STATE OF THE CORAL TRIANGLE:
Indonesia

ADB

CORAL TRIANGLE INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

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Foreword

The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (referred to in this report as Coral Triangle Initiative [CTI]) was launched in 2007 as a multilateral partnership of the governments of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. The CTI recognizes the need to safeguard the coastal and marine resources of the seas that surround these countries, which together constitute a uniquely diverse and economically important region often referred to as the Coral Triangle. In 2009, these six countries—now often referred to as the CT6—adopted a 10-year, five-point regional plan of action for improving management of the region's coastal and marine resources. The ultimate objectives of this plan are to ensure food security and sustainable livelihoods for all residents of the Coral Triangle, and to protect the region's unique ecosystems and the marine species that inhabit them in perpetuity.

The Asian Development Bank (ADB) has a long-term commitment to sustainable development of coastal and marine resources, and decades of experience in coastal and marine resource management in Southeast Asia and the Pacific. As an implementing agency of the Global Environment Facility, ADB manages a broad array of technical and financial support programs both within the Coral Triangle and beyond. It is thus rewarding that ADB is a key development partner of the CT6 countries, both collectively and individually. ADB has undertaken a number of loan, grant, and technical assistance initiatives that directly support and complement the CTI, as well as the national and regional action plans that are central to it. These initiatives help strengthen regional policy dialogue, facilitate CTI-wide exchange of data and information, build institutional capacity, and encourage policy and program development based on global best practice.

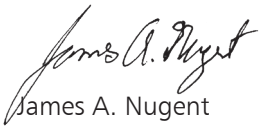
Other ongoing ADB-sponsored projects that support the CTI include Regional Cooperation on Knowledge Management, Policy, and Institutional Support to the CTI and Strengthening Sound Environmental Management in the Brunei Darussalam–Indonesia–Malaysia–Philippines East ASEAN Growth Area. Further, ADB supports the CTI's technical and financial working groups, and has set up a business development unit to liaise with and support the CT6 countries, its development partners, and the CTI regional secretariat. This unit coordinates inputs to knowledge and project management, facilitates project assessment and feasibility studies, and provides assistance to CTI monitoring and evaluation systems.

ADB's support to the CTI includes the publication of several CTI knowledge products. These include a State of the Coral Triangle (SCT) report for each member country, as well as a regional SCT report that promotes regional and international understanding of current ecological, political, and socioeconomic issues in the Coral Triangle. These SCT reports describe the current

condition of coastal ecosystems—particularly their exploited resources—in each of the CT6, as well as in the entire Coral Triangle region. They likewise document these countries' biophysical and socioeconomic characteristics, the environmental vulnerabilities of their coastal and marine ecosystems, and the aspects of governance currently in place for addressing these vulnerabilities.

As these SCT reports are the first to be published, they provide a baseline against which future progress in improving management of the Coral Triangle's marine resources can be measured. They likewise memorialize the commitment of these six countries to the CTI through elaboration of goals and the creation of a national plan of action for each country to achieve sustainable use of marine resources within the Coral Triangle.

Through publication of these national and regional SCT reports—and the *Economics of Fisheries and Aquaculture in the Coral Triangle*—we hope to promote a more complete regional and international understanding of current ecological, political, and socioeconomic issues in the Coral Triangle. Similarly, we hope that future updates of these SCT reports will enable the CT6 countries to monitor their progress, evaluate projects, refine their action plans as necessary over time, and thus create a sustainable development trajectory for both the communities and the marine ecosystems that inhabit the Coral Triangle.



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Executive Summary

The Coral Triangle covers an area between the Indian and Pacific oceans that represents the global epicenter of abundant marine life and diversity. The region surrounding these oceans includes some or all of the land and seas of six countries—Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste.

This report provides general information on the status of biophysical characteristics; governance; socioeconomic characteristics; and threats to, and vulnerabilities of, the coral reef ecosystems of Indonesia, part of which lies within the Coral Triangle. It outlines Indonesia's plans and initiatives and its progress toward the conservation and sustainable use of these ecosystems.

Biophysical Characteristics

Indonesia is the world's largest archipelagic state. The country's land area extends 5,120 kilometers (km) from east to west and 1,760 km from north to south. Indonesia's area of national jurisdiction is about 7.73 million square kilometers (km^2), which is composed of 1.93 million km^2 of land, 2.8 million km^2 of archipelagic waters, 0.3 million km^2 of territorial sea, and 2.7 million km^2 of exclusive economic zone.

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges the continents of Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins. The archipelago's climate is almost entirely tropical—temperatures in coastal plains average 28°C, in inland and mountain areas 26°C, and in higher mountain regions 23°C. The area's relative humidity ranges between 62% and 81%. However, the main variable of Indonesia's climate is not temperature or pressure, but rainfall, which varies greatly by month and place, ranging from 997 millimeters (mm) to 4,927 mm.

Indonesian waters, especially the eastern part of the archipelago, play an important role in the global water mass transport system, in which warm water at the surface conveys heat to the deeper cold water in what is known as the great ocean conveyor belt. The eastern archipelago is the only place in the Pacific Ocean that connects with the Indian Ocean at lower latitudes. The water mass transport from the Pacific to the Indian Ocean through various channels in Indonesia is called Arlindo (*Arus Lintas Indonesia*), also known as the Indonesian Throughflow.

Tidal phenomena in the Indonesian seas are among the most complex in the world. Complicated coastal geometries with narrow straits and myriad of small islands, rugged bottom topography

next to wide shelves of shallow water, and massive tidal power input from the adjoining Indian and Pacific oceans, all combine to form a complex system of interfering three-dimensional waves.

Indonesia has the largest coral reef area in Southeast Asia. Estimates of the extent of these coral reefs vary, but they likely total about 51,000 km^2. Indonesia's coral reefs are among the most biologically rich in the world. More than 590 species of corals have been identified in Indonesian waters. The archipelago is estimated to harbor over 75% of the world's coral species. At least 553 species of Scleractinian corals are found in Raja Ampat, which has one of the world's richest coral reef fish fauna, consisting of at least 1,320 species, the highest count in the world for an area of that size. Annual surveys of coral reefs in Indonesia have improved slightly over the last decade. At the end of 2008, about 5% of the reefs were in excellent condition, 25% in good condition, 37% in moderate condition, and 32% in bad condition.

There are currently 13 species of seagrass recorded in Indonesia, spread over at least 30,000 km^2 throughout the country; and 41 species of mangroves, occupying some 3.2 million hectares, half of which are in West Papua.

Legal and Policy Framework

The regulatory framework for marine resource management in Indonesia is extensive and complex. No single Indonesian law or regulation specifically addresses the use and management of coral reef resources. A group of natural resource laws and regulations cover the conservation and management of coastal and marine resources—17 natural resources management laws relate to coastal and marine management: 15 laws on natural resources management and ocean activities, and 2 national laws for the ratification of international conventions.

Governance of coastal and ocean resources in Indonesia is the primary responsibility of the state, with three main agencies at the national level: the Ministry of Marine Affairs and Fisheries (MMAF), the Ministry of Forestry (MOF), and the State Ministry for Environment. In practice, however, at least nine line departments, three state ministries, one coordinating ministry, four nondepartmental government agencies, and one interministerial council are involved in coastal management at the national level.

Several national government institutions jointly share the enforcement of Indonesia's coastal and ocean resources management. The two major departments are the MMAF and the MOF.

Socioeconomic Characteristics

More than 300 ethnic groups comprise Indonesia's population of 237.6 million (2010). The Javanese are the largest ethnic group, comprising 41% of the total population. Over time, Indonesia's population has become concentrated in Java Island.

Capture fisheries in Indonesia contribute significantly to the national economy's income, foreign exchange, and employment. In 2010, the industry produced 5.4 million tons of fish valued at Rp64.5 quintillion ($6.8 trillion). Of the total capture fisheries produced, marine fisheries were

valued at Rp48.8 quintillion ($5.1 trillion) and inland open water capture at Rp4.3 quintillion ($453.0 million).

To manage the fishery areas, the government has established 11 fishery management areas covering Indonesia's territorial sea and exclusive economic zone. In 2009, aquaculture produced almost half of Indonesian fisheries, which totaled 4.7 million tons, valued at Rp40.5 quintillion ($4.3 trillion). During the last 5 years, this industry has grown significantly from a production of 2.1 million tons in 2005—an average annual increase of 21.5%.

Rich oil and minerals in Indonesia's land and seas contribute significantly to national income. Indonesia's oil represents about 1% of the world's total reserve. Minerals such as tin, nickel, copper, gold, and coal, are mined from rich deposits and are important national commodities, either for export or for domestic markets.

Seas and coastal areas are important in the country's transport and communication. Many cities are located adjacent to the coast and river and are used for domestic transport. Indonesia's strategic geographic position is an advantage in international shipping as the archipelago connects the eastern and the western parts of the world. Indonesia has developed a contingency plan for addressing oil spills in its waters.

There are many traditional management systems for marine resources in Indonesia. However, only a few are still practiced in some areas, such as the *sasi* in the Moluccas and Papua region, the *panglima laot* in Aceh, the *awig-awig* in Lombok, and the *mane'e* in Sangir and Talaud Islands in North Sulawesi.

Women play a crucial role in coastal resource management activities in Indonesia. Their involvement in fishing activities varies across ethnic groups, culture, religion, and economic status. Women's role in pre and postharvest activities in traditional small-scale artisanal fisheries is vital. They also dry fish for consumption, especially during times of food scarcity.

In the last few decades, Indonesia has practiced the payment for ecosystem services (PES) approach, with the income mostly used for biodiversity conservation, watershed protection, carbon sequestration, and landscape and/or seascape beautification (in the tourism sector). The PES approach has been tested in marine tourism, but has not yet involved commercial fisheries. The legal basis for PES is found in several acts that call for setting up PES in water management, forest utilization, environmental service, and other areas where terrestrial and marine natural resources are used.

Although the Government of Indonesia has developed 11 fisheries management areas or *wilayah pengelolaan erikanan*, lack of enforcement and lack of awareness of the need for sustainable fisheries management have resulted in the degradation of fish stocks in several areas. The use of unsuitable fishing gear has further declined fish stocks in certain areas, especially the coastal zone, which is exploited by 85% of Indonesian fishers. In addition, foreign fleets continue to threaten fisheries, although it is difficult to obtain accurate data on the number of vessels and their mode of operations.

A live reef food fish trade primarily targets groupers, humphead wrasses, and barramundi cods. Although many species in this trade have been successfully cultivated from eggs, some highly

priced species, such as the humphead wrasse and the coral trout, are captured as fingerlings for grow-out in Indonesia, making them the main target of local fishers.

Over the last few decades, overexploitation of Indonesia's coastal and marine resources has degraded coastal and marine biodiversity. Indirect impacts of marine- and land-based activities on the ecosystems include (i) rareness or extirpation of some coastal and marine species; (ii) destruction of critical coastal habitats, particularly mangroves and coral reefs; and (iii) overfishing. Protected species now include the humphead wrasses, sea turtles, giant clams, some mollusk species, crustaceans, cetaceans (dolphins and whales), and the dugongs.

During the last 15 years, nongovernment organizations (NGOs), the private sector, and the government have implemented several programs to rehabilitate and restore coastal ecosystems. The Coral Reef Rehabilitation and Management Program, launched in 1998, is one of the most extensive marine environment rehabilitation programs in Indonesia.

About 40% of domestic sewage in Indonesia is discharged directly or indirectly via rivers and into the sea without proper treatment. The high organic and nutrient content of untreated sewage can lead to eutrophication or excessive nutrient enrichment, which triggers the growth of phytoplankton in the form of harmful algal blooms, or red tides, in many places in Indonesia.

Although not well documented, marine invasive species pose another threat to biodiversity in Indonesia. Such species may include the toxic red tide species *Pyrodinium bahamense* from ballast water transported by ships from abroad. However, no specific policy or regulation directly addresses this problem.

Indonesia is one of the most "at risk" countries in terms of climate change impact. Changes in sea surface temperature, sea level, and extreme climate events will adversely affect marine fisheries and other sectors. Sea temperature increase causes massive bleaching and death of many coral reefs—a condition that needs further investigation for its implications in prioritizing and designating marine protected areas (MPAs) and in designing MPA networks in areas of high resilience.

Action Plans and Initiatives

The Coral Triangle Initiative in Indonesia aims to (i) improve the governance and management of priority seascapes, (ii) implement the ecosystem-based approach to fisheries management (EAFM), (iii) improve management of MPAs, (iv) adopt climate change adaptation measures, and (v) improve the conservation status of threatened species. Progress in meeting targets of these five goals are summarized below.

Improving the Governance and Management of Priority Seascapes

Of Indonesia's 12 marine ecoregions or seascapes, 6 are prioritized to be managed in 2010–2014. The government will integrate the seascapes program and fisheries management regulations in those areas by 2014.

Implementing Ecosystem-Based Approach to Fisheries Management

The targets of EAFM are to (i) put in place strong legislative, policy, and regulatory frameworks; (ii) improve income, livelihoods, and food security in more coastal communities across the region through the sustainable Coastal Fisheries and Poverty Reduction Initiative —an implementation that requires intensive capital and, therefore, open to other marine environmental projects or programs; (iii) establish effective measures to help ensure sustainable exploitation of shared tuna stocks, with adequate protection for tuna spawning areas and juvenile growth stages; and (iv) achieve a more effective management and sustainable trade in live reef fish and reef-based ornamentals.

Although not all targets were achieved in 2010–2012, several actions were undertaken, including the temporary closure of the Banda and Arafura seas for fishing, to protect fish stocks. In addition, a ministerial regulation was drafted for a fishery management plan that stipulates the inclusion of the size and type of fishing gears for capturing reef fish. There is no specific regulation relating to the protection of coral reefs, but the implementation of these regulations will help protect coral reef areas in Indonesia's portion of the Coral Triangle.

Improving the Management of Marine Protected Areas

This goal aims to implement the Coral Triangle MPA System region-wide. In 2010–2012, Indonesia has implemented most of the following actions: (i) establish and strengthen the national strategy of MPAs and transboundary protected areas through collaboration with neighboring countries, (ii) improve the planning and management of MPAs to address local and global threats, (iii) create enabling policy and institutions for MPAs, (iv) build institutional capacity for managing MPAs, and (v) ensure sustainability of funding for MPAs.

Other actions included (i) strengthening of the Savu Sea National Marine Park management, and designating a new Anambas National Marine Park (1.2 million hectares); (ii) strengthening national capacity in MPA management by establishing technical implementation units; and (iii) initially putting up a management body to manage eight national MPAs.

Adopting Climate Change Adaptation

This goal aims to develop and implement an early action climate adaptation plan region-wide for the nearshore marine and coastal environment, and to establish and fully operate a network of national centers of excellence on climate change adaptation for marine and coastal environment. In 2010–2012, Indonesia's MMAF and the United States National Oceanic and Atmospheric Administration carried out collaborative research on the impact of climate change upon marine and coastal ecosystems such as coral bleaching in Indonesian waters.

Improving the Conservation Status of Threatened Species

The target of this goal is improvement in the conservation status of sharks, sea turtles, seabirds, marine mammals, corals, seagrass, and mangroves. In 2010–2012, Indonesia (i) identified and made an inventory of the potential and distribution of sharks toward their limited protection, (ii) developed guidelines for supervising protected fish species, and (iii) identified the potential of ornamental coral for trade.

Capacity Building

As in other developing countries, lack of capacity is one of the main bottlenecks of coastal and marine sustainable development in Indonesia. The MMAF, together with some international NGOs, has given training courses on the critical aspects of managing coastal and marine ecosystems and MPAs in Indonesia.

Financial Sustainability

Government funds are inadequate to cover MPA operational costs. Hence, the government is setting up a trust fund for the conservation of biodiversity in Indonesia. In 2011, the MMAF initiated the establishment of the Sustainable Financing Working Group (SFWG) for MPA management to develop instruments of financial sustainability and other working procedures. MPA management in Indonesia is estimated to cost Rp225 billion ($25 million) per year. So far, funds from all sources in Indonesia and from international NGOs amount to only Rp75 billion ($8.3 million) per year. The deficit would increase to Rp150 billion per year ($27.7 million) if capacity building and maintenance cost components are included. The SFWG is examining strategies of action at different levels—from conservative to optimistic—of funding.

Public Awareness

Lack of awareness in marine and coastal environment and the value of biodiversity are major constraints in sustainable coastal development in Indonesia. Many programs and projects are now investing in awareness and educational initiatives that focus on the marine and coastal resources and environment. The Government of Indonesia has implemented several initiatives through several environmental projects such as the Coral Reef Rehabilitation and Management Program.

Abbreviations

ADB	–	Asian Development Bank
BAPPENAS	–	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
CITES	–	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CTC	–	Coral Triangle Center
CTMPAS	–	Coral Triangle Marine Protected Area System
COREMAP	–	Coral Reef Rehabilitation and Management Program
CTI	–	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (also referred to as Coral Triangle Initiative)
EAFM	–	ecosystem approach to fisheries management
EEZ	–	exclusive economic zone
GEF	–	Global Environment Facility
ha	–	hectare
HAB	–	harmful algal bloom
IUU	–	illegal, unregulated, and unreported
kg	–	kilogram
km^2	–	square kilometer
LIPI	–	Indonesian Institute of Sciences
MARPOL	–	International Convention for the Prevention of Pollution from Ships
m	–	meter
mm	–	millimeter
MMAF	–	Ministry of Marine Affairs and Fisheries
MOF	–	Ministry of Forestry
MPA	–	marine protected area
NGO	–	nongovernment organization
NOAA	–	National Oceanic and Atmospheric Administration
PES	–	payment for ecosystem services
SFWG	–	sustainable financing working group
TNC	–	The Nature Conservancy
WPP	–	*wilayah pengelolaan perikanan* (fisheries management areas)
WWF	–	World Wide Fund for Nature

Introduction

The Coral Triangle covers an area between the Indian and Pacific oceans that represents the global epicenter of abundant marine life and diversity. The Coral Triangle region includes some or all of the land and seas of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. Covering only 1.6% of the planet's oceans, the region hosts 37% of all known coral reef fish species; and contains 76% of all known coral species, 53% of the world's coral reefs, the greatest extent of mangrove forests in the world, and spawning and juvenile growth areas for tuna and other globally significant commercial fish species. These unparalleled marine and coastal living resources provide significant benefits—food, income, recreation, culture, and protection from severe weather events—to a population of 360 million people who reside in the Coral Triangle area, particularly the 120 million people living on or near the coast.

This report describes the biophysical characteristics of marine and coastal ecosystems in Indonesia; their governance in terms of the legal and policy framework and institutional arrangements and compliance; the socioeconomic characteristics of the population and their pattern of resources use; the threats to and vulnerabilities of the coastal and marine ecosystems; and how Indonesia proposes to ensure their future sustainable use through a plan of action that includes improving governance and effective management, ecosystem approach to fisheries management, and climate change adaptation measures.

Biophysical Characteristics

Physical Geography

Extent and Boundary

Indonesia is located between 6°08′ North and 11°15′ South latitude, and from 94°45′ East and 141°05′ West longitude. Surrounded by ocean, it is a huge archipelagic country extending 5,120 kilometers (km) from east to west, and 1,760 km from north to south. Indonesia's area of national jurisdiction is about 7.73 million square kilometers (km^2), which is composed of 1.93 million km^2 of land, 2.80 million km^2 of archipelagic waters, 0.30 million km^2 of territorial sea, and 2.70 million km^2 of exclusive economic zone.

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins. The shelves in the west connect to Asia (Sunda Shelf), and in the east to Australia (Sahul Shelf). The Sahul Shelf extends from the north coast of Australia across to New Guinea, covering a total area of about 1.5 million km^2. A slightly deeper channel heads west to east toward Torres Strait. Several reefs, banks, and some small islands lie near the edge of the shelf. There are 27 deep basins and trenches in this area with extremely deep seas at the Weber Deep in the Banda Sea (7,440 meters [m] deep) and in the Celebes (Sulawesi) Basin (6,220 m deep). The sills that form the shallowest areas bordering deep depressions are important in the ventilation of deep water. When the United Nations Convention on the Law of the Sea of 10 December 1982 came into force in 1994, it clarified Indonesia's status as the world's largest archipelagic state. The length of Indonesia's coastline, covering 18,110 islands, is estimated to measure 108,820 km. It is the second largest coastline in the world after Canada. There are five main islands (Sumatra, Java, Kalimantan, Sulawesi, and Papua), two major archipelagos (Nusa Tenggara and the Maluku Islands), and 60 smaller archipelagoes. Four of these islands are shared with other countries: Borneo is shared with Malaysia and Brunei Darussalam; Sebatik, on the eastern coast of Kalimantan, is shared with Malaysia; Timor is shared with Timor-Leste; and the newly divided provinces of Papua and West Papua share the island of New Guinea with Papua New Guinea.

Since 2005, Indonesia has been administratively divided into 33 provinces with 3 new provinces—Kepulauan Riau, Sulawesi Barat, and Irian Jaya Barat. In 2005, the provinces were further subdivided into 399 districts, 98 municipalities, 6,487 subdistricts, and 76,613 villages. All the provinces and more than 80% of the districts and municipalities have coastal areas.

Climate

Located on the equator, the Indonesian archipelago is almost entirely tropical in climate—temperature in coastal plains averages 28°C, in inland and mountain areas 26°C, and in the higher mountain regions 23°C. Relative humidity ranges between 62% and 81% (BPS 2006). Rainfall varies greatly by month and place, from 997 millimeters (mm) to 4,927 mm (BPS 2006). Generally, wind velocities range from 2.5 km/hour to 21.0 km/hour (BPS 2006). The extreme variations in rainfall are linked with two monsoons—the northeast and southeast monsoons. The northeast monsoon usually occurs in June to July. The southeast monsoon occurs in December to January. A transition period occurs in August to November, and a second transition period usually occurs in February to May.

Indonesia has two seasons—dry and wet. The dry season is spread from June to September; the rainy season occurs in December to March. Typhoons and severe storms pose little hazard to mariners in Indonesian waters; and the major danger is from swift currents in channels such as the Lombok and Sape straits.

Oceanography

Surface currents in Indonesian waters are more strongly influenced by circulation from the Pacific Ocean than from the Indian Ocean. The currents are also greatly influenced by the winds of the prevailing monsoon. The current tends to flow in the same direction as the prevailing winds. The southeast monsoon is milder than the northwest monsoon when current velocities are in the range of 12–23 centimeters/second, while in the northwest monsoon, they are 25–38 centimeters/second (Hutomo, Nontji, and Dirhamsyah 2009).

The variation of atmospheric circulation parallels the variation of water circulation. Just as the monsoons change direction twice a year and are practically reversed at the time of their strongest development, oceanic circulation is also reversed over large areas. This complete reversal is typical of the circulation in these waters.

Indonesian waters, especially the eastern part of the Indonesian archipelago, play an important role in the global water mass transport system where the warm waters at the surface convey the heat to the deeper cold water in what is known as the great ocean conveyor belt. The belt flows from the Pacific Ocean to the Indian Ocean through the Indonesian archipelago, the only place where the two oceans connect at lower latitudes. This water mass transport is known as the Indonesian Throughflow or Arlindo (Arus Lintas Indonesia) in local terms (Hutomo, Nontji, and Dirhamsyah 2009).

Tidal phenomena in Indonesia's seas are among the most complex in the world. Complicated coastal geometries with narrow straits and a myriad of small islands, rugged bottom topography next to wide shelves of shallow water, and massive tidal power input from the adjoining Indian and Pacific oceans all combine to form a complex system of interfering three-dimensional waves (Ray et al. 2005).

Variability in sea surface temperature in the region is generally small compared with that in the tropical eastern Pacific because of the lack of strong equatorial upwelling. During the northeast monsoon, high surface temperatures of 29°C–30°C generally prevail in the western coast of

Sumatra and the eastern archipelago waters. However, the inflow of water masses from higher latitudes causes some areas in the South China Sea to have colder water (26°C–27°C) (Hutomo, Nontji, and Dirhamsyah 2009). During the southeast monsoon, high surface temperatures (29°C–30°C) occur in the South China Sea, and lower surface temperatures (26°C–27°C) in the Arafura Sea and the southern coast of Java. Upwelling occurs in the Banda Sea and the southern coast of Java during the southeast monsoon where colder waters of deeper layers rise to the surface (Wyrtki 1961; Gieskes et al. 1990; Gordon 2005; Hutomo, Nontji, and Dirhamsyah 2009). The sea surface temperature extends down to a certain depth by the action of the winds, currents, and tides, varying between 25 m and 50 m. Over the shallow Sunda Shelf and Sahul Shelf, this homogenous layer extends to the bottom.

During the northeast monsoon, mixed oceanic and coastal waters (32%–34%) extend from the South China Sea to the eastern archipelago, pushing the oceanic waters (>34%) eastward. During the southeast monsoon, oceanic waters from the Pacific Ocean penetrate far westward, occupying most of the eastern part of the archipelago. This condition makes the Java Sea flushed alternately each year by the mixed and coastal waters (Hutomo, Nontji, and Dirhamsyah 2009).

Biodiversity of Coastal and Marine Ecosystems

Coral Reefs

Indonesia has the largest coral reef in Southeast Asia (Burke, Selig, and Spalding 2002), estimated to range from 17,500 km^2 to 85,707 km^2 depending on the varying criteria and assumptions used by scientists (Table 1). In a 2002–2003 study, the Research Center for Oceanography–Indonesian Institute of Sciences (LIPI) and the National Institute of Aeronautics and Space of Indonesia (LAPAN), using satellite data (Landsat TM), calculated the area of Indonesian corals to a depth of 10 m (the limit of the satellite's sensor) to be 19,500 km^2. This calculation is significant because, for the first time, it is based on real data and not on estimates. If this conservative estimate is accurate, 51% of the region's coral reefs and 18% of the world's coral reefs are found in Indonesian waters. Although arguable, the total area of coral reefs in Indonesia may be about 51,000 km^2.

Table 1 **Estimates of Coral Reef Area in Indonesia**

Source	Area (square kilometer)
Dahuri (1995)	17,500
Cesar (1996)	75,000
Spalding et al. (2001a)	51,020
Tomascik et al. (1997)	85,707
Burke et al. (2002)	51,000
Pet-Soede et al. (2002)	85,000

Sources: Various authors, as indicated.

Indonesian coral reefs are distributed from west to east, showing better development in remote areas where there are no major rivers. The best coral growth is found in eastern Indonesia where corals develop well to a depth of more than 30 m, due to currents that flow continuously from the Pacific Ocean to the Indian Ocean, making this area a center for species diversity and the origin of existing coral species (Hutomo, Nontji, and Dirhamsyah 2009).

Coral reefs in Indonesia can be divided into fringing, patch, barrier reefs, and atolls. Most are fringing reefs; and the atoll of Takabonerate, South Sulawesi, is the third biggest in the world. In Indonesia, there are about 590 coral species belonging to 82 genera (Veron 1995). Of the 114 *Acropora* species, 91 are found in Indonesia, with the highest number in Tomini Bay (Wallace, Richard, and Suharsono 2001).

The Raja Ampat Islands in eastern Indonesia has outstanding coral diversity. The archipelago is estimated to harbor over 75% of the world's coral species. At least 553 species of Scleractinian corals are found there (Veron et al. 2009). Soft coral diversity in this area is also very high, encompassing intact forests and functional coral reefs, often separated by only meters. It is unusual to find such "ridge-to-reef" ecosystem integrity in Indonesia (Veron et al. 2009).

The results of monitoring activities in 1,076 stations all over Indonesia indicate that at the end of 2011, about 5.6% of coral reefs were in excellent condition, 27.0% in good condition, 36.9% in fair condition, and 30.8% in poor condition (CRITC COREMAP 2012) (Table 2). From 1993 to 2008, evaluations of coral reef indicated a slight improvement in their condition.

Table 2 **Status of Coral Reefs in Indonesia, 2011**

Location	Number of Stations	Excellent (%)	Good (%)	Fair (%)	Poor (%)
West	479	5.64	28.81	34.03	31.52
Middle	292	5.82	30.14	44.18	20.55
East	305	5.25	20.98	34.43	39.34
Indonesia	1,076	5.58	26.95	36.90	30.76

Notes:
Data collected from 1,076 observation stations across Indonesian waters.
Excellent: 75%–100% live coral cover.
Fair: 25%–49% live coral cover.
Poor/Bad: 0%–24% live coral cover.
Source: CRITC COREMAP (2011).

Indonesia has the greatest diversity of coral reef fishes in the world—about 2,057 species, of which 97 are Indonesian endemics (Allen and Adrim 2003). Raja Ampat Islands have one of the world's richest coral reef fish fauna, consisting of at least 1,320 species, the highest count in the world for an area of that size (Allen and Erdmann 2009).

Coral reefs are vital sources of food and income for coastal communities. More than one-third of the Indonesian population living in coastal areas depends on nearshore fisheries for livelihood. Along with population increase, the annual fish consumption rate rose from

Photographs in this box: Anugerah Nontji

Distinctive coral species from Indonesia *(from top left to right)*: *Acropora suharsonoi*, *Acropora indonesia*, *Acropora desalwii*, *Acropora hoeksemani*, *Acropora sukarnoi*, and *Acropora togianensis*.

15.9 kilograms (kg) per capita in 1991 to 19.0 kg per capita in 2000 (KLH and United Nations Development Programme [UNDP] 1997). More than 60% of the animal protein consumed by the population in 2000 was derived from fisheries. About 90% of Indonesia's marine landings come from artisanal fisheries for direct consumption or local markets (Tomascik et al. 1997).

Coral reefs contribute to tourism growth. Water skiing, scuba diving, and underwater photography have become increasingly popular in Indonesia.

Coral reef fishes of Indonesia.
Source: Allen and Adrim (2003).

Coral reefs are also effective in preventing shoreline erosion and protecting mangrove and seagrass communities. Fringing and barrier reefs act as natural barriers that protect low-lying coastal areas from erosion and other mechanical, destructive actions by the sea. Under certain hydrodynamic conditions, coral reefs also contribute to terrestrial accretion by serving as sources of sand for beaches and low islands (Nontji 2000).

Coral reefs are potentially valuable to the pharmaceutical industry for their biochemical properties. Some compounds from reef sources have anticancer, antibiotic, antiviral, and anti-oxidation properties. Thus, their economic benefits could be staggering (UNEP 2007c).

Coral reefs are excellent field laboratories for education and research. Scientists and students use coral reef ecosystems to illustrate and understand ecological and biological processes.

The international trade in ornamental corals, shells, turtles, and coral reef fishes began in the late 1960s; and is now generating widespread concern (Alcala et al. 1988). Indonesia is the world's largest exporter of corals under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), harvesting over 1,000 tons of coral per year in the early

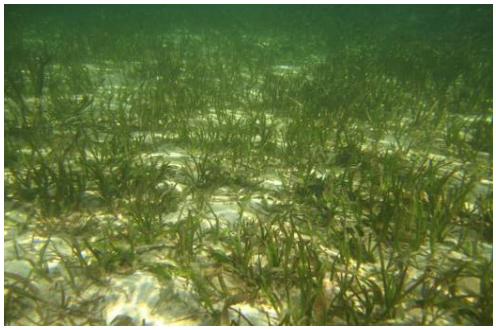
1990s and exporting around 500 tons per year (Spalding et al. 2001b). Indonesia provided approximately 41% of coral exports worldwide from 1995 to 2001 (Spalding et al. 2001b).

Seagrass

Seagrass is a critical ecosystem. Its role in fisheries production and in sediment accumulation and stabilization is well documented. Most of the data presented in this report are extracted from the *Regional Coastal Resources and Environment Profile for ASEAN Region* (Hutomo, Nontji, and Dirhamsya 2009). Based on the existing information, Kuriandewa et al. (2003) estimated the extent of Indonesian seagrass areas to be at least 30,000 km^2. This figure is very conservative because only a few areas to date have been surveyed and mapped using remote sensing and geographic information systems and ground truthing (ISC 2004). Based on various publications, unpublished data, field observations, and discussion with seagrass experts, 13 species of seagrass are recorded in Indonesia (Table 3).

Similar to the mangrove and coral reef ecosystems, seagrass plays an important function in the marine food chain. It is the main diet of dugongs and sea turtles; and provides habitat for many commercially important species of fishes, shrimps, and shellfishes. In Indonesia, various studies have identified more than 200 fish species, 85 crustaceans, and other marine species in seagrass beds.


Muin Sinaga


Susi Rahmawati


Kiswara


Muin Sinaga

(From top left to right): Dense monospecific stand of *Thallassodendron ciliatum* in Berakit Village, Bintan Island; monospecific stand of *Cymodocea rotundata* in Wowoni Island, Southeast Sulawesi; patches of *Enhalus acoroides* at Kuta Bay, Lombok Island; and mixed vegetation of seagrass at Trikora Beach, Bintan Island.

Table 3 Seagrass Species in Indonesia and their Ecology

Family Genus			Specialist	Habitat
I	Hydrocharitaceae Enhalus	1	*Enhalus acoroides*	Common on silty and/or muddy to medium and coarse sediments and areas with high bioturbation; found in estuarine habitats and low salinity anchialine lagoons; forms monospecific meadows and dominates in mixed communities where it often grows with *T. hemprichii*; wide depth distribution to ca. 30 m; important shelter for juvenile fishes and shrimps
II	Halophila	2	*Halophila ovalis*	Dominant species in the intertidal; wide depth range to a maximum of ca. 40 m; pioneering species common in areas with high bioturbation; frequently follows *Halodule* species in succession; often found just seaward of mangroves
		3	*Halophila decipiens*	Known as dugong food; found in lagoonal environment on fine-to-medium sands
		4	*Halophila minor*	Found in shallow lagoonal environments with sandy substrates, often with *H. ovalis*
		5	*Halophila spinulosa*	Found in deep lagoonal environments with fine sand; it may be confused with two species of green algae, *Caulerpa sertularioides* and *C. Mexicana*
		6	*Halophila sulawesii*	Not yet known.
III	Thalassia	7	*Thalassia hemprichii*	Most abundant and widespread species; often dominates in mixed communities; depth range from intertidal to 30 m; grows on various substrates, such as silty sand, medium coarse sand, and coarse coral rubble
IV	Cymodoceaceae Cymodocea	8	*Cymodocea rotundata*	One of the dominant species in the intertidal; pioneering species; known as dugong food in eastern Indonesia
		9	*Cymodocea serrulata*	Known as dugong food; frequently found just seaward of mangroves
V	Halodule	10	*Halodule uninervis*	Often forms monospecific meadows in disturbed inner reef flats and steep sediment slopes
		11	*Halodule pinifolia*	Fast-growing, pioneering species; often occurring in the intertidal; forms monospecific stands on muddy substrates
VI	Syringodium	12	*Syringodium isoetifolium*	Common in shallow subtidal sand/mud/silt substrates; food for dugong in captivity
VII	Thalassodendron	13	*Thlassodendron ciliatum*	Often dominates in the upper sublittoral in association with corals; depth ranges from reef crest to ca. 4 m; common in atoll lagoons where it forms large monospecific meadows

ca = about, m = meter.

Source: Hutomo et al. (2009).

Enhalus acoroides fruits and/or seeds are edible and are still eaten by the coastal communities of Seribu Island, Jakarta, and eastern Indonesia. The nutritional value of the flour derived from *Enhalus acoroides* is comparable to that of wheat and rice flour in carbohydrate and protein content; and higher in calcium, iron, and phosphorus content.

Some seagrass species have long leaves that can be used as raw material for handicrafts. In Bali, leaves of seagrass, particularly *Enhalus acoroides* and *Thalassia hemprichii*, are used for handicraft products such as handbags and baskets. Bed mattresses made of seagrass are popular in Greece, and Indonesian entrepreneurs are producing and exporting them. Sales in Europe have soared; however, this is a boutique industry based on a renewable resource. Research is needed to ensure sustainability of seagrass products.

Seagrass beds are an important source of livelihood for coastal communities in Indonesia. During low tide, many coastal villagers collect seashells, shrimps, and crabs in seagrass beds. In Banten Bay, West Java, beds of *Enhalus acoroides* and *Thalassia hemprichii* covering 330 hectares (ha) provide economic opportunities to 50 fishers (Hutomo, Nontji, and Dirhamsyah 2009). The dove snail *Pyrene versicolor* lives in *Enhalus acoroides* beds, in some areas at high densities, where it is collected and used as raw material for curtains, lampshades, and picture frames.

Seagrass is also used for terrestrial animal (cattle) feed. Local people in Kuta Bay, Lombok Island, sometimes use seagrass leaves, particularly *Enhalus acoroides* and *Thalassia hemprichii*, for feeding cattle (goats or sheep), usually in the dry season when fresh grass is difficult to find.

Mangroves

Mangrove forests in Indonesia can be divided into two geographical zones: the Asia zone and the Oceania zone. Both zones have the highest plant, animal, and microorganism diversity in the world. In 2009, the total area of mangrove forest in Indonesia was 3.24 million ha based on Landsat Imagery by the National Coordinating Agency for Survey and Mapping (BAKOSURTANAL). West Papua accounts for half, Kalimantan 20%, Sumatra 18%, Maluku 5%, Sulawesi about 5%, and Java and Nusa Tenggara 2% (Saputro 2009).

Some 15 plant families, with 18 genera and 41 species, and 116 associated species are found in the mangrove ecosystems in Indonesia. Mangroves are also home to hundreds of animal species, including mammals, reptiles, birds, and marine fauna (Santoso 2004).

Mangrove ecosystems have several important ecological functions. They act as physical barriers against storm waves and are productive systems that export energy and organic matter to adjacent systems. This, in turn, may support commercially important coastal finfish and shrimp fisheries. In Indonesia, mangroves are used for many economic and livelihood purposes, as described below.

Charcoal and firewood. In several areas, particularly in Riau and West Kalimantan provinces, charcoal is produced from mangroves. Most of the outputs in western Indonesia were exported to Japan and Taipei,China (Santoso 2004). However, the government stopped charcoal production due to the depletion of mangrove forests. Some species of mangroves are also used

Photographs in this box: Pramudji

(From left to right): Mangrove forest in pristine condition in Lasolo Delta, Southeast Sulawesi; and Rhizophora apiculata in pristine condition in Weda Bay, Halmahera.

for firewood, but with the spread of natural gas for family cooking, only a few households in small islands use mangroves for this purpose.

Construction. In some regions in Indonesia, *Rhizophora apiculata*, *R. mucronata,* and *Bruguiera gymnorrhiza* are used as construction materials in many villages (Santoso 2004), and for wood chip production. Under forestry regulations, there is a selective cutting system with 30 years rotation, a planting system in abandoned logging areas, and green belt protection along riverbanks and coastlines. Wood chip production is very extensive; in 1998, production output totaled 250,000 tons, mostly exported to the Republic of Korea and Japan.

Tannin. The bark of some mangrove species, such as *Rhizophora apiculata, R. mucronata,* and *Xylocarpus granatum*, can be used for tanning. The liquid concentrated extract was formerly exported in large amounts for coloring animal skin products (bags, shoes, and others), but this has been replaced by synthetic chemical products. In fishing communities, mangrove tannin is still used for coloring fishing nets (Santoso 2004).

Medicinal plants. Traditionally, some mangrove species are sources of medicinal materials. The decoction of *R. apiculata* is used as an astringent, and the bark of *R. mucronata* is useful for blood purification. The decoction of *Ceriops tagal* is used as an antiseptic, and *Acanthus ilicifolius* is for diabetes; *Xylocarpus granatum* fruits mixed with rice powder are skin repellents and a topical treatment for skin diseases (Santoso 2004).

Tambaks. Brackishwater fish farming in mangrove areas, mainly for milkfish, has been practiced in Indonesia for more than 300 years (Santoso 2004). The area of brackishwater ponds (*tambaks*) has increased significantly since the early 1980s when the government banned trawling in some of Indonesia's waters. From 180,000 ha in 1975, the total area reached 290,000 ha by 1991. In 2010, the total area was 682,726 ha, with total production of 990,403 tons (MMAF 2011a). Ponds are distributed across Kalimantan (31%), Java (23%), Sumatra (23%), Sulawesi (21%), with the rest in Bali-Nusa Tenggara and Maluku-Papua. Traditionally, *tambaks* include cultured mangrove trees on the dikes. Some environment-friendly operations integrate fishing and mangrove growing (Santoso 2004).

Despite the significance of mangroves to humans and the environment, mangrove forests continue to be degraded. The total mangrove area is estimated to have reduced to about 30% over a 20-year period (UNEP 2004a).

Dolphins and Whales

According to visual and acoustic cetacean surveys in Berau waters in 2003–2004, 10 species of cetacean have been observed in that area; and 22 species in Raja Ampat (West Papua), Savu Sea, and Bali–Lombok (Lesser Sunda). Table 4 indicates the levels of diversity recorded for several sites within Lesser Sunda and Papua ecoregions (Huffard et al. 2009).

Table 4 Marine Mammal Species Recorded from the Lesser Sunda and Papua during Surveys in 2005, 2006, and 2007

Common Name	Taxon Name	Raja Ampat	Solor Alor/ Savu Sea	Bali–Lombok
Toothed whales				
Killer whale	*Orcinus orca*	x	x	
False killer whale	*Pseudorca crassidens*	x	x	x
Pygmy killer whale	*Feresa attenuata*		x	x
Sperm whale	*Physeter macrocephalus*	x	x	
Dwarf sperm whale	*Kogia sima*	x	x	
Pygmy sperm whale	*Kogia breviceps*		x	
Spinner dolphin	*Stenella longirostris*	x	x	
Pan tropical spotted dolphin	*Stenella attenuata*	x	x	x
Risso's dolphin	*Grampus griseus*	x	x	
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	x	x	
Common bottlenose dolphin	*Tursiops truncatus*	x	x	x
Fraser's dolphin	*Lagenodelphus hosei*	x		x
Indo-Pacific humpback dolphin	*Sousa chinensis*	x		
Long-nosed spinner dolphin	*Sousa longirostris*			x
Rough-toothed dolphin	*Sousa bredanensis*		x	x
Melon-headed whale	*Peponocephala electra*	x	x	
Short-finned pilot whale	*Globicephala macrorhynchus*	x	x	x
Cuvier's beaked whale	*Ziphius cavirostris*		x	
Baleen whales				
Blue whale	*Balaenoptera musculus*		x	
Bryde's whale	*Balaenoptera brydei*	x	x	x
Pygmy Bryde's whale	*Balaenoptera edeni*	x		
Humpback whale	*Megaptera novaeangliae*		x	

x = indicates species recorded during survey.
Source: Huffard et al. (2009).

The Lesser Sunda Islands form migration corridors and foraging habitats for great whales and oceanic dolphins (massive productive upwelling areas), and the Savu Sea is a calving area. Blue whales reside in the Banda Sea for up to 3 months every year. Papua Bird's Head and Sangihe–Talaud are calving areas for sperm whales because of excellent prey densities. Triton Bay in South West Papua and the Arafura Sea are prime coastal whale habitats (such habitats have now largely disappeared in Southeast Asia). The mangrove areas in the Mahakam and Berau rivers of East Kalimantan are major habitats of Irrawaddy dolphins and finless porpoises (Hutomo et al. 2009).

Turtles

According to the Ministry of Forestry (2009), there were about 107 turtle nesting beaches throughout the country. Annual nesting populations may exceed 35,000 female green turtles and 28,000 female hawksbill turtles. Olive ridley turtles, one of the most endangered turtle species in Indonesia, have been nesting only in a few beaches, mainly in West Bali–East Java, West Sumatra, and the Lesser Sunda Islands. The major nesting population for this species is in Ngagelan Beach of Alas Purwo National Park in East Java with a nesting population of about 500 per year. The largest remaining green turtle nesting rookery in Southeast Asia is Derawan Island and Sanggalaki Island of East Kalimantan, with an annual nesting density of 4,500–7,994 females. Available information on flatback turtles in Indonesia is limited. This species may only feed in Indonesian waters and nest mainly in Australian beaches. The northern coast of Papua (including Jamursba Medi) remains the largest leatherback turtle rookery in the Pacific.

Dugong

The dugong is found in the coastal waters of Indonesia, particularly in areas with large tracts of seagrass, mangroves, and coral reefs. Scientific information of dugong abundance and distribution in Indonesian waters is very limited. There is strong anecdotal evidence that dugongs are residents in both western and eastern Indonesian waters, i.e., the coast of Riau Archipelago, Bangka and Belitung Islands, Sunda Strait, South and East Kalimantan, East Java, North and South Sulawesi, Arafura Sea, and Cendrawasih Bay (Hendrokusumo, Sumitro, and Tas'an 1981; Kiswara 1995; ISC 2004). Salm, Petocz, and Soehartono (1982) reported the presence of dugongs in northern Irian Jaya. In Java, dugongs have been reported from Ujung Kulon National Park and adjacent waters such as Miskam Bay and Blambangan in the southern coast of East Java. In Maluku, dugongs were reported to be numerous around Aru Island (Compost 1980).

Economic Value of Coastal and Marine Ecosystems

In Indonesia, economic valuation of natural resources and the environment has been done since the early 1980s (Dixon and Hufschmidt 1986), and has since become a standard method for most major protected areas and other conservation areas of significance. A review of 37 valuation studies on mangrove ecosystems and 19 studies on coral reef ecosystems, mostly done as university degree requirements, was made for this report.

Many mangrove valuation studies were concerned on ecosystem goods (35 studies). Twenty-five studies covered information and/or life-fulfilling services, ranging from recreational to bequest

values (e.g., existence values). Most of the studies were on regional economic benefits and/or values (i.e., the benefits accruing to an area larger than village level); and only a few studies were concerned with ecosystem services, which are difficult to value. Limited information on the economic aspects of coral reef was available. There were also valuation studies on the seagrass ecosystem (Dirhamsyah 2007, Unsworth et al. 2010) and damage assessment studies (Kusnandar 2008).

Based on this review, Indonesia has sufficient expertise to undertake such studies. Many experts are from academe; however, many are also researchers in government agencies who undertake valuation as part of their research work for their postgraduate degrees. Surprisingly, many researchers collected primary data through a stated preference survey (such as contingent valuation survey) for quantifying one type of benefit, yet used benefit–transfer methods for quantifying other benefits. Willingness-to-pay surveys, especially for non-use values, are notoriously unreliable and prone to bias (Freeman 2003). Some benefit–transfer observations were outdated and inaccurate; for example, Ruitenbeek (1992) is often cited for biodiversity values, which he calculated based on the allocation of international project funding for mangroves in pristine condition of $1,500/ha. However, this was an error; the original research stated a figure of $15/ha.

Overall, the beneficiaries of the ecosystem service being valued in the studies were not well articulated. Commercial enterprises and the public sector play a dominant role in decision making on resource allocation in Indonesia. The economic interests of different agents (individuals versus commercial enterprises versus the public sector) differ and need to be considered.

Pending regulations related to Law No. 32 (2009), entered into force in 2011, include the mandate for internalizing environmental costs (Article 43). Environmental valuation can be readily used for this purpose. Also, the Coral Triangle Initiative, as a group of stakeholders of Indonesia's marine and coastal resources, can act as a forum where trade-offs between sector activities are discussed, for example, between extractive or nonextractive uses of a coral reef ecosystem of high value. Resource valuation can be the tool for weighing policy options; and their distributional impacts across agents, time, and space.

Governance

Policy and legal instruments play key roles in ensuring the sustainable management of Indonesian coastal habitats, preventing marine pollution, and prohibiting certain fishing activities that threaten the marine environment.

Legal and Policy Framework

The regulatory framework for marine resource management in Indonesia is extensive and complex. Section 33, Para 3 of the 1945 Basic Constitution lays down the foundation:

> Land and water and natural resources therein shall be controlled by the State and shall be utilized for the greatest benefit of or welfare of the people.

Indonesia's legal framework for marine and coastal management includes seven levels of laws in two groups: the first group of laws addresses the management of national or internal issues; and the second group is composed of national laws to implement international obligations as a consequence of the government's ratifying international conventions.

National Legal Framework for Coastal Resources Management

No single Indonesian law or regulation specifically addresses the use and management of coral reef resources. Conservation and management of coastal and marine resources are regulated by a group of natural resource laws and regulations.

According to Ginting (2003) and Patlis et al. (2001), at least 20 acts or laws and hundreds of regulations and ministerial decrees relate to the management of coastal resources. However, only 17 laws on natural resources management relate to coastal and marine management: 15 on natural resources management and ocean activities, and 2 national laws for ratifying international conventions. The 15 national laws are grouped into six broad categories: (i) ocean jurisdiction claims, (ii) ocean resources and activities on the sea, (iii) terrestrial spatial and general planning laws, (iv) coastal and marine resources management, (v) general legislation of environmental management, and (vi) legislation on decentralization.

Indonesia ratified many relevant international conventions and other multilateral instruments. One is the International Convention for the Prevention of Pollution from Ships (MARPOL) of 1973 and MARPOL 1978. Annexes I and II of MARPOL, and the Protocol 1978 of MARPOL, were ratified by Indonesia in 1988. Others are listed in Table 5.

Table 5 **International Conventions and Agreements Ratified by Indonesia**

No.	Convention	Year Ratified
1	The International Convention for the Safety of Life at Sea (SOLAS) of 1960	1966
2	The International Agreement for the Facilitation of Search Ships in Distress and Rescue of Survivors of Ship Accidents	1976
3	International Convention on Load Lines of 1966	1976
4	The International Convention on Civil Liability for Oil Pollution Damage of 1969	1978
5	The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage of 1971	1978
6	Convention on the International Regulation for Preventing Collisions at Sea (COLREG) of 1972	1979
7	International Convention for the Safety of Life at Sea (SOLAS) of 1974	1980
8	The International Convention for the Prevention of Pollution from Ships (MARPOL, Annexes I and II) 1973, and MARPOL Protocol 1978	1986
9	The International Convention on Standards of Training, Certification and Watch Keeping for Seafarers (STCW) of 1978	1988
10	SOLAS Protocol of 1978	1988
11	International Convention for Safe Containers (CSC) of 1972	1989
12	The United Nations Framework Convention on Climate Change (UNFCCC)	1994
13	Basel Convention for the Control of Transboundary Movement of Hazardous Waste and Disposal of 1989	1994

Source: Dirhamsyah (2005).

The MARPOL Convention imposed stricter controls in certain "special areas," including coral reef ecosystems, on pollution from ships. Indonesia has also established several sensitive special areas for coral reef protection such as marine protected areas (MPAs).

The International Maritime Organization has developed guidelines for identifying fragile ecosystems, such as coral reefs and mangroves, which may be designated as "particularly sensitive sea areas" susceptible to pollution from ships (Gibson and Warren 1995). Although some Indonesian coral reefs exist close to designated archipelagic sea-lane areas, Indonesia has not declared any sensitive areas to protect coral reefs from oil pollution produced by shipping operations.

Indonesia's Policy Framework for Coastal and Marine Resources Management

The basis of the national marine policy is Chapter X of Indonesia's 2010–2014 National Medium-Term Development Plan (RPJMN 2010–2014) concerning the development of natural resources and the living environment. Regional governments must also consider RPJMN 2010–2014 when formulating or adjusting their respective regional development plans to reach national development targets. Chapter X of the RPJMN 2010–2014 suggests that management of natural resources and the environment be continued to improve the quality of water resources,

rehabilitate and conserve land and forest, manage marine resources, and improve the carrying capacity of the environment.

The remaining part of this section analyzes aspects of Indonesia's marine policy subsequent to Chapter X of the RPJMN 2010–2014 such as policies in fisheries, marine environment, forestry, small island development and management, marine tourism, mining, and sea transport.

Fisheries policy. Since early 2000, the development of Indonesian fisheries has encountered microtechnical and macrostructural problems. Microtechnical problems include the high rate of poverty among Indonesia's fishers, low productivity, overfishing in some areas, illegal fishing by national and foreign fishers, increasing degradation of fish habitats, use of illegal gears (bombing, poisoning, and other prohibited fishing gears), conflict of interest on spatial planning, lack of postharvest production skills, and lack of data and information. Macrostructural problems occur because of external conditions, including the lack of legal and institutional arrangements, and lack of a macroeconomic policy for sustainable fisheries development; in essence, the lack of political commitment to sustainable natural resource management. The three components of fisheries policy in Indonesia are on (i) the management of fish catch through monitoring and control, (ii) the enhancement of aquaculture production, and (iii) increasing added value of fisheries processing.

Environmental policy. Overfishing and other destructive fishing practices have caused degradation of coastal and marine resources (Nontji 2000). Policy on the marine and coastal environment entails two major activities: (i) conserving marine resources, and (ii) preventing marine pollution. Both aspects are addressed by Indonesia's environment policy (BAPPENAS 2011).

Forestry policy. The policy on conservation and management of coastal ecosystems in forestry is included in the national policy for the management of Indonesia's wetlands. The National Strategy and Action Plan for the Management of Indonesia's Wetlands of 2004 contains the following five management policies: (i) sustainable development and use, (ii) benefits and priority principles, (iii) community-based management, (iv) adoption of an integrated management approach, and (v) application of good governance principles (State Ministry of Environment 2004).

Small islands development policy. Almost 10 years ago, Indonesia approved the Convention on Biological Diversity and other results of the United Nations Conference on Environment and Development (such as Agenda 21), but problems still face the development of small islands in Indonesia. One program of Agenda 21 is the sustainable development of these islands. While more than two-thirds of Indonesia's islands are small, they have considerable natural resources that can potentially be developed. However, five limitations are encountered in developing small islands because of their uniqueness (Kusumastanto 2003): (i) size and location, which create a limitation on human resource development; (ii) lack of natural resources and environmental services; (iii) difficulty in generating profitable economic activities; (iv) the close link between natural resources productivity and environmental services such that exploitation of natural resources (e.g., coral reefs and mangroves) contributes to the degradation of the natural ecosystem; and (v) some local community cultures against marine development, especially marine tourism, and not permitting marine tourism development such as swimming, snorkeling, and other beach activities for religious reasons.

Marine tourism policy. Marine tourism, including seaside tourism, culture tourism, sports tourism, and cruise tourism, is a potential sector for marine development in Indonesia. An early 2000 study estimated the potential contribution of marine tourism to the Indonesian economy at $26.6 billion during 2004–2024 (Kusumastanto 2003). Several policies have been developed to realize this potential. Policies relating to the use and development of coral reefs (i) develop a model of marine tourism management that stresses sustainable development of marine ecosystems and encompasses the cultural aspects of the local community, and (ii) increase the capacity and capability of human resource development in the management of the marine tourism industry (Kusumastanto 2003).

Mining policy. The Indonesian mining policy applies to mining of all nonliving resources and exploration in both land and ocean. Oil and gas are primarily mined in Indonesia and have been the country's main source of revenue since the 1970s. Almost 35% of oil production in Indonesia is derived offshore (Soegiarto and Stel 1998). Sand was mined in Riau Province to meet Singapore's demand for sand to construct roads and buildings and reclaim its beaches. Thus, the industry contributed to Indonesia's economy, but had a negative impact on marine ecosystems, including coral reefs. About 5% of Riau Province's income, or Rp26 trillion ($2.8 million), came from sea-sand mining (JATAM 2001). However, in 2003, the Government of Indonesia finally placed a moratorium on sea-sand mining for export.

Marine transport policy. The development of marine transport may not directly affect the use and management of coral reefs, but, if uncontrolled, can create pollution that can damage coral reef ecosystems. An estimated 27% of the world's oil traffic or 7 million barrels of crude oil per day are transported through the Malacca Straits and other archipelagic sea lanes of Indonesia such as the Sunda, Makassar, and Lombok straits. There have been several maritime accidents and casualties. During 1975–1997, oil spills from 104 shipping accidents polluted marine and coastal areas (Nontji 2000). Although Indonesia has ratified several international conventions that address the prevention of pollution from ships, interagency cooperation and enforcement and/or implementation of the laws are weak. No single program within the marine transport policy relates directly to preventing ship-sourced pollution and rehabilitating coastal and marine ecosystems.

In summary, although Indonesia has a wide range of national policies on coastal and marine management, they are scattered among several government institutions. The establishment of an integrated, sustainable national policy on marine and coastal and/or coral reef resources management could be considered a solution to reduce fragmentation. Such a policy should also define the rights and duties of government institutions and other stakeholders on coastal and marine resources. Establishing an effective interagency mechanism to integrate development planning and implementation of such plans at all levels is urgently required. Further, one cannot enforce policy; one can only enforce the law. It is thus necessary for Indonesia to ensure that national policy is enacted into national law.

Institutional Arrangements for Coastal Management

Governance of Indonesia's coastal and ocean resources is the primary responsibility of the state. The authority for coastal and ocean resources management is shared among various agencies under the responsibility of state ministries (Table 6).

Table 6 **Government System of Indonesia for Coastal Management**

Government Agencies	Major Duties and Functions in Coastal Management
Line Agencies	
Ministry of Marine Affairs and Fisheries (MMAF)	• Responsible for overall coastal and marine resources management—from policy development to implementation
Ministry of Forestry (MOF)	• Manage and control forestry resources, including mangroves • Directorate General of Forest Protection and Nature Conservation responsible for managing the trade and conservation of endangered plant and animal species, and marine parks and reserve areas
Ministry of Energy and Mineral Resource (MOEMR)	• Regulate mining exploitation activities in all Indonesian territories, including coastal areas • Prevent negative impacts of mining activities on marine and coastal ecosystems
Ministry of Home Affairs and Regional Autonomy (MOHARA)	• Coordinate national and regional policies and programs, including spatial planning • Through the Directorate General of Regional Development, MOHARA responsible for supervising regional government agencies
Ministry of Transportation and Communication (MOTC)	• Reduce and prevent pollution from ship operations. • Supervise the development of ports, harbors, and navigational aids and safety
Ministry of National Education (MONE)	• Manage national educational systems, through its universities, including the conduct of research in marine science
Ministry of Resettlement and Regional Infrastructure (MORRI)	• Establish national policy for water resources • Develop national spatial planning • Coordinate and implement coastal engineering, coastal erosion prevention, and coastal infrastructure
Ministry of Defence and Security (MODS)	• Conduct national and regional security and defense, including in coastal and marine areas • Conduct hydrographic surveys and mapping
Ministry of Trade and Industry (MOTI)	• Regulate industrial development in coastal areas • Administer the trade activities of coastal and marine resources, including the trade of endangered species and sea-sand mining

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Law Enforcement and Compliance

Some common global management strategies for coastal and marine resources management are also used in Indonesia to enforce its laws and regulations on coastal and marine resources. Enforcement is a joint responsibility of at least 11 national government institutions. The two major departments are the Ministry of Marine Affairs and Fisheries and the Ministry of Forestry (MOF).

Table 6 *continued*

Government Agencies	Major Duties and Functions in Coastal Management
Coordinating Ministries or Agencies	
Coordinating Ministry for Economic Affairs (MENKO EKU)	• Coordinate and synchronize economic policies that relate to ocean and coastal activities
State Ministry for Environment (SME)	• Develop a national policy for the living environment • Establish national guidelines for the management and conservation of all natural resources
State Ministry for Culture and Tourism (SMCT)	• Develop and establish national policy for culture and tourism • Encourage community involvement in ecotourism industries • Protect natural ecosystems, including coral reefs
State Ministry for Research and Technology (SMRST)	• Develop and establish government policy on research, science, and technology activities, including marine science and technology
Nondepartment Government Agencies	
National Development Planning Agency (BAPPENAS)	• Develop and establish national development planning • Coordinate sectoral and regional development planning and institutional control for international projects
Indonesian Institute of Sciences (LIPI)	• To establish national guidelines for basic scientific studies • Through the Research Centre for Oceanography, this institute plays an important role in coral reef management in Indonesia • LIPI is also a scientific authority for biodiversity management
National Coordinating Agency for Survey and Mapping (BAKOSURTANAL)	• Establish national guidelines for surveys and mapping • Conduct surveys and mapping in all areas, including coastal areas
Board of Implementation and Assessment of Technology (BPPT)	• Review and establish national policy for the application of technology • Carry out research on technology development related to natural and energy resources
Permanent Interministerial Council	
Indonesian Maritime Council (DMI)	• Establish a general national policy for the maritime sector

Source: Dirhamsyah (2007b).

Indonesia practices two modes of enforcement to ensure compliance with the laws and regulations—sea patrols and aerial surveillance (maritime surveillance). Aerial surveillance is important in the maritime law enforcement program; but in the absence of a national integrated air surveillance system, aerial surveillance has been ineffective.

Sea patrols, which focus on monitoring, control, and conservation of marine biodiversity, are usually controlled by the Directorate General of Forest Protection and Nature Conservation of the MOF, with support from the Indonesian Navy and the Marine Police. Several Indonesian agencies also conduct sea patrols beyond the territorial waters and into the exclusive economic

zone. These sea patrols mainly focus on national sovereignty; and keep watch for other illegal activities, such as smuggling, piracy, and illegal fishing.

Progress in maritime law enforcement includes the introduction of the concept of community enforcement, which encourages the local community to conduct regular sea patrols in village MPAs or marine conservation zones near their villages; and implementation of the Fisheries Act, enacted on 15 October 2004, which has provisions that revolutionize aspects of maritime law enforcement in Indonesia.

For the first time since independence, Indonesia will have specific ad hoc fisheries courts to adjudicate on fisheries infractions. Four factors distinguish the ad hoc fisheries courts from the general courts. First, the prosecutor is required to understand marine, coastal, and fisheries ecosystems and have certified proof of formal training. Second, in some circumstances, it is possible to recruit an ad hoc judge from academe, government institutions, nongovernment organizations, and other formal fisheries associations. Third, the maximum time for the proceedings of law enforcement (from investigation to punishment) has been reduced to approximately 2.5 months. Fourth, in some circumstances, to speed up court processes, delinquents can be sentenced in absentia.

Significantly, the new Fisheries Act has increased sanctions for fisheries violations. For example, the maximum penalty for the use of illegal gear was increased from Rp100 million ($12,000) to Rp1.2 billion ($133,000). However, the maximum imprisonment for the same violation was decreased from 10 years to 6 years.

Socioeconomic Characteristics

Socioeconomic Features

The total population of Indonesia in 2010 was 237.6 million. Annual population growth rate decreased significantly from 2.31% per annum in the 1980s to 1.49% in the 1990s. Over time, 57% of the population has become concentrated in Java Island, which covers only 7% of the country's total land area. Only 2% of the Indonesian population lives in Maluku and Papua, which occupy 24% of the total area (BPS 2011). Population density in 2005 varied from 1,002/square kilometers (km^2) in Java to 7/km^2 in Papua (BPS 2008).

Indonesia's total labor force in 2011 was 117.3 million, of which 68% were employed (BPS 2011).

Indonesia is home to many cultural communities, or ethnic groups, hill tribes, and minorities, which are characterized by their precolonial lifestyle and religion. Of the more than 300 ethnic groups, the Javanese comprise the largest ethnic group, making up 41% of the total population. They are concentrated on the island of Java, but millions have migrated to other islands. The Sundanese, Malay, and Madurese are the next largest groups in the country.

The economy of Indonesia is based mainly on natural resources, especially petroleum, agriculture, fisheries, and tourism. Other prominent economic sectors include the electrical and electronic industry, foreign labor, and industrial services.

Resource-Use Patterns and Issues

Capture Fisheries (Commercial and Subsistence)

Capture fisheries in Indonesia contribute significantly to the national economy's income, foreign exchange, and employment. In 2010, this industry produced 5.4 million tons of fish valued at Rp64.5 trillion ($6.8 billion) (MMAF 2011a). Of this total, marine capture fisheries were valued at Rp48.8 trillion ($5.1 billion) and open freshwater capture fisheries at Rp4.3 trillion ($453 million) (Table 7).

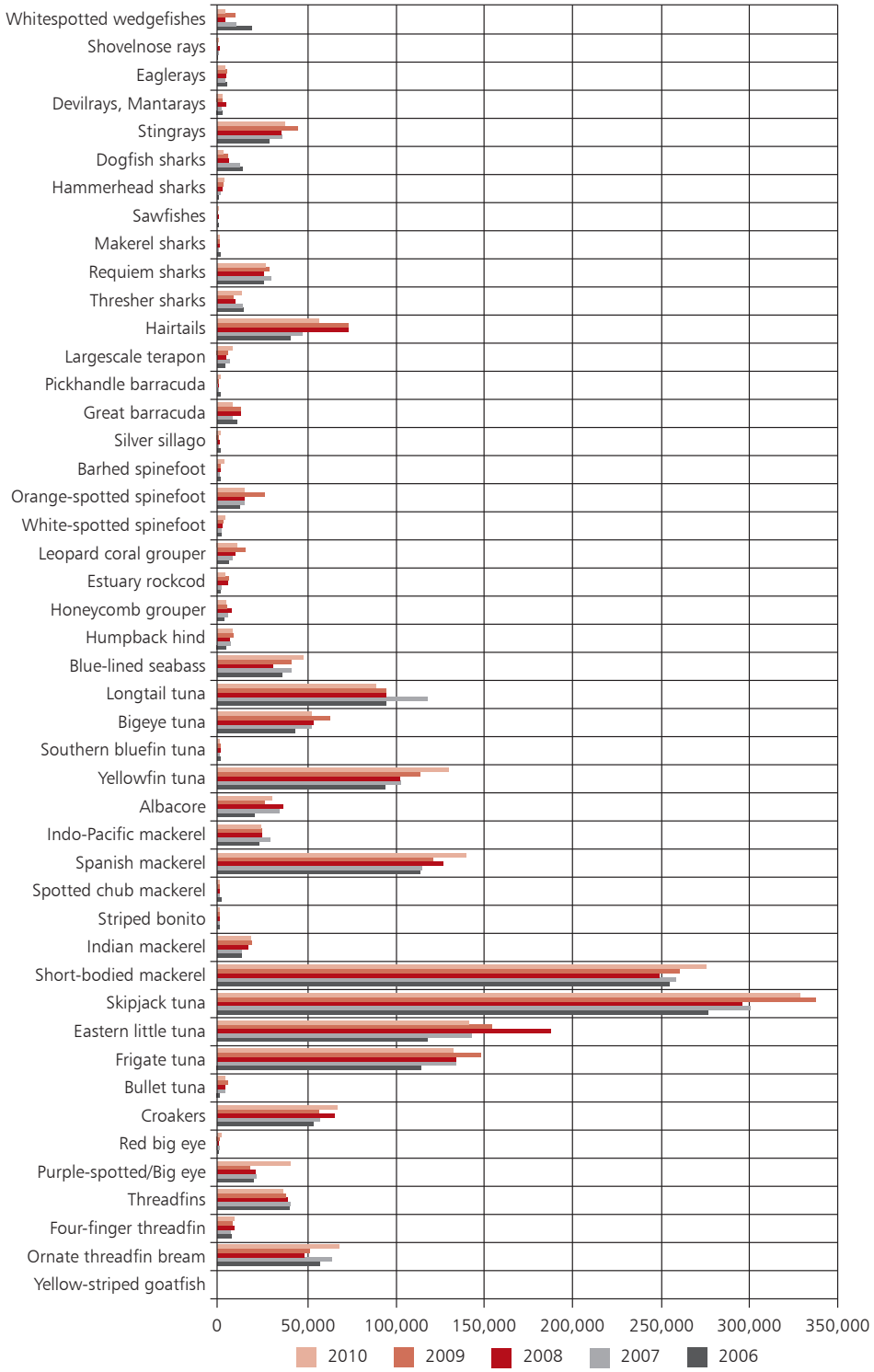
Total capture fisheries production increased annually at an average of 2.7% from 2000 (4.1 million tons) to 2010 (5.4 million tons). During this period, marine capture fisheries increased gradually at 2.7% per year; inland fisheries increased at 1% per year (Table 7); and among the species groups, mollusk harvests increased the most (7.0% per year), and finfish

Table 7 Total Volume and Value of Capture Fisheries Production by Species Group, 2000–2010

Species Group	Year										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	(ton)										
Total Volume	**4,125,525**	**4,276,720**	**4,378,495**	**4,691,796**	**4,651,121**	**4,705,869**	**4,806,112**	**5,044,737**	**5,003,115**	**5,107,971**	**5,384,418**
Marine Areas	**3,807,191**	**3,966,480**	**4,073,506**	**4,383,103**	**4,320,241**	**4,408,499**	**4,512,191**	**4,734,280**	**4,701,933**	**4,812,235**	**5,039,446**
Fish	3,350,475	3,446,389	3,507,860	3,785,356	3,832,733	3,991,940	4,059,690	4,232,722	4,221,635	4,327,259	4,540,145
Crustaceans	273,531	297,812	273,634	289,144	291,665	249,561	279,140	316,587	304,872	302,601	302,544
Mollusks	105,857	161,574	171,897	147,779	172,735	144,634	159,101	171,592	166,390	168,713	184,946
Other animals	34 616	26,255	64,384	96,214	14,431	12,694	9,264	8,736	6,119	10,632	9,114
Aquatic plants	42,712	34,450	55,731	64,610	8,677	9,670	4,996	4,643	2,917	3,030	2,697
Inland water	**318,334**	**310,240**	**304,989**	**308,693**	**330,880**	**297,370**	**293,921**	**310,457**	**301,182**	**295,736**	**344,972**
Fish	297,189	288,065	285,489	289,510	312,125	275,761	274,735	291,769	282,233	274,730	322,374
Crustaceans	17,269	17,141	15,605	15,350	14,310	16,666	14,267	14,825	15,352	16,715	18,336
Mollusks	1,203	3,104	1,340	1,177	1,703	1,131	2,492	1,108	1,164	2,026	753
Other animals	2 673	1,930	2,555	2,656	2,742	3,812	2,427	2,755	2,433	2,265	3,509
	(Rp '000)										
Total Value	**20,052,180,265**	**24,044,822,088**	**26,773,560,675**	**28,986,862,096**	**31,584,962,809**	**36,171,338,838**	**40,069,059,875**	**48,431,934,804**	**50,742,232,425**	**53,929,365,908**	**64,549,401,277**
Marine Areas	**18,466,368,808**	**22,154,235,830**	**24,741,519,513**	**26,641,072,151**	**29,110,268,823**	**33,255,308,006**	**37,162,917,780**	**45,025,650,747**	**46,598,552,733**	**49,527,135,768**	**59,580,474,171**
Fish	12,599,726,357	15,383,535,566	17,499,001,330	19,920,371,182	21,895,699,048	25,897,229,908	29,789,154,456	34,515,936,415	36,162,775,149	39,807,632,713	48,805,096,330
Crustaceans	5,283,029,707	6,072,281,952	6,145,765,728	5,623,761,483	5,983,575,734	5,888,262,451	5,852,687,687	8,426,887,477	7,966,378,357	7,295,081,845	8,054,489,202
Mollusks	439,190,776	584,056,899	878,370,781	797,499,073	1,022,697,061	1,207,512,737	1,228,669,846	1,862,276,929	2,263,880,823	2,126,200,105	2,465,322,290
Other animals	86,468,529	74,870,326	157,373,894	226,466,714	193,403,073	244,273,088	280,995,548	207,713,333	194,572,910	290,670,100	242,693,902
Aquatic plants	57,953,439	39,491,087	61,007,780	72,973,699	14,893,907	18,029,822	11,410,243	12,836,593	10,945,494	7,551,005	12,872,447
Inland water	**1,585,811,457**	**1,890,586,258**	**2,032,041,162**	**2,345,789,945**	**2,474,693,986**	**2,916,030,832**	**2,906,142,095**	**3,406,284,057**	**4,143,679,692**	**4,402,230,140**	**4,968,927,106**
Fish	1,396,009,021	1,678,370,515	1,780,532,455	2,054,377,777	2,204,701,580	2,441,809,852	2,563,275,348	2,997,304,732	3,635,317,908	3,739,240,900	4,320,429,918
Crustaceans	174,202,450	196,109,971	228,691,163	259,398,774	236,527,336	438,280,842	302,706,213	368,602,513	466,894,578	624,288,837	602,355,478
Mollusks	2,092,141	4,037,387	3,309,130	3,586,776	3,838,930	3,292,979	6,892,725	6,514,419	6,732,209	7,511,263	2,627,017
Other animals	13,507,845	12,068,385	19,508,414	28,426,618	29,626,140	32,647,159	33,267,809	33,862,393	34,734,997	31,189,140	43,514,693

Source: MMAF (2011a).

Figure 1 **Total Volume of Marine Capture Production by Species, 2006–2010** (ton)



Source: MMAF (2011a).

(3.2% per year). Production of other animals and aquatic plants decreased at an average of 6.7% and 8.5% per year, respectively. The top five provinces in marine capture fisheries in 2009 were South Sulawesi, East Java, Central Sulawesi, West Java, and East Nusa Tenggara.

In 2006–2010, among the finfish species, tuna—especially skipjack—and mackerels dominated the catch; production of some species grew remarkably, while that of others declined (Figure 1). Harvest of most species in the crustacean group increased: mangrove mud crab (15.5% per year), swimming crab (14.3%), and spiny lobster (13.6%). Average annual increases in mollusks production included octopuses (30.4%), clams (22.8%), Pacific oysters (19.8%), and scallops (16.1%). Among other animals, sea cucumber production increased at 12.2% per year, and jellyfish at 0.3% per year. Seaweed production declined at an average of 11.7% per year.

More than 58% of marine capture production was marketed fresh. A small part of the remainder (3.5%) was processed through modern methods—canning, fishmeal production, and freezing—generally for export. The rest, for the domestic market, was processed traditionally through salting and/or drying (15.0%), boiling (3.5%), fermentation (0.8%), and smoking (2.2%).

Fishing Fleets and Gears

The national fishing fleet comprised 742,369 units at the end of 2010, of which 570,827 were marine vessels and 171,542 were inland open water boats. More than 75% were motorized. More than 85% of the fishing boats were concentrated in the western and central parts of the country—with Sumatra (22.7%), Sulawesi (22.9%), and Java (19.7%) having the most concentration of fishing boats. The rest were in Bali and Nusa Tenggara (9.6%), East and South Kalimantan (10.7%), and Maluku and Papua (14.5%).

Many types of fishing gears operated in marine waters (Table 8), with the total showing a slight declining trend from 1.4 million units in 2005 to 0.9 million in 2010. In 2010, most fishing units in West Sumatra were other lines, drift gill nets, and stow nets; in South Java, other lines, set gill nets, and drift gill nets; in Malacca Strait, drift gill nets, portable traps, and set gill nets; in East Sumatra, drift gill nets, set gill nets, and other lines; in North Java, Danish seine, set gill nets, and trammel nets; in Bali–Nusa Tenggara, handlines, troll lines, and drift gill nets; in South and West Kalimantan, drift gill nets, set gill nets, and trammel nets; in East Kalimantan, trammel nets, set gill nets, and drift gill nets; in South Sulawesi, set gill nets, other lines, and handlines; in North Sulawesi, handlines, other lines, and troll lines; and in Maluku, other lines and set gill nets.

Status of Fishery Resources Utilization

There are 11 marine fisheries management areas (*wilayah pengelolaan perikanan* [WPP]) in the country that are based on bottom bathymetry; environmental characteristics; cartographic principles; and maritime boundaries, particularly exclusive economic zone (EEZ) boundaries with neighboring countries. The state of fishery resources utilization in the WWPs is summarized below.

WPP 571 Malacca Strait and Andaman Sea. This WPP covers parts of three provinces: Aceh, North Sumatra, and Riau; they comprise the eastern part of Aceh and North Sumatra waters, and the western and southern parts of Riau. The fisheries are mostly dominated by shrimp

Table 8 Number and Type of Fishing Gears, 2004–2010

Type of Fishing Gear	2004	2005	2006	2007	2008	2009	2010
Double rigs shrimp trawl	1,524	2,937	2,143	2,051	2,755	2,186	2,543
Stern shrimp trawl	4,167	3,155	4,355	4,335	4,399	2,605	3,530
Beam trawl				21			156
Fish net	1,992	3,505	5,494	3,650	12,414	4,192	7,369
Pelagic Danish seine	33,873	41,260	36,013	35,349	48,171	31,012	27,002
Demersal Danish seine	23,445	22,763	23,784	26,208	26,820	28,372	19,726
Beach seine	23,588	22,654	22,121	17,919	19,845	17,837	19,556
Purse seine	13,714	17,198	20,211	22,741	22,338	18,423	17,572
Drift gill net	131,708	127,542	128,166	154,407	115,009	101,097	99,983
Encircling gill net	29,490	19,017	19,128	16,075	13,845	16,560	18,353
Shrimp entangling gill net	35,725	35,063	35,315	40,774	35,839	32,303	23,116
Set gill net	111,041	98,948	92,274	119,171	102,765	93,975	97,495
Trammel nets	53,690	54,255	48,783	44,817	43,000	45,731	37,798
Boat/raft lift net	28,272	22,032	19,537	13,966	12,520	11,293	13,120
Stationary lift net	15,010	16,704	15,904	26,180	25,769	23,689	14,008
Scoop net	8,864	19,325	7,897	13,944	12,110	27,752	11,884
Shore lift net	7,156	308	457	1,289	1,330	864	2,417
Other lift nets	3,627	16,477	18,161	2,596	8,080	8,101	7,245
Tuna longline	5,656	5,226	9,290	8,983	10,239	10,345	8,558
Other drift longline	14,139	16,653	20,267	20,813	19,381	18,327	12,306
Set longline	30,072	23,126	28,787	45,770	40,774	39,441	24,175
Set bottom longline	3,302	5,039	6,211	13,059	13,944	10,385	11,144
Skipjack pole and line	5,032	3,872	6,861	15,765	16,486	12,727	7,379
Troll line	93,523	101,525	98,966	83,514	87,011	84,953	64,554
Handlines	33,018	22,863	30,250	53,768	56,580	67,444	71,046
Vertical line (including vertical longline)	9,051	6,626	8,779	14,293	16,305	21,405	22,222
Squid jigger	8,123	1,772	4,524	5,443	8,687	10,150	22,192
Other lines	258,320	246,464	241,710	222,092	238,627	189,509	118,405
Guiding barrier	22,642	11,700	10,257	16,387	15,279	14,186	9,335
Stow net	6,590	6,243	3,434	4,092	3,767	3,673	7,300
Portable trap	214,443	269,447	85,443	85,978	76,528	63,643	44,885
Other traps	40,722	35,340	26,703	30,236	71,920	75,371	18,624
Seaweed collectors	11,070	4,143	4,115	2,660	2,020	2,437	1,791
Shellfish gears	10,739	11,798	8,657	8,618	8,321	9,031	12,298
Sea cucumber gears	1,927	1,588	1,197	2,889	2,372	2,153	1,770

continued on next page

Table 8 *continued*

Type of Fishing Gear	2004	2005	2006	2007	2008	2009	2010
Crab gears	2,139	4,424	6,965	9,111	12,732	13,803	16,979
Muro-ami	1,711	722	1,073	1,004	1,260	1,033	1,021
Cast net	3,344	5,892	12,317	4,071	3,894	4,970	6,826
Harpoon, and others	52,067	63,213	48,959	43,758	52,304	53,296	41,537
Total	**1,354,516**	**1,370,819**	**1,164,508**	**1,237,797**	**1,265,440**	**1,174,274**	**947,220**

Source: MMAF (2011a).

(demersal) and small pelagic fish. There is a fishery for large pelagic fish northwest of the area close to the Andaman Sea.

WPP 572 West Sumatra Indian Ocean and Sunda Strait. This WPP is mainly located in deep-sea Indian Ocean waters west of Sumatra, with international borders. The area includes parts of six provinces: Aceh, Banten, Bengkulu, Lampung, North Sumatra, and West Sumatra. Tuna longline is the main fishing gear used in the area. Indonesian fishers compete with developed-country fleets that use more modern fishing technology. The Indian Ocean Tuna Commission coordinates the management of tuna fisheries in that area. Besides tropical tuna (albacore, yellowfin, and bigeye tuna), Indonesian fishers also catch subtropical southern bluefin tuna, which is managed and/or coordinated by the Commission on Conservation of Southern Bluefin Tuna.

WPP 573 Southern Java Indian Ocean, Southern Nusa Tenggara, Sawu Sea, and West part of Timor Sea (Lesser Sunda). This WPP is the extension of the WPP 572 in the Indian Ocean. The area includes the Indonesian EEZ and territorial waters of eight provinces: Bali, Banten, Central Java, East Java, East Nusa Tenggara Jogjakarta, West Java, and West Nusa Tenggara. The fisheries are mostly dominated by tuna (large pelagic) and small pelagic fish.

WPP 711 Karimata Strait, Natuna Sea, and South China Sea. This WPP covers the waters of five provinces: Bangka and Belitung Islands, Jambi, Riau Archipelago, South Sumatra, and West Kalimantan. This WPP also includes Indonesian EEZ waters in the Natuna Sea and South China Sea. The area is part of the Sunda Shelf and relatively shallow, with an average depth of 70 meters and a flat bottom. The monsoon governs productivity in this area. Fisheries are mainly small pelagic fish and demersal species.

WPP 712 Java Sea. This area covers the entire Java Sea and a small part of Sunda Strait, including waters in the management territory of eight provinces that include Central Java, Central Kalimantan, DKI Jakarta, East Java, Lampung, South Kalimantan, and West Java. A wide variety of fishing gears is used in this WPP, from the most traditional to the most modern and efficient, such as the use of high-wattage lamps to lure fish to school around the boat at night for capture with a purse seine net. The demersal and shrimp resources were rapidly exploited after trawls were introduced in the late 1960s. Fisheries are mainly small pelagic fish and demersal species.

WPP 713 Makassar Strait, Gulf of Bone, Flores Sea, and Bali Sea. This WPP covers the Makassar Strait and Gulf of Bone and includes the Flores Sea and Bali Sea as the discharge areas of those waters. Fisheries are dominated by small pelagic fish.

WPP 714 Tolo Bay and Banda Sea. The main area of this WPP is the Banda Sea, with small areas of Tolo Bay in the northwestern Banda Sea. Traditional fishing gears are usually used in this WPP such as handlining and trolling in Bandaneira, pole and line gear by Kendari fishers, and tuna purse seines with support of night-light boats in this area. Large pelagic fishes are the main harvest in this WPP; but small pelagic fishes are also important, including *layang* (scads), *teri* (anchovies), and *lemuru* (sardines).

WPP 715 Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay. Large and small pelagic fishes are harvested in this area. In Tomini Bay, traditional fishers catch pelagic resources by surrounding the bay. Coral fish catches are dominated by snappers (*Lutjanus spp.*), groupers (*Epinephelus spp.*), and emperors (*Lethrinus spp.*). In July and August, the reef fish catch is dominated by the fusilier *Caesio erythrogaster*.

WPP 716 Sulawesi Sea and Northern Part of Halmahera Island. This WPP covers the whole area of Sulawesi Sea and some parts of the Pacific Ocean. The area includes Indonesia's EEZ in the Sulawesi Sea and southern Pacific Ocean. The North Sulawesi waters and its surroundings are one of the most important tuna fishing grounds in Indonesian waters. In 1980, a joint venture was developed with the Philippines in tuna and skipjack fishing using purse seine in these waters.

WPP 717 Cendrawasih Bay and the Pacific Ocean. This WPP covers the whole area of Cendrawasih Bay, but most of the area is Indonesian EEZ in the southern Pacific Ocean. Similar to WPP 716, pelagic fishes are the basis of an important fishery in this area, but production is low.

WPP 718 Aru Sea, Arafura Sea, and East of Timor Sea. The Arafura Sea and part of the Moluccas Sea are large shrimp and demersal fishing grounds; more than 1,100 trawlers catch about 0.5 million tons annually. This WPP has the third largest potential fishery production among the 11 WPPs.

Aquaculture

Almost 50% of Indonesia's fisheries are produced from aquaculture. In 2009, aquaculture production totaled 4.7 million tons (Table 9) valued at about Rp40.5 trillion ($4.3 billion). This industry grew significantly from 2005 to 2009 at an average annual increase of 21.5%. Marine aquaculture, mainly of highly valued species, accounted for 60% of the total; and brackishwater ponds made up 19.3%.

Seaweed (2.96 million tons), shrimp (0.34 million tons), milkfish (0.33 million tons), Nile tilapia (0.32 million tons), and carp (0.25 million tons) were the top five species groups, making up almost 90% of the total in 2009 (Table 10). Seaweed was produced from South Sulawesi, Central Sulawesi, East Nusa Tenggara, and East Java; while shrimp was mainly grown in South Sumatra, Lampung, and East Java.

Table 9 Aquaculture Production, 2005–2009

Items	Volume (ton)					Average Annual Growth Rate (%)	
	2005	2006	2007	2008	2009	2005–2009	2008–2009
Marine culture	890,074	1,365,918	1,509,528	1,966,002	2,820,083	34.41	43.44
Brackishwater pond	643,975	629,610	933,832	959,509	907,123	10.84	(5.46)
Freshwater pond	331,962	381,946	410,373	479,167	554,067	13.72	15.63
Cage	67,889	56,200	63,929	75,769	101,771	12.34	34.32
Floating net	109,421	143,251	190,893	263,169	238,606	23.18	(9.33)
Paddy field	120,353	105,671	85,009	111,584	86,913	(5.65)	(22.11)
Total	**2,163,674**	**2,682,596**	**3,193,564**	**3,855,200**	**4,708,563**	**21.47**	**22.14**

( ) = negative.
Source: MMAF (2010).

Table 10 Aquaculture Production by Main Species Group, 2005–2009

Commodity	Volume (ton)					Average Annual Growth Rate (%)	
	2005	2006	2007	2008	2009	2005–2009	2008–2009
Shrimp	280,629	327,610	360,096	409,594	338,062	5.73	(17.46)
Giant sea perch	6,493	4,021	8,035	5,006	8,793	24.93	75.64
Nile tilapia	151,363	179,934	206,904	291,035	323,390	21.41	11.12
Carp	216,924	247,633	264,349	242,322	249,279	3.86	2.87
Milkfish	254,067	212,883	263,139	277,474	328,290	7.79	18.31
Barramundi	2,935	2,182	4,418	4,371	6,399	30.53	46.40
Cat fishes	32,575	31,489	36,755	102,014	109,686	49.62	7.52
Java barb	69,386	77,332	91,735	114,372	144,756	20.33	26.57
Giant gourami	25,442	28,711	35,708	36,637	46,254	16.52	26.25
Mud crab	4,379	5,525	6,631	7,642	7,516	14.95	(1.64)
Shell	16,348	18,896	15,623	19,662	15,857	1.19	(19.35)
Seaweed	866,383	1,374,463	1,728,475	2,145,060	2,963,557	36.66	38.16
Others	236,754	171,918	173,167	200,016	166,724	(6.95)	(16.64)
Total	**2,163,678**	**2,682,597**	**3,195,035**	**3,855,205**	**4,708,563**	**21.47**	**22.14**

( ) = negative.
Source: MMAF (2010).

Coastal Tourism

Tourism in Indonesia has expanded rapidly, in part because of the country's long sandy beaches and islands and rich underwater vistas. The total number of visitors in 2002–2010 (Table 11) declined in some years because of terrorism. In 2005, more than 50% of visitors to Indonesia came for tourism; while the average expenditure per visitor was $904, and the average length of stay was 9 days (BPS 2006). Bali, West Java, and Jakarta were the most popular tourist destinations.

Table 11 **Total Foreign Visitors to Indonesia, 2002–2010**

Year	No.
2002	5,033,400
2003	4,467,021
2004	5,321,165
2005	5,002,101
2006	4,871,351
2007	5,505,759
2008	6,234,497
2009	6,323,730
2010	7,002,944

Source: BPS (2011).

Minerals, Oil, and Gas

Oil meets 75% of energy demand in Indonesia while gas provides 10%. Indonesia's known oil reserve represents about 1% of the total world reserves (Suryantoro and Manaf 2002). According to Badan Pengelola Minyak dan Gas (BP MIGAS 2011), many coastal and marine areas in Indonesia contain oil and gas. Delta Mahakam in East Kalimantan is one of the biggest gas fields in shallow waters. Gas and condensate also exist in many offshore areas in Indonesia, in waters of 400–1,785 meters (m) depth. In the Macassar Strait, gas exists at 975–1,785 m deep; and in the Arafura Sea, at 400–700 m deep.

Many of Indonesia's marine areas have not yet been targeted for mineral exploration. Based on geological characteristics, many more discoveries will most likely occur in the future (Suryantoro and Manaf 2002).

The exploitation of oil and minerals has contributed significantly to national income, but mining them also affects the environment. Although some regulations under various acts are in place, many accidents occur due to mining activities. Gold mining in Timika (Papua) produces tailings containing hazardous substances, which have been reported to destroy mangrove forests and other marine resources. In another gold mine in Teluk Buyat (North Sulawesi), tailing outfalls reach the sea, and have been reported to cause illness among residents of coastal communities in the area. Uncontrolled small-scale gold mining where mercury is used, poses another problem for coastal environments (Hutomo, Nontji, and Dirhamsyah 2009).

Marine traffic in Indonesia, particularly in the Malacca Straits, is one of the busiest in the world. The straits alone carry half of the world's oil supplies and a third for world trade. From 1997 to 2002, 11 collisions and grounding incidents occurred in the Malacca Straits (Razak 2006; Hutomo, Nontji, and Dirhamsyah 2009). Such accidents threaten the health of marine ecosystems, particularly when cargo and oil spill onto major fishing grounds and tourist beaches.

The most recent oil spill was caused by the eruption of the Montara underwater well in August 2009, which discharged an estimated 5 million liters of marine fuel oil into the Timor Sea, and resulted in tremendous losses to the marine environment and fisheries. It could also have

harmed whales, turtles, and dolphins; and other marine organisms that live in deep water.

Another major mining incident was the eruption of the mud volcano in Sidoarjo, East Java. A drilling accident on 29 May 2006 apparently caused the Sidoarjo mudflow in the Porong subdistrict of East Java. Mud covered about 440 hectares; inundated 4 villages, homes, roads, rice fields, and factories; displaced about 24,000 people; and killed 14. Studies by nongovernment organizations in 2007 indicated that sedimentation was smothering marine life, particularly bottom-dwelling creatures like snails.

BPMIGAS

Offshore oil/gas facilities in Indonesian waters.

Transport and Shipping

Marine transport is vital to the economic and social progress of the coastal zone and the country as a whole. Indonesia has developed many types of ports to serve international and domestic trade. In 2009, the Indonesian Port Authority recorded 602,851 international and domestic vessels serviced from its ports and harbors (BPS 2011). In 2006, there were 1,724 ports, of which 141 were international ports (Department of Transportation 2007).

Traditional Knowledge Management

Each ethnic group in Indonesia has its own culture, norms, and beliefs. In eastern Indonesia, the ethnic groups' culture and beliefs are more oriented to coastal and marine areas. Most activities of coastal communities are influenced by weather and sea conditions.

Several decades ago, traditional knowledge has been successfully used to manage coastal and marine resources in some parts of Indonesia. However, only a few coastal communities continue their traditions such as the *sasi* system in the Moluccas and Papua, the *panglima laot* in Aceh, the *awig-awig* in Lombok, and the *mane'e* in Sangir and Talaud Islands in North Sulawesi.

The *sasi* is a system of closed access to a forest area, savannah, coral reef, or fishing ground (including the river and estuary areas) at a certain time and in a certain area (Thorburn 1998). The boundaries of these community-controlled territories are frequently associated with the natural features of the particular village. Marine *sasi* covers products such as giant clams, trochus, sea cucumbers, and lobsters; the Moluccas people consider these products common property (Adrianto, Solihin, and Amin 2011). These marine *sasi* products are primarily for social and conservation purposes.

The *panglima laot* has existed in Aceh since the 14th century, and served as the traditional institution that guides livelihood activities of fishers in a certain fishing ground. It also served as a connecting component between fishers and the government in addressing fisheries-related matters (Sulaiman 2010). However, Regional Government Regulation of Aceh No. 7/2000

defines the *panglima laot* as a person who leads traditional customs during marine fisheries activities and addresses disputes or problems among fishers. Its organizational structure is composed of several levels of positions covering provinces and districts, some with authority to manage fisheries, and others with a coordinating function. Each district or city has its own policies to implement.

The *mane'e* is traditional fishing using the coconut leaf, which has been practiced in some islands in North Sulawesi (bordering the Philippines' waters) for hundreds of years. This tradition is usually performed one day in May when the moon is full during spring tide, and often in coral reef areas along the adjacent island waters. The location of *mane'e* is decided at an *adat* (local community) meeting.

Clearly, it is impossible for Indonesia as an archipelagic country to adopt a centralized democratic system because it lacks the financial and personnel capacity and capability to control its inshore waters. The centralized implementation of resource management systems has increased financial, administrative, and personnel burdens upon the central government. One solution to this is community empowerment, in which communities manage their own marine resources and ecosystems with some support from the government.

At least six lessons can be noted:

(i) In developing sustainable policies for marine resources management, the government, community, and other stakeholders should consider and use as its main basis the traditional knowledge that has been practiced by a community. Therefore, it is necessary to keep a record of and document traditional knowledge systems and their various modifications over time.

(ii) New rules should be adapted, as much as possible, to the rules that were enacted in the previous era or by communities, adding complementary scientific information and/or justification. It includes information relating to the (i) existing biodiversity, (ii) manner of determining the group or community that has authority to harvest it, (iii) type of fishing gear that can be used in the area (Adhuri and Satria in Ruddle and Satria 2011), (iv) appropriate gear, (v) marine protected areas, (vi) open and closed seasons, and (vii) rehabilitation of degraded areas.

(iii) The local community or institution should be empowered. For example, in certain areas in eastern Indonesia, the church, mosque, or local chief previously held the right and authority to manage the resources; such rights and authority should be returned to them (Adhuri 2005, Adrianto et al. 2011).

(iv) The local community should be provided with assistance in the form of alternative livelihoods.

(v) Law enforcement at sea should be properly carried out.

(vi) Community awareness training on the importance of marine resources and ecosystems should be conducted.

Since the reform era in 1998, the government has made efforts to revive traditional management in Indonesia. However, political problems remain: (i) the implementation of regional autonomy is still being challenged, (ii) conflicts arise among marine fishers, and (iii) conflict among the

local elite. In such situations, the national government could act as facilitator and/or mediator among the parties.

Gender Issues

Although women actively participate in fisheries and fisheries-related activities in Indonesia, data on employment of women in fisheries are few, making women's roles invisible. Moreover, available data tend to be outdated or anecdotal.

Almost the entire household and community are involved in small-scale fisheries. According to the gender-based division of labor in many communities, mostly men engage in fishing; while women take care of shore-based work such as making preparations for the fishing trip, mending nets, sorting and selling fish, processing fish, and others (Sitorus 1995, Siason 2001). Wives or daughters of fishers are usually involved in small-scale fisheries (Siason 2001). In some areas such as Bali and South Sulawesi, women are very active in fish marketing. Women's role in pre and postharvest traditional small-scale fisheries is thus vital.

Women's involvement in fishing activities across the country varies by ethnic group, culture, religion, and economic status. For example, in certain areas in eastern Indonesia, it is acceptable for women to go fishing; but in other areas, such as in North Sumatra, taking a woman on board a fishing vessel is considered bad luck (Markkannen 2005). Women in coastal fishing communities often engage in income-generating activities. However, the income generated tends to be unstable and unpredictable. Women also have reproductive and family roles, managing household chores and various other tasks. They run the household while their husbands go fishing offshore for long periods.

Although the Government of Indonesia has exerted much effort in promoting gender concerns and women's involvement in fisheries and coastal resource management, women have generally been excluded from planning "mainstream" fisheries activities and comanagement arrangements. Increasing women's roles and involvement in utilizing these resources are, thus, a challenge for the government and other stakeholders of fisheries and coastal resources.

Payment for Ecosystem Services

Marine and coastal ecosystems provide direct benefits—food, fiber, and fuel. They also provide an array of indirect benefits, including water filtration, climate regulation, nutrient cycling, pollination, pest control, and disease regulation, which support and promote the natural resource base on which economic activities are founded.

Payment for ecosystem services (PES) has become a tool for sustaining ecosystems in many countries and circumstances. Suyanto et al. (2005) reviewed the market for ecosystem services in Indonesia; and found 81 examples categorized into the following groups: 41% for biodiversity conservation, 20% for watershed protection, 19% for carbon sequestration, and 20% for landscape and/or seascape beauty. Of these, 9 were functioning markets, 7 markets were being proposed, and 65 markets were for potential development.

Marine PES is mostly related to the tourism market, where the ecosystem service is in the form of scenic beauty, especially in the context of coral reef ecosystems. The commercial fisheries sector, arguably the largest beneficiary of services from coastal and marine ecosystems in monetary terms, is not yet involved in any PES arrangements (Agung et al. 2012).

The legal basis for PES at the national level is found in several acts, which arrange for a PES for each ecosystem or resource such as water management, forest utilization, or environmental service. PES has been recognized explicitly by Act No. 32/2009 concerning environmental management, which is replete with mandates for implementing economic instruments as a method for planning, for financing environmental activities, and as an incentive and/or disincentive mechanism (Article 42). PES (or *imbal jasa lingkungan*) is one such economic instrument (Article 43). Operational regulations for this law are still being drafted under the coordination of the Ministry of Environment in the form of a draft government regulation on environmental economic instruments (*Rancangan Peraturan Pemerintah tentang Instrumen Ekonomi Lingkungan*), which includes PES (LPM Equator 2011a).

The government plans to expand the use of the economic instruments in resource management, including PES, which is stipulated under the Fisheries Law. However, numerous challenges are encountered in implementing PES in Indonesia. At least three basic issues need to be addressed in the short and medium term to lay the foundation for PES development in marine and fisheries:

(i) **Right to access resources.** Three preconditions for a rights system will efficiently facilitate entry into the market—exclusivity, transferability, and enforcement of rights (Tietenberg 2003). Rights over coastal and marine resources are mostly held by groups and/or institutions rather than individuals. Further, the Constitution of the Republic of Indonesia warrants the use of natural resources in a way that maximizes the benefits to society.

(ii) **System and mechanism of payment.** Given the present legal environment, PES implementation involving the government can be done through a mechanism of state non-tax income (*penerimaan negara bukan pajak*) and public service unit (*badan layanan umum*). Where the government is not directly involved as either buyer or seller, the transaction is simpler: buyer and seller agree on a price and a compensation and/or disbursement mechanism. It should be noted, however, that enforcement may mean that a legal contract (rather than unofficial and/or informal one) will be needed, if only as a base upon which legal enforcement agencies can take action.

(iii) **Institutional structure.** At the moment, no specific unit in the marine sector is dedicated to overseeing and/or leading the process. The Ministry of Marine Affairs and Fisheries (MMAF) needs to create an institution that can help draft a government regulation on environmental economic instruments; assess how the regulation will affect coastal and fisheries policies such as the fisheries licensing policy; and develop and/or draft relevant regulations. Such a unit would, additionally, have to network with other similar units, engage with the private sector, and collaborate with the MMAF Center for Socio-Economic Research.

Threats and Vulnerabilities

Current Issues for Marine and Coastal Resource Management

Fish Stock Degradation and Food Security

Much of Indonesia's fish resources have been exploited with no consideration for their sustainability. This has caused overfishing of certain fish species in many fisheries management areas or *wilayah pengelolaan perikanan* (WPPs). The use of unsuitable fishing gear for marine and coastal ecosystems has further aggravated this condition, resulting in the decline of some fish stocks.

According to the National Commission on Fish Stock Assessment, the total potential catch of fish resources in Indonesia's waters was 6.5 million tons in 2011 (Table 12). Of the WPPs listed, 6 (WPPs 713–718) and half of a 7th (WPP 573) are located within the Coral Triangle. Table 13 shows the status of exploitation of species groups in WPPs, indicating that four groups of species—small pelagic, demersal, shrimp, and large pelagic fish—are overexploited or fully exploited in some WPPs (mostly in the western part of Indonesia).

Table 12 **Estimated Potential of Fish Resources by Fisheries Management Area, 2011** (ton)

Management Areas	Species Group							Total
	Large Pelagic	Small Pelagic	Demersal Fish	Shrimp	Coral Fish	Lobster	Squid	
WPP 571	27,700	147,300	82,400	11,400	5,000	400	1,900	272,100
WPP 572	164,800	315,900	68,900	4,800	8,400	600	1,700	564,300
WPP 573	201,400	210,600	66,200	5,900	4,500	1,000	2,100	491,700
WPP 711	66,100	621,500	334,800	11,900	21,600	400	2,700	1,059,000
WPP 712	55,000	380,000	375,200	11,400	9,500	500	5,000	836,600
WPP 713	193,600	605,400	87,200	4,800	34,100	700	3,900	927,700
WPP 714	104,100	132,000	9,300	ND	32,100	400	100	278,000
WPP 715	106,500	379,400	88,800	900	12,500	300	7,100	595,500
WPP 716	70,100	230,900	24,700	1,100	6,500	200	200	333,700
WPP 717	105,200	153,800	30,200	1,400	8,000	200	300	299,100
WPP 718	50,900	468,600	284,700	44,700	3,100	100	3,400	855,500

ND = no data available.

Source: Directorate of Fish Resources, Directorate General of Capture Fisheries (2011).

Table 13 State of Exploitation per Species Group by Fisheries Management Area, 2010

Species Group	Fisheries Management Area										
	571	572	573	711	712	713	714	715	716	717	718
Shrimp	O	O	O	O	O	O	U	M	M	M	O
Demersal	F	F	O	F	F	O	F	M-F	M	M	O
Small pelagic	M	O	F	O	O	O	F	F	M	M	O
Large pelagic											
Non-tuna	M	O	F-O	O	F	O	O	O	O		O
Tuna group											
• Skipjack	M	M	M			M	M	M	M	M	
• Yellow fin	F	F	F				F	F	F	F	
• Big eye		O	O				O	O	O	O	
• Southern bluefin tuna			O								
• Albacore			F								
Squid			M	M			M				
Coral fishes											
Lobster											

O	Overexploited	M	Moderate	U	Underexploited
F	Fully exploited	M-F	Moderate to fully exploited	F-O	Fully to overexploited

Source: Directorate of Fish Resources, Directorate General of Capture Fisheries (2011).

Fisheries in Indonesia's waters are very complex and diverse, and reflect the region's extraordinary heterogeneous geography and species richness. While most of the fish catch is artisanal, industrial fisheries contribute considerably more in value since they target high-value shrimp and tuna stocks. Reef fisheries are vital to subsistence fishers in each WPP. They supply high-value products for expanding international, national, and local markets.

Because of their life history attributes, groupers are highly susceptible to overexploitation, and targeting of their spawning aggregations is a serious concern. In addition to catching adult groupers for direct food consumption, the live reef fish food trade captures wild fry and fingerlings to supply the grouper aquaculture industry in Southeast Asia.

Arguably, the best empirical evidence for overfishing is found in the Aru Sea, northern Arafura Sea, where high-intensity fishing has overexploited demersal and shrimp stocks—a condition reflected in smaller catches, dominated by low-value shrimp and demersal fish species. The shrimp harvest in 2001 (274,000 tons) was almost three times the maximum sustainable yield. By 2007, shrimp production declined to 260,000 tons, according to the Ministry of Affairs and Fisheries data. Catch per unit effort in the Arafura Sea declined from 95 kilograms (kg)/haul in 1974 to 38 kg/haul in 1996. Analysis of species composition of caught fish in 1991, 1997, and 2003 showed sharp declines for the dominant *Sciaenidae* group, as well as the *Pomadasydae, Synodontidae, Lutjanidae, Nemipteridae*, and *Formionidae* families. However, there were increasing numbers of small fish of the *Leiognathidae* and *Mullidae* families. The

volume of swimming crabs and squids also increased in the catch in the Aru Sea. Uncontrolled use of trawl fishing gear has most likely caused considerable damage to the seabed.

Over the centuries, heavy and chronic overfishing in many of Indonesia's coral reefs have resulted in major losses in productivity and cascading effects to other components of the ecosystem. Overexploited stocks include many species of reef fish such as groupers, and threatened and endangered species such as sea turtles and dugongs. Benthic invertebrates, such as sea cucumbers and clams, are also overexploited, particularly around major coastal population centers.

The catch per unit effort of pelagic species, such as sharks, tunas, and billfishes, has declined sharply, as has the size of the fish caught. There have also been local extirpations and reductions in market availability.

Threatened Species

The decline of coastal and marine species has led the Government of Indonesia to legally protect them. All 6 species of sea turtles in Indonesia's waters have full protection status while 16 invertebrate species are also protected (Table 14).

Turtles. Every year, as many as 7,700 turtles in Indonesia's waters are estimated to be killed by accidentally getting caught in shrimp trawls and tuna longlines. Several factors threaten all turtle species: illegal trade and direct consumption (of meat, eggs, shell, leather, and curios), bycatch (trawlers, longlines, and gill nets), habitat destruction and alteration (coastal tourism and industrial development), pollution, disease, and climate change (WWF 2012).

Dolphins and whales. The impact of human activities, such as pollution from the discharge of untreated waste and accidental capture by fishing gears, threaten the 10 dolphin and whale species in Indonesia's waters. These are listed in Appendixes I and II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Dugong. Dugongs are protected by a decree of the Minister of the Department of Agriculture No. 327/Kpts/Um/1972. However, dugongs obtain 90% of their food from seagrass beds, which, at the moment, are not protected. The loss of seagrass beds are therefore a major threat to the dugongs. They are also hunted excessively for their meat as food, and other parts of their body such as teeth and skeleton; they are accidentally caught in fishing activities; and are killed or injured by boat propellers. The population of the dugong in Indonesia was estimated to be about 10,000 in the 1970s; by 1994, it was down to about 1,000 (de Longh 1996). The latest reports on dugong distribution and their status in Indonesia are those of de Longh et al. (2009a) and Kiswara et al. (2011).

Humphead wrasse. The humphead wrasse (*Cheilinus undulates*) is overexploited in the live reef fish trade, and threatened by habitat destruction. Together with Malaysia and the Philippines, Indonesia is the main exporter of this species in the world. Dirhamsyah (2011) has critically reviewed the status of this species, highlighting the issues of the trade, and recommending actions by relevant authorities. This species is listed in Appendix II of CITES.

Table 14 Protected Marine Biota in Indonesia

Latin Name	Indonesian Name	Common Name
Mammals		
Balaenoptera musculus	Paus biru	Blue whale
Balaenoptera physalus	Paus bersirip	Common finback whale
Megaptera novaeangliae	Paus bongkok	Humpback whale
Dugong dugon	Duyung	Dugong
	Paus (all cetacean species and families)	All species in the family
Reptiles		
Dermochelys coriacea	Penyu belimbing	Leatherback turtle
Caretta caretta	Penyu tempayan	Loggerhead turtle
Eretmochelys imbricata	Penyu sisik	Hawksbill turtle
Lepidodhelys olivacea	Penyu ridel	Olive/Pacific ridley
Natator depressa	Penyu pipih	Flatback turtle
Chelonia mydas	Penyu Hijau	Green turtle
Crocodylus porosus	Buaya muara	Marsh crocodile
Fish		
Latimeria manadoensis	Ikan raja laut	Coelacanth
Corals		
Antiphates spp.	Akar bahar/koral hitam	All species in the genus
Mollusks		
Hippopus hippopus	Kima tapak kuda	Horsehoof (bear paw clam)
Hippopus porcellanus	Kima cina	China clam
Tridacna crocea	Kima kunia, Lubang	Crocus, saffron-colored clam
Tridacna derasa	Kima selatan	Southern giant clam
Tridacna gigas	Kima raksasa	Great clams
Tridacna maxima	Kima kecil	Largest claw mussel
Tridacna squamosa	Kima sisik/Kima seruling	Scaly, fluted giant clam
Charonia tritonis	Triton terompet	Trumpet triton
Cassis cornuta	Kepala kambing	Horned helmet
Trochus niloticus	Susu bunder	Top shell
Turbo marmoratus	Batu laga/Siput hijau	Green shell, turban shell
Nautilus pompillus	Nautilus berongga	Pearly-chambered nautili
Crustaceans		
Tachypleus gigas	Ketam tapak kuda	Horseshoe crab
Birgus latro	Ketam kelapa	Coconut crab

Source: Government Regulation No. 7/1999.

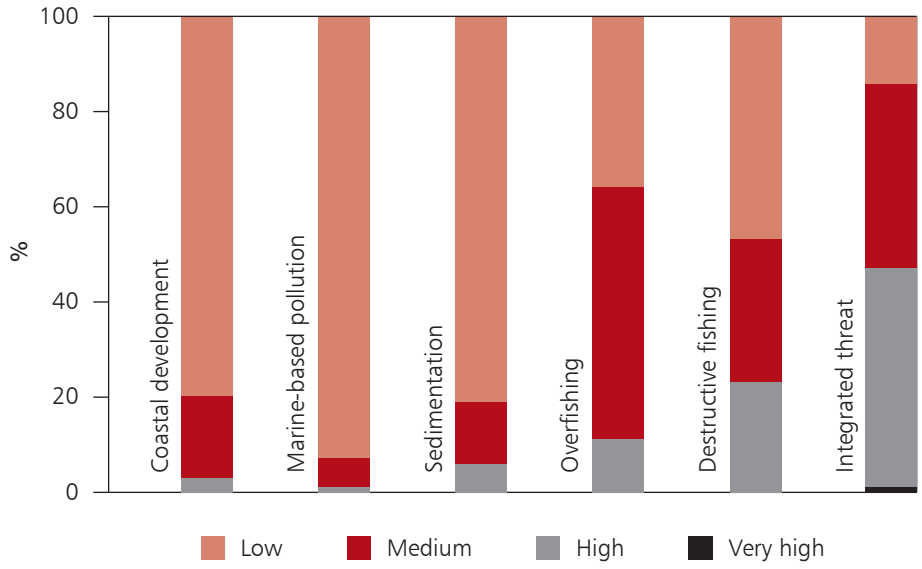
Others (mollusks, corals, and crustaceans). All species of coral genus *Anthipates* are protected. Two crustacean species—the horseshoe crab and the coconut crab—are protected. Twelve species of mollusks have protection status (Table 14), however, some of them are still widely exploited. For instance, giant clams and large snails are harvested for food and for sale as tourist curios (Moosa et al. 1996).

Threatened Habitats

Coral reefs. Heavy reliance on marine resources across Indonesia has overexploited and degraded many coral reefs, particularly those near major population centers. The main threats include destructive fishing practices such as bombing and cyanide fishing, overfishing, sedimentation, pollution, coral mining, and coastal development (Figure 2). According to Burke, Selig, and Spalding (2002), Indonesia is the most at risk in this region. For about 50% of these reefs, the level of threat is "high" or "very high." Only about 12% is low risk.

Bleaching events caused by high water temperatures put stress on coral reefs. These are usually associated with El Niño events, such as those that occurred in 1983 and 1998 (Suharsono 1990, 1999), which resulted in the mass mortality of corals and other marine organisms. Indonesia's coral reefs are also adversely affected by natural phenomena such as earthquakes and tsunamis (Hopley and Suharsono 2000), and coral predators. Indonesia is one of the most tsunami-prone regions on earth—the last event in 26 December 2004 caused numerous deaths and massive damage to thousands of kilometers of coastline in Aceh and North Sumatra and the western islands. The initial assessment of the damage was estimated at 30% loss of approximately 97,250 hectares of coral reefs, or an equivalent net loss of $332.4 million (BAPPENAS 2005).

Figure 2 **Reefs at Risk in Indonesia**



Source: Burke et al. (2002).

Coral predators may also damage coral reefs. The crown-of-thorns starfish is a major coral predator in the Indo-West-Pacific area (Miller 2000). Before the 1990s, it was rarely reported in Indonesia, although large numbers of juveniles were reported in Ambon. Damage from the starfish was reported in the 1980s in northern West Papua (Lane 1996), and outbreaks were reported in several areas in the 1990s (Fraser et al. 1998, Suryadi and Supriatna 1999).

Coral reef rehabilitation. Since the end of the 1990s, initiatives to rehabilitate coral reefs using various techniques have increased sporadically. One simple technique is coral transplantation, which is widely applied by nongovernment organizations (NGOs), students, government agencies, and private sector institutes. The activities are often packaged in public awareness and education programs; marine tourism; and environment-related events for youth, community groups, and private companies.

Other more complex techniques are being developed, field-tested, or installed by NGOs and marine area managers, such as promoting chemical (accretion) processes, providing suitable substrates for recruitment, and asexual propagation (Table 15).

Table 15 **Coral Reef Rehabilitation Efforts in Indonesia**

Approach	Technique	Location
Promoting chemical process	Biorock	Bali, West Nusa Tenggara (Lombok Island)
Providing suitable substrate for recruitment	Reef ball	• West Nusa Tenggara (West Sumbawa), North Sulawesi by Reefball Foundation and PT Newmont • Jakarta (Seribu Islands) by Seribu Islands District • Bali by Reefball Foundation
	Rockpile	East Nusa Tenggara (Komodo National Park) by The Nature Conservancy
	Ecoreef	Sulawesi Utara (Bunakan Marine National Park) by the Board of Implementation and Assessment of Technology (BNPB)
	Other variations of artificial substrates	• Pyramid (Jakarta) by Seribu Islands District • Hexadome (Bali) by the Indonesia Nature Foundation (LINI) • Steel box (Sulawesi) by JFE Steel Corporation • Submarine reef by Bali Tourism Development Corporation (BTDC), Bali
Asexual propagation	Transplantation	The most extensive application throughout Indonesia found in the following: • Banten: Tanjung Lesung, Ujung Kulon National Park by WWF and PT Dana Reksa • Bali by BTDC, LINI, and many more • Jakarta by many community groups • Nanggroe Aceh Darussalam by Wetland Indonesia, WWF (Green Coast Project) • Central Java (Karimunjava Islands) • Lampung by LINI, and many more

Source: Authors.

The Coral Reef Rehabilitation and Management Program (COREMAP) is a large project funded by the Government of Indonesia, the Asian Development Bank (ADB), the World Bank, and the Global Environment Facility (GEF). Launched in 1998, it aims to protect, rehabilitate, and achieve sustainable use of Indonesia's coral reefs and their associated ecosystems. The project uses a "manage the people" approach rather than physical restoration, and is being carried out in 22 districts. It includes an initiation phase (Phase 1, 1998–2003) on public education and awareness, community-based management, and marine conservation; and an acceleration phase (Phase 2, 2004–2011) on community empowerment to protect coastal habitats and to generate income; governance; continuing public awareness and education; collection of long-term ecological, social, and economic data; and development of marine protected areas. A third phase will run up to 2018.

Another initiative to rehabilitate coral reef habitats comes from the ornamental coral culture (coral propagation) policy. Coral traders, under the Ministry of Forestry (MOF) Regulation No. P19/Menhut-II/2005, are obliged to return 10% of the corals produced by propagation to the natural ecosystem. The policy has yet to be fully implemented.

Seagrass. Many of Indonesia's seagrass are severely threatened by coastal construction; coastal reclamation; sand and mineral mining activities; marine pollution; land run-off; and land-based activities such as human settlement, industrial and urban development, logging, and land clearing. For example, the Manado Bay Reclamation Project caused the loss of seagrass beds in the Manado Bay area (Hutomo, Nontji, and Dirhamsyah 2009). Besides anthropogenic impacts, natural stresses such as cyclones, tidal waves, and volcanic eruptions also affect seagrass.

Seagrass rehabilitation. Records of seagrass rehabilitation in Indonesia are very limited, with available information coming only from two institutions. The Research Centre of Oceanography–Indonesian Institute of Science (RCO–LIPI) started rehabilitation in 1988 in Seribu Islands, Jakarta, then continued in 2000 in Banten. The Seribu Islands Marine National Park initiated rehabilitation in 2006. Both institutions used seagrass transplantation.

Mangroves. Coastal erosion and sea level rise, and the impacts of rapid economic development in coastal areas—unsustainable forest practices; conversion/reclamation of land for agriculture, aquaculture, mining, port expansion, urbanization, tourism, and infrastructure development; and coastal pollution from oil spills and domestic and industrial wastes—have severely reduced mangrove areas.

Mangrove rehabilitation. Initiatives for mangrove rehabilitation have been implemented throughout Indonesia. An earlier effort was made by fishers in Sinjai, Sulawesi (Choudhury 1996, Setyawan et al. 2004). The MOF has a routine program for mangrove rehabilitation. In 2003, it started Forest and Land Rehabilitation (*Gerakan Rehabilitasi Hutan dan Lahan* or GERHAN), which included mangrove forests. According to the MOF report, 5,653 ha of mangrove forests were rehabilitated by the GERHAN in 2005–2009. Around the same period, the MOF reported that 175,525 ha mangrove forests were rehabilitated under its routine program, involving planting of 780,000 seedlings.

Besides the GERHAN, the One Billion Indonesian Trees (*Gerakan Penanam 1 Milyar Pohon Tahun* 2010), more popularly known as the "One Man One Tree" program, implemented by the government together with communities, has replanted 1.8 billion trees, of which 98.3 million

Table 16 **Mangrove Rehabilitation Projects Initiated by Nongovernment Organizations, Private Sector, and Community Groups**

Project/Initiator	Area
Green Coast project (Wetlands International and Oxfam)	Nanggroe Aceh Darussalam and Nias (50,000 seeds)
Wetlands International	Banten (2001–2010: 126,000 seeds)
Mangrove Action Project	Central Java (Segara Anakan), Riau (Bengkalis), and North Sulawesi (Bunaken)
Japan International Cooperation Agency (JICA) Mangrove Project Bali Alumni	Throughout Indonesia (1992–2010: 3,000 hectares [ha])
World Wide Fund for Nature, local government, and PT Mustika Aurora	East Kalimantan (Tarakan, 2008: 52,000 seeds in 12 ha)
Indonesian Institute of Sciences (LIPI) and local government	Bintan (2010: 5,000 seeds)
PT Pertamina	West Java (Indramayu, 2011: 2,000 seeds); East Java (Cilacap, 2011: 91,800 seeds); Central Java (Semarang, 2011: 54,000 seeds)
Garuda Indonesia	Jakarta (2012: 18,600 seeds)
Yayasan Gajah Sumatera and PT Danone	North Sumatra (Deli Serdang, 2011: 500 ha)
Community groups of students, fishers, and others	Throughout Indonesia

Source: Authors.

were planted in conservation and mangrove areas. There are two other government mangrove rehabilitation projects in Java and several by nongovernment groups (Table 16).

The habitat rehabilitation initiatives, especially for coral reefs and mangroves, although enormous, have several weaknesses. Except for COREMAP, most have been sporadic, short-term projects. Minimal effort has been made to maintain the object of rehabilitation, and documentation is limited. However, where documentation is available—as in the Reefball Foundation, Biorock project, Ecoreef project, Indonesia Nature Foundation, The Nature Conservancy, and Wetlands International—progress is evident. Many rehabilitation efforts might have made good progress locally or at the project scale, but their impact over a wider area or upon overall coral reef or mangrove condition in the country is not known.

Emerging Issues for Marine Resource Use

Harmful Algal Blooms

Harmful algal blooms (HABs), often called "red tides," are the result of excessive microalgae (phytoplankton) growth in the water. The toxin they produce can contaminate seafood or cause massive fish kills. Some 30 microalgae species have potential to cause HABs or red tides in Indonesia's waters. Most of the responsible species are dinoflagellates (*Dinophyceae*), diatoms (*Bacillariophyceae*), and blue-green algae (*Cyanophyceae*). Some cases of HABS have been

reported in Indonesia with a general tendency to increase in recent years. Severe or fatal cases have been reported in Lewotobi (East Nusa Tenggara), Ambon Bay and Kau Bay (Halmahera), Sebatik and Nunukan (East Kalimantan), the eastern coast of Lampung on the southern tip of Sumatra (Thoha and Fukuyo 2011), and Jakarta Bay. The minister of Marine Affairs and Fisheries issued a policy to monitor the safety of seafood, such as shellfish, from contamination by HAB species.

Climate Change Impacts

The 2007 report of the Intergovernmental Panel on Climate Change indicated that if emission of greenhouse gases continues at the current rate, by the end of 2100, atmospheric carbon dioxide will increase from the present 350 parts per million to 550 parts per million in volume, temperature will rise by 2.0°C–4.5°C, sea level will rise by 14–43 centimeters, and alkalinity (pH) of seawater will drop from 8.2 to 7.8. These changes will have detrimental impacts on the marine environment.

Warmer temperatures in Indonesia's seas might trigger massive coral bleaching of coral reefs (Case, Adriansyah, and Spector 2007, Measey 2010). Coral bleaching has already been reported in Bali Barat National Park, Bunaken Island, Derawan Island, Komodo Island, Nusa Penida, Wakatobi, Raja Ampat, and Misool (NOAA 2012). In other areas monitored, such as Karimun Java National Park, Mentawai Island, Thousand Island National Park, and Weh Island, coral bleaching has not been reported.

Sea level rise will increase the frequency of erosion and inundation of low-lying lands and islands. In densely populated coastal areas, such as Jakarta, Surabaya, and Semarang, inundation has been increasingly widespread. Together with land subsidence because of overextracting groundwater, Jakarta's coastline has been pushed back by a distance ranging from 0 kilometers (km) to 10 km, Semarang's coastline has retreated by up to 6 km, and Surabaya's coastline by up to 5 km (BAPPENAS 2010).

Some low islands could disappear. In Riau Archipelago District, about 120 of the district's 2,408 islands will be submerged if sea level rise continues at the present rate (BIG 2009). This will have wide-ranging environmental and socioeconomic, and legal and political impacts. As an archipelagic state acknowledged by the United Nations Convention on the Law of the Sea, the national borders are based on a line connecting the outermost points of the outermost islands. If the referenced island disappears, the borderline will change, creating political problems nationally and with neighboring states.

Selayar District, South Sulawesi, in the Flores Sea includes Takabonerate Atoll, the third largest atoll in the world, which has an area of about 2,220 square kilometers (km^2). With the rise of sea level, the atoll and many adjacent small islands will disappear. Former Minister of Environment Emil Salim stated that about 3,000 of the 18,110 islands in Indonesia will disappear under rising sea levels (BIG 2009).

Another potential risk is the acidification of seawater due to increased carbon dioxide levels, which will inhibit the formation of calcium carbonate, the basic substance forming the skeleton of corals, calcareous algae, mollusks, echinoderms, and crustaceans. Indonesia's extensive coral reefs will be in peril.

Marine Invasive Species

Invasive alien species may be defined as a species that are "non-native" (or alien) to the ecosystem under consideration; and, upon introduction, causes or is likely to cause harm to the economy, to the environment, or to human health. Information on marine invasive species in Indonesia is limited as few studies have been undertaken. The HAB-causing dinoflagellate *Pyrodinium bahamense* around Southeast Asia, including Indonesia, is thought to have been introduced in the region through ships' ballast water. Under the Association of Southeast Asian Nations (ASEAN)–India cooperation, the Indonesian Institute of Sciences (LIPI) is conducting studies on marine invasive species that are transported on the hulls and ballast water of national ships and international ocean liners.

In addition, invasive species can escape into the local waters of "alien species," such as fishes, shellfishes, and seaweeds, from aquaculture operations. The seafood trade is another potential source. Imported species purchased as seafood may later be dumped or released into local waters. These species can carry diseases, parasites, and other organisms.

Although no specific policy and regulation directly addresses problems arising from marine invasive species, two government acts and one regulation control the introduction of alien flora and fauna: Act No. 16 of 1992 regarding Quarantine of Agriculture, Cattle, and Fish; and Act No. 5 of 1990 Conservation of Biological Resources and their Ecosystems. Government regulations pertaining to environmental impact assessments need to be put in place before performing such a sensitive activity. Technical guidelines on risk review and risk management related to species introduction have not yet been established.

Other national policies and strategies address the invasive species issue and can be used to minimize their impact: Indonesian Biodiversity Strategy and Action Plan 2003–2020, Plant Quarantine Policy, MOF Strategy and Action Plan for the Conservation of Rhinos in Indonesia, and National Strategy and Action Plan for the Management of Wetlands in Indonesia.

National Plan of Action Initiatives and Future Plans

The National Plan of Action (NPOA) for each of the six countries under the Coral Triangle Initiative (CTI) has five goals:

(i) Goal 1: Improve the governance and management of priority seascapes

(ii) Goal 2: Implement ecosystem-based fisheries management

(iii) Goal 3: Improve management of marine protected areas

(iv) Goal 4: Adopt climate change adaptation measures

(v) Goal 5: Improve the conservation status of threatened species

Under each goal, several targets need to be accomplished through several specific actions.

Progress of the National Plan of Action

Goal 1: Improve the Governance and Management of Priority Seascapes

According to marine bioecoregion classification, there are 232 marine ecoregions, of which 12 are in Indonesia (Spalding et al. 2007). In the NPOA, these are called "seascapes."

Targets. Goal 1 aims to (i) formulate priority actions for seascape development within the Seascapes Comprehensive and Sustainable Investment Plan, and (ii) sustainably manage marine and coastal resources within all "priority seascapes."

Progress in 2010–2012. Development profiles were made in 2010 for the following seascapes: Banda Sea, BASTUNAMATA (Anambas-Natuna-Karimata), Bird's Head of Papua, Halmahera Sea, and Tomini Bay. These priority seascapes were acknowledged as *wilayah lumbung ikan nasional* in 2011. A development profile for the Sunda Shelf was made in 2012.

Action Plan for 2013–2014. Profiles for the remaining seascapes will be developed to support the integration of Indonesia's fisheries management with Papua spatial planning. Priority

seascapes of Tomini Bay, Banda Sea, and Halmahera Sea will be integrated with Indonesia's fisheries management and between national and local development plans. These will be part of the Sulawesi and Maluku–Papua Economic Corridor. The Sunda Shelf and BASTUNAMATA seascapes will become part of the Bali Nusa Tenggara Economic Corridor.

Goal 2: Implement Ecosystem-Based Fisheries Management

Targets. This goal has four targets:

(i) Strong legislative, policy, and regulatory frameworks in place to apply an ecosystem approach to fisheries management (EAFM);
(ii) Improved income, livelihoods, and food security of an increasingly significant number (trend) of coastal communities across the region through a sustainable coastal fisheries and poverty reduction initiative (COASTFISH);
(iii) Effective measures in place to help ensure sustainable exploitation of shared tuna stocks, with adequate protection for tuna spawning areas and juvenile growth stages; and
(iv) Effective management and more sustainable trade in live-reef fish and reef-based ornamentals.

Progress in 2010–2012. For target (i), regulations have been developed and implemented and fisheries management planned in the fisheries management areas; a decree has been established for temporary closure (moratorium) in the Banda and Arafura seas; and ministerial regulations on aspects of the management plans have been drafted. Legislation and regulations pertaining to illegal, unreported, and unregulated (IUU) fishing have been augmented with regulations on logbooks, data collection, observers, and ship registration.

For target (ii), alternative income-generating programs have been pursued and more support provided to small-scale enterprises in communities. Actions are under way to improve fish habitats and fish stocking. Certification schemes for best fisheries practices and products are being developed.

For target (iii), tuna fisheries are being revitalized through capacity building across the industry.

For target (iv), a strategic plan for sustainable fisheries in the live reef fish trade is being prepared, while standards for the aquarium fish industry are also being developed.

Action Plan for 2012–2015. Implementing the above actions will continue, especially those relating to fisheries management, IUU fishing (including joint Australia–Indonesia patrols), establishing indicators for EAFM, strengthening management and technical capacity, developing alternative livelihoods, developing a sustainable live reef fish trade, and establishing standards for fishery products.

Goal 3: Improve Management of Marine Protected Areas

Marine protected areas (MPAs) play an important role in implementing the precautionary approach to fisheries exploitation and in mitigating the effects of fishing in an ecosystem (Yoklavich 1998). Indonesia is currently developing MPAs and networks of MPAs and plans to have 20 million hectares (ha) of MPAs by 2020.

Target. The single target of this goal is to have a region-wide fully functional Coral Triangle MPA System (CTMPAS) in place. Ten activities, which are related to MPA management and monitoring, community involvement and capacity building, sustainable funding, and education and public awareness, have been set out to accomplish the target and/or goal.

Progress in 2009–2012. A national MPA system, which will be integrated into regional and global networks, is being developed, and is now a part of the CTMPAS. At the national level, the Ministry of Marine Affairs and Fisheries (MMAF) is collaborating with partners on decision support systems, scientific inputs, integrating MPAs into fisheries management areas, capacity building, and sustainable financing. MPAs increased in size from 13.5 million ha in 2009 to 15.4 million ha in 2011; and there has been much activity in strengthening MPA management, zoning, capacity, and statistics. Local communities are expected to participate in MPA management. Indonesia has been implementing about 400 village-based MPAs through the Coral Reef Rehabilitation and Management Program (COREMAP) II and locally managed marine areas in eastern Indonesia (Kei and Papua). National and district government policies that enable local community participation in MPA planning and management have been made. Several acts, regulations, and decrees have also been developed in support of MPA planning management.

Capacity development has included the establishment of a school for marine conservation in Wakatobi, Southeast Sulawesi; a study program of marine conservation development in Bitung Fisheries College; and the Coral Triangle Center (CTC) as a government partner to develop a learning network program in the Coral Triangle area, as well as an MPA training curriculum and a series of training activities.

The MMAF has established the Sustainable Financing Working Group (SFWG), a multistakeholder forum consisting of four ministries and several nongovernment organizations (NGOs). The SFWG is establishing a trust fund for conservation, which will be legalized by ministerial decree and incorporated into government financial management systems. The SFWG is finalizing the organizational structure; tasks; responsibilities; and other institutional arrangements of the fund, including standard operating procedures for the Trust Fund Board, grant management, financial management, human resources, administration, and fund raising.

National workshops have strengthened communication, education, and public awareness on MPAs, while local government and NGOs have conducted public consultations and environmental education. Books, posters, leaflets, and bulletins have been printed and distributed to communities. A management effectiveness tool has been created. The MPA management status is monitored annually to understand progress and determine where further action is needed.

Action Plan for 2012–2015. An extensive list of priority activities toward further improvement of MPAs has been made. These activities include (i) a strategy to align them with fisheries management areas (*wilayah pengelolaan perikanan* [WPPs]), (ii) governance, (iii) transboundary MPAs, (iv) threat analysis, (v) further development of the school for marine environmental conservation management and MPA training centers, (vi) finalization of a sustainable funding mechanism, (vii) further education and awareness activities, as well as putting MPAs in school curricula, (viii) and improving the monitoring and evaluation of MPAs.

Goal 4: Adopt Climate Change Adaptation Measures

Targets. This goal aims to

(i) develop and implement region-wide an early action climate adaptation plan for the nearshore marine and coastal environment, and
(ii) establish and ensure the operation of networked national centers of excellence on climate change adaptation for marine and coastal environments.

Progress in 2009–2012. Research on reef ecosystems has included observations with sensors; coral reef assessment, monitoring, and rehabilitation; mapping, site selection, and zoning plans of some areas; and prediction of dynamic physical parameters.

Action Plan for 2012–2015. During this period, a database on climate change adaptation research and a mechanism for information exchange will be developed. In addition, implementation of research findings and recommendations will be reviewed.

Goal 5: Improve the Conservation Status of Threatened Species

Target. The single target of this goal is the improved status of sharks, sea turtles, seabirds, sarine mammals, corals, seagrass, and mangroves.

Progress in 2010–2012. Studies have been made on the potential distribution and population assessment of these threatened groups; a national plan of action for shark conservation and management is being implemented; and the humphead wrasses, marine mammals, and turtles are being protected.

Other Management Issues

Capacity Building

Lack of capacity at the national, regional, and local levels has been identified as one of the main bottlenecks for marine and coastal sustainable development in Indonesia. The issues include (i) shortage of qualified staff, (ii) limited resources and time for training activities, (iii) uncoordinated sector efforts, (iv) limited understanding of coastal biodiversity and links to development planning and management, and (v) weak and fragmented communication channels among the various stakeholders. Furthermore, there is a systemic lack of marine conservation education because of practitioners' limited access to appropriate guidance and training in addressing local problems. Often, training is provided on an ad hoc basis without follow-up assistance or mentoring. Such training has used nonstandard modules; and, in many cases, curricula are duplicated or overlapped, target the same people, or omit basic competencies. Systematic and well-designed capacity development approaches are needed to support effective and efficient MPA management.

The Government of Indonesia plans to have 20 million ha of MPAs by 2020—an ambitious increase from the 14 million ha legislated by 2011. To achieve this goal, Indonesia's Ministry

of Marine Affairs and Fisheries (MMAF) and several NGOs, which include Conservation International, WWF, The Nature Conservancy (TNC), World Conservation Society, and Coral Triangle Center supported by the United States (US) Coral Triangle Support Program and continued by the US Agency for International Development–Marine Protected Areas Governance, are developing a standard certification and curriculum for MPA managers. These aim to enhance their capacity in marine conservation, to turn knowledge into action, and to bring an institutionalized capacity building program into the formal and informal education systems.

The following section discusses the efforts of the Government of Indonesia and these NGOs in capacity-building activities in marine and coastal resources and ecosystems related to CTI programs.

The Coral Triangle Center

TNC established the Coral Triangle Center (CTC) in 2000, mainly to assist the Government of Indonesia in training its stakeholders on management of coastal resource and ecosystems. The center has conducted more than 100 training sessions for more than 2,000 regional practitioners, many internships and international exchange programs, and policy dialogues on sustainable management of the region's diverse marine natural resources. To support the establishment of MPAs in Indonesia, the CTC has developed 12 MPA training modules, covering every stage of MPA planning and management. The CTC serves as a hub for marine conservation practitioners and training alumni to gather and exchange ideas. The CTC also worked with TNC's Technology Learning Center in the US to initially provide three online training modules covering the principles of marine protected area management, marine conservation planning, and MPA management effectiveness. The CTC has conducted several training events on-site, which were funded by the US Coral Triangle Support Program, for example, to support the establishment of the Nusa Penida MPA and Berau MPA.

Some training courses for practitioners are designed for local institutions. Working through existing infrastructure and human resources—teachers and trainers—will be fundamental to the success of this project, helping to ensure local ownership and long-term application of the training materials. Such learning sites are envisioned as on-site training platforms for managers and practitioners, government officials, community groups, scientists, and NGOs; and as learning exchanges among practitioners and between sites in the Coral Triangle and beyond.

The MMAF has requested the CTC's support in developing the skills and capacity of government employees tasked with marine resource management by facilitating the planning and establishment of the School for Marine Resource Conservation and Management. This includes helping design curricula, identifying resource experts and trainers, establishing matrixes and certification requirements, and ensuring practical field experiences for all students. Graduates of the school will be the next cohorts to manage MPAs across the archipelago. The CTC has received a planning grant from the United Nations Development Programme (UNDP) to further facilitate planning for the Global Environment Facility (GEF) project on Strengthening MPA Systems in Indonesia, on behalf of the MMAF. The establishment and management of the School for Marine Resource Conservation and Management are central to the GEF project. It is part of the MMAF's larger scheme of establishing the National Institute for Marine Resources Management and Fisheries in Indonesia, including the Wakatobi Campus in Wakatobi National Park, Sulawesi, as one of its field training facilities.

RARE: Social Marketing for Conservation

Community engagement is a critical element for better management of MPAs. In Indonesia, local capacity is lacking to fully and correctly engage communities whose members depend on marine resources. RARE, an organization that focuses on using social marketing for changing people's behavior, has been working in Indonesia to develop the capacity of district offices for fisheries and marine issues. RARE's Pride Program inspires people to take pride in the species and habitats that make their communities unique, while giving them alternatives to environmentally destructive behavior. The Pride Program is a partnership with the University of Texas at El Paso in the US. The program is recognized as a global master's program in communication for conservation. RARE is currently working with several MMAF offices.

Government Training Centers

Besides NGO initiatives, there are training centers relating to MPA management under government responsibility, which includes a training center under the MMAF (Pusat Pelatihan–Badan Pengembangan Sumberdaya Manusia). This center aims to enhance human resource capacity and institutionalize training by working closely with relevant directorates to ensure the sustainability of MPA management capacity development programs. These programs are aligned with the MMAF strategic plan on human resources development for marine resources conservation (2011–2020), which basically covers training needs analysis, general concept, strategic approaches, and action plans; and is implemented in close cooperation with partners. Initial analysis conducted by the Directorate of Conservation for Area and Fish Species, or the Direktorat Konservasi Kawasan dan Jenis Ikan, shows that Indonesia needs to train and recruit about 2,500 people for the management of almost 100 MPAs by 2014.

The Human Resource Development Agency or Badan Pengembangan Sumber Daya Manusia (BPSDM), in collaboration with the Marine Protected Areas Governance or Majlis Perbandaran Alor Gajah (MPAG), and the US National Oceanic and Atmospheric Administration (NOAA), has conducted training in MPA management planning, sustainable fisheries, integrated coastal management, and sustainable tourism. The three agencies are working toward certification and institutionalization of training modules.

Status of Sustainable Financing

The enactment of regional autonomy and financial distribution acts that followed the change of government in 1999 granted regional governments (provincial and district) the right to manage their marine resources. However, due to the lack of awareness on the importance of protecting marine and coastal ecosystems, there has been inadequate financial support for some MPAs.

Although MPAs produce goods and services with considerable economic benefits, they incur significant costs. MPAs need diverse financial sources to provide funding. International sources include the multilateral development banks such as the World Bank; international and national donors and development partners; environment funds such as GEF; and debt-relief mechanisms such as debt-for-nature swaps. At the national level are taxes from tourism-related activities, including coastal real estate; government bonds; special projects such as lotteries; private sector investment; and fishing industry revenue. Local governments can avail of community-based initiatives, marketing ecosystem services, and tourism-based revenues.

The Government of Indonesia has enacted Regulation No. 80/2011, which mandates the government to develop a trust fund for funding the conservation of biodiversity in Indonesia.

The SFWG for MPA management made an extensive desk study of analyses of MPA costs in Indonesia and elsewhere, which showed that Indonesia needs at least Rp225 billion ($25 million) per year for managing its present 15.4 million ha of MPAs. Current resources, including those from the central government budget, local government budget, and international NGOs, are estimated at Rp75 billion ($8.3 million) per year, a gap or deficit of about Rp150 billion ($16.6 million). The annual deficit increases to Rp250 billion ($27.7 million) if capacity building and maintenance cost components are added.

MPA cost recovery is based on the width of the area. On this basis, the SFWG divided the MPAs in Indonesia into five groups. The cost of operation per hectare of each group will be the basis of budget calculations for all current MPAs and other conservation areas. To determine the potential financial support for the MPAs, the SFWG developed three scenarios: conservative, middle, and optimistic. The conservative scenario includes a budget for operational cost only; the middle scenario includes cost of operation, maintenance, and personnel training; while the optimistic scenario includes costs of operations, maintenance, training, and procurement of infrastructure facilities. Table 17 shows the objectives and present and future activities in relation to sustainable funding of related CTI activities in Indonesia.

Public Awareness, Education, and Support Communication

Lack of awareness about the marine and coastal environment and the value of biodiversity is one of the main bottlenecks for sustainable coastal development in Indonesia. NGOs and the private sector conduct many public awareness activities on the importance of protecting the country's marine and coastal resource and ecosystems. However, most of them are ad hoc and in one or two sites or aspects only.

The Coral Reef Rehabilitation and Management Program (COREMAP) is one of the largest environmental projects in Indonesia, which has been operating since 1999 and may run until 2017. COREMAP includes Indonesia's largest public awareness activity on marine conservation. Three programs—public awareness, education, and support communication—relate to community awareness on the importance of coral reef ecosystems. These program activities during 2004–2011 are summarized below.

Public awareness program. This program aims to support behavioral change toward sustainable coral reef comanagement by providing public awareness materials; conducting campaigns; and undertaking advocacy at the international, national, provincial, district, subdistrict, and village levels. The main activities consist of media campaigns and public awareness materials, and public relations and advocacy.

Media campaigns and public awareness materials include development of pamphlets; primers; posters; billboards; calendars; portable exhibit panels; banners; audiovisual materials; billboards; games; and other communication materials on coral reef conservation, rehabilitation, and management.

Table 17 Activities toward Sustainable Funding of the Coral Triangle Initiative in Indonesia

Funding Source	Objectives/Goals	Resources and Future Activities
Working Group on Sustainable Financing of Marine Protected Areas (MPAs)	Identify models for sustainable financing of MPAs, with a focus on trust funds	• Estimate total cost of MPA management in Indonesia • Model for costing • Draft presidential decree on trust fund mechanism
Coral Reef Rehabilitation and Management Programme (COREMAP)	Identify sustainable financing modes for the three areas under its management	• Initial scoping of coral conservation financing needs • Team of experts
Asian Development Bank Regional Technical Assistance on Knowledge Management, Policy, and Institutional Support to the Coral Triangle Initiative	One component is to facilitate the estimation of costs of the regional and national plans of action (NPOAs), current sources of funds, financial shortfalls, and identify sources to address those shortfalls	• Sustainable financing expert • Payments for ecosystem services (PES) expert/ environmental economist • Building a database on payment for PES mechanisms in Indonesia (both marine and terrestrial)
BAPPENAS Indonesia Climate Change Trust Fund	Develop mechanisms for allocating activities relating to Reducing Emissions from Deforestation and Degradation (REDD)	Mechanism in place and disbursement in progress; mechanism to be refined based on constraints encountered during Phase 1
Seascapes Working Group, Indonesia National Coordinating Committee (NCC)	Estimate cost of NPOA for Goal 1 (Seascapes)	Estimate priority targets under Goal 1 of the NPOA; further refinement needed
Climate Change Working Group, Indonesia NCC	Estimate cost of climate adaptation for Indonesia by the Ministry of the Environment	Refinement needed for targets relating to the Coral Triangle Initiative
Capacity building working group, Indonesia NCC, a crosscutting working group to support the achievement of Indonesia's NPOA goals	Prioritize training for MPA managers as initial activity	Estimate cost of construction and operation of MPA school in Wakatobi, Sulawesi
Association of Southeast Asian Nations (ASEAN)	Political cooperation among the 10 ASEAN member countries	Various funding mechanisms in place, including trust fund mechanisms; ASEAN holding more than $400 million in program funding for various donor and/or partner agencies
Debt swaps (debt-for-nature, debt-for-environment, debt-for-education programs)	Debt swap (reduction or deletion of debt in exchange for development programs)	Mechanism in place, and debt swaps in operation (e.g., with US, Germany)
Sumatra Sustainability Fund	Biodiversity conservation	Operating structure, implementation, and others

Source: Authors.

The main purpose of the public relations and advocacy program is to encourage communities and stakeholders to maintain and conserve marine and coastal resources and ecosystems. Activities include workshops and training courses for community residents, government officials, students, media, journalists, and others; media gatherings and media briefings; courtesy calls; community consultations; and participation in national conferences and exhibitions. Well-known musicians, artists, divers, and local government authorities have been involved in these successful programs. By 2010, 75% of people surveyed were aware of the need to protect coral reefs. The President of Indonesia has taken the lead in promoting the CTI.

Education program. This program aims to ensure that coral reef conservation and sustainable use are mainstreamed into participating districts' education systems. The three-pronged approach includes (i) developing education materials; (ii) increasing the capacity of school institutions, especially at COREMAP locations; and (iii) increasing support from key stakeholders, particularly from the Ministry of National Education and its district offices.

Three series of books, *Pesisir dan Laut Kita* (Our Coast and Ocean), have been developed and produced for elementary, junior, and senior high schools. These books contain not only coral reef ecosystem and conservation information but also their sustainable use, including coastal and surrounding ecosystems and other relevant human activities. The Ministry of National Education, particularly the Center of Curriculum, was involved in developing the education materials; hence, all books have met the National Education Standard and can be used in all schools throughout the country.

Another major accomplishment of the COREMAP educational program is the Young Innovator Contest or *Kontes Inovator Muda* (KIM) for high school students on scientific topics, and the Communication Forum for Coral Reef Lovers or *Forum Komunikasi Pecinta Terumbu Karang* (FORKOM MATABUKA). These events provide an opportunity for students and young people to express their awareness through original and creative ideas, and contribute to sustainability of coral reefs. An evaluation has shown COREMAP's education program to be very successful. Most of the materials produced have been used in all COREMAP sites. KIM and FORKOM MATABUKA have also been recognized as valuable events that assist students and youth through nonformal channels.

Support communication program. This program ensures that the COREMAP philosophy, objectives, activities, outputs, and outcomes are effectively communicated to all staff, partners, and key stakeholders. This program has five activities:

(i) development of communication protocols,
(ii) media training for key COREMAP representatives,
(iii) development of internal communication systems,
(iv) development of information sheets and newsletters, and
(v) establishing public relations to generate a clear understanding of COREMAP to target audiences.

Communication protocols include the conceptualized, designed, and developed mission/vision statements, logos, slogans, themes, songs, and mascots (Si Umbu and Reva). These branding tools are continually exposed in mass media campaigns.

Media training is intended to maintain relationships with key stakeholders. COREMAP staff have received hands-on advice from industry representatives on how to best promote both the program and themselves. The annual 3-day journalist (Forjubi) workshops have been especially helpful.

Communication protocols for internal program management and materials, such as information kits and press releases, are designed and developed to address important and sensitive issues and concerns arising from COREMAP implementation. Essentially, these protocols and materials respond to program questions, comments, concerns, and criticisms.

Information sheets, newsletters, and others provide the community and stakeholders with information regarding COREMAP activities and plans. These materials have reached not only staff but also key partners in industry, academe, NGOs, related media (such as Asia Scuba Diver and Asian Geographic magazines), and the public. Excellent examples are the *COREMAP II Bulletin*, launched in 2007 and then published quarterly; and a coral reef song album (It's Umbu Time), which has proven popular.

The project's public relations program used simple, clear, and concise messages to share the project's mission, goals, objectives, and activities. A special public relations element worked with media to organize electronic "infotainment" campaigns that included television talk shows, television features, social networking, celebrity figures' engagement in campaign activities, and television appearance of COREMAP managers.

Conclusions and Recommendations

Conclusions

Indonesia's coastal areas are important resources for the economic and social development of the people, particularly to 40% of the population living within 200 kilometers of the coastline. Economic benefits, such as revenue from fisheries, food production, tourism, and transport links, are a direct result of the efforts of people living in the coastal and ocean regions.

As part of the Coral Triangle, Indonesia lies at the center of global marine biodiversity. Mangroves, seagrass beds, and coral reefs provide goods and services, including valuable fisheries resources, while protecting the coast from storms and coastal erosion. However, the impact of human activities and natural events—overfishing and destructive fishing methods—threaten coral reefs, seagrass beds, and fish resources. Integrated coastal and marine management, focused on rational utilization of natural resources and the maximization of benefits, should be introduced as soon as possible.

Although several legal and nonlegal instruments regarding the management of marine and coastal resources and ecosystems have been developed, their effectiveness has been limited. Coordination among agencies in implementing marine and coastal resources management needs to be strengthened; and all stakeholders, particularly communities and including women, need to be involved.

Indonesia has put much effort into achieving sustainability of marine resources management, including capacity building, public awareness campaigns, and development of national strategies for managing marine ecosystems. However, stakeholder participation in, and ownership of these activities, are lacking.

Recommendations

An integrated approach to management of marine and coastal resources should be introduced. At the institutional level, overlapping functions and responsibilities of government agencies inhibit improvements in marine management, resulting in restricted implementation of some policies and recommendations. It may be necessary to reform or reallocate responsibilities

among the agencies involved in coastal resource management; revise existing plans, laws, and regulations; and mobilize gender and community participation.

Recommendations to address national issues relating to marine and coastal resource management are as follows:

(i) Implement a sustainable financing approach for marine protected areas (MPA) management, in which Indonesia can address the lack of funds for cost recovery of MPA management, and use the payment of ecosystem service in addition to government and international funds. Otherwise, the MPA management planning that has been developed may become only a "paper tiger" that cannot be implemented because of lack of funds.
(ii) Continue public awareness campaigns on the importance of coastal and marine resources and ecosystems to improve community knowledge of sustainable resource management.
(iii) Continue to improve national capacity building on resource management through training and education.
(iv) Introduce initiatives that encourage the private sector to invest in coastal and marine resources and thereby contribute to the economy and the program.

Recommendations that apply in Indonesia, which also could be explored in the other Coral Triangle countries, are as follows:

(i) Disseminate and adopt the working model of transboundary ecosystems management, which has been successful in some Asia–Pacific marine ecosystems such as the Bay of Bengal's large marine ecosystem.
(ii) Improve and increase the number of training events and support for technical experts by creating more positions for scientists—not loading existing scientists with administrative duties or converting them into administrators—and improving their career path as scientists.
(iii) Promote data, information, and resource sharing and/or collaboration among the various agencies that share common interests in the coastal zone.
(iv) Establish more monitoring networks to improve the information base of the country's resources and environment.
(v) Participate in developing regional agreements for the management of the region's seas.
(vi) Seek ways to cooperate with many ongoing regional activities and projects aimed at coastal and marine resource management, such as the COREMAP, the Coordinating Body on the Seas of East Asia (COBSEA), the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), the South East Asian Global Ocean Observing System (SEAGOOS), and many others.

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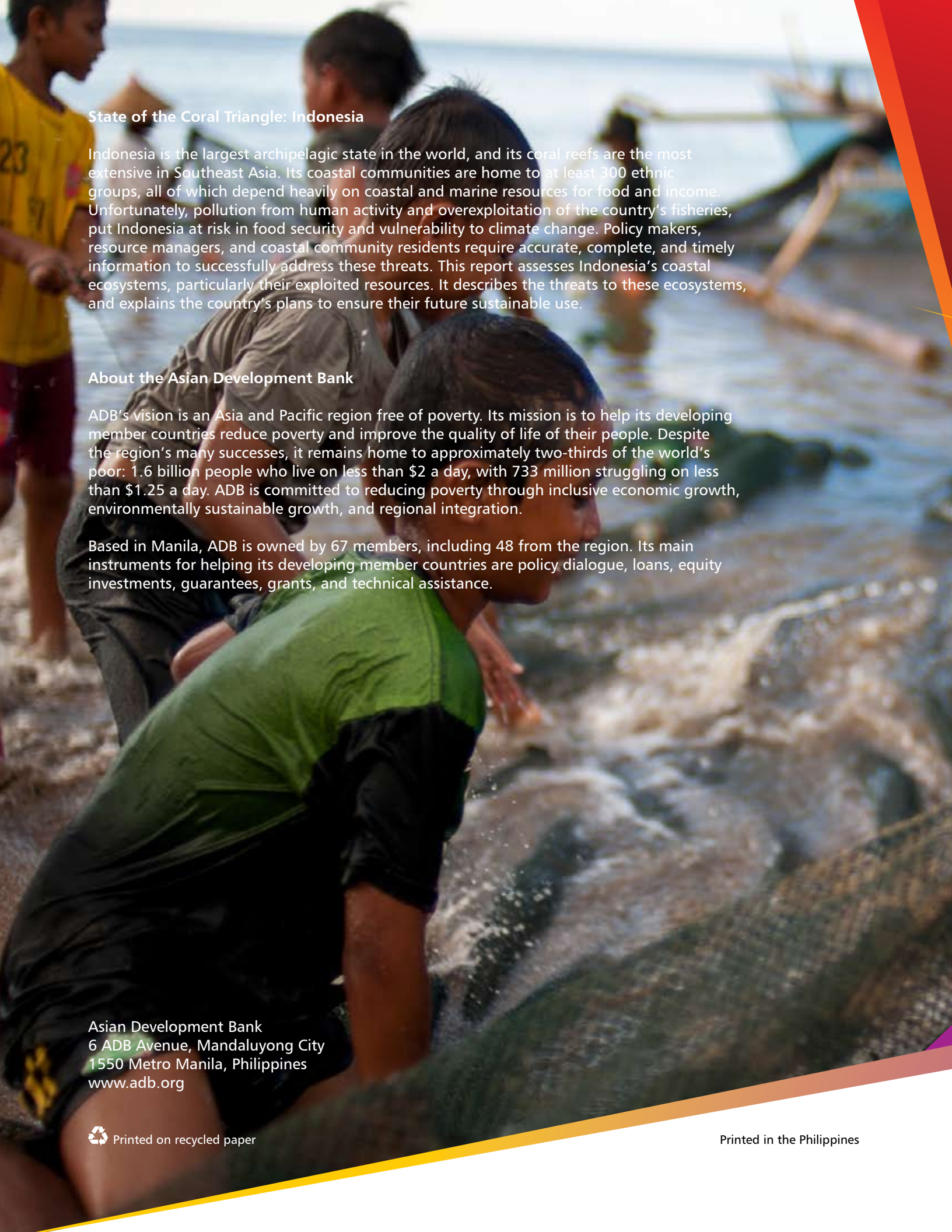

State of the Coral Triangle: Indonesia

Indonesia is the largest archipelagic state in the world, and its coral reefs are the most extensive in Southeast Asia. Its coastal communities are home to at least 300 ethnic groups, all of which depend heavily on coastal and marine resources for food and income. Unfortunately, pollution from human activity and overexploitation of the country's fisheries, put Indonesia at risk in food security and vulnerability to climate change. Policy makers, resource managers, and coastal community residents require accurate, complete, and timely information to successfully address these threats. This report assesses Indonesia's coastal ecosystems, particularly their exploited resources. It describes the threats to these ecosystems, and explains the country's plans to ensure their future sustainable use.

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