety nets if such would have negative effects on indigenous peoples
Malaysia	• Boat registration ongoing • Territorial use rights through 92 fisheries districts • Implementation of fishing zones • Enforcement of Wildlife Protection Act and Fisheries Act of 1985 • Buyback schemes implemented for fishing gears and boats • Banning of export of *Cheilinus undulatus* (humphead wrasse) from Malaysia		
Philippines	• Ratification of Executive Order No. 530, which adopts integrated coastal management as the national framework for managing coastal areas • Conditional cash transfer (CCT) implemented for poorest of the poor, including fishing households, on condition that children will be sent to school • Continued enforcement of Republic Act No. 8550, the Philippine Fisheries Code, primarily to apprehend illegal fishers • Destructive fishing practices reduced by 10% (2002–2012) • Commercial fishing vessel registration implemented		

continued on next page

Table A2 *continued*

Country	National	Seascape	Regional
	• Closed season for sardine fishing implemented in Zamboanga, Philippines • Increased capture fisheries production through use of FADs to offset production targets in areas regulated by close and open seasons		
Papua New Guinea	• Regulating fish effort by limiting the number of fishing permits • Regulation of FADs • Ban on fishing of bêche-de-mer • Active membership in the Western and Central Pacific Fisheries Council (WCPFC) (e.g., by implementing tuna regulations and monitoring)	**Bismarck–Solomon Seas Marine Ecoregion:** • General consensus of excess in fishing capacity due to distant fishing fleets • Application of circular hooks	
Solomon Islands	• Ban on fishing of bêche-de-mer • Active membership in WCPFC (e.g., by implementing tuna regulations and monitoring)		
C. Actions Related to Improvement in Affordability, Availability, and Quality and Safety of Food from Coastal and Marine Resources			
Indonesia	**COASTFISH**: Marine and fisheries national independent community empowerment • Development of small-scale fisheries • One Man One Thousand Fry Program (fish stocking) • Catch certification activities scheme • Formulation/development of certification scheme and the process of capture fisheries and aquaculture products • Promotion and development of joint ventures		**Gaps**: • Empowering subsistence fisheries to increase access to fish resources for food and other livelihood opportunities • Monitoring of food security needs accurate and timely information and accountability (e.g., CCT linked to stewardship, monitoring responsibility, and food-for-work incentives) • Diversifying livelihood options to enhance opportunities for availability of and accessibility to other food sources • Improving equitable allocation of costs and benefits to minimize perverse and negative impacts of livelihood and food access and availability

continued on next page

Table A2 *continued*

Country	National	Seascape	Regional
Malaysia	• National Agro Food Security Program launched in January 2012		
Philippines	• Poverty and food security linkage established • Livelihood support to fishers to overcome poverty provided • Seaweed and sea cucumber aquaculture contributing to gains in food security, employment, and incomes derived from the export industry • Ongoing ecotourism development to alleviate poverty • Continuing implementation of projects related to reproductive health and integrated coastal management		
Papua New Guinea	• Planned development and expansion of aquaculture for food security		

Source: Extracted from the national State of the Coral Triangle (SCT) reports at the national, seascape, and regional levels; some gaps were identified in the national SCT reports, which need to be filled to meet these higher-level outcomes.

References

Abesamis, R.A. and G.R. Russ. 2005. Density-dependent spillover from a marine reserve: long-term evidence. *Ecological Applications*. 15(5). pp. 1,798–1,812.

Asian Development Bank (ADB). 2011a. *Comprehensive Action Plans of the Sulu–Sulawesi Marine Ecoregion: A Priority Seascape of the Coral Triangle Initiative*. Manila.

_____. 2011b. *Key Indicators for Asia and the Pacific 2011*. Manila.

_____. 2012. *Key Indicators for Asia and the Pacific 2012*. Manila.

Adora, G.A. 2009. Food Security through Sustainable Mariculture Park Projects in the Philippines. Paper presented at the East Asian Seas Congress. Manila. 23–27 November.

Aliño, P. 2012. Regional State of the Coral Triangle Report. Paper presented at the 12th International Coral Reef Symposium, "Science and Governance in the Centre of Global Marine Biodiversity: The State of the Coral Triangle Reports Meeting." Caivas, Australia. 7 July 2012.

Allain, V., E. Fernandez, S.D. Hoyle, S. Caillot, J. Jurado-Molina, S. Andréfouët, and S.J. Nicol. 2012. Interaction between coastal and oceanic ecosystems of the Western and Central Pacific Ocean through predator-prey relationship studies. *PLoS ONE.* 7(5): e36701.

Allen, G.R. 2008. Conservation Hotspots of Biodiversity and Endemism for Indo–Pacific Coral Reef Fishes. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 18(5). pp. 541–556.

Allison, E.H. and F. Ellis. 2001. The Livelihoods Approach and Management of Small-Scale Fisheries. *Marine Policy*. 25(5). pp. 377–388.

Atkins, J.P., D. Burdon, M. Elliott, and A.J. Gregory. 2011. Management of the marine environment: integrating ecosystem services and societal benefits with the DPSIR framework in a systems approach. *Marine Pollution Bulletin*. 62(2). pp. 215–226.

Bailey, M., J. Flores, S. Pokajam, and U.R. Sumaila. 2012. Towards Better Management of Coral Triangle Tuna. *Ocean and Coastal Management*. 63. pp. 30–42.

Bell, J.D., M. Kronen, A. Vunisea, W.J. Nash, G. Keeble, A. Demmke, S. Pontifex, and S. Andréfouët. 2009. Planning the Use of Fish for Food Security in the Pacific. *Marine Policy.* 33. pp. 64–76.

Block, B.A., I.D. Jonsen, S.J. Jorgensen, A.J. Winship, S.A. Shaffer, S.J. Bograd, E.L. Hazen, D.G. Foley, G.A. Breed, A.-L. Harrison, J.E. Ganong, A. Swithenbank, M. Castleton, H. Dewar, B.R. Mate, G.L. Shillinger, K.M. Schaefer, S.R. Benson, M.J. Weise, R.W. Henry, and D.P. Costa. 2011. Tracking Apex Marine Predator Movements in a Dynamic Ocean. *Nature*. 475. pp. 86–90.

Bruno, J.F. and E.R. Selig. 2007. Regional Decline of Coral Cover in the Indo–Pacific: Timing, Extent, and Subregional Comparisons. *PLoS ONE*. 2(8). pp. e711.

Burke, L., K. Reytar, M. Spalding, and A. L. Perry. 2011. *Reefs at Risk Revisited*. Washington, DC: World Resources Institute.

_____. 2012. *Reefs at Risk Revisited in the Coral Triangle*. Washington, DC: World Resources Institute.

Burke, L., E. Selig, and M. Spalding. 2002. *Reefs at Risk in Southeast Asia*. Washington, DC: World Resources Institute.

Cabral, R.B. and P.M. Aliño. 2011. Transition from Common to Private Coasts: Consequences of Privatization of the Coastal Commons. *Ocean & Coastal Management*. 54(1). pp. 66–74.

Cabral, R.B., A. Cruz-Trinidad, R.C. Geronimo, and P.M. Aliño. 2012. Opportunities and challenges in the Coral Triangle. *Environmental Science and Technology*. 46(15). pp. 7930–7931.

Cabral, R., A. Cruz-Trinidad, R. Geronimo, L. Napitupulu, P. Lokani, D. Boso, C.M. Casal, N.A. Fatan, and P. Aliño. 2013. Crisis Sentinel Indicators: Averting a Potential Meltdown in the Coral Triangle. *Marine Policy*. 39. pp.241–247.

Carpenter, K.E., P.H. Barber, E.D. Crandall, M.C.A. Ablan-Lagman, Ambariyanto, G.N. Mahardika, B.M. Manjaji-Matsumoto, M.A. Juinio-Meñez, M.D. Santos, C.J. Starger, and A.H.A. Toha. 2011. Comparative Phylogeography of the Coral Triangle and Implications for Marine Management. *Journal of Marine Biology.* pp. 1–14.

Carr, E.R., P.M. Wingard, S.C. Yorty, M.C. Thompson, N.K. Jensen, and J. Roberson. 2007. Applying DPSIR to sustainable development. *The International Journal of Sustainable Development and World Ecology*. 14(6). pp. 543–555.

Center for International Earth Science Information Network (CIESIN). 2007. National Aggregates of Geospatial Data Collection: Population, Landscape, and Climate Estimates, v2 (1990, 2000) (PLACE II), Palisades, NY: CIESIN, Columbia University.

Chin, A., T. Lison De Loma, K. Reytar, S. Planes, K. Gerhardt, E. Clua, L. Burke, and C. Wilkinson. 2011. *Status of Coral Reefs of the Pacific and Outlook: 2011*. Global Coral Reef Monitoring Network. http://www.icriforum.org/sites/default/files/Pacific-Coral-Reefs-2011.pdf

Chua, T.E. 2006. Chapter 14: ICM Indicators. In *The Dynamics of Integrated Coastal Management: Practical Applications in the Sustainable Coastal Development in East Asia*. Quezon City, Philippines: GEF/UNDP/IMO Regional Programme on Building Partnerships in Environmental Management for the Seas of East Asia (PEMSEA). pp. 278–289.

Cinner, J.E., M.J. Marnane, and T.R. McClanahan. 2005. Conservation and Community Benefits from Traditional Coral Reef Management at Ahus Island, Papua New Guinea. *Conservation Biology*. 19(6). pp. 1714–1723.

Cruz-Trinidad, A., R.C. Geronimo, and P.M. Aliño. 2009. Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines. *Ocean & Coastal Management*. 52(3). pp. 173–180.

Coral Reef Information Network of the Philippines (PhilReefs). 2008. Reefs Through Time 2008: Initiating the State of the Coasts Reports. PhilReefs, MPA Support Network, Marine Environment and Resources Foundation and the Marine Science Institute, University of the Philippines, Diliman, Quezon City. 152 pp.

D'Agnes, L., H. D'Agnes, J.B. Schwartz, M.L. Amarillo, and J. Castro. 2010. Integrated management of coastal resources and human health yields added value: a comparative study in Palawan (Philippines). *Environmental Conservation*. 37(4). pp. 398–409.

Department of Agriculture, Bureau of Agricultural Statistics. 2012. Fishery: Supply Utilization Accounts by Commodity, Year and Item. http://countrystat.bas.gov.ph/ (accessed 25 October 2012).

Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA–BFAR). 2007. *Philippine Fisheries Profile, 2007*. Quezon City, Philippines: DA-BFAR. http://www.bfar.da.gov.ph/pages/AboutUs/maintabs/publications/pdf%20files/2007.pdf

European Environment Agency (EEA). 1999. Environmental indicators: Typology and overview. *Technical Report No.* 25. Copenhagen.

Fidelman, P. and J.A. Ekstrom. 2012. Mapping Seascapes of International Environmental Arrangements in the Coral Triangle. *Marine Policy*. 36(5). pp. 993–1004.

Foale, S., D. Adhuri, P. Aliño, E.H. Allison, N. Andrew, P. Cohen, L. Evans, M. Fabinyi, P. Fidelman, C. Gregory, N. Stacey, J. Tanzer, and N. Weeratunge. 2013. Food Security and the Coral Triangle Initiative. *Marine Policy*. 38. pp. 174–183.

Food and Agriculture Organization of the United Nations (FAO). 1996. *Report of the World Food Summit*. Rome. 13–17 November.

_____. 2001. *The State of Food Insecurity in the World 2001*. *Food Insecurity: When People Live with Hunger and Fear Starvation.* Rome.

_____. 2010. Fishery and Aquaculture Statistics Food Balance Sheets. ftp://ftp.fao.org/FI/CDrom/CD_yearbook_2008/navigation/index_content_food_balance_e.htm (accessed 19 February 2012).

_____. 2011. *The State of Food Insecurity in the World 2010*. *How does international price stability affect domestic economies and food security?* Rome.

_____. 2012a. Food Security Data and Definitions, 2012. http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en/ (accessed 18 February 2012).

_____. 2012b. *FAO Country Profile*. http://www.fao.org/countryprofiles/selectcountry.asp?lang=en (accessed 18 February 2012).

_____. n. d. FishStat Plus—Universal Software for Fishery Statistical Time Series. http://www.fao.org/fishery/statistics/software/fishstat/en

Garcia, S.M. 2009. *Rising to Depletion towards a Dialogue on the State of National Marine Fisheries*. Washington, DC: The World Bank.

Gillet, R. 2009. Fisheries in the Economies of Pacific Island Countries and Territories. *Pacific Studies Series*. ADB: Asian Development Bank–World Bank–Australian Government–Pacific Islands Forum Fisheries Agency–Secretariat of the Pacific Community.

Giyanto. 2012. Changes in Coral Coverage in Eastern Indonesia during COREMAP 2. Poster presented during the 12th International Coral Reef Symposium. 9–13 July. Cairns, Queensland. http://www.icrs2012.com/eposters/P188.pdf

Green, A., P. Ramohia, M. Ginigele, and T. Leve. 2006. Fisheries Resources: Coral Reef Fishes. In A. Green, P. Lokani, W. Atu, P. Ramohia, P. Thomas, and J. Almany, eds. Solomon Islands

Marine Assessment. Technical Report of Survey conducted from 13 May to 17 June 2004. TNC Pacific Island Countries Report No. 1/06.

Green, E.P. and F.T. Short. 2003. *World Atlas of Seagrasses*. UNEP World Conservation Monitoring Centre. Berkeley, US: University of California Press.

Green, S.J., A.T. White, J.O. Flores, M.F. Carreon III, and A.E. Sia. 2003. *Philippine Fisheries in Crisis: A Framework for Management*. Coastal Resource Management Project of the Department of Environment and Natural Resources (DENR). Cebu City: DENR.

Hamilton, K., G. Ruta, K. Bolt, A. Markandya, S. Pedroso, P. Silva, M.S. Ordoubadi, G.-M. Lange, and L. Tajibaeva. L. Gronnevet, and M. Dyoulgerov. 2005. *Where is the Wealth of Nations? Measuring Capital for the 21st Century*. Washington, DC: World Bank.

Hoegh-Guldberg, O., H. Hoegh-Guldberg, J.E.N. Veron, A. Green, E.D. Gomez, J. Lough, M. King, Ambariyanto, L. Hansen, J. Cinner, G. Dews, G. Russ, H.Z. Schuttenberg, E.L. Peñaflor, C.M. Eakin, T.R.L. Christensen, M. Abbey, F. Areki, R.A. Kosaka, A. Tewfik, and J. Oliver. 2009. *The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk*. Brisbane: WWF–Australia.

Hopley, D. and Suharsono. 2000. *The Status of Coral Reefs in Eastern Indonesia*. Global Coral Reef Monitoring Network. http://www.worldwildlife.org/what/wherewework/coraltriangle/species.html

Hughes, A. 2006. Benthic Communities. In A. Green, P. Lokani, W. Atu, P. Ramohia, P. Thomas, and J. Almany, eds. *Solomon Islands Marine Assessment: Technical Report of Survey Conducted from May 13 to June 17, 2004*. TNC Pacific Island Countries Report No. 1/06.

Hughes, S, A. Yau, L. Max, N. Petrovic, F. Davenport, M. Marshall, T.R. McClanahan, E.H. Allison, and J.E. Cinner. 2012. A Framework to Assess National Level Vulnerability from the Perspective of Food Security: The Case of Coral Reef Fisheries. *Environment Science & Policy*. 23. pp. 95–108.

Ingles, J. and L.P. Soede. 2010. *Solving the Juvenile Tuna Dilemma*. Technical Report. WWF. http://awsassets.panda.org/downloads/opinion_piece___solving_the_juvenile_tuna_dilemma.pdf

International Food Policy Research Institute (IFPRI), Concern Worldwide, and Welthungerhilfe. 2011. *Global Hunger Index 2011. The Challenge of Hunger: Taming Price Spikes and Excessive Food Price Volatility*. Bonn; Washington, DC; and Dublin.

Jago-on, K.A.B., S. Kaneko, R. Fujikura, A. Fujiwara, T. Imai, T. Matsumoto, J. Zhang, H. Tanikawa, K. Tanaka, B. Lee, and M. Taniquchi. 2009. Urbanization and subsurface environmental issues: an attempt at DPSIR model application in Asian cities. *Science of the Total Environment*. 407(9). p. 3089–3104.

Kaufmann D., A. Kraay, and M. Mastruzzi. 2009. Governance Matters VIII: Aggregate and Individual Governance Indicators, 1996–2008. *World Bank Policy Research Working Paper No. 4978*. Washington, DC: The World Bank. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1424591

Kimmerer, R. W. 2002. Weaving Traditional Ecological Knowledge into Biological Education: A Call to Action. *BioScience*. 52(5). pp. 432–438.

Kool, J.T., C.B. Paris, P.H. Barber, and R.K. Cowen. 2011. Connectivity and the Development of Population Genetic Structure in Indo–West Pacific Coral Reef Communities. *Global Ecology and Biogeography*. 20(5). pp. 695–706.

Lachica-Aliño, L., L.T. David, M. Wolff, P.M. Aliño, and M.C.G. Rañola. 2009. Distributional Patterns, Habitat Overlap and Trophic Interactions of Species Caught by Trawling in the Ragay Gulf, Philippines. *The Philippine Agricultural Scientist*. 92(1). pp. 46–65.

Licuanan, W.Y., S.S. Mamauag, R.O.M. Gonzales, and P.M. Aliño. 2008. The Minimum Sizes of Fish Sanctuaries and Fishing Effort Reductions Needed to Achieve Sustainable Coastal Fisheries in Calauag and Tayabas Bays. *The Philippine Agricultural Scientist.* 91(1). pp. 51–59.

Lymer, D., S. Funge-Smith, and W. Miao. 2010. Status and Potential of Fisheries and Aquaculture in Asia and the Pacific 2010. *RAP Publication* 2010/17. FAO Regional Office for Asia and the Pacific. Bangkok.

Mangi, S.C., C.M. Roberts, and L.D. Rodwell. 2007. Reef fisheries management in Kenya: Preliminary approach using the driver–pressure–state–impacts–response (DPSIR) scheme of indicators. *Ocean & coastal management*. 50(5–6). pp. 463–480.

Marine Protected Areas Support Network (MSN). 2012. Unpublished data, personal communication.

Martins, J.H., A.S. Camanho, and M.B. Gaspar. 2012. A review of the application of driving forces–Pressure–State–Impact–Response framework to fisheries management. *Ocean & Coastal Management*. 69. pp. 273–281.

McLeod, E., J. Hinkel, A.T. Vafeidis, R.J. Nicholls, N. Harvey, and R. Salm. 2010. Sea-Level Rise Vulnerability in the Countries of the Coral Triangle. *Sustainability Science*. 5(2). pp. 207–222.

McLeod, E., R. Moffitt, A. Timmermann, R. Salm, L. Menviel, M.J. Palmer, E.R. Selig, K.S. Casey, and J.F. Bruno. 2010. Warming Seas in the Coral Triangle: Coral Reef Vulnerability and Management Implications. *Coastal Management*. 38(5). pp. 518–539.

Ministry of Marine Affairs and Fisheries and Japan International Cooperation Agency. (MMAF–JICA). 2011. *Indonesian Fisheries Book 2011*. http://www.kkp.go.id/upload/jica/ifb_2011_pub.pdf

Moberg, F. and C. Folke. 1999. Ecological Goods and Services of Coral Reef Ecosystems. *Ecological Economics*. 29(2). pp. 215–233.

Muallil, R.N., R.C. Geronimo, D. Cleland, R.B. Cabral, M.V. Doctor, A. Cruz-Trinidad, and P.M. Aliño. 2011. Willingness to Exit the Artisanal Fishery as a Response to Scenarios of Declining Catch or Increasing Monetary Incentives. *Fisheries Research*. 111(1–2). pp. 74–81.

Muldoon G., R. Cola, and L.-P. Soede. 2009. *Towards a More Sustainable Live Reef Fish Trade in the Coral Triangle*. First Regional Workshop. WWF Coral Triangle Program. Hong Kong, China. 10 to 12 November. http://awsassets.panda.org/downloads/towardssustainablelrfftworkshopcoraltriangle2009.pdf

Nanola Jr., C., P. Alino, H. Arceo, W. Licuanan, A. Uychiaoco, M. Quibilan, W. Campos, A. Alcala, A. White, and E. Gomez. 2006. Status Report on Coral Reefs of the Philippines–2004. *Proceedings of the 10th International Coral Reef Symposium*. Okinawa, Japan. 28 June, 28–2 July. pp. 1,055–1,061.

Nanola, C.L., P.M. Alino, and K.E. Carpenter. 2010. Exploitation-Related Reef Fish Species Richness Depletion in the Epicenter of Marine Biodiversity. *Environmental Biology of Fishes*. 90(4). pp. 405–420.

Ojeda-Martínez, C., F.G. Casalduero, J.T. Bayle-Sempere, C.B. Cebrián, C. Valle, J.L. Sanchez-Lizaso, A. Forcada, P. Sanchez-Jerez, P. Martin-Sosa, J.M. Falcon, F. Salas, M. Graziano, R. Chemello, B. Stobart, P. Cartagena, A. Pérez-Ruzafa, F. Vandeperre, E. Rochel, S. Planes, and A. Brito. 2009. A conceptual framework for the integral management of marine protected areas. *Ocean & Coastal Management*. 52(2). pp. 89–101.

Organisation for Economic Co-operation and Development (OECD). 2003. *OECD Environmental Indicators: Development, Measurement, and Use*. Reference paper. Paris.

Patterson, J., E. Linden, J.K.P. Edward, D.Wilhelmsson, and I. Lofgren. 2009. Community-Based Environmental Education in the Fishing Villages of Tuticorin and Its Role in Conservation of the Environment. *Australian Journal of Adult Learning*. 49(2). pp. 383–393.

Pauly, D. and V. Christensen. 1993. Stratified Models of Large Marine Ecosystems: A General Approach and an Application to the South China Sea. In K. Sherman, L.M. Alexander, and B.D. Gold, eds. *Large Marine Ecosystems: Stress, Mitigation, and Sustainability*. Washington, DC: American Association for the Advancement of Science.

Pauly, D. and C. Thia-Eng. 1988. The Overfishing of Marine Resources: Socioeconomic Background in Southeast Asia. *AMBIO*. 17(3). pp. 200–206.

Reef Check. 2010. *Reef Check Malaysia Annual Survey Report, 2010*. Kuala Lumpur: Reef Check Malaysia. http://ftp01.economist. com.hk/oceans2011/reef_check_malaysia_2010.pdf

Rehr, A.P., M.J. Small, P. Bradley, W.S. Fisher, A. Vega, K. Black, and T. Stockton. 2012. A decision support framework for science-based, multi-stakeholder deliberation: A coral reef example. *Environmental Management*. 50(6). pp.1204–1218.

Rhyne, A.L., M.F. Tlusty, P.J. Schofield, L. Kaufman, J.A. Morris, Jr., and A.W. Bruckner. 2012. Revealing the Appetite of the Marine Aquarium Fish Trade: The Volume and Biodiversity of Fish Imported into the United States. *PLoS ONE*. 7(5). e35808.

Sadovy, Y.J. , T.J. Donaldson, T.R. Graham, F. McGilvray, G.J. Muldoon, M.J. Phillips, M.A. Rimmer, A. Smith, and B. Yeeting. 2003. *While Stocks Last: the Live Reef Food Fish Trade*. Manila: ADB.

Samson, M.S. and R.N. Rollon. 2008. Growth Performance of Planted Mangroves in the Philippines: Revisiting Forest Management Strategies. *AMBIO*. 37(4). pp. 234–240.

San Diego-McGlone, M.L., R.V. Azanza, C.L. Villanoy, and G.S. Jacinto. 2008. Eutrophic Waters, Algal Bloom and Fish Kills in Fish Farming Areas in Bolinao, Pangasinan, Philippines. *Marine Pollution Bulletin.* 57(6–12). pp. 295–301.

Sea Around Us Project (SAUP). 2012. http://www.seaaroundus.org/eez/ (accessed 25 October 2012).

Secretariat of the Pacific Community (SPC). 2011. *Food Security in the Pacific and East Timor and its Vulnerability to Climate Change*. A report to the Australian Government Department of Climate Change and Energy Efficiency by the SPC in conjunction with the Commonwealth Scientific and Industrial Research Organisation. Noumea, New Caledonia.

Skoulikidis, N.T. 2009. The environmental state of rivers in the Balkans—A review within the DPSIR framework. *Science of the Total Environment.* 407(8). pp. 2501–2516.

Smeets, E. and R. Weterings. (1999). Environmental indicators: Typology and overview. *Technical report No. 25*. Copenhagen: European Environment Agency. http://www.brahmatwinn.uni-jena.de/fileadmin/Geoinformatik/projekte/brahmatwinn/Workshops/FEEM/EEA_tech_rep_25_Env_Ind.pdf

Smith, L.C., and L. Haddad. 2000. Overcoming child malnutrition in developing countries: past achievements and future choices. A 2020 vision for food, agriculture, and the environment. Washington, DC: International Food Policy Research Institute.

Solomon Islands National Statistics Office and UNDP Pacific Centre. 2008. *Analysis of the 2005/06 Household Income and Expenditure Survey*. Final Report on the Estimation of Basic Needs Poverty Lines, and the Incidence and Characteristics of Poverty in Solomon Islands. Suva. http://www.undppc.org.fj/_resources/article/files/solomon%20report%20final%20LOW.pdf

Spalding, M.D., C. Ravilious, and E.P. Green. 2001. *World Atlas of Coral Reefs*. Berkeley, US: University of California Press.

Spalding, M., M. Kainuma, and L. Collins. 2010. *World Atlas of Mangroves*. London and Washington, DC: Earthscan.

Stobutzki, I.C., G.T. Silvestre, A.A. Talib, A. Krongprom, M. Supongpan, P. Khemakorn, N. Armada, and L.R. Garces. 2006. Decline of Demersal Coastal Fisheries Resources in Three Developing Asian Countries. *Fisheries Research*. 78 (2–3). pp. 130–142.

Tetra Tech ARD. 2012. Summary Report: CTI-CFF Monitoring & Evaluation Working Group Meeting—Review of Regional State of the Coral Triangle Report and Monitoring & Evaluation Indicators. Jakarta. 22–25 October. Prepared for the United States Agency for International Development (USAID) under Contract No. EPP-I-00-06-00008-00.

_____. 2013. Activity Report: Monitoring & Evaluation Manual Development Workshop. Prepared for USAID under Contract No. EPP-I-00-06-00008-00. Pasig City. 10–12 April.

The Coral Triangle Atlas. 2012. http://ctatlas.reefbase.org/

Treml, E.A. and P.N. Halpin. 2012. Marine Population Connectivity Identifies Ecological Neighbors for Conservation Planning in the Coral Triangle. *Conservation Letters*. 56(4). pp. 441–449.

Tscherning, K., K. Helming, B. Krippner, S. Sieber, and S.G. Paloma. 2012. Does research applying the DPSIR framework support decision making?. *Land Use Policy*. 29(1). pp. 102–110.

Tun, K., L.M.. Chou, T. Yeemin, N. Phongsuwan, A.Y. Amri, N. Ho, K. Sour, N.V. Long, C. Nanola, D. Lane, and Y. Tuti. 2008. Status of Coral Reefs in Southeast Asia. In C. Wilkinson, ed. *Status of Coral Reefs of the World: 2008*. Townsville, Australia: Global Coral Reef Monitoring Network and Reef and Rainforest Research Center. pp. 131–144.

Turak, E. 2006. Coral Communities and Reef Health. In A. Green, P. Lokani, W. Atu, P. Ramohia, P. Thomas, and J. Almany, eds. *Solomon Islands Marine Assessment: Technical Report of Survey Conducted from May 13 to June 17, 2004*. TNC Pacific Island Countries Report No. 1/06.

United Nations Development Programme (UNDP). n.d. *Human Development Reports: Human Development Index*. New York. http://www.hdr.undp.org/en/statistics/hdi/

_____. United Nations Development Assistance Framework (UNDAF), 2009–2013, Democratic Republic of Timor-Leste. www.tl.undp.org/timor_leste/en/home.html

_____. 2005. *Sustaining the Environment to Fight Poverty and Achieve the MDGs: The Economic Case and Priorities for Action*. New York.

_____. 2011. Human Development Report 2011. *Sustainability and Equity: A Better Future for All*. New York. http://hdr.undp.org/en/reports/global/hdr2011/download/

United Nations Statistics Division. The official United Nations site for the Millenium Development Goals Indicators. Millennium Development Goals Indicators. http://mdgs.un.org (accessed on 18 February 2012).

Veron, J.E.N. 2000. *Corals of the World*. Townsville, Australia: Australian Institute of Marine Sciences.

_____. 2009. Coral Geographic: A Spatial Database. http://www.coralreefresearch.org/html/crr_cg.htm (accessed 18 February 2012).

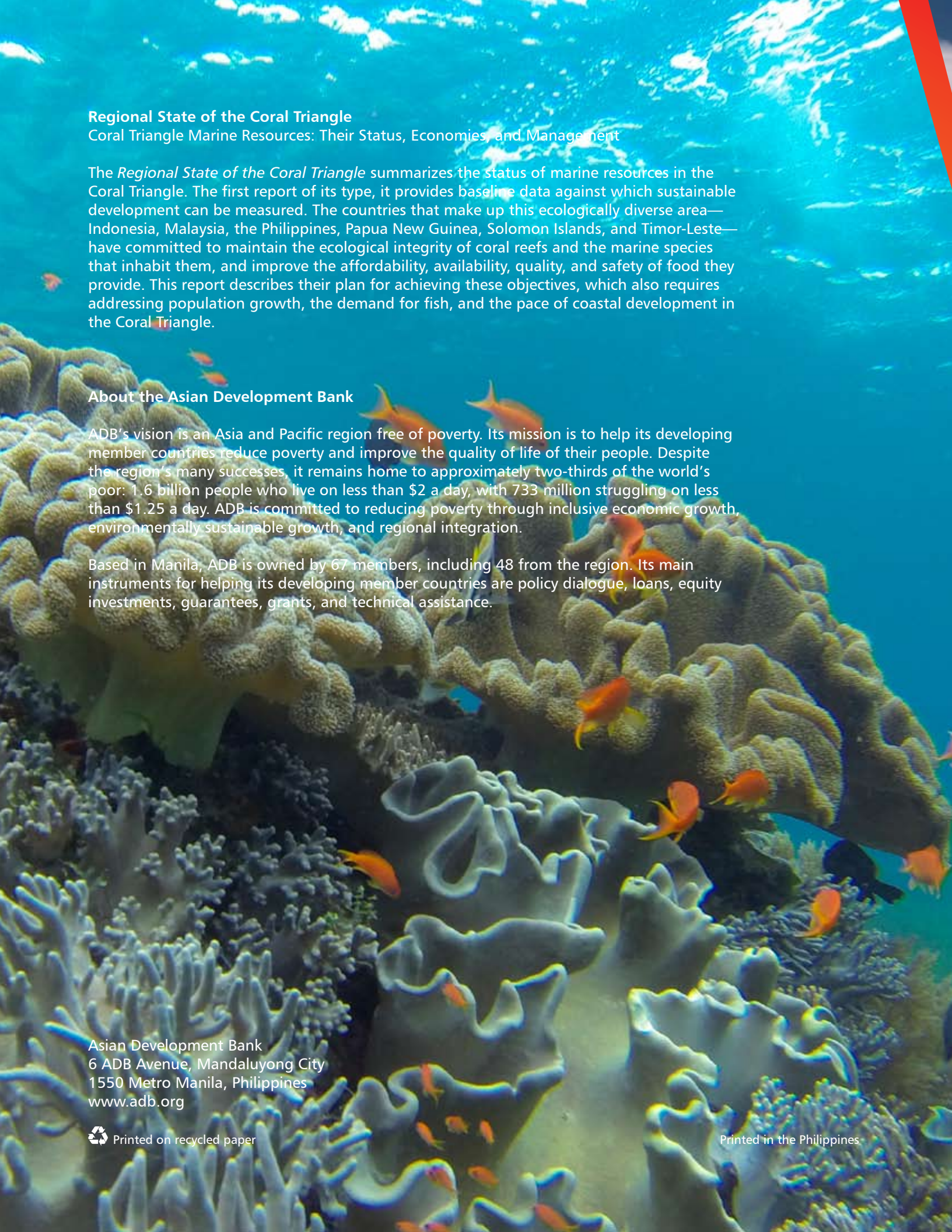
Villanoy, C., L. David, O. Cabrera, M. Atrigenio, F. Siringan, P. Aliño, and M. Villaluz. 2012. Coral reef ecosystems protect shore from high-energy waves under climate change scenarios. *Climatic change*. 112(2). pp. 493–505.

White, A.T. and A. Cruz-Trinidad. 1998. *The Values of Philippine Coastal Resources: Why Protection and Management Are Critical*. Cebu City: Coastal Resource Management Project of the DENR.

Wilkinson, C., ed. 2008. *Status of Coral Reefs of the World: 2008.* Townsville, Australia: Global Coral Reef Monitoring Network and Reef and Rainforest Research Center.

World Bank. *World Development Indicators*. http://data.worldbank.org/data-catalog/world-development-indicators

_____. 2012. *World Development Indicators*. Fish species treatened. http://data.worldbank.org/indicator/EN.FSH.THRD.NO (accessed 1 September 2012).



Regional State of the Coral Triangle
Coral Triangle Marine Resources: Their Status, Economies, and Management

The *Regional State of the Coral Triangle* summarizes the status of marine resources in the Coral Triangle. The first report of its type, it provides baseline data against which sustainable development can be measured. The countries that make up this ecologically diverse area—Indonesia, Malaysia, the Philippines, Papua New Guinea, Solomon Islands, and Timor-Leste—have committed to maintain the ecological integrity of coral reefs and the marine species that inhabit them, and improve the affordability, availability, quality, and safety of food they provide. This report describes their plan for achieving these objectives, which also requires addressing population growth, the demand for fish, and the pace of coastal development in the Coral Triangle.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to approximately two-thirds of the world's poor: 1.6 billion people who live on less than $2 a day, with 733 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org

Printed on recycled paper

Printed in the Philippines