Global International Waters Assessment

Sulu-Celebes (Sulawesi) Sea

GIWA Regional assessment 56

De Vantier, L., Wilkinson, C., Souter, D., South, R., Skelton, P. and D. Lawrence

Global International Waters Assessment

Regional assessments

Other reports in this series:

Russian Arctic – GIWA Regional assessment 1a

Caribbean Sea/Small Islands – GIWA Regional assessment 3a

Caribbean Islands – GIWA Regional assessment 4

Barents Sea – GIWA Regional assessment 11

Baltic Sea – GIWA Regional assessment 17

Caspian Sea – GIWA Regional assessment 23

Gulf of California/Colorado River Basin – GIWA Regional assessment 27

Yellow Sea – GIWA Regional assessment 34

East China Sea – GIWA Regional assessment 36

Patagonian Shelf – GIWA Regional assessment 38

Brazil Current – GIWA Regional assessment 39

Amazon Basin – GIWA Regional assessment 40b

Canary Current – GIWA Regional assessment 41

Guinea Current – GIWA Regional assessment 42

Lake Chad Basin – GIWA Regional assessment 43

Benguela Current – GIWA Regional assessment 44

Indian Ocean Islands – GIWA Regional assessment 45b

East African Rift Valley Lakes – GIWA Regional assessment 47

South China Sea – GIWA Regional assessment 54

Indonesian Seas – GIWA Regional assessment 57

Pacific Islands – GIWA Regional assessment 62

Global International Waters Assessment

Regional assessment 56
Sulu-Celebes (Sulawesi) Sea

GIWA report production

Series editor: Ulla Li Zweifel

Editorial assistance: Johanna Egerup, Monique Stolte, Kristin Bertilius

Maps & GIS: Rasmus Göransson

Design & graphics: Joakim Palmqvist

Global International Waters Assessment
Sulu-Celebes (Sulawesi) Sea, GIWA Regional assessment 56

Published by the University of Kalmar on behalf of
United Nations Environment Programme

ISSN 1651-940X

University of Kalmar
SE-391 82 Kalmar
Sweden

United Nations Environment Programme
PO Box 30552,
Nairobi, Kenya

CITATIONS
When citing this report, please use:
UNEP 2005. De Vantier, L., Wilkinson, C., Souter, D., South, R., Skelton, P. and D. Lawrence. Sulu-Celebes (Sulawesi) Sea, GIWA Regional assessment 56. University of Kalmar, Kalmar, Sweden.

DISCLAIMER
The views expressed in this publication are those of the authors and do not necessarily reflect those of UNEP. The designations employed and the presentations do not imply the expressions of any opinion whatsoever on the part of UNEP or cooperating agencies concerning the legal status of any country, territory, city or areas or its authority, or concerning the delimitation of its frontiers or boundaries.

This publication has been peer-reviewed and the information herein is believed to be reliable, but the publisher does not warrant its completeness or accuracy.

Contents

Executive summary

The GIWA region 56 Sulu-Celebes (Sulawesi) Sea includes some of the land and sea areas of three nations; the Philippines, Indonesia (North Sulawesi and East Kalimantan) and Malaysia (Sabah), and forms part of the Philippine-Malay Archipelago, which lies at the centre of global biodiversity. The marine waters of the region form a Large Marine Ecosystem (LME), bounded on most of its western and northern extent by the islands of the Philippines and GIWA region 54 South China Sea, on its southern extent by the Islands of Borneo and Sulawesi and GIWA region 57 Indonesian Seas and eastern extent by GIWA region 62 Pacific Islands.

Severe environmental impacts to national and international waters are caused by deforestation and other forms of land clearing in many of the approximately 300 drainage basins, with estimated loss of some 1 billion m^3 of sediment annually, and siltation rates among the highest on Earth. Approximately 80% of original vegetation cover has been lost or altered, including more than 60% of the mangrove resources in the Philippines. Destructive fishing, muro-ami, blast and poison fishing has damaged or destroyed more than 70% of coral reefs, while benthic trawling no longer produces significant by-catch or discards; rather, virtually all of the highly diminished catch is kept, including rare and endangered marine mammals and turtles. About 70% of coral reefs are heavily overfished, producing less than 5 tonnes/km^2/year, with clear indications of trophic overfishing, in comparison with the remaining 30% of reefs that produce 15-20 tonnes/km^2/year. There is steadily decreasing catch per unit effort, indicative of ecosystem overfishing, and population pressures are leading to Malthusian overfishing. Priority concerns for the future are the same as those for the present: Habitat and community modification, and Unsustainable exploitation of fish and other living resources. Environmental and socio-economic impacts of Pollution and Freshwater shortage are also expected to be severe by 2020. Freshwater shortage is a major food security issue impacting millions of people in the region.

The population of the region, some 34 million (approximately 25 million Filipinos, less than 2 million Malaysians in Sabah and 7 million Indonesians in East Kalimantan and North Sulawesi), is expected to increase at approxiamtely 2.5% per year to 50 million in 2020, with a doubling by 2035. There is expected to be increasing urbanisation, industrialisation and reliance on extractive industries; mining, plantation agriculture and industrial fishing. Total pressures are likely to increase moderately over the next 20 years, being driven by the continued population growth, causing significant deterioration in the environment and socio-economy. The widespread overexploitation and use of inappropriate technologies raises serious concerns as to even the medium-term sustainability of the production systems, with additional limits to development likely to result from complex linkages between freshwater shortage, habitat loss, fisheries and global change.

The Causal chain analysis focused on Habitat loss and community modification, and considered the strong linkages with Pollution (suspended solids) and Unsustainable exploitation of fish and other living resources. The key root causes are population growth coupled with widespread poverty and international market trends. Population growth is impacting on migration, urbanisation, lack of employment and poverty, all of which, in turn, place greater pressure on services provided from the environment (e.g. fish resources) and contribute to increased pollution and damage to habitats. The near-total dependence of millions of poor people on natural resources for their subsistence is so strong that every available resource is being extracted at all cost. Economics and international market trends, including the insatiable international demand for seafood, also drive the unsustainable use of resources, and foster corruption and illegal practices. Coupled with the burgeoning population, poverty, and migration to coastal and urban areas, market trends create a dangerous mix of driving forces that do not augur well for the future. Most importantly, the resource owners themselves must be persuaded that long-term sustainability is a much

better option for the future than short-terms gains presently being made at the expense of irreversible damage to the environment.

The Policy options analysis was predicated on the tri-lateral geo-politics of the Sulu-Celebes (Sulawesi) Seas, with the Philippines, Indonesia and Malaysia each having their own cultural, religious, socio-economic and political systems, goals and objectives. There are many transboundary issues, and actions by any one nation have the potential to impact on the jurisdictions of another. Yet, at both international and national levels there is generally sufficient legislation addressing resource management and protection, the three nations having ratified most of the relevant international treaties and conventions and with numerous national laws in place. However, there is little effective implementation, with serious inefficiencies relating to the transfer and application of international and national legislation at provincial and local levels, compounded by a lack of awareness and/or acceptance of most laws among local populations. National and provincial laws relevant to different sectors - fisheries, mining, forestry and environmental protection - are not fully integrated, causing uncertainty in application of legislative instruments, and confusion over which laws have priority, responsibilities for management, and the rights of stakeholders.

Key government departments are hampered by a lack of qualified and experienced staff, and also by funding shortfalls and cutbacks. Despite considerable recent progress, there is insufficient capacity for effective alleviation, in part related to currency depreciation and shifts in government spending. There are, however, many national, regional and international "players" actively pursuing sustainable development initiatives, and best use of this developing network should be made during future policy implementation. Improved integration among government departments, international donor agencies and NGOs, better allocation and use of government funds, as well as continuing international donor assistance are urgently required in the short-term. In particular, population and development policies require urgent review if growth over the next several decades is to be managed effectively and the present rapid rate of increase of impacts is to be curbed.

More extensive and intensive intervention should be focused through:

- Direct on-the-ground community-based conservation programmes, particularly focused on family planning and poverty alleviation, with alternative or supplemental income generation (AIG) for locals;
- Improved management of existing protected areas, in relation to both biodiversity conservation and fisheries restoration;
- Continued expansion and improved integration of the protected areas network, with assessment programmes for identification of additional critical areas;
- Improved integration of local, provincial, and national laws and regulations, and tri-lateral integration to maximise effectiveness of obligations under international conventions and treaties;
- Training programmes to build additional long-term capacity among government, NGOs, and communities.

Difficulties in establishing strong tri-lateral support for interventions, such as those being developed by the Global Environment Facility (GEF), WWF and partners in the Sulu-Sulawesi Marine Ecoregion Programme (SSME), and others are beginning to be overcome. The SSME provides a useful model for policy implementation, with a two-pronged approach: (i) conservation planning in the long-term; and (ii) implementation of immediate conservation actions in key sites, with interventions in five priority areas:

- Bio-physical and socio-economic research to provide the necessary information for sound management;
- Establishment of an effective integrated network of protected areas, to play dual key roles in biodiversity conservation and fisheries restoration;
- Development of sustainable livelihoods, e.g. AIG, to relieve pressure on natural resources;
- Information/education/communication to raise public awareness;
- Institution and capacity building, including establishment of inter-governmental mechanisms to best use limited funds.

Improved management and expansion of the protected areas network is the key recommended policy option arising from this analysis, in light of the strong linkages between habitat loss and overexploitation of fish, the ameliorative role of protected areas in both regards cannot be overemphasised. Specific policy recommendations for improving the management and coverage of the Protected Areas (PAs) network include:

- Review the current administrative frameworks and design strategies to resolve overlapping legal authority and jurisdiction in protected areas;
- Identify which protected areas are working, which are not and why, and document successful case histories of protected area management;
- Where necessary, design management plans that include identified source(s) of operational funding;
- Retain flexibility in management approach, recognising the value of small-scale local, community-based and co-management approaches and large-scale internationally-supported management initiatives;
- Design and foster implementation of a system whereby each municipality or village (e.g. Barangay in the Philippines) is

empowered to assist in management of (or manage) the local protected area;

- Conduct strategic assessment of human resource requirements, including day-to-day management, surveillance and enforcement on a case-by-case basis;
- Encourage government and private sector to carry out integrated coastal zone planning and management (including watersheds), and incorporate protection of critical land areas within the parks or as buffer zones;
- Set aside as much as practicable (at least 20%) of marine protected areas as 'no take' zones for biodiversity conservation and fisheries replenishment;
- Ensure Environmental Impact Asssessments (EIAs) are conducted prior to any development in or adjacent to protected areas, and wherever practicable, minimise all future development of land within and adjacent to protected areas to maintain buffer zones;
- Establish/refine monitoring programmes and re-evaluate research priorities to best address bio-physical and socio-economic management concerns;
- Work through Association of South East Asian Nations (ASEAN) and other multi-lateral, international agencies and organisations to develop joint programmes, including innovative sources of ongoing funding.

In particular, it is crucial that the relevant government agencies in the Philippines, Indonesia and Malaysia provide:

- Clear written policy in support of site-specific co-management of National Parks and other protected areas. Such policy should delegate clear support and responsibility to all National Park directors to develop flexible co-management structures that reflect the site-specific opportunities and constraints of their National Park. Criteria for co-management include excellence in technical service delivery, professionalism and flexibility.
- Relevant conservation user fee policies assessed and revised in order to clearly support local self-financing for conservation management. A national policy on protected areas conservation financing should ensure local collection and distribution of a majority of user fees, with only a minority going to the central government. All finances should be accounted for and booked at the national level. Transparent third party monitoring and evaluation on financial management as well as conservation management impact is essential.
- Clear guidelines and standard operating procedures are necessary for both joint patrol systems and participatory zonation processes.

The above recommended policy options should assist in the establishment of well-planned, well-funded, and well-implemented protected areas encompassing major habitats and serving as models (coastal and marine examples include Tubbutaha, Bunaken and Turtle Island) for future marine park development. These policy recommendations will impact the entire range of civil society, and place major responsibilities on governments, NGOs, educational institutions and the private sector, if the most problematical issues of habitat loss and overexploitation are to be ameliorated in the coming decades. The refinement of these policy options will emerge during continuing development of the SSME and GEF programmes.

Without doubt, Sulu-Celebes (Sulawesi) Sea must be a priority region for future GEF initiatives. The region is at the centre of the world's marine biodiversity with many species of global significance and it is surrounded by a rapidly growing population and rapidly deteriorating marine ecosystems. The very recent discovery of the Indonesian Coelacanth (*Latimera manadoensis*), demonstrates the need to improve marine ecosystem protection so that other yet undiscovered but potentially valuable species are not eliminated. The challenge of securing the necessary national and international, transboundary cooperation necessary for the sustainable development of this critical region is great, but not insurmountable.

Acknowledgements

The authors gratefully acknowledge the expert contributions of (in alphabetical order): Achmad Abdullah (deceased), Heni Augustina, Angel Alcala, Porfirio Alino, Imam Bachtiar, Ronald Bonifacio, Annadel Cabanban, Catherine Cheung, Chua Thia-Eng, Laura David, Rili Djohani, Mark Erdmann, Miguel Fortes, Ed Gomez, Kevin Hiew, Jose Ingles, Gil Jacinto, Roger Juliano, Teng Seh Keng, Hugh Kirkman, Maarten Kuijper, David Lawrence, Al Licuanan, Medel Limsuan, Evangeline Miclat, Peter Mous, Cleto Nanola, Jos Pet, Lida Pet-Soede, Nicolas Pilcher, Srihartiningsih Purnomohadi, Ketut Sarjana Putra, Jan Steffan, and Romeo Trono, and others forming the GIWA regional Task team.

The authors also thank Dag Daler, Olof Linden, Niklas Holmgren, Johanna Egerup and the GIWA Co-ordination Office in Kalmar University, Sweden; Prof. Russell Reichelt and staff of the Cooperative Research Centre for the Great Barrier Reef World Heritage Area; the Australian Institute of Marine Science; and the International Ocean Institute (Australia) for support. We also thank the reviewers Prof. Helen Yap and Prof. Loke Ming Chou.

Abbreviations and acronyms

AIG	Alternative Income Generation
ASEAN	Association of South East Asian Nations
BAPEDAL	Indonesia's Environmental Impact Management Agency
BNP	Bunaken National Park
BOD	Biological Oxygen Demand
BRS	Bureau of Research and Standards
BSWM	Bureau of Soils and Water Management
BTNB	Bunaken National Park Office
CBD	Conservation on Biological Diversity
CI	Conservation International
CIS	Communal Irrigation Systems
CITES	Convention on International Trade in Endangered Species
CPUE	Catch Per Unit Effort
DANIDA	Danish International Development Agency
DENR	Philippines Department of Environment and Natural Resources
DGF	Indonesian Directorate General of Fisheries
DGWRD	Directorate General of Water Resources Development
DID	Department of Irrigation and Drainage
DOA	Department of Agriculture
DOE	Department of Environment
DPWH	Department of Public Works and Highways
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FMB	Forest Management Bureau
GEF	Global Environment Facility
GDP	Gross Domestic Product
GNP	Gross National Product
HYV	High Yielding Varieties
ICLARM	International Center for Living Aquatic Resources Management
ICRAN	International Coral Reef Action Network
IOC	Intergovernmental Oceanographic Commission
IUCN	The World Conservation Union
IUU	Illegal Unreported and Unregulated
LME	Large Marine Ecosystem
LWUA	Local Water Utilities Administration
MARPOL	International Convention on Prevention of Marine Pollution from ships
MEA	Millennium Ecosystem Assessment
MMAF	Ministry for Martine Affair & Fisheries
MOH	Ministry of Health
MPA	Marine Protected Area
MRIIS	Magat River Integrated Irrigation System
MSY	Maximum Sustainable Yields
MWSS	Metropolitan Waterworks and Sewerage System
NEA	National Electrification Administration
NGO	Non-Governmental Organisation
NIA	National Irrigation Administration
NIA	Department of Agriculture
NIS	National Irrigation Systems
NP	National Park
NPC	National Power Corporation
NRMP	Natural Resources Management Project
NRWB	National Water Review Board
NRWC	National Water Resources Council
NWRB	National Water Resources Board
PA	Protected Areas
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PEMSEA	GEF/UNDP/IMO Regional Programme on Partnerships in Environmental Management for the Seas of East Asia
PHKA	Indonesian Department of Nature Conservation
PMO	Project Management Office
PROPER-PROKASIH	Indonesian Programme for Pollution Control, Evaluation and Rating
PWD	Public Works Department

SAP	Strategic Action Programme
SSME	Sulu-Sulawesi Marine Ecoregion Programme
SST	Sea Surface Temperature
SWIM	Small Water Impounding Management
TDA	Transboundary Diagnostic Analysis
TNC	Nature Conservancy
TSS	Total Suspended Solids
ULCC	Ultra Large Crude Carriers
UNCLOS	UN Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UPRIIS	Upper Pampanga River Integrated Irrigation System
USAID	US Agency for International Development
WCMC	World Conservation Monitoring Centre
WESTPAC	Sub-Commission for the Western Pacific
WHA	World Health Assembly
WRI	World Resources Institute
WUA	Water Users Association
WWF	World Wildlife Fund

List of figures

List of tables

List of boxes

Regional definition

This section describes the boundaries and the main physical and socio-economic characteristics of the region in order to define the area considered in the regional GIWA Assessment and to provide sufficient background information to establish the context within which the assessment was conducted.

Boundaries of the region

The GIWA region 56 Sulu-Celebes (Sulawesi) Sea region contains most of the Philippine islands (excluding northern Luzon, the north and eastern part of Samar and east Mindanao to the east of Diuata Mountains), the most northern islands of Indonesia (Kepuluan Sangihe, northern Sulawesi and east Kalimantan) and Malaysian Sabah. Of the 7 000 islands that comprise the Philippines, only 3 144 islands are named. There are also thousands of small islets grouped with the larger islands. The Philippines is divided into three major island groups: Luzon, with an area of 142 000 km^2 (the southern portion of which is included in the region); Visayas, with an area of 56 000 km^2; and Mindanao, with an area of 102 000 km^2 (both included in the region).

The northern boundary of the GIWA region 56 Sulu-Celebes (Sulawesi) on Luzon Island (Philippines) follows the drainage basin boundary and south-flowing streams and rivers of Batangas province to near the town of San Pablo, continuing to the east along the central mountains of eastern Luzon to include the southern part of the Island. The boundary excludes Manila Bay and Laguna de Bay and the catchments and rivers that feed into South China Sea or Pacific Ocean. The boundary includes the drainage basins of Batangas province and southern parts of Quezon, Masbate, Camarines Sur, Albay and Sorsogon Provinces and Bicol Region, with Balayan, Batangas, Tayabas and Caima bays, Ragay Gulf, Sorsogo Bay and the Sibuyan Sea.

To the east, the region includes the drainage basins feeding streams and rivers flowing south and west on Samar, all the Visayan Islands and Visayan and Camotes seas. Further south, the boundary includes the Bohol Sea, passing along the Diuata mountain range of eastern Mindanao to include drainage basins, rivers and urban areas of western and southern Mindanao and the Davao and Moro gulfs. The boundary continues through the Philippine and Indonesian island chains (Kepuluan Karakaralong and Kepuluan Sangihe) between Mindanao and Sulawesi.

On its southern extent, the boundary includes the catchments and streams of northern Sulawesi emptying into the Celebes (Sulawesi) Sea, crosses the northern entrance to Makassar Strait at its narrowest point and extends inland into northeast Borneo to include catchments and rivers of East Kalimantan and Sabah, notably the Sandakan River Basin. On its western extent, the region extends from the northern tip of Sabah to Palawan, to include the catchments of eastern Palawan, then north to include the Calamianes Island group, Busuanga and Mindoro, joining the northern boundary in Luzon.

The Mahakam River Basin and major population centres of East Kalimantan province of Balikpapan and Samarinda are excluded, as the river discharges into the generally south-flowing Makassar Strait (GIWA region 57 Indonesian Seas). The rivers in the western part of Sabah and Sarawak are also excluded, as these mainly drain into the South China Sea, and their impact is seasonal in the Sulu Sea, when ocean currents may transport sediment-laden waters around the northern coast of Sabah. The boundaries exclude parts of the South China Sea west of Palawan and Luzon (in GIWA region 54 South China Sea), the Pacific Ocean east of Mindanao (GIWA region 62 Pacific Islands) and Makassar Strait between Sulawesi and Borneo (East Kalimantan, included in region 57 Indonesian Seas). These boundaries conform well with the WWF definition of the boundaries of the Sulu-

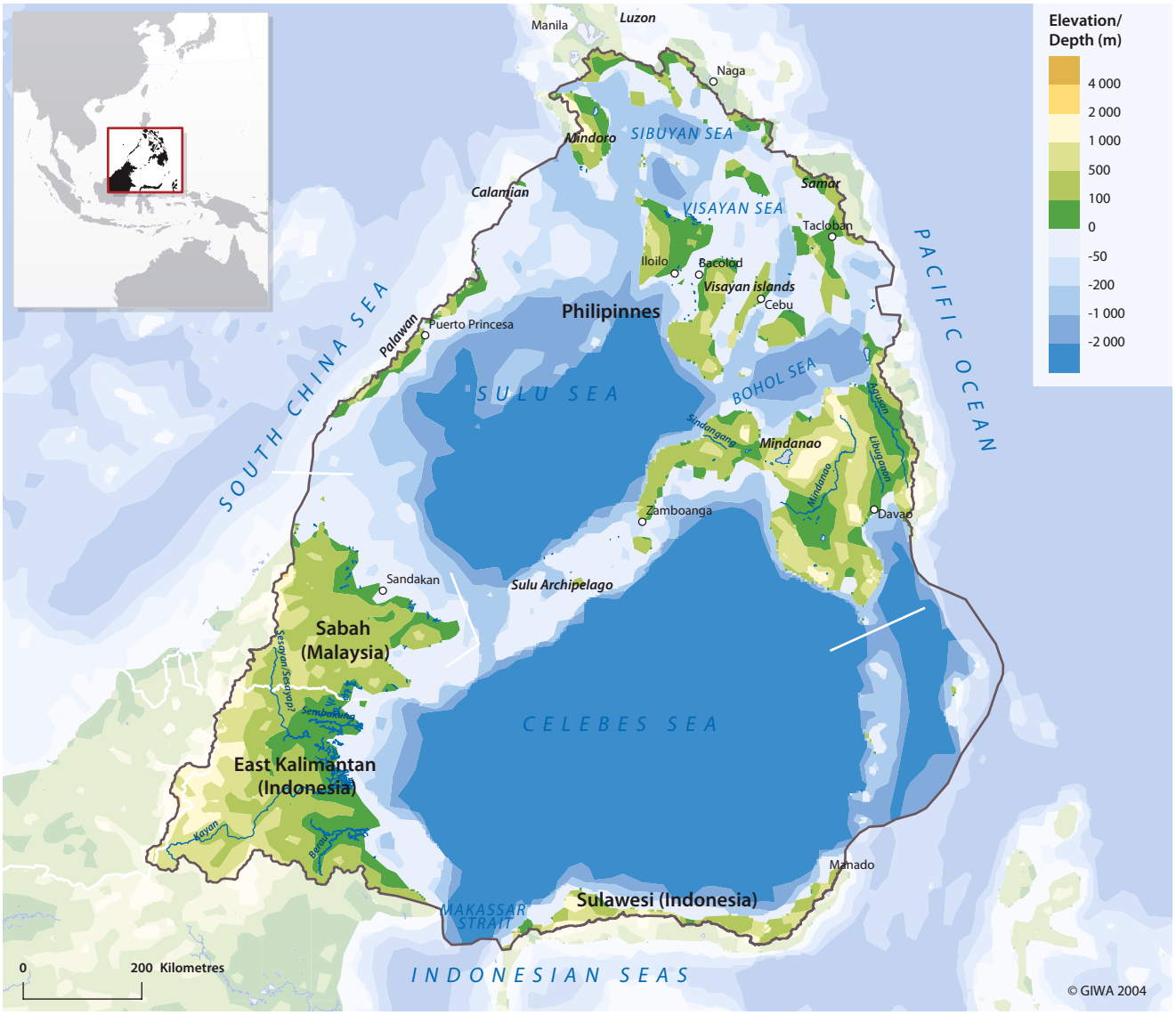


Figure 1 Boundaries of the Sulu-Celebes (Sulawesi) region.

Sulawesi Marine Ecoregion (WWF 2003) except for GIWA's inclusion of the drainage basins. Figure 1 shows the boundaries of the Sulu-Celebes (Sulawesi) region.

Physical characteristics

The region is oceanographically, geologically and topographically diverse. The Island of Borneo, the northeastern portion of which Indonesian East Kalimantan and Malaysian Sabah forms the southwestern corner of the region, lies on the Asian continental shelf and is physically stable. The remaining islands of northern Indonesia and the Philippines, and the seas themselves, are subject to more tectonic activity and volcanic instability (with several active volcanoes). The total area of the region is 333 200 km^2 of which 50% lays in the Philippines, almost 20% in Malaysia and 32% in Indonesia (Table 1).

The Philippines has a varied topography with highlands and numerous valleys. Its four major lowland plains are the central plain and the Cagayan valley in Luzon, the Agusan valley and the Cotabato valley in Mindanao. These lowlands contrast sharply with the adjacent high mountain areas of the central and east Cordilleras and the Zambales mountains. The highest peaks reach almost 3 000 m above sea level at less than 30 km from the sea. In Indonesia, most of the major islands have a mountain range running their entire length. The mountains are

Table 1 Physical characterstics of the Sulu-Celebes (Sulawesi) region.

Country	Country area in the region (km^2)	Country area total (km^2)	Percentage of country in region (%)	Percentage of region in country (%)
Indoensia	106 900	1 826 440	32.1	5.9
Malaysia	60 220	328 550	18.1	18.3
Philippines	166 080	298 170	49.8	55.7
Total	333 200			

(Source: EROS Data Center 2003, ESRI 2002)

of volcanic origin and, in some cases, are still active. The elevations of the islands range from 0 to 5 030 m above sea level. In Malaysia, the interior of Sabah is criss-crossed by a series of mountain ranges and hills, the most prominent of which is the Crocker Range with the highest point at Gunung Kinabalu (4 101 m).

International waters

International waters include all of the coastal and marine waters of the Sulu Sea and Celebes (Sulawesi) Sea and the smaller adjacent seas, as these are all potential sources or recipients of transboundary impacts, primarily from shipping, fisheries and riverine discharges, and the transport of waters in ocean currents.

Climate

The region lies within the sub-equatorial and equatorial zones (from latitudes 1-14° N), with annual rainfall exceeding 1 000 mm in most areas and annual minimum temperatures of more than 20°C, except in the highlands. Rainfall is highest on the upland areas, notably of central and northern Borneo, central Palawan, and central and eastern Mindanao. These areas receive more than 3 000 mm of rain annually. Some parts of the lowlands, coastal areas and other areas in rain-shadows receive far less rain (less than 500 mm per year), and may experience severe water shortages. The northern and central parts of the region are affected by revolving tropical storms (typhoons) during the southwest monsoon months, bringing intense rains and destructive winds to coastal areas. Passing from the Pacific into the South China Sea through the Philippines Archipelago, typhoons can deliver in excess of 1 000 mm of rain in less than 1 week, causing extensive flooding and loss of life in worst affected areas.

The climate of the Philippines is tropical and monsoonal. It is characterised by uniformity of temperature (average temperature of 27°C throughout the year), high relative humidity (above 70% everywhere throughout the year except in southern Tagalog where it falls to 65% in March/April), low solar radiation, diversity of rainfall and high frequency of tropical cyclones. The main air streams that affect the Philippines are the northeast monsoon from late October to March, the southwest monsoon from May to October and the North Pacific trade winds, dominant during April and early May (FAO AQUASTAT 2003). Many of the larger islands of the Philippines have high mountain ranges, most of which lie along a generally north-south axis across the paths of movement of the important air streams. Thus, apart from temperature effects due to elevation, the orographic effects of mountains have important influences on regional rainfall patterns by causing increased precipitation on windward slopes and rain shadows in their lee during the monsoon periods.

The average annual rainfall in the Philippines between 1961 and 1990 was 2 373 mm, but this figure varies from 961 mm (General Santos City in southeast Mindanao) to more than 4 051 mm (Infanta in central Luzon). The rainfall pattern and annual amount are influenced mainly by altitude and wind. The northwest of the Philippines has a dry season from November to April and a wet season during the rest of the year (i.e. the southwest monsoon) (FAO AQUASTAT 2003). The southeast receives rainfall all year round, but with a pronounced maximum from November to January during the northeast monsoon. In the areas not directly exposed to the winds, rainfall is evenly distributed throughout the year, or there are two seasons but not very pronounced; from November to April, the weather is relatively dry while it is relatively wet the rest of the year. The lowest rainfall occurs in the provinces of Cebu, Bohol and Cotabato in the centre of the country. The archipelago lies in the typhoon belt, and many islands are liable to extensive flooding and damage during the typhoon season from June to December. The frequency of typhoons is greater in the northern portion of the archipelago than in the south. Usually, two or three typhoons reach the country each year. The Philippines' annual average run-off is estimated at 444 km^3. In 9 years out of 10, the annual run-off exceeds 257 km^3 (FAO AQUASTAT 2003).

Compared with the Philippines, data describing climatic patterns in the Indonesian and Malaysian portions of the region, particularly Sabah and East Kalimantan, are sparse and, in many cases, inaccessible or difficult to disaggregate from national statistics. In Indonesia, there are two seasons, the dry season and the wet season. The dry season lasts from March to August and the wet season from September to March with the heaviest rainfall usually from November to February. The temperature ranges from 21° to 33°C, but at higher altitudes the climate is cooler. Humidity varies between 60 and 80%. Like Indonesia, Malaysia lies entirely within the equatorial zone, and the climate is governed by the regime of the northeast and southwest monsoons. The northeast monsoon blows from October to March, and is responsible for the heavy rains that

frequently cause widespread floods during the wettest season in Sabah. The southwest monsoon period occurs between May and September, and is a drier period for the whole country. The period between these two monsoons is marked by heavy rainfall. The average temperature throughout the year is very stable (26°C), and the mean annual rainfall is 3 000 mm. Regional variations in temperature and rainfall are mainly due to topographic relief. In general, Sabah experiences more rainfall (3 000-4 000 mm annually) than the Malaysian Peninsula. The humidity is high (80%) due to the high evaporation rate (FAO AQUASTAT 2003).

River basins and water resources

According to FAO AQUASTAT (2003) there are more than 300 major drainage basins in the region, with the major river systems being:

- The Sandakan and other river catchments of Sabah;
- The Kayan, Ketai, Berau, Sesayan and Sembakung rivers of East Kalimantan;
- The Mindanao River and tributaries, the Agusan River and tributaries, the Libuganon and Sindangang rivers of Mindanao.

There are numerous smaller rivers and streams flowing from the mountainous interiors of most of the islands. Much of the protected coastlines were originally fringed by mangrove forests and seagrass beds. However, extensive cutting for timber, conversion for aquaculture and other forms of coastal development and sedimentation have caused major fragmentation and reduction in the area of these habitats.

In the Philippines as a whole, there are 421 rivers, excluding small mountain streams that sometimes swell to three times their size during rainy months (FAO AQUASTAT 2003). The rivers are an important means of transportation and a valuable source of water for irrigation for the fields and farms through which they pass. There are also 59 natural lakes and more than 100 000 ha of freshwater swamps. The two principal river basins (more than 5 000 km^2) in the Philippines part of the region are the Mindanao River Basin (23 169 km^2) and the Agusan River Basin (10 921 km^2), both on the Island of Mindanao. Overall, only 18 river basins have an area greater than 1 000 km^2: eight of them are on Mindanao, seven on the Island of Luzon, two on Panay and one on Negros. The smallest river basins are frequently under 50 km^2.

Indonesia has over 5 590 rivers, of which only the Mahakam River of East Kalimantan plays a significant role in the region. Although water resources are abundant, the seasonal and spatial variation in the rainfall pattern and the lack of adequate storage create competition and conflicts among users. Municipal and industrial wastewater is discharged virtually untreated into the waterways causing rapid deterioration in the quality of river water (FAO AQUASTAT 2003).

In Malaysia, major river basins in the east tend to be larger than those on the Malaysian Peninsula. From an annual rainfall volume of 990 km^3, 360 km^3 (36%) are lost through evapotranspiration (FAO AQUASTAT 2003).

Coastal and marine ecosystems

The Sulu-Celebes (Sulawesi) region lies within the global centre of biodiversity for both terrestrial and marine species with, for example, more than 400 species of reef-building corals and 2 500 species of marine fishes present (Chou 1997, Veron 2000). The ecosystems that sustain this rich biodiversity are under severe threat in much of the region (e.g. Chia & Kirkman 2000). The coast under the immediate influence of the major river systems is mostly devoid of fringing coral reefs, although small fringing and patch reefs are present in some places. Fringing reefs are very well developed away from the major river estuaries. Offshore, series of large platform reefs and atolls are developed, as exemplified by the Tubbataha reefs of the Sulu Sea. All major reef types; fringing, patch, platforms (including 'barrier') and atolls occur, with a total estimated reef area of more than 20 000 km^2. As with the coastal habitats, reefs of the region have been damaged through destructive fishing, sedimentation and other forms of human use. Many of the region's reefs are at extremely high risk of further damage from human activities (e.g. Bryant et. al. 1998, Burke et al. 2002).

Most of the coastal waters, particularly around the Visayas Islands, are shallow (less than 200 m deep) and influenced by both marine and river/terrestrial inputs. By contrast, the central Sulu Sea has depths exceeding 4 000 m and the Celebes (Sulawesi) Sea has depths greater than 5 000 m. The region receives an influx of surface oceanic water from the North Equatorial Current, flowing into the area from the northeast through corridors in the Visayas and northern Mindanao, with sub-surface flow in the opposite direction. Additionally, waters from the South China Sea may flow seasonally into the Sulu Sea around the northern coast of Sabah, transporting sediment-laden waters from northwest Sabah (Bate 1999). Surface waters of Sulu-Celebes (Sulawesi) Sea flow south out of the region through the Makassar Strait and also between Sulawesi and Morotai-Halmahera, contributing to the Indonesian through-flow. Local current patterns form complex eddies and counter-currents, particularly in the vicinity of the Visayas Islands.

The region forms a Large Marine Ecosystem (LME); comprised of two large seas, Sulu and Celebes (Sulawesi) and several smaller seas, the Sibuyan, Visayan and Camotes seas in the northeast and the Bohol Sea further south between Bohol and Mindanao. There is a deeper area (>3 000 m) and a chain of islands known as the Sulu Archipelago, separating the two seas. These seas can be characterised as 'marginal

seas', being mostly enclosed by island landmasses, and with oceanic input as through-flow from the Pacific in corridors among the Visayas and between Mindanao and Sulawesi. The Sulu-Celebes Sea LME has an area of about 900 000 km^2 (LME 2003). The Sulu Sea's surface currents come from the south in the summer, whereas the winter currents follow a counter-clockwise gyre. The Celebes Sea's strong currents, its deep sea trenches, seamounts and active volcanic islands result in a complex oceanography. For more information see Annex V.

Protected areas

The Philippines, Indonesia and Malaysia have legally designated protected areas including coastal and marine habitats. The Philippines has gazetted 19 terrestrial protected areas (IUCN Categories I-V) covering an area of 1 454 000 ha, representing some 4.8% of the total land area of 300 000 km^2. The Philippines also has 159 gazetted Marine Protected Areas (MPAs) (areas unknown), two biosphere reserves (1 174 000 ha), two World Heritage sites (53 000 ha) and 4 wetlands of international importance (68 000 ha) (WRI 2003). Indonesia has gazetted 331 terrestrial protected areas covering some 19 253 000 ha and representing about 10% of total land area of 1.8 million km^2. Indonesia also has 102 gazetted MPAs (areas unknown), five biosphere reserves (1 329 000 ha), three World Heritage sites (2 845 000 ha) and two wetlands of international importance (Ramsar sites) (243 000 ha). Malaysia has gazetted more than 150 terrestrial and marine parks. The terrestrial parks cover more than 1 500 000 ha, representing more than 5% of the land area of 329 800 km^2. Areas of MPAs are unknown. Malaysia also has one wetland of international importance.

In total, there are more than 200 MPAs in the region of which 66 are indicated in Figure 2. Many of the MPAs contain coral reefs (Spalding et al. 2001, Cheung et al. 2002), although the effectiveness of many MPAs is limited at present by insufficient resources for management and enforcement of regulations. The Tubbataha Reef Marine Park is a World Heritage site in the Sulu Sea, comprising some 33 200 ha and situated inside the Palawan Man and Biosphere Reserve (1 150 000 ha). The Tubbataha Marine Park is a unique example of an atoll with high diversity and density of tropical marine biota, is among the most biologically diverse coral reef system in the Philippines, and is of great importance for maintenance and replenishment of harvested species in the greater Sulu Sea. The reef areas around Bunaken and Manado in North Sulawesi are also recognised as being of exceptional conservation value, and the area also supports a recently discovered population of a second species of the 'living fossil' fish Coelacanth (*Latimeria manadoensis*) (Erdmann et al. 1999). Indonesia has established the marine protected area Bunaken National Park and Nature Reserve. The Philippines and Malaysia have established bi-national agreements

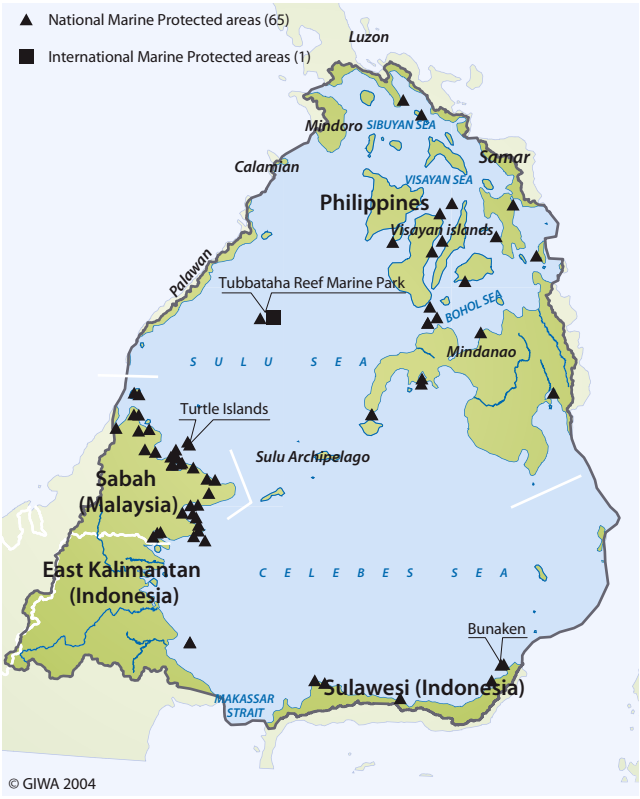


Figure 2 International and national marine protected areas in the Sulu-Celebes (Sulawesi) region.
(Source: UNEP/WCMC 2003)

for conservation of marine turtles, with the establishment of the Turtle Island protected area. This agreement represents one of very few examples of transboundary management between these two neighbouring countries. At the largest spatial scale, the entire coastal and sea area between Malaysian Sabah, Indonesian East Kalimantan and the Philippines is recognised as a special management area; Sulu-Sulawesi Marine Ecoregion (SSME) by WWF, ranked as one of their top four global priority sites (number one in Asia-Pacific) (Trono, Miclat pers. comm.) for coastal and marine management).

Socio-economic characteristics

Large gaps remain in reliable socio-economic data at the scale of the region. This is in part because of the inherent inaccuracies in disaggregating the more readily available national statistics to the smaller Philippines, Indonesian and Malaysian components of the region, in part because of government restrictions on data access, which is compounded by the transboundary nature of the area, and in part because of the lack of accurate census information from the widespread

Table 2 Population in the Sulu Celebes Sea region.

Country	Population in the country (million)		Population in the region (million)	Annual population growth (%)			Population density (inhab./km²)
	1997	2003		1999	2001	2003	
Indonesia	198.2	214.5	7.0	1.34	1.31	1.29	105
Malaysia	21.7	24.8	<2.0	2.36	2.26	1.91	63
Philippines	71.5	81.5	25	2.30	2.18	1.93	231

(Source: ORNL 2003, World Bank 2003a, 2003b, 2004)

human populations. Where possible, data specific to the area of each country comprising the region has been made. However, in cases where this was not feasible, national statistics have been provided as a guide.

The region's human population is represented by ethnic groups of three nations: Philippines, Malaysia (Sabah) and Indonesia (North Sulawesi and East Kalimantan) and is comprised predominantly of peoples of Indo-Malay origin. Peoples of other ethnic origins are also present, some forming ancestral tribal groups, particularly in Borneo, others of more recent arrival (e.g. Chinese and Indian traders). Within these broad ethnic groups, there are substantial cultural differences and various forms of religious belief, principally Christianity and Islam. The Philippines is mostly Christian (Roman Catholic) with the exception of areas in Mindanao, which practice Islam. Indonesia and Malaysia are mostly Islamic. There is a broad acceptance of different religious viewpoints in parts of the region, although racial, cultural and religious tensions have been building in recent times, concomitant with the economic difficulties of the late 1990s. For example, southern Mindanao has an Islamic separatist movement, the MNLF/MILF, that has been involved in civil and political instability in the area.

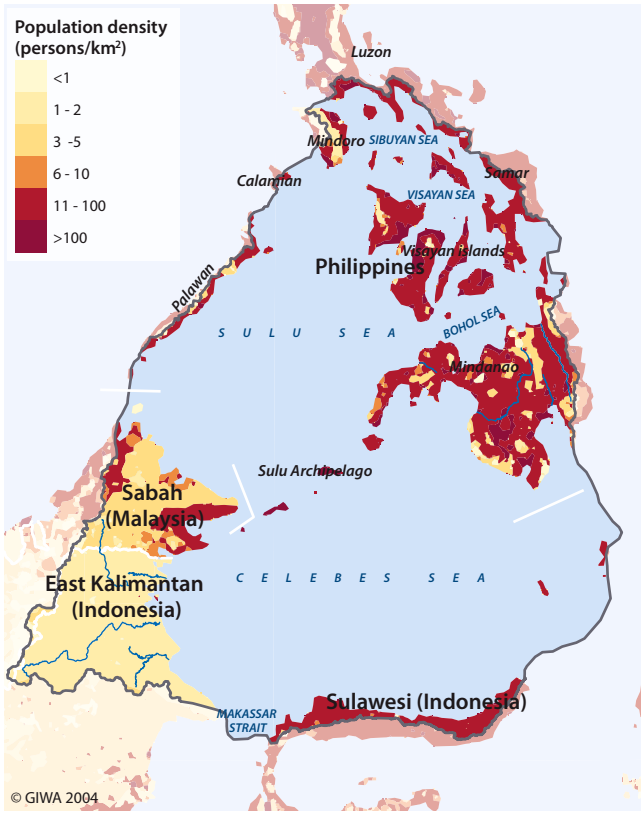


Figure 3 Population density in the Sulu-Celebes (Sulawesi) region.
(Source: ORNL 2003)

Population

In the Philippines in 1996, the total population was estimated at 69.3 million (45% rural). This had risen to 81.5 million in 2003 (World Bank 2003a, 2004). The average population density is 231 inhabitants/km² and the average annual population growth in 2003 was 1.9%. In Indonesia in 1997, the total population was about 198.2 million people (63.6% rural), rising to 214.5 million in 2003, with a growth rate of 1.3% (World Bank 2003a, 2004). The average population density was 105 inhabitants/km². The population is unevenly distributed with about 60% living on the Island of Java (outside the region) and another 20% of the population live on the Island of Sumatra (also outside the region). In Malaysia in 1996, the population was estimated at 20.58 million inhabitants (45.5% rural), increasing to 24.77 million in 2003 (World Bank 2003a, 2004). The population is concentrated along the west coast of the Malaysian Peninsula and in the capital city, Kuala Lumpur (outside the region). The average population density in Malaysia is 63 inhabitants/km². The Malaysian population grew at an average annual rate of 2.8% in the 1980s, but the rate has since slowed to the current 1.9% (World Bank 2004). Table 2 shows some population characterstics of the Sulu-Celebes (Sulawesi) region and Figure 3 shows the population density

Disaggregation of the national statistics suggests that the total population of the region is approximately 34 million, of which about 75% are in the Philippines (25 million), 21% in Indonesia (7 million in East Kalimantan and North Sulawesi) and 4% are in Malaysian Sabah (less than 2 million) (WWF 2001, ORNL 2003). The population is distributed in the larger urban settlements and throughout hundreds of villages spread along the coast, across the lowlands and into the highlands. The larger urban centres include Davao City (> 2 million and the administrative and commercial hub of Mindanao), Zamboanga City

(more than 2 million, West Mindanao), Manado (North Sulawesi), Sandakan (Sabah), Puerto Princesa (less than 1 million, Palawan), Cebu City (Cebu), Bacolod City (Negros), Iloilo City (Panay), Tacloban City (Leyte) and Naga City (southeast Luzon).

Populations are increasing at between 1.3 to 1.9% annually and Sabah is also experiencing substantial immigration, of the order of 4% annually. An annual growth rate of 5.3% is occurring in the Malaysian part of the region, due to immigration from Indonesia and the Philippines (WWF 2001), through a previous bi-lateral transmigration project developed to ease population pressures in Indonesian Java. There is also substantial emigration to overseas countries, but much of this is for extended work periods (1-5 years), rather than as permanent migration. It is predicted that the population of the region will double by 2035. Many of the region's people live in poverty, with the poverty rate for the Philippines estimated at 36.8%, but with illiteracy declining from 6 to 5% from 1997 to 2001 (World Bank 2003b). Illiteracy rates are higher in Indonesia and Malaysia (both at 12% in 2001).

Economic activities

The region supports a full gamut of economic activities, from subsistence agriculture and artisanal fisheries to high technology industries. Rapid economic expansion during the 1980s has slowed recently, and GDP and economic growth for the three nations has declined and stabilised over the past several years (Table 3). Subsistence farming and fishing are the major activities of large numbers of people outside of the main urban centres (LME 2003). The coastal areas of the Sulu-Celebes Sea, while serving as important spawning grounds for the entire region, also provide a livelihood for the fishing communities crowding its shores. The uncontrolled exploitation is wrecking the habitats and at the same time, it is asking a lot to close these areas to fishing when communities need to fish in order to survive. Population pressure in the local fishing communities, poverty, and a lack of economic alternatives all contribute to the problem. The resources of the sea are a source of hard currency for the debt-burdened government. Other economic activities in the region are oil and gas production from offshore areas as well as tourism. Tourism increases every year and contributes both to the local and to the national economy. Figure 4 shows the land cover in the Sulu-Celebes (Sulawesi) region.

Table 3 The GDP and economic growth of each of the three countries that share the Sulu-Celebes (Sulawesi) region.

	1999	2001	2003
Indonesia			
GDP (billion USD)	140 000	141 254	208 310
GDP growth (%)	0.79	3.44	4.12
Malaysia			
GDP (billion USD)	79 148	87 976	103 161
GDP growth (%)	6.14	0.30	5.2
Philippines			
GDP (million USD)	76 157	72 043	80 574
GDP growth (%)	3.40	2.96	4.52

(Source: World Bank 2004)

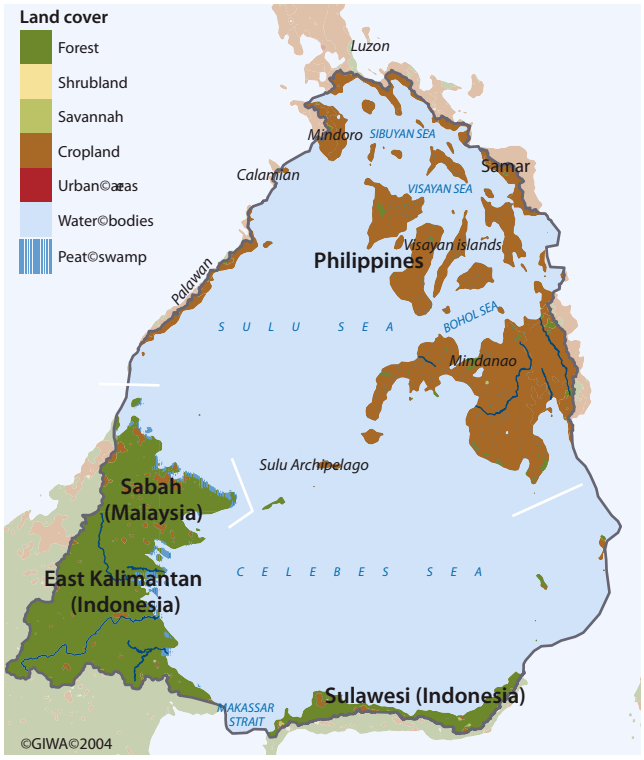


Figure 4 Land cover in the Sulu-Celebes (Sulawesi) region.
(Source: based on USGS 2002)

Agriculture

In the Philippines, agriculture is the prime mover of the country's economy, being at present the least import-dependent activity. From 1988 to 1990, the agriculture sector's contribution to GNP fluctuated around 17%. It provided about 30% of GDP and generated more than 60% of total export earnings. Between 1997 and 2001, the agriculture sector's contribution to the GDP ranged from 18.9 to 15.2%. It employed about 41.5% of the labour force in 1996. The total cultivated area is estimated at 9.5 million ha, of which 56% is used for annual crops. The average farm size is 2.2 ha (FAO AQUASTAT 2003).

In Indonesia, agricultural crop production and livestock contribute approximately 18% of GDP. The agriculture sector provides employment

for 49% of the population. In 1995, the total cultivated area was estimated to be 35.5 million ha (FAO AQUASTAT 2003). Of the cultivated area, 13.8 million ha were under permanent crops such as rubber, coconut, coffee, cocoa and palm oil. Annual crops such as rice, maize, soybean, sugar cane and tobacco were grown on 21.7 million ha. Farm-holdings in Indonesia are relatively small: 34% are less than 0.25 ha and a further 25% are between 0.25 and 0.5 ha. In total, the contribution to the GDP from agriculture in Indonesia averaged approximately 16-17% from 1997 to 2001 (FAO AQUASTAT 2003).

In Malaysia, the contribution of agriculture to GDP has progressively declined from 18.7% in 1990 to 13.6% in 1995, 11% in 1997 and to 8.5% in 2001. In 1995, the agriculture sector contributed 19.1% of export earnings. Palm oil, rubber and saw logs accounted for more than 58% of total agricultural exports. In 1996, the total arable area was 14.17 million ha, or 43% of the total land area. About 5.1 million ha, or 36%, was cultivated. Permanent crops occupied 91% of this cultivated area, while the remaining 9% (445 700 ha) was under annual crops, mainly rice. The agriculture sector is divided into large-scale plantations concentrating on three crops (rubber, palm oil and cocoa), and smallholders who constitute the majority of the farming population (FAO AQUASTAT 2003).

Fisheries

The Philippines, Indonesia and Malaysia obtain 60-70% of their animal protein from marine fishes (McManus 2000). In the Indonesian areas of the region in 1998, there were more than 43 000 boats operating in North Sulawesi and more than 26 000 in East Kalimantan alone (Kahn & Fauzi 2001). In North Sulawesi, dominant gear types were hook and line (77%), gill nets (16%), and lift nets (2.4%). By contrast, in East Kalimantan, gill nets are more widely used (46%), with traps (15%) and lift nets (14%). The marine fishery of the region contributes significantly to the economies of Indonesia and the Philippines, and to a lesser extent to Malaysia. In Indonesia for example, the estimated contribution of fisheries sector to the national GDP is about 2%. However, a significant proportion of total catch is illegal and unreported. Indonesia's relevant government minister Sarwono recently suggested that the losses in revenue suffered by the Indonesian economy as a result of poaching of fish by foreign fishers may exceed 4 billion USD. In North Sulawesi, the total volume of export fishery products in 1997 was some 50 000 tonnes (worth around 70 million USD), increasing in 1998 to more than 81 000 tonnes (worth around 76 million USD) (Kahn & Fauzi 2001).

Reef fisheries provide essential sustenance to artisanal fisherman and their families throughout the region, and also play an important role in supplying commercial quantities of high value products for export to

Figure 5 Fish market in Sandakan, Malaysia.
(Photo: S. Palaniappan, ReefBase)

expanding international, national, and local markets. Live reef fish export operations to Hong Kong and the Chinese mainland have burgeoned since the 1980s, with removal of large numbers (totalling thousands of tonnes) of demersal coral reef fishes, mostly through poison fishing, initially using cyanide but more recently using locally-produced and inexpensive vegetable poisons.

Destructive fishing activities, such as dynamite and poison fishing, are widespread and have caused severe damage (Cabanban 1998). Benthic trawling occurs in close proximity to coral reefs, with adverse direct effects on reef community structure. Trawl fishermen now retain virtually all the catch, and so by-catch and discards are no longer an issue. Collecting of ornamental reef fishes and other organisms for the global aquarium market is also widespread and continues to expand in the region, and has already caused serious damage to reefs, through use of destructive techniques of poison fishing and/or coral breakage.

There have been massive increases in aquaculture in all three nations, notably mariculture, mostly of shrimps (and to a lesser extent reef fish and lobster) in coastal ponds, and also Tilapia in lakes and inland waters. This supplies increasing local demand and the live fish trade to Hong Kong, China and Japan. At present, fish mariculture is largely dependent on capture of wild stocks for grow-out, although hatcheries are being developed.

Forestry

Forestry is also a major industry in parts of East Kalimantan and Sabah, and less so in the Philippines, where much of the harvestable forests have already been exploited or are now protected. Much of the land area of the region was originally covered by tropical forest. However,

substantial deforestation has taken place since the colonial era and, with some notable exceptions (e.g. Palawan, Philippines) (Annexes III and IV), continuing logging is further reducing the original forest cover. Fertile lowlands and hill areas have been extensively developed for rice production, as rice paddies and upland terraces. Lowland areas and river flood plains also support mixed agriculture. Overall, this has resulted in alteration to some 80% of the original vegetation cover in the Philippines (e.g. Burke et al. 2002). The Philippines has in total just 58 000 km^2 of forests remaining, with an annual deforestation rate of 1.4% (1990-2000). In total, Indonesia and Malaysia have 1 million km^2 and 192 800 km^2 of forests remaining respectively, and deforestation of 1.2% (World Bank 2003a).

Exports

In the region generally, the major export earners include: commercial exploitation of natural resources; particularly fisheries, aquaculture; mariculture; palm oil and other forms of plantation agriculture; and mining. The value added to GDP from exports in the Philippines averaged 49% from 1997-2001, and ranged from 28% to 42% in Indonesia. Much of the exports (and imports) are transported by ship. The Makassar Strait and Celebes (Sulawesi) Sea is a major oil tanker route (the ULCC - Ultra Large Crude Carriers - route) between Japan and the greater Pacific Ocean and the Indian Ocean, west Asia and Europe, with associated risks of collisions and spills (Etkin 1997, MPP-EAS 1998).

Industries

The industries involve mostly resource processing and light manufacturing, and are of growing importance. The total value added to GDP from the industrial sector in 2003 was 32% in the Philippines, 44% in Indonesia and 49% in Malaysia (Table 4) (World Bank 2004). Service industries, including tourism, were expanding during the 1990s and make a substantial contribution to GDP. Tourism has been increasing at 5% annually from 1987-1995 in the Philippines. However, tourist kidnap and murder, and growing civil unrest in Mindanao and also in Indonesia have caused a recent major decline in international tourism. This is expected to be exacerbated over the next few years by the unstable global situation.

Table 4 Total added value to GDP from the agricultural, industrial and service sectors.

Country	Agriculture (% of GDP)		Industry (% of GDP)		Services etc. (% of GDP)	
	1999	2003	1999	2003	1999	2003
Indonesia	20	17	43	44	37	40
Malaysia	11	9	46	49	43	42
Philippines	17	14	31	32	52	53

(Source: World Bank 2004)

Governance

The region has various forms of traditional land-ownership customs and systems of natural resource use. Recently, the three nations have taken steps at local, community, provincial and national levels, including implementation of legislation, to provide a modern framework for sustainable resource management (Chua pers. comm.) (Annexes III and IV). With their neighbours, the three nations form part of the Association of South East Asian Nations (ASEAN), with strong multi-lateral links at political and trade levels. The nations are all constitutional democracies. In the Philippines, the President is elected for three-year terms and based in Manila. The Philippines has a three-tiered system of government, with national, provincial and local levels. In total there are 52 provinces defined by cultural aspects, population and location.

Malaysia is a federal country, divided into 13 states plus the federal territories of Kuala Lumpur and Labuan Island. The Prime Minister is elected for four-year terms and is based in Kuala Lumpur on the Malaysian Peninsula. Malaysia has a three-tiered system of government, with national, state and local levels. The state of Sabah is governed from Kota Kinabalu on the west coast of the Island of Borneo, outside the regional boundary.

In the Republic of Indonesia, the President is elected for five-year terms and is based in Jakarta. Indonesia also has a three-tiered system of government, with national, provincial and local levels. East Kalimantan province is governed from Balikpapan on the southeast coast outside the regional boundary, while North Sulawesi province is governed from Manado, within the region.

None of the three national capitals or major political centres is located within the region, and much of the political life is focused in the provinces, cities, towns and villages. In the Philippine portion of the region, major urban centres include Davao City and Zamboanga City (Mindanao), Cebu City (Cebu), Peurto Princesa (Palawan), Batangas City and Lucena (Luzon), Bacalod and Daumagete City (Negros) and Iloilo (Panay). In the Indonesian section, the major urban centres are Manado (North Sulawesi) and Tarakan (East Kalimantan). In Sabah the major centre is Sandakan. For more information on the institutions involved in the water resources management see Box 1.

Irrigation and drainage development

According to FAO AQUASTAT (2003), the irrigation potential in the Philippines was estimated at 3.1 million ha in 1990. It corresponds to the area where irrigation facilities can easily be provided by the Department of Agriculture (NIA).

Box 1 Institutions involved in water resources management in the Sulu-Celebes (Sulawesi) region.

Philippines

In the Philippines, the 1976 Water Code of the Philippines revised and consolidated the laws governing the ownership, appropriation, utilisation, exploitation, development, conservation and protection of water resources which are subject to government control and regulation through the National Water Resources Council (NRWC). The NRWC divided the country into 12 water resources regions in order to have manageable units for comprehensive planning of water resources. In this regionalisation, the major considerations were hydrological boundaries defined by physiographic features and homogeneity in climate of the different parts of the country. Nonetheless, the water resources regions generally correspond to the existing political regions in the country. Minor deviations dictated basically by hydrography affected only northern Luzon (outside the region) and northern Mindanao. The NWRC coordinates the activities of the different agencies involved in the water sector: irrigation, hydropower, flood control, navigation, pollution, water supply, waste disposal, watershed management, etc.

The others main agencies in the Philippines involved in water resources management are:

(i) In water supply and wastewater:

- The Metropolitan Waterworks and Sewerage System (MWSS) of the Department of Public Works and Highways (DPWH), which is responsible for water supply, storage, treatment, research, design, construction and maintenance of water supply and sewage systems in the national capital region and outlying service areas in nearby provinces;
- The Local Water Utilities Administration (LWUA) of the Department of Public Works and Highways (DPWH), which is responsible for the development and improvement of water and sewerage systems in areas not covered by the MWSS.

(ii) In water resources monitoring and development:

- The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), which conducts monitoring, data gathering and maintenance of information on rainfall and evaporation;
- The National Power Corporation (NPC), which conducts water resources monitoring, research and hydropower generation;
- The Bureau of Research and Standards (BRS) of the DPWH, which is engaged in monitoring and studies of water resources as well as water research and quality standards. The DPWH is also responsible for flood control.

(iii) In irrigation:

- The Bureau of Soils and Water Management (BSWM) of the Department of Agriculture, which handles, through its Project Management Office (PMO), the construction and maintenance of Small Water Impounding Management (SWIM) projects;
- The National Irrigation Administration (NIA) of the Department of Agriculture, which was created in 1974 with the mandate to initiate an 'irrigation age'. Its tasks include the development, operation and maintenance of irrigation systems throughout the country. In particular, it has been responsible for the construction of National Irrigation Systems (NIS), and is now responsible for the recovery of irrigation fees.

The SWIM projects have been implemented by the Philippines Government to mitigate damage brought about by insufficient water supply during the dry season and the frequent floods during the rainy season. The objectives might differ from one project to another, and the following agencies are involved: the DPWH, for water supply, inland fishing and mini-hydropower; the NIA, for irrigation; the Forest Management Bureau (FMB), for watershed management with an incidental purpose of flood control; and the National Electrification Administration (NEA), for mini-hydropower generation .

Indonesia

In Indonesia, the 1945 constitution declared national water and land resources to be controlled by the State and that they should be utilised in an equitable manner for the benefit of the people. The responsibilities for the development and management of water resources and irrigation schemes are specified in laws, presidential instructions and government regulations. The most important are:

- Presidential Instruction No. 1 (1969), on the management of irrigation water and maintenance of irrigation networks;
- The law on water resources development No. 11 (1974);
- The government regulations on: beneficiaries contribution for maintenance cost of water resources facilities No. 6 (1981); water management No. 6 (1982); irrigation No. 23 (1982); rivers (1991); and swamps (1991);
- The Decree of the Minister of Mining and Energy concerning underground water resources management (1983).

Numerous institutions are presently involved in water resources management. Their tasks and responsibilities are clearly stated in national legislation:

- The Ministry of Public Works, with its Directorate General of Water Resources Development, is responsible for planning, design, construction, equipment, operations and maintenance, and guidance in water resources development;
- The Ministry of Forestry is responsible for catchment area development;
- The Ministry of Environment is responsible for environmental quality development and management;
- The Environmental Impact Management Agency is responsible for environmental impact control.

Malaysia

In Malaysia, the responsibility for water resources planning and development is shared by various government agencies. Malaysia has no single water resources authority for an overall coordinated planning and integrated river management approach, and water supply is undertaken by government agencies and privatised water companies. The coverage for water supply is 99% for urban areas and 77% in the rural areas. The Department of Irrigation and Drainage (DID), under the Ministry of Agriculture, is responsible for the planning, implementing and operation of irrigation, drainage and flood control projects throughout the country. The Department of Agriculture (DOA) is responsible for providing advice and extension services to the farmers.

In the water supply sector, the Public Works Department (PWD), under the Ministry of Public Works, is responsible for the planning, implementation and operation of urban water supply projects. However, in line with the Government's privatisation policy, many water supply projects have already been taken over by water supply companies or privatised. The Ministry of Health (MOH) provides untreated but drinkable water to rural communities not served by the local water authorities. The MOH also monitors water quality at water treatment plant intakes as well as the quality of water within the distribution system for compliance with national drinking water standards.

The control of water pollution is the responsibility of the Department of Environment (DOE), which is empowered to enforce compliance with effluent standards for point sources of pollution. The Ministry of Housing and Local Government is responsible for compliance with regulations and standards on sewerage works which have been privatised to a national sewerage company. Although either directly or indirectly much legislation touches on water resources, most of the existing laws are considered outdated. The Water Act of 1920 is inadequate for dealing with the current complex issues related to water abstraction, pollution and river basin management.

(Source: Excerpted from FAO AQUASTAT 2003)

Irrigation development in the Philippines was undertaken by rural communities (Banawe terraces, cooperative irrigation societies (zinjara) and lowland schemes near Manila) in earlier centuries. However, the major irrigation investment periods have been the 1920s, the post-war period, and the 1970s and early 1980s when public involvement in the irrigation sub-sector was at its maximum. In this respect, the creation of the NIA in 1964 has been decisive. In 1992, the area of land equipped for full/partial control irrigation was estimated at 1 532 751 ha (FAO AQUASTAT 2003). Irrigation water is generally supplied by river diversion. There are three types of irrigation systems in the Philippines: national irrigation systems (NIS), communal irrigation systems (CIS) and private schemes. The development of irrigation has resulted in substantial increases in crop yields, as it has coincided with the introduction of HYVs (High Yielding Varieties), particularly for rice. The main irrigated crop is rice, which is cultivated throughout the Philippines during the wet season and in some areas during the dry season when other crops with higher added value are also grown. In 1992, almost 45% of the total rice harvested area was irrigated, generating about 57% of output. The yields are much lower (30-40%) in the communal schemes than in the national schemes, because the water supplies are more uncertain in the small catchment areas where communal schemes are located. On average, the 1992 yield for irrigated rice was estimated at 3.34 tonnes/ha/season, which was 2.9 times the average yield of irrigated rice in 1961. For rainfed rice, the 1992 average yield was estimated at 2.07 tonnes/ha, which is twice the 1961 average yield (FAO AQUASTAT 2003).

In Indonesia, the development of community irrigation systems started more than 2 000 years ago. Modern irrigation systems were introduced in the middle of the 19th century. In 1969, with the launching of the five year development plan (Repelita), the Government started a major programme in irrigation development which included:

- Rehabilitation of existing irrigation works;
- Expansion of service areas in existing schemes;
- Construction of new irrigation systems;
- Upgrading of semi-technical irrigation systems to technical level;
- Introduction of special maintenance to upgrade the physical infrastructure;
- Implementation of efficient operations and maintenance for launching sustainable operations and maintenance programmes;
- A credit programme;
- Strengthening of Water Users Associations (WUA).

In the first 25 years of development, spanning five Repelitas (1969-1993), termed 'Pembangunan Jangka Panjang I' (PJP I), or first phase of long-term development, water resources policies were directed to support the development of different sectors with the primary emphasis being on agriculture. During PJP I, about 1.44 million ha were provided with new irrigation systems, whilst 3.36 million ha of existing irrigation systems were rehabilitated or upgraded through special maintenance. The success of this development is demonstrated by the country having achieved food self-sufficiency, particularly in rice, since 1984. Another result of Indonesia's development was the reduction of poverty from 44% of the population (54 million people) in 1969 to 13% (26 million people) in 1993.

Indonesia has now embarked on the second 25 year development period (1994-2019), termed PJP II, which started in April 1993 with Repelita VI. Here the emphasis is on sustainable development and management of water resources. Water resources have now been elevated to a full sector level and policies are directed to promoting a more effective and efficient management of water resources in an integrated manner. Greater emphasis is placed on sustaining self-sufficiency in rice and on the operations and maintenance of water resources infrastructure. In addition, the Government is implementing a crash programme in Repelita VI to improve 1.0 million ha of village irrigation systems and to develop a 600 000 ha rice estate by swamp reclamation in central Kalimantan (FAO AQUASTAT 2003).

In total, Indonesia has an estimated 39.0 million ha of coastal and inland swamps. The extent of arable swampland has not been assessed in detail but is estimated to be 7.5 million ha. In 1996, the tidal and non-tidal swamp area used for irrigation (mainly for rice) was about 1.18 million ha (FAO AQUASTAT 2003).

In Malaysia, the area that could potentially be irrigated accounts for about 413 700 ha. Irrigation development dates back to the end of the 18th century. The Kerian irrigation schemes were the first large schemes to be constructed in 1892. Since the formation of the Department of Irrigation and Drainage in 1932, irrigated areas for rice cultivation have progressively increased. By 1960, about 200 000 ha had been developed, the emphasis then being on supplementing rainfall for single crop cultivation. During the 1960s and early 1970s, the introduction of double cropping of rice required the development of adequate water resources for the second cropping season. During the 1980s, the priority for irrigation took on a new dimension with the need to rationalise rice cultivation and increase its productivity. The Government developed a policy to concentrate efforts in irrigation development in eight large irrigated areas, designated as granary areas of the country and totalling 210 500 ha (FAO AQUASTAT 2003).

Malaysia has over 932 irrigation schemes covering an area of 340 633 ha, comprising the eight granary schemes (210 500 ha), 74 mini-granary schemes (29 500 ha) and 850 non-granary schemes (100 633 ha). The non-granary schemes are scattered all over the country and their size varies between 50 and 200 ha. In addition, there are 21 967 ha which are inundation and control drainage schemes (1994 estimates). The total irrigation area was estimated at 362 600 ha in 1994.

Irrigation is predominately for rice cultivation and to a minor extent for vegetables and cash crops. Rice cultivation is mostly carried out by individual farmers working on small plots of about 1-1.5 ha. Irrigation facilities for double cropping are mainly focused on the eight main granary schemes and the 74 mini-granary schemes, with an average cropping intensity of 150%. The current irrigation efficiency is around 35-45% with a water productivity index for rice of about 0.2 kg/m^3. The average yield for irrigated rice was 4 tonnes/ha in 1995. In the major irrigation schemes, flooding irrigation is practised on rice fields, and the water depth is controlled individually by the farmers. Major irrigation schemes are designed with proper farm roads to cater for farm mechanisation especially for ploughing and harvesting. Most of the irrigation schemes are provided with separate drainage facilities. The issues of salinity, waterlogging and water-borne diseases are not reported as being significant. Farmers pay nominal irrigation charges which vary from 3 to 15 USD/ha/year. It is estimated that fees collected from farmers cover only 10-12% of the actual operational cost. The Government does not seek full cost recovery because the farming community is considered a low income group. A total of 917 million USD have been spent on irrigation development by the Government since 1970 (FAO AQUASTAT 2003).

The long-term objectives of irrigation development are:

- To provide infrastructure for 74 secondary granary areas in order to raise the cropping intensity from 120% to 170% by 2010;
- To provide infrastructure for the main granary areas in order to raise the cropping intensity from 160% to 180% by 2010;
- To convert 120 small rice schemes to other crops by 2010;
- To develop 20 small reservoirs, 100 groundwater tube-wells and four dams by 2010 in order to provide reliable irrigation by introducing new technologies and modern management to increase crop production.

In 1994, the total drained area in Malaysia was 940 633 ha. About 600 000 ha were drained for oil palm cultivation, using public funding for smallholders.

International treaties and conventions

The Philippines, Indonesia and Malaysia are signatory to most of the key international conventions and have enacted various national laws and regulations that are relevant to water-related issues in the region (see Annex IV for details). For example, the three nations have ratified the:

- Conservation on Biological Diversity (CBD);
- Convention on International Trade in Endangered Species (CITES);
- Ramsar wetlands convention;
- United Nations Framework Convention on Climate Change (UNFCCC);
- World Heritage Convention.

The Philippines and Malaysia have also ratified the UN Convention on the Law of the Sea (UNCLOS). The three nations have sovereign rights to the 12 nautical mile limit and have also declared the 200 mile Exclusive Economic Zone (EEZ). The Philippines and Indonesia unilaterally use the 'Archipelagic Doctrine' to define their territorial waters. Several government sectors concerned with use of natural resources have proposed policies or legislation relevant to obligations under the various international conventions. However, it is apparent that despite the ratifications, there has been little progress to date in implementation and the resolution of related problems. This has been attributed to the lack of action by the various governments in addressing their obligations under the conventions. A recently developed 'Environmental Strategy for the Seas of East Asia' provides many pertinent recommendations and solutions to these problems (Chua pers. comm.) (Annex III).

The Global Environment Facility (GEF) and United Nations Development Programme (UNDP) has funded a PDF-A for development of a Transboundary Diagnostic Analysis (TDA) and preliminary framework of a Strategic Action Programme (SAP) for the Sulu-Celebes Large Marine Ecosystem (also see Annexes III and V). Notably, the International Waters grant proposal for Sulu-Sulawesi Sea has not received support at present, at least in part because of difficulties in gaining tri-lateral government support, and considerable challenges remain in engendering and coordinating government support among the three nations and across the different levels - national, provincial, and local. There is, however, increasing regional capacity for science and policy development and conservation measures, including the establishment and management of protected areas. A developing 'critical mass' of regional expertise now resides in inter-government and government agencies such as:

- United Nations Environment Programmes (UNEP) Regional Seas programme;
- United Nations Educational Scientific and Cultural Organization - Intergovernmental Oceanographic Commission - Sub-Commission for the Western Pacific (UNESCO/IOC/WESTPAC);
- GEF/UNDP/IMO Regional Programme on Partnerships in Environmental Management for the Seas of East Asia (PEMSEA);
- Indonesia's Environmental Impact Management Agency (BAPEDAL);
- Department of Environment and Natural Resources, Philippines (DENR);
- Research and Development Centre for Oceanography, Indonesian Institute of Science.

Considerable expertise also resides in academic institutions and NGOs, including:

- The Marine Science Institute of the University of the Philippines;
- University of the Philippines Visayas, College of Fisheries;
- University of Malaysia, Sabah (Borneo Marine Research Unit);
- Coastal Management Center, Philippines;
- World Wide Fund for Nature (WWF);
- The Nature Conservancy (TNC);
- Conservation International (CI).

Assessment

Table 5 Scoring table for the Sulu-Celebes (Sulawesi) region.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter).

0 No known impact
1 Slight impact
2 Moderate impact
3 Severe impact

The arrow indicates the likely direction of future changes.

↗ Increased impact
→ No changes
↘ Decreased impact

Sulu-Celebes	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	2* ↗	2 →	1 ↗	1 ↗	1.9	4
Modification of stream flow	2					
Pollution of existing supplies	2					
Changes in the water table	2					
Pollution	2* ↗	2 ↗	2 ↗	2 ↗	2.5	3
Microbiological pollution	1					
Eutrophication	2					
Chemical	1					
Suspended solids	3					
Solid waste	2					
Thermal	1					
Radionuclide	0					
Spills	1					
Habitat and community modification	3* →	3 →	2 ↗	3 →	2.9	2
Loss of ecosystems	3					
Modification of ecosystems	3					
Unsustainable exploitation of fish	3* →	3 →	3 →	3 →	3.0	1
Overexploitation of fish	3					
Excessive by-catch and discards	3					
Destructive fishing practices	3					
Decreased viability of stock	1					
Impact on biological and genetic diversity	3					
Global change	1* →	1 ↗	1 ↗	1 ↗	1.1	5
Changes in hydrological cycle	1					
Sea level change	1					
Increased UV-B radiation	0					
Changes in ocean CO_2 source/sink function	0					
Changes in sea surface temperature	1					

* This value represents an average weighted score of the environmental issues associated to the concern. For further details see Detailed scoring tables (Annex II).

** This value represents the overall score including environmental, socio-economic and likely future impacts. For further details see Detailed scoring tables (Annex II).

*** Priority refers to the ranking of GIWA concerns.

This section presents the results of the assessment of the impacts of each of the five predefined GIWA concerns i.e. Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, Global change, and their constituent issues and the priorities identified during this process. The evaluation of severity of each issue adheres to a set of predefined criteria as provided in the chapter describing the GIWA methodology. In this section, the scoring of GIWA concerns and issues is presented in Table 5.

Freshwater shortage

Of the more than 300 drainage basins in the region, the major systems include the Sandakan and tributaries of Sabah; the Kayan, Ketai, Berau, Sesayan and Sembakung rivers of East Kalimantan; the Mindanao River and its tributaries; the Agusan River and its tributaries; and the Libuganon and Sindangang rivers of Mindanao. Numerous smaller rivers and streams flow from the mountainous interiors of most of the islands in the region. Many of these rivers have been extensively modified, primarily through loss of riparian vegetation, major clearing of catchments, with resulting loss of soils as sedimentation into rivers and streams (also see Suspended solids, and Loss and modification of ecosystems or ecotones).

Water withdrawal

In the Philippines in 1995, the total water withdrawal was estimated at 55.4 km^3 on the basis of the water rights issued by the National Water Resources Board (NWRB), of which 88% is for agricultural purposes, 8% for domestic and 4% for industry (Table 6). Other sectors using water (non-consumptive use of water) included hydropower (89 km^3), fisheries (498 million m^3) and recreation (93 million m^3) (FAO AQUASTAT 2003).

Table 6 Water withdrawal in the Sulu-Celebes (Sulawesi) region.

Country	Total water withdrawal (km^3)	Water withdrawal by sector (%)		
		Agriculture	Domestic	Industry
Indonesia	74.34	93	6	1
Malaysia	12.73	76	11	13
Philippines	55.42	88	8	4

(Source: FAO AQUASTAT 2003)

Production of wastewater in the national capital region and nearby provinces is estimated at 74 million m^3, while the volume of treated wastewater reached 10 million m^3 in 1994 at the Ayala and Dagat-Dagatan pond. Disposal of wastewater is expected to increase as new sewer lines are being built every year (FAO AQUASTAT 2003).

In Indonesia in 1990, total water withdrawals were 74.3 m^3 (Table 6). As the nation has started to implement development programmes in order to meet the sharply increasing needs for irrigation, safe drinking water, industrial water, energy, etc., the demand on water resources has increased rapidly. It is estimated that between 1990 and 2020, the demand will increase by about 220%. More than 50% of all irrigation water is consumed in Java (in the neighbouring GIWA region Indonesian Seas) (FAO AQUASTAT 2003).

In Malaysia in 1995, the total water withdrawal was 12.7 km^3 (Table 6). About 32% of the water produced is lost in the distribution system due to several factors such as pipe leakage, under-metering, and other unaccounted water losses. The total water demand increased from 8.7 km^3 in 1980 to 12.7 km^3 in 1995. Irrigation currently accounts for about 9.7 km^3 or about 76% of the total water consumption. However, irrigation demand is expected to taper off as no further expansion in irrigated rice cultivation is envisaged (FAO AQUASTAT 2003).

Dams

In the Philippines, the total dam capacity in 1995 was 4 753 million m^3 (Table 7) (FAO AQUASTAT 2003). Three of the large dams are managed by the National Power Corporation (NPC) (Angat, Ambuklao and Palangui IV for a total capacity of 1.5 km^3), the two largest dams being managed by the NIA (Magat River Integrated Irrigation System (MRIIS), and Upper Pampanga River Integrated Irrigation System (UPRIIS) for a total capacity of 3.2 km^3). The remaining large dam (La Mesa) is managed by the Metropolitan Waterworks and Sewerage System, which is also responsible for the management of a small dam (Ipo). The NPC is also in charge of three small dams (Agus II, IV and V for a total capacity of 27.7 million m^3) while all other small dams have been created with various objectives within the framework of the small water impounding management (SWIM) projects, which are implemented by several agencies. A survey of surface water storage potential has identified sites for 438 major dams and 423 smaller dams (FAO AQUASTAT 2003).

Table 7 Hydropower in the Sulu-Celebes (Sulawesi) region.

Country	Dam capacity (km^3)	Dams	Hydropower potential (GW/h)	Total installed power capacity (MW)	Electricity generated by hydropower (%)
Indonesia	15.8	82	3 388	2 061	16.3
Malaysia	ND	56	5 800	ND	30
Philippines	4.75	60	ND	ND	ND

Note: ND = No Data.

(Source: FAO AQUASTAT 2003)

In Indonesia and Malaysia, most major dams are situated outside the regional boundaries. In Indonesia in 1995, there were 82 dams, with large dam capacity of 15.83 km^3 (Table 7) (FAO AQUASTAT 2003). Malaysia has a total of 56 dams, of which 32 are more than 15 m high. The gross theoretical hydropower potential of the Malaysian Peninsula is 123 000 GWh/year, and that of Sabah and Sarawak together is 107 000 GWh/year. In 1995, the total hydropower generation was about 5 800 GWh, or 30% of all power production in Malaysia (FAO AQUASTAT 2003).

Groundwater

In the Philippines, the total groundwater resources are estimated at 180 km^3/year, of which 80% (145 km^3/year) would constitute the base flow of the river systems (FAO AQUASTAT 2003). The total internal water resources would therefore amount to 479 km^3/year. There are four major groundwater reservoirs (Cagayan, 10 000 km^2; Central Luzon, 9 000 km^2; Agusan, 8 500 km^2; Cotobato, 6 000 km^2) which, when combined with smaller reservoirs, aggregate to an area of about 50 000 km^2. Private wells are extensively used in rural areas for domestic purposes. Municipal waterworks wells are drilled by the Local Water Utilities Administration for domestic purposes and deep wells have been drilled by the National Irrigation Administration (NIA) for irrigation purposes (FAO AQUASTAT 2003).

In Indonesia, groundwater resources are estimated at 455 km^3/year, although most (an estimated 90%) return as base flow to the rivers. The groundwater potential in Indonesia is, therefore, limited and can meet only part of the urban and rural needs for water supply, while providing irrigation water for very limited areas in the eastern part of Indonesia. In some places, overexploitation of groundwater has led to critical problems (FAO AQUASTAT 2003).

In Malaysia, the total surface run-off is 566 km^3, and about 64 km^3 (7% of the total annual rainfall) contribute to groundwater recharge. However, about 80% of the groundwater flow returns to the rivers and is therefore

not considered an additional resource. The total internal water resources of Malaysia are estimated at 580 km^3/year (FAO AQUASTAT 2003).As surface water is readily available throughout the year, it is abstracted mainly for irrigation and domestic uses. Groundwater resources are limited to some pockets of the coastal region and is generally exploited by rural people to supplement their piped water supply. Surface water represents 97% of the total water use, while groundwater represents 3%. About 60-65% of groundwater utilisation is for domestic and/or municipal purposes, 5% for irrigation and 30-35% for industry.

Environmental impacts

Modification of stream flow

Modification of stream flow is having moderate environmental impact in the region as a whole at present, but with severe local effects in some areas of the Philippines (Mindanao and the Visayan Islands) and northeast Borneo. Major dam construction has altered river flows in many Philippines rivers (see above). Here also, significant loss of riparian vegetation has occurred through effects of logging and other destructive land use practices. This has been most severe in the small islands of the Sulu Sea and Visayas, and also significant on the larger scales of Mindanao, Negros, Cebu, East Kalimantan and Sabah. On Negros, the 50% of original forest that remained in the 1930s has been reduced to approximately 4% today. Overall, there has been greater than 80% loss of original land cover in most of the Philippines area of the region, with some 40-60% loss in the Malaysian (Sabah) areas of Borneo (Burke et al. 2002). By contrast, much of the original forest remains in Indonesian East Kalimantan and North Sulawesi.

Pollution of existing supplies

Pollution of existing supplies has caused moderate environmental impact, but with highly localised severe damage. There have been reports of fish kills from various chemical inputs, notably from a nematocide in banana pesticides used in Compostela Valley province, Mindanao. There have also been increases in nutrient loads to lakes from aquaculture activities, with likely increases in other inputs.

Changes in the water table

Changes in the water table have also caused moderate environmental impact in the region as a whole, with severe impact in small islands of the Sulu Sea, Visayan Islands, Mindanao and Cebu. Wells have been deepened over hundreds of square kilometres in these areas of the Philippines. On Cebu, deforested since the 1880s, saline intrusion has occurred up to 11 km from the coast, and there is little or no potable water available from traditional coastal sources. By contrast, on Palawan, where logging was halted in 1992 and 40% of the monsoon forests remain, there has been relatively little salt intrusion.

Socio-economic impacts

Socio-economic impacts range from slight (health and other social and community) to moderate (economic) at present. Most of the major socio-economic impacts are concentrated in the Philippines areas of the Sulu Sea, Visayan Islands and Mindanao and in Indonesian East Kalimantan. For large numbers of people in the region, there is no secure access to potable drinking water from wells or piped supply. According Lins (pers. comm.) speaking at the 10th Annual Philippine Water Conference and Exhibition on Water Resource Management (Philwater) September 2001, many Filipinos, especially the poor, lack safe, potable drinking water to meet even their basic survival needs. About one third of the Philippines population of 81 million people devise their own ways of obtaining water because they have no access to formal sources such as deep wells or reticulated water. Half of the poor and rural households consume less than 30 litres per person per day, barely meeting normal requirements. Many poor people are required to buy water, with the daily consumption levels averaging just 15 litres per day, dangerously close to the survival minimum. Of the 25 million Filipinos whose water supply is self-provided, many are getting water from sources contaminated by human, agricultural and industrial wastes, particularly in Mindanao where the need for safe and adequate water remains is often not met. Some of the surface water does not meet WHO drinking water criteria because of human inputs, particularly in Mindanao. The Philippines population affected by water-related diseases in 1989 was 782 000 and include gastro-enteritis, schistosomiasis and hepatitis (FAO AQUASTAT 2003).

Even in some areas with reticulated water, there are interruptions to supply. Despite its moderate score for the region as a whole, freshwater shortage is already a food-security concern, and is the focus of national and international interventions. Expanded programmes targeting both rural and urban water supplies, with the goal of delivering a reliable potable supply, will be necessary to achieve significant alleviation. In parts of the region (e.g. Mindanao), civil unrest caused by separatist movements is likely to contribute to difficulties in effectively implementing remedial interventions. In Indonesia in 1990, just 35% of the urban population and 33% of the rural population were supplied with water (FAO AQUASTAT 2003).

Additional economic impacts accrue from costs in supplying water for irrigation. In the Philippines, under the National Irrigation System (NIS) schemes, the average cost of irrigation development is estimated at 3 800 to 7 600 USD/ha for new schemes, while the cost for the rehabilitation of existing schemes varies from 1 000 to 1 600 USD/ha (FAO AQUASTAT 2003). Although the cost of the system is borne entirely by the Department of Agriculture (NIA), often poor farmers have to pay

fees to cover operations and maintenance expenditure. There are also about 6 200 communal schemes. In Mindanao, these schemes are generally large, many of them being implemented by the government settlement programmes and then transferred to farmer groups. The association bears 10% of the direct cost of construction, and pays back the balance within 50 years at a 10% interest rate. Private schemes (about 152 100 ha in 1992) are generally supplied through pumping. They find their origin in publicly assisted river lift and groundwater development projects. In 1980, public involvement in this sector ceased because of the high cost of energy needed to operate these systems. Most of the schemes have been abandoned or are now inoperable. For example, of the 379 public tube-wells constructed in 1971, only 22 were still in operation in 1990. Pump schemes located along rivers have also been developed by private owners serving up to about 20 ha. Although this can be successful when supporting high value crops, many are no longer used, largely due to the high cost of operations and maintenance, particularly for rice paddies (FAO AQUASTAT 2003).

On all NIS schemes, the fees collected by the NIA should cover the costs for operation, maintenance and even the investment cost within a reasonable period of time to an extent consistent with government policy. However, in practice, capital cost recovery is confined to the communal sector and the fees collected covered only 80% of operations and maintenance expenditure in 1989. The fees can be paid either in rice or in cash. For crops other than rice, the fees are calculated on the basis of 60% of the rate given for rice fees. In Indonesia, the main objective of irrigation development is to expand the cultivation of rice, the staple food. The major crops cultivated under controlled irrigation are rice and palawija (dry season crops, e.g. corn, soybean). In 1992, the average cost of developing a surface irrigation scheme was 3 645 USD/ha while the average operations and maintenance cost of a surface irrigation system was 8.4 USD/ha/year.

There is also growing water competition among the users; water supply, hydropower, environment, fishing and watershed management are competing with irrigation for water. In the Philippines, the National Water Review Board (NRWB) was established in order to coordinate the use of water for different purposes, but its action is hampered, in part, by a lack of reliable data on present water resources and water use. Erosion and siltation of the canals have resulted in high costs for the operation and maintenance of irrigation schemes, and many are thus in need of frequent rehabilitation. The conversion of agricultural lands for industrial or residential use has significantly reduced the area that can actually be used for irrigated agriculture. The high cost of energy hampers the development of pump irrigation systems. The present pump systems are no longer economically viable if devoted solely to rice irrigation.

Thus, socio-economic impacts from Freshwater shortage in the Sulu-Celebes (Sulawesi) region include:

- Loss/interruptions to human drinking water supplies particularly in rural areas of the Philippines;
- Increased costs of irrigation and alternative water supplies, with one-third of the Philippines population having no secure access to potable water;
- Reduction in future use options;
- Human health impacts from lack of regular supply of potable water, as noted above;
- Future costs of improving supply, both reticulated and through deepening wells and pumping;
- Potential damage to infrastructure;
- Increased potential for upstream/downstream conflicts, or conflicts among urban and squatter groups. The water authorities presently do not have adequate capacity for effective enforcement, and much of the infrastructure dates from colonial times.

Conclusions and future outlook

Freshwater shortage has caused moderate environmental impact at present and is expected to deteriorate markedly, becoming severe by 2020. Impacts to health and other social and community aspects are expected to deteriorate from slight to moderate by 2020 although the economic situation is expected to improve slightly over the next 20 years, remaining at a moderate level of impact.

Major forcing factors on freshwater shortage include widespread increases in human populations, with a doubling expected by 2035, compounding problems of poor water supply and contamination. Despite the best efforts of government (as outlined in Box 2) and NGOs, a continuing lack of effective regulation and little environmental control is expected to contribute to the further deterioration in socio-economic aspects of freshwater shortage. For example, in both Indonesia and the Philippines, with the sharply increasing needs for irrigation, safe drinking water, industrial water, energy, etc., the demand on water resources has increased rapidly. In 1990, just 35% of Indonesia's urban population and 33% of the rural population is supplied with water, and it is estimated that between 1990 and 2020, the demand will increase by about 220%. Notably, the actual rate of deterioration will depend largely on the success of the planned interventions (see Annexes III and IV).

Box 2 Trends in water resource management in the Sulu-Celebes (Sulawesi) region.

Phlilippines

The majority of the population depends on agriculture for its livelihood and irrigation is considered a crucial element in agricultural production. With the potential irrigable area of 3.1 million ha, irrigation development is only at the halfway stage. Self-sufficiency in food has been set as a target by the Government. Agricultural development through irrigation, therefore, still remains a priority on the Government's agenda.

The Irrigation Crisis Act (Republic Act No. 6978) signed into law in January 1991, mandated the NIA to develop the remaining 1.5 million ha of irrigable lands within 10 years through the construction of irrigation projects including other related project components. Irrigation, soil and water management have been set as a priority on the agenda of the Department of Agriculture. The Medium Term Philippine Development Plan (1994-1998) also envisages rapid irrigation development. However, there are numerous economic and environmental problems, as described above. In addressing these challenges, the NIA, together with the Department of Environment and Natural Resources, is expected to:

- Fully enforce existing laws on environmental protection and conservation, in order to reduce erosion.
- Establish institutional arrangements with the NPC, the NEA and the electric cooperatives to reduce power rates for pumps as a government subsidy to small farmers.
- Work with the Department of Agrarian Reform, under the Comprehensive Agrarian Reform Law, to approve or disapprove the transformation of agricultural lands for non-agricultural uses.

Indoneisa

The Ministry of Public Works through its Directorate General of Water Resources Development (DGWRD) has identified four main missions in water resources sector programming as part of Repelita VI (1994-999). They are:

- Maintenance of self-sufficiency in rice production to achieve long-term food security. Although Indonesia achieved self-sufficiency in rice production in 1984, demographic growth, land use changes, variations in rainfall, climatic changes, drought, flooding, drainage problems in low-lying areas and urbanisation have resulted in rice shortages requiring the importation of rice and the building up of costly rice buffer stocks. The DGWRD directs its programming towards activities that support the continued increase in rice production to maintain self-sufficiency.
- Provision of water to meet increasing water supply demands. Rapid industrialisation, increasing urbanisation and the need to supply the nation's population with safe drinking water have necessitated the development and maintenance of adequate water sources and supplies of proper quality water in many regions of the country. Often, the water is required at locations far away from good quality water sources, so large capital investments for conveyance infrastructures are needed. The water sources are continuously subjected to water quality degradation due to urban, industrial and upper watershed pollution. The DGWRD directs its programming to develop sources of good quality water and supply to demand centres in order to meet the needs for water.
- Flood alleviation and river management. Many of Indonesia's agricultural and urban areas are located in the lowlands. The majority of rivers flood frequently due to the high intensity rainfall in the watersheds and influx of sediment, particularly in lowland areas. In addition, the river morphology and carrying capacities are continuously changing due to sediment problems, large variations in flow, and human encroachment. In order to protect investment and economic activity as well as to ensure the availability of surface water resources close to demand centres, the DGWRD direct its programming to continuously improve flood protection and drainage, through both structural and non-structural measures, and to manage water bodies such as ponds, lakes and reservoirs.
- Water resources development, conservation and management. The archipelagic nature of the country, variations in rainfall, large fluctuations in river flows and lack of proper storage sites have hindered the nation's ability to meet the increasing water demands. The gradual degradation of upper basins, poor groundwater resources, increasing water quality problems in the lower reaches of the rivers, and the inefficient use of water require a greater focus on water resources, conservation and prevention. Thus, in order to ensure the continued availability of water resources, the DGWRD direct its programming towards steps to improve water resources availability through appropriate conservation and management measures.

The four missions directed by the DGWRD are being implemented through a number of major and support programmes. The water resources sector now has two major sub-sectors:

– Water resources development, with three major programmes:Water resources development and conservation; supply and management of water; and management of rivers, lakes and other water resources;
– Irrigation with, two major programmes: development and management of irrigation networks; and development and management of swamp areas.

Malaysia

Agriculture will remain the main user of water in the future. However, its importance will decline from the present 76% to about 70% of total water consumption by 2020. In the irrigation sector, future efforts will focus on demand management through improved water management rather than on supply management. Future trends in rice cultivation will focus on group farming as practised in the Trans Perak Area Integrated Agriculture Development Scheme.

In the long-term, sustainable rice cultivation will depend on the establishment of effective farmers' organisations. More business-oriented rice farming is seen as a way to reduce government subsidies to small farmers. Owing to the high cost of rice production, the National Agriculture Policy (1992-2010) aims to gradually reduce the country's self-sufficiency in rice from the current 80 to 65%.

In the water resources sector, there is a need to review the planning and development of dams. Most of the existing dams were generally designed for one single purpose by various government agencies and privatised utility companies.

Future dams will be designed with consideration for multipurpose usage through improved coordination and the optimisation of resources. There is also an urgent need to address the issue of water pollution, which could have a serious economic impact if left unchecked. The Government is studying the feasibility of setting up a national body to manage the rivers as well as the creation of a national water council to improve cooperation between federal and state governments in water resources management.

(Source: Excerpted from FAO AQUASTAT 2003)

Pollution

Industrial forms of water pollution are focused in the major urban centres, include Davao City and Zamboanga City (Mindanao), Cebu City (Cebu), Peurto Princesa (Palawan), Batangas City and Lucena (Luzon), Bacalod and Daumagete City (Negros), Iloilo (Panay), Tarakan (East Kalimantan), Manado (North Sulawesi) and Sandakan (Sabah, Malaysia). Here also, sewage treatment is superficial at best, with raw and/or primary treated sewage discharged directly into water courses. Agricultural pollution is also widespread, through leaching of fertilisers and pesticides into water courses, massive loss of soils following land clearing and forestry and increasing aquaculture activities.

Total emissions of organic water pollution have remained relatively steady in the Philippines from 1980 (estimated at 182 000 kg per day) to 1993 (181 700 kg per day) with an average input per worker of 0.19 kg per day sector's share of organic water pollution was mostly contributed by food (53% of the total) (World Bank 2003b). In Indonesia by contrast, there has been a rapid increase in emissions, from some 214 000 kg per day in 1980 to more than 537 000 kg per day in 1993. Here food is the major industrial contributor (59%). Similarly in Malaysia, emissions of organic water pollution have increased, from 77 200 kg per day in 1980 to 136 100 kg per day in 1993, again with food being the major industrial contributor (32%) (World Bank 2003b).

Environmental impacts

Microbiological

Despite its slight environmental impact overall, microbiological pollution is a locally significant problem in the major urban centres, notably Davao and Zamboanga cities (Mindanao) from inadequate sewage disposal and treatment. There are also elevated levels of faecal coliform contamination and in the Visayan Islands there has been a slight increase in incidence of bacterial-related gastro-enteric disorders in fisheries product consumers (affecting hundreds of people), but no fisheries closures or advisories. Blooms of toxic dinoflagellates have caused paralytic shellfish poisoning in parts of the region (Maclean 1989).

There is only rudimentary sewage treatment for much of the region, where most sewage is treated by settlement and most primary treatment consists of screening, particularly in the urban areas (e.g. Davao City, Mindanao). For example, the production of wastewater in the Manila region and nearby provinces (part of GIWA region 54 South China Sea) is estimated at 74 million m^3 in 1994, while the volume of treated wastewater reached just 10 million m^3 at the Ayala and Dagat-Dagatan pond (FAO AQUASTAT 2003). Disposal of wastewater is expected to increase as new sewer lines are being built every year. In Indonesia, municipal and industrial wastewater is discharged virtually untreated into the waterways causing rapid deterioration in the quality of river water. In Malaysia, although much legislation touches on water resources either directly or indirectly, most of the existing laws are considered outdated. For example, the Water Act of 1920 is inadequate for dealing with the current complex issues related to water abstraction, pollution and river basin management (FAO AQUASTAT 2003).

Eutrophication

The present level of environmental impact from eutrophication in the region as a whole is moderate. Impacts are most significant in enclosed bays, harbours and lagoons with limited water circulation, and particularly where sewage or industrial discharges are present, notably in areas of southern Luzon and the Visayan Islands. As noted in the assessment of the impacts of microbiological pollution, blooms of toxic dinoflagellates have caused paralytic shellfish poisoning in parts of the region (Maclean 1989).

Chemical

Chemical pollution is causing only slight environmental impact in the region as a whole, in part related to the lack of major industrial centres in the region (all national capitals and most major industrial areas are outside the regional boundaries), and to the physical oceanography of the Sulu-Sulawesi (Celebes) Sea. Nonetheless, this is a locally significant problem in worst affected areas such as Batangas Bay (heavy metals), urban areas of Mindanao, the Visayas Islands and other industrial, urban (e.g. all larger cities and towns) and major agricultural areas.

Some water contamination also occurs from manufacturing, metal fabrication, ship repair and agricultural and food processing industries (oil milling, sugar refining, and meat and fish processing) and from mining, with contaminant loads concentrated near the discharges. Pargal et al. (In prep) noted that in the case of Indonesia, the textiles, leather tanning, food products and pulp and paper industries are more BOD-intensive than other manufacturing sectors. Pulp and paper is significantly more intensive in organic water pollution (BOD) than food products, although textiles and leather tanning are also relatively BOD-intensive; metal and machinery industries are the least BOD-intensive. Pulp and paper and miscellaneous manufacturing are most intensive in total suspended solids (TSS), while the machinery industry is least intensive.

Philippine coastal waters off Luzon, Negros, Cebu, Samar, Balabac and the Calamian group have suffered from chemical pollution due to mining activities. Releases of chemical and to a lesser extent microbiological pollution from shipping in harbours are also common and widespread, as regulations and controls relating to ship-derived pollution are rarely enforced. Pesticide use is widespread, particularly in plantation agriculture (e.g. nematocides in banana farms). For example, chlorinated residues from pesticides used on rice paddies, such as Aldrin, Dieldrin, Lindane and Endrin, are found in the water column and sediments in Manila Bay and Segara Anakan, with levels exceeding allowable limits set by national agencies (Ludwig 1985, Gunnerson & Cuellar 1988). As noted above, fish kills have occurred from various chemical inputs, notably from a nematocide in banana pesticides used in Compostela Valley province, Mindanao. Nonetheless, there are no indications that pollution from agricultural run-off is a significant problem at the scale of the region at present.

Suspended solids

Environmental impacts from suspended solids are severe, especially in the coastal waters of the Philippines, the result of extensive deforestation (e.g. Chia & Kirkman 2000, Hodgson & Dixon 1988, 1992, Burke et al. 2002). This is compounded by high rates of erosion and siltation rates that are among the highest on Earth. For example, in the Philippines, it is estimated that approximately 1 billion m^3 of sediment is lost to coastal waters annually (Burke et al. 2002), carrying high loads of particle-bound nutrients. Additional transboundary impacts result from sediment-laden waters flowing seasonally into the region around the northern coast of Sabah and to the south of Palawan from the

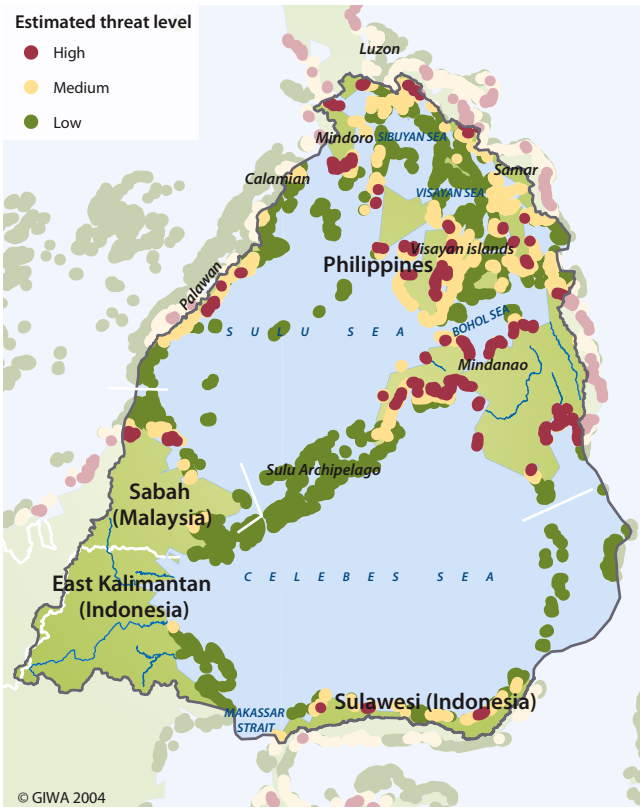


Figure 6 Reefs at risk due to sedimentation in the Sulu-Celebes (Sulawesi) region.
(Source: Burke et al. 2002)

South China Sea (Bate 1999). At present, effects of the nutrients are uncertain and are partly dependent on rates of mineralisation and retention of the dissolved nutrients. There is little evidence of visible effects on the abundance and distributions of biota, of increased frequency of hypoxic conditions, reduced levels of dissolved oxygen, or fish or zoobenthos mortality other than in some enclosed bays (e.g. in southern Luzon and Visayas) and in the immediate vicinity of river mouths. Blooms of toxic dinoflagellates have caused paralytic shellfish poisoning (Maclean 1989). The extent and level of threat posed by sedimentation to coral reefs of the region ranges from low to high (Figure 6). High threat sites include much of the northern coast of Mindanao, several smaller areas of northern Sulawesi and northern Borneo (Sabah, Malaysia) and much of southern Luzon (Burke et al. 2002).

Solid wastes

Solid wastes have caused moderate environmental impact in the region. However, there has been severe impact locally, particularly around the larger cities, towns and villages, including Davao City and Zamboanga City (Mindanao), Cebu City (Cebu), Peurto Princesa (Palawan), Batangas City and Lucena (Luzon), Bacalod and Daumagete City (Negros), Iloilo (Panay), Tarakan (East Kalimantan), Manado (North Sulawesi) and Sandakan (Sabah, Malaysia). Here, waste management is generally poor or non-existent. There is widespread litter on beaches giving rise to public concerns regarding recreational use. There are high frequencies of benthic litter recovery and interference with trawling activities, and there are also frequent reports of entanglement/suffocation of species by litter.

Thermal

Thermal pollution has only negligible and at most slight impact, being notable only in the immediate vicinity (less than 1 km^2) of the few power plants where ocean discharge of cooling waters occurs.

Radionuclide

There is no known environmental impact of radionuclide pollution at present. There are no nuclear power plants in the region, although there may be some episodic minor discharge from nuclear-powered ships navigating through the area.

Spills

Spills have caused only slight environmental impact at present, despite the southeastern Celebes Sea forming part of the major ULCC oil tanker route between the Indian and Pacific Oceans. International trade is expected to triple by 2020, and much of this trade will be transported by sea. Increased tanker traffic using the ULCC route has the potential for spills to occur that could damage oceanic and coastal habitats; mangroves and coral reefs. Major oil production is being carried out in northwest Palawan, Erb West and Samarang off west Sabah, and the potential for oil spills to affect adversely marine and coastal ecosystems in the region is high. Overall, Southeast Asia produces about 3.5% of the world's crude oil and 2.5% of its natural gas (Valencia 1989), and oil spills in neighbouring regions could also potentially affect the ecosystems of the Sulu-Celebes Sea, especially if occurring during monsoon season. Caution and good management practices must be exercised in current and future exploration initiatives, including the Shell Company's multi-billion dollar Malampaya Gas Project (in Palawan province, Philippines), which was scheduled to begin operation in 2002-2003 (Werner & Allen 2000). The Philippines and Malaysia have ratified the UN Convention on the Law of the Sea (UNCLOS) and the International Convention on Prevention of Marine Pollution from ships (MARPOL). These nations have taken some steps towards developing oil spill contingency planning, yet little spill control equipment is in place and emergency procedures are not well established.

Socio-economic impacts

The three indicators of socio-economic impacts of pollution have moderate impacts at present. Most impacts are related to poverty and are concentrated in the major urban centres, the Visayas Islands, Mindanao, East Kalimantan and Sabah. The GIWA experts conclude that there have also been significant health issues in these areas, including cases of mercury poisoning, although the total number of cases is unknown. The key socio-economic impacts include:

- Increased risks to human health;
- Increased costs of human health protection;
- Loss of water supplies (e.g. potable water, see Freshwater shortage);
- Increased costs of water treatment (see Freshwater shortage and Regional definition, Socio-economic characteristics);
- Costs of preventive medicine (mostly future cost);
- Costs of medical treatment (e.g. blooms of toxic dinoflagellates have caused paralytic shellfish poisoning in parts of the region) (Maclean 1989);
- Costs of clean-up;
- Loss in fisheries (see Unsustainable exploitation of fish and other living resources);
- Change in fisheries value (see Unsustainable exploitation of fish and other living resources);
- Costs of reduced fish marketability due to aesthetic perceptions (see Unsustainable exploitation of fish and other living resources);
- Reduction in options of other uses of freshwater (see Freshwater shortage);
- Damage to equipment (e.g. particle impacts);
- Avoidance of amenities and products due to perceptions of effects of contamination;
- Costs of preventative measures;
- Costs of contingency measures.

A typical local scale case study in socio-economic impact is provided by recent and future proposed port reclamation in North Sulawesi, close to the city of Manado and the regionally significant Bunaken National Park (Box 3).

Box 3 Planned Minahasan container port.

The proposed project would involve reclamation of approximately 8 ha of fringing reef in the Pasir Panjang area southwest of Manado, just a few kilometres from the southern section of Bunaken National Park. The proposed reclamation follows six years of reclamation activities in Manado Bay that have been largely opposed by the general public but that have continued in a relatively non-transparent and non-accountable manner.

The social impacts of such a development range from the loss of fishing grounds for local artisanal fishers to the likely increase in container truck traffic, bars, brawling and prostitution that often accompany port development. Issues discussed included environmental impacts of the proposed plan on both the local reefs and those in nearby Bunaken National Park as a result of reclamation and sedimentation during construction and oil spills, ballast water dumping and other marine pollution during port operation, and the related negative economic and health effects on locals.

The hearing was concluded without any specific commitments other than that due to the large number of issues raised, the Minahasan government would re-evaluate the plan. While the eventual outcome of this debate is not yet clear, the fact that the project is being openly discussed prior to construction is a huge step forward for natural resources management in North Sulawesi and for principles of transparent and accountable governance. The public hearing on the port was successful in bringing together a large number of relevant stakeholders (both pro and contra) and in facilitating focused and informed debate on the project.

(Source: Excerpted from NRM Headline News 2002a)

Conclusions and future outlook

For the GIWA concern of Pollution as a whole, present level of environmental impact is moderate. However, environmental impact of suspended solids is already severe, primarily resulting from deforestation over the past century and a half (Burke et al. 2002). Over the next years, environmental impacts from pollution in streams and rivers, the intertidal zone, and waters deeper than 200 m are likely to deteriorate markedly. Overall impact in 2020 is expected to be severe, primarily because of the predicted major increase in population (doubling by 2035) without sufficient major improvements in infrastructure to compensate.

The three nations are adopting industrial water pollution control standards similar to those in developed countries. However, formal regulation in the region has been greatly hampered by the absence of clear and legally binding regulations; limited institutional capacity; lack of appropriate equipment and trained personnel; and inadequate information on emissions (Hettige et al. 1996). Indonesia began formal regulation in 1992 (Pargal et al. in prep.), with establishment of maximum allowable volumes and concentrations (in kg/tonnes of output) for emissions of BOD and other water pollutants from 14 broadly-defined industry sectors (e.g. textiles, wood pulping). Although self-reported BOD emissions are now mandated by law, reporting was extremely sparse until recently. Until 1995, the only consistent programme of monitoring and pressure for compliance was a voluntary arrangement instituted in 1989. This PROKASIH or 'Clean Rivers,' programme, covers about 5% of Indonesian manufacturing facilities in 11 river basins on the islands of Java, Sumatra (in the neighbouring GIWA region Indonesian Seas) and Kalimantan. While it has succeeded in eliciting significant pollution reductions from some of Indonesia's largest polluters, PROKASIH represents only the first stage of regulation.

Yet, despite weak or non-existent formal regulation, there are many clean industrial plants in these countries. However, there are also many plants that are among the world's most serious polluters (Hettige et al. 1996). The analysis of Hettige et al. (1996) demonstrated that pollution intensity was negatively associated with scale, productive efficiency,

and the use of new process technology. It was strongly and positively associated with public ownership, but foreign ownership had no significant effect once other plant characteristics were taken into account. Among external sources of pressure, community action, or informal regulation, emerged as a clear source of interplant differences. The results suggested that local income and education are powerful predictors of the effectiveness of informal regulation. They also showed that existing formal regulation had measurably beneficial effects, even when it was quite weakly developed. Abatement is generally subject to significant scale economies; within-country variations in labour and energy prices have little impact on pollution intensity; and community incomes have a powerful negative association with pollution intensity (Pargal et al. in prep.). Although the plant and firm characteristics are important in Indonesia (and other Asian developing economies), community income is particularly important, since this suggests a powerful role for informal regulation whether or not formal regulation is in place.

Indonesia's Environmental Impact Management Agency (BAPEDAL) has recently initiated PROPER-PROKASIH. This programme gives participating industrial and other manufacturing plants colour-coded grades indicating their compliance with pollution regulations. PROPER-PROKASIH is in its second year and preliminary results suggest it has had a positive impact on polluter behaviour as well as BAPEDAL's capacity for regulation. In the Philippines, the Department of Environment and Natural Resources (DENR) is introducing a public disclosure programme called EcoWatch, modelled on Indonesia's PROPER programme. Despite these and other pollution mitigation initiatives, future deterioration is expected in all three indicators, such that the socio-economic prognosis for 2020 is for severe impacts to economy, health and other social and community aspects from water pollution issues, despite regulatory and other interventions.

Addressing water security alone is a major challenge (as noted in Freshwater shortage above), and little progress is being made in addressing the other major forms of water pollution at present. For example, river and coastal aquaculture projects are growing rapidly, with little regulation or enforcement. In Indonesia, up to 1 million ha of land, mostly mangrove forests, were allocated by the government for the shrimp hatchery industry during the 1980s and 1990s. By 2001, about 70% of the shrimp farms had been abandoned, because the operators found them unsustainable due to the high concentrations of chemicals and the destruction of the mangrove habitat.

IMPACT Habitat and community modification

The region is located in the Indo-West Pacific centre of diversity and supports mega-diversity, located near the junction of three major biogeographic zones (Roberts et al. 2002, Cheung et al. 2002). The warm clear waters of the Sulu-Celebes Sea, its currents and upwellings, its active underwater volcanoes, its seamounts, trenches, corals and inter-island passages, constitute an exceptionally rich marine life hot spot. The region supports a significant proportion of the total coral reef area of the Philippines, with some 20 000 km^2 of coral reefs, and forms part of the 'coral triangle' of highest coral diversity with Indonesia and New Guinea (with more than 500 reef-building species) (Burke et al. 2002).

The Sulu-Celebes Large Marine Ecosystem support around 400 species of algae, 5 species of sea turtles, 22 species of marine mammals and over 450 types of coral (LME 2003). More than 2 500 species of fish occur in the region, many of which are exploited using a large variety of different gears and methods. The fishery is comprised predominantly of pelagic species, mostly tuna (*Thunus* spp.), skipjack (*Katsuanus* sp.), scads and sharks, representing some 80% and 60% of total production of North Sulawesi and East Kalimantan respectively. Five species of sea turtles (Green, *Chelonia mydas*; Hawksbill, *Eretmochelys imbricate*; Olive ridley, *Lepidochelys olivacea*; Loggerhead, *Caretta caretta*; and Leatherback, *Dermochelys coriacea*) and 22 species of marine mammal have been recorded (Jacinto et al. 2000). Dugongs (*Dugong dugon*) are still present in Palawan and Sarangani provinces (Philippines), and to the south of the region in areas of Sulawesi and Flores (GIWA region 57 Indonesian Seas), although these were once common in suitable seagrass habitat throughout the entire region. .

Environmental impacts

Loss of ecosystems or ecotones

There is already severe loss of ecosystems in the region, with permanent destruction having reduced the surface area of marshes, swamps, riparian belts and forest catchments by more than 30% between the 1850s and the 1970s. As noted above, significant loss of riparian vegetation has occurred through effects of logging and other destructive land use practices. This has been most severe in the small islands of the Sulu Sea and Visayas, and also significant at larger scales on Mindanao, Negros, Cebu, East Kalimantan and Sabah. On Negros, the 50% of original forest that remained in the 1930s has been reduced to approximately 4% today. Overall, there has been greater than 80% loss of original land cover in most of the Philippine area of the region, with some 40-60% loss in the Malaysian (Sabah) areas of Borneo (Figure 7) (Burke et al. 2002). By contrast, much of the original forest cover remains

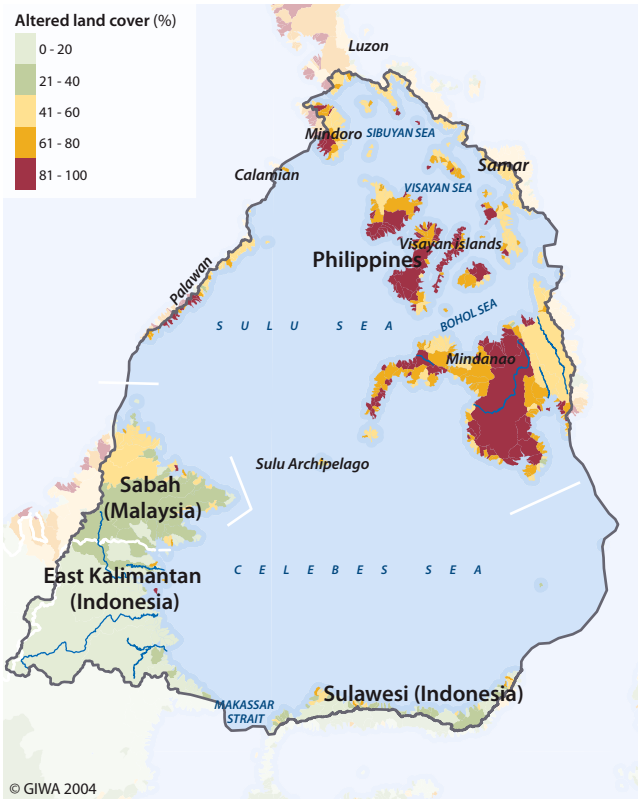


Figure 7 Altered land cover in the Sulu-Celebes (Sulawesi) region.
(Source: Burke et al. 2002)

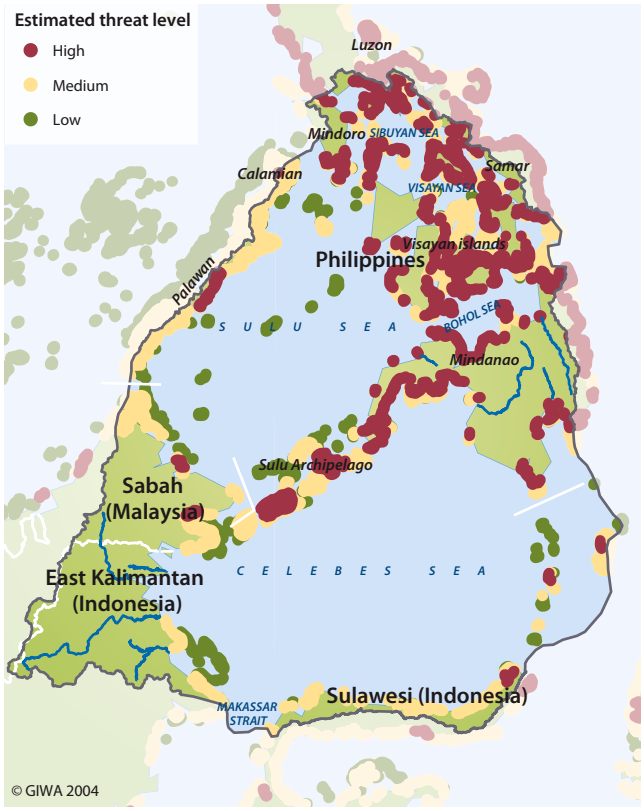


Figure 8 Reefs at risk due to overfishing in the Sulu-Celebes (Sulawesi) region.
(Source: Burke et al. 2002)

in Indonesian East Kalimantan (Borneo) and North Sulawesi. There is also extensive evidence of human-induced fragmentation of coastal and marine habitats from siltation, development and destructive fishing practices. It is estimated that 60-80% or possibly more of the mangrove resources in the Philippines has been lost (Atmadja & Man 1994). Development of most ports has resulted in foreshore reclamation and channel dredging, while muro-ami, (Hopley & Suharsono 2000, Pilcher & Cabanban 2000), blasting (Cabanban 1998) and poison fishing (Pratt 1996) has damaged or destroyed more than 70% of coral reefs throughout the region. Muro-ami involves setting a net over a coral reef into which a group of 10-30 swimmers drive the fishes. The swimmers are equipped with weighted (usually rocks) lines that are bounced up and down on the reef in an effort to drive out the fishes (Werner & Allen 2000). Seagrass beds, muddy and sand-gravel bottoms and fringing coral reefs are also impacted by trawling.

Modification of ecosystems or ecotones

There is also severe modification of habitats, with changes to riverine habitats (fast flowing stony bottomed streams and slow flowing sandy/muddy floodplain rivers) and their natural species compliment from introductions (e.g. Tilapia and African catfish). In Indonesia, at least 60 of the 1 400 freshwater fish species are threatened with extinction. In the Philippines, at least 26 of the 230 freshwater species are similarly threatened, whereas in Malaysia some 14 species of a total of 449 freshwater fish species are threatened (WRI 2003).

Overfishing has caused changes in population structures and/or functional group composition (e.g. coral reef fishes) and major changes in ecosystem services (e.g. reef fisheries, mangrove resources). For example, about 70% of coral reefs have been degraded in terms of destructive and overfishing and the important fisheries 'nursery ground' roles of large sections of mangroves and seagrass beds have been seriously depleted (Figure 8).

The major causes of loss and modification of the freshwater, coastal and marine habitats include:

- Siltation, conversion for aquaculture, agriculture, industrial development affecting marshes, swamps, rice paddies and riparian belts, notably in northern Mindanao, eastern Palawan, Visayas Islands, southern Luzon and Sabah (Figure 9);
- Deforestation, siltation, damming and waste disposal affecting rice paddies and rivers (most of the Philippines area of the region);

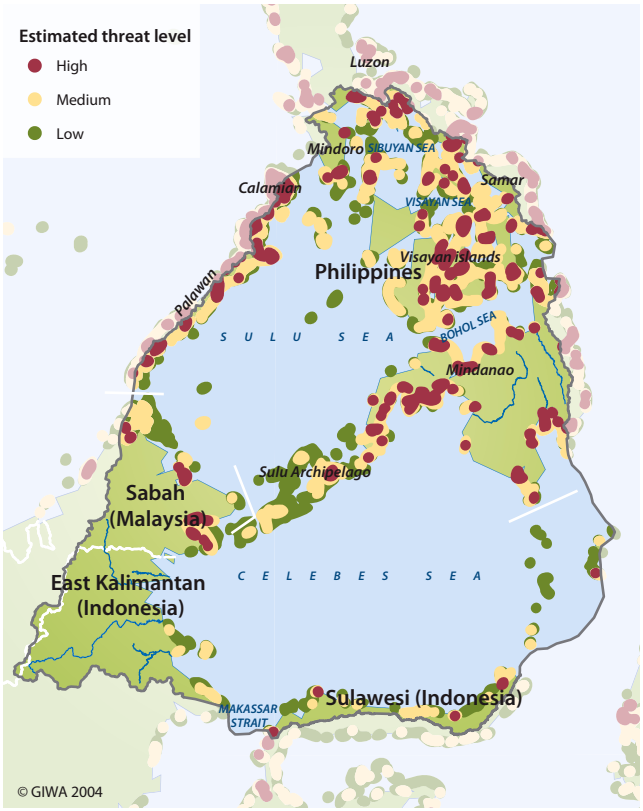


Figure 9 Reefs at risk due to coastal development in the Sulu-Celebes (Sulawesi) region.
(Source. Burke et al. 2002)

- Silica mining and solid wastes affecting sandy foreshores (southern Luzon, Mindanao and Sabah);
- Aquaculture conversion and timber collecting affecting mangroves (many areas);
- Sediment run-off - siltation and dredging affecting seagrass beds and coral reefs (many areas of the Philippines, notably northern Mindanao and parts of eastern Palawan) (Figure 6);
- Destructive fishing affecting coral reefs (much of the region, and notably at the World Heritage Tubbataha);
- Trawling affecting soft-bottom habitats (much of the region, notably Sabah);
- Mid-water trawling, drift netting and other forms of pelagic fisheries, oil and gas exploration and pipelines affecting oceanic habitats (Sulu Sea).

Socio-economic impacts

Socio-economic impacts of habitat and community modification are already moderate (health) to severe (economic and other social and community impacts). The GIWA experts conclude that there are serious economic and health issues in subsistence fishing communities with the highest birth rates, from reductions in animal protein. Additional economic impacts have occurred from loss of mangrove habitats, notably near Zamboanga (Mindanao), and strip mining.

Major economic costs are accruing from loss and modification of coral reef habitats, which are of immense economic value. In Southeast Asia generally, reefs are estimated to be worth some 2 400 million USD per year, based on their value in food security, employment, tourism, pharmaceutical research and shoreline protection (Burke et al. 2002). The reefs of Indonesia and the Philippines provide annual economic benefits of 1.6 billion and 1.1 billion USD per year in 2002, however, over the next 20 years, human impacts, notably overfishing, destructive fishing and sedimentation could cost Indonesia and the Philippines some 2.6 billion USD and 2.5 billion USD respectively (Burke et al. 2002). As noted above in the Pollution section, up to 1 million ha of land in Indonesia, mostly mangrove forests, were allocated by the government for the shrimp hatchery industry. By 2001, about 70% of the shrimp farms had been abandoned because the operators found them unsustainable due to the high concentrations of chemicals and the destruction of the mangrove habitat. Local NGOs claim that the donor agencies (including the World Bank) should be held accountable for environmental destruction caused by shrimp farming and that the government should establish clear criteria for sustainable shrimp farming and ways to rehabilitate damaged mangroves. In other parts of the region, similar habitat modification and destruction has occurred, and this has also led to human conflict.

Progress in managing human use of habitats is not expected to be sufficient to fully mitigate the damaging effects of population growth, causing:

- Reduced capacity to meet basic human needs (e.g. fisheries) for local populations;
- Changes in employment opportunities for local populations and associated changes in social structures (e.g. through loss of future employment opportunities related to degradation of habitats);
- Loss of existing income and foreign exchange from fisheries, tourism (see Box 4);
- Loss of opportunity for investment income and foreign exchange;
- Human conflicts, national and international, particularly related to fisheries exploitation;
- Increased risks to capital investment;
- Costs of controlling invasive species;
- Costs of restoration of modified ecosystems;
- Inter-generational inequity, particularly in relation to loss of ecosystem services from coastal and marine habitats of coral reefs, seagrass beds and mangrove forests.

Box 4 Socio-economic costs of destructive fishing.

Fish bombs, usually constructed from soda bottles stuffed with explosive potassium nitrate, detonate underwater, killing or stunning fish so that they are easy to net. For the fisherman, the short-term gains from bombing may be impressive, with a 1-2 USD investment returning up to 15-40 USD in profit on the local market. Moreover, given the ease with which fish bombs are assembled - potassium nitrate is a common component of fertiliser - fishermen seldom want to make the switch to more sustainable, but time-consuming, technology like spears and hooks. As a result, in coastal areas like Manado, North Sulawesi, bombed reef fish often dominate local markets. But the practice has a devastating effect on coral reefs, which may take more than 50 years to recover.

According to Burke et al. (2002), destructive fishing practices are the single largest threat to Indonesia's and the region's reefs. While the benefits to an individual fisherman may be high in the short-term, the costs as a whole are staggering. The WRI report estimates that the cost from fish bombing alone over the next 20 years will be at least 570 million USD. That sum is more than 10% of the debts recently rescheduled with Indonesia's international lenders.

Cyanide use can be nearly as destructive, but its focus is often the international market. Prized reef fish like grouper and Napoleon wrasse (*Cheilinus undulatus*) are chased into corals, where the diver uses cyanide-filled squirt bottles to stun the fish for capture and sale on the live reef fish market, often shipping their specimens aboard large cargo ships to discerning diners in Hong Kong, Singapore, and Taiwan, where the fish are picked out of aquariums just prior to cooking. The cyanide does more than stun the fish, though. Coral is killed as well, particularly since the divers often have to tear apart the coral structure with crowbars to pull the fish out.

Burke et al. (2002) puts the cost to Indonesia from cyanide use at 46 million USD annually. By comparison, the report estimates the annual economic benefit to Indonesia from it's reefs - which not only harbour valuable fish, but protect shorelines from erosion and facilitate the growth of coastal mangroves and seagrass beds - at 1.6 billion USD.

(Source: NRM Headline News 2002b. Photo: T. Heeger, ReefBase)

Notably, local businessmen involved in the live reef fish trade, upset at the heightened enforcement in some MPAs (e.g. Bunaken National Park), began lobbying to have effective MPA Director's reassigned, but in the case of Bunaken National Park, a concerted media campaign has stemmed those efforts for the time being. While surveillance and enforcement may be stemming destructive fishing in the few MPAs like Bunaken, the situation around Indonesia is far less promising. In areas like West Nusa Tenggara in the GIWA region Indonesian Seas, marine police have been the subject of death threats, and fish bombs have been thrown at police boats that dare to approach illegal fishermen. Moreover, the scale of Indonesia's territory, including over 9 500 km of coastline, makes uniform enforcement and protection all but impossible. For example, the WRI 'Reefs at Risk in Southeast Asia' report (Burke et al. 2002) estimates that up to 50% of Indonesia's 51 000 km^2 of reef have already been degraded, with 85% threatened by human activities, which includes coastal development, overfishing, and marine-based pollution. Exact figures are difficult to gauge, however, because of the paucity of long-term monitoring and data. Efforts to improve existing data are continuing, particularly in areas like Bunaken, but conservationists worry that the damage being done outside national parks is far worse than that which occurs within view of park officials and police.

Conclusions and future outlook

For the GIWA concern of Habitat and community modification as a whole, present level of environmental impact is already severe, and future levels of environmental impact are expected to remain severe, with continuing deterioration over the next 20 years, because population growth and related exploitation of habitats and target species will more than counter ameliorative interventions (see Causal chain and Policy option analyses).

At present, most habitats are only poorly represented in protected areas and, of those, most are poorly managed. For example, approximately 4% of Philippine reefs are listed as being protected, although most of these are being degraded at increasing rates from destructive fishing, sedimentation and pollution, and a lack of enforcement (Cheung et al. 2002, Spalding et al. 2001). Coastal development also poses a serious threat to coastal habitats (mangroves, seagrass beds and fringing coral reefs). The 'Reefs at Risk' analysis for Southeast Asia (Burke et al. 2002) identified areas of North Mindanao, Cebu, the Visayas Islands, Palawan and North Sulawesi as high threat (Figure 9).

International NGOs including WWF, The Nature Conservancy and Conservation International, among others, are presently working towards assessment and management of critical biodiversity sites in the region. A key strategy in slowing the rate of deterioration is the successful implementation of marine protected areas, many of which are already gazetted but lack adequate management. Improvements in management capacity are occurring, at both local scale (e.g. Apo Island and Danjugan Island, Philippines; Bunaken National Park, Indonesia; Turtle Island, Malaysia) and the larger scale of the coastal and marine areas of the region as a whole (e.g. WWF Sulu-Sulawesi Marine Ecoregion programme). The entire coastal and sea area between Malaysian Sabah, Indonesian East Kalimantan and Philippines is recognised as a special management area named Sulu-Sulawesi Marine Ecoregion (SSME) by WWF, ranked as one of their top four global priority sites (number one in Asia-Pacific) (Trono and Miclat pers. comm.) for coastal and marine management. Objectives of the WWF programme are to conserve the outstanding biodiversity of the area through improved implementation of ecologically sustainable forms of development that allow traditional communities to practice customary fishing rights, while also providing for commercial fisheries and seabed management. There are a total of 16 gazetted protected seascapes measuring at least 10 000 ha within the Philippine territory of the WWF SSME. A 17th MPA was proposed as a network of small protected areas in the Visayas. At present, levels of funding for these initiatives are not assured, which adds an additional degree of uncertainty in assessing the likely situation in the region in the future.

In total, some 100 marine protected areas have already been gazetted in the region, including:

- Pulau Sangalaki and Pulau Semama (East Kalimantan);
- Bunaken National Park (North Sulawesi);
- Benkoka Peninsula, Elopura, Gum Gum, Kuala Segama and Kuala Maraup, Pulau Penyu (Turtle Island), Sibyte, Pulau Berhala, Pulau Batik, Lahad Datu, Selangan Island, Tanjong Nagas, Semporna, Trusan Kinabatangan and others in Sabah;
- Caohagen, Malampaya Sound, Cagayan Island, Ursula Island, Calauit Island, Davao Gulf, Panglao Island, Guindolman, Guiuan, Carbin Reef, Lassuan, Tulapos and others in the Philippines.

At the larger spatial scale, the Tubbataha Reefs of the Sulu Sea is the only World Heritage site conserving coral reef habitats in the region, despite the conservation of representative habitats and communities through development of protected areas being a global priority (e.g. International Coral Reef Initiative 'Call to Action' and 'Renewed Call to Action'). As noted above, the Tubbataha Reef National Marine Park comprises some 33 200 ha, inside the Palawan Man and Biosphere Reserve (1 150 000 ha). The Tubbataha Marine Park includes the North and South Atolls and is a unique example of atolls with high diversity and density of tropical marine biota. The site is recognised as the most biologically diverse coral reef system in the Philippines, and of great importance for maintenance and replenishment of harvested species in the greater Sulu Sea. In Indonesia, the reef areas around Bunaken and Manado in North Sulawesi are of exceptional conservation value. Bunaken National Park (BNP), founded in 1991, is one of the most strategically important marine protected areas in the world, located near the centre of the world's highest marine biodiversity region ('coral triangle' of New Guinea, Indonesia, and Philippines, the central Indo-West Pacific) (Box 5). The BNP covers some 90 000 ha of coral reefs, mangrove forests and seagrass beds surrounding five islands and the northern coastal area of Sulawesi, and supports a population of some 30 000 people. Bunaken National Park has become one of Indonesia's most well known marine ecotourism destinations (Erdmann & Merrill 2003).

Figure 10 Local fisherman with bag of sea urchin, Olango Islands, Philippines.
(Photo: J. Oliver, ReefBase)

Box 5 The Bunaken National Park, Indonesia.

The Bunaken National Park is divided into a southern mainland section (the Arakan-Wowontulap coast, set aside primarily for its old-growth mangrove forests and dugong population) and a northern island section (with five islands famous for their drop-off fringing coral reefs). Management authority for the park is vested in the Bunaken National Park Office (BTNB), which is controlled by the national-level Department of Nature Conservation (PHKA). Today, BNP supports almost 30 000 villagers living in 22 villages within the park's borders, as well as an active marine tourism industry with over 20 dive operators that service approximately 20 000 visitors to the park on an annual basis. Besides its high conservation value as an MPA in the epicentre of global marine biodiversity, BNP contributes roughly 3.8 million USD per year in fisheries and seaweed aquaculture production and 4.4 million USD per year in tourism revenues to the North Sulawesi economy. Given the strong potential for conflicts of interest between conservation, fisheries and tourism values of the park, a multiple-use zonation system is the centrepiece of the BTNB's park management plan (see Policy options). This zonation scheme is legally mandated in Indonesia's 1990 Biodiversity Conservation Act, which requires that management of Indonesia's national park system be based upon zonation plans. Since the establishment of the park, USAID's Natural Resources Management Project (NRM) has provided technical assistance for the development of the park management plan (including zonation system) and the eventual zonation revision process.

(Source: Excerpted from Erdmann & Merill 2003. Photo: © 2004, www.ecoreefs.com)

Integrity of the natural ecosystem of the Bunaken National Park, and indeed parks throughout the region generally, is threatened by human activities that are both marine and land-based, such as resource overexploitation, destructive fishing practices and unsustainable tourism. Coupled with, and contributing to, these threats is the lack of awareness among villagers, and the lack of human resources for management within the Park and the region generally. The low capacity among Park personnel in the marine sector is demonstrated by the fact that in the late 1990s the majority of recruits had forestry background with no marine related training. These and other shortcomings continue to hinder adequate management, although recent advances are beginning to address some of these issues (also see Policy options and Annex IX). For example, living coral cover (a simple and widely used index of reef condition) was recovering following impacts from destructive fishing and to a lesser extent coral bleaching in the 1990s (Box 6).

At the smaller spatial scale, the region has many community-based MPAs, particularly in the Philippines. These have had mixed success in relation to management effectiveness, particularly in

Box 6 Increase in coral cover in the Bunaken National Park.

A recent re-survey in 2001 of reefs around Bunaken Island in Bunaken National Park, North Sulawesi, has shown an average increase of 6.56% live hard coral cover in the past 8 months (with an overall average live hard coral cover of 47.5%). Such a rapid increase in hard coral cover is extremely encouraging and provides strong evidence that recent management initiatives assisted by NRM and its partners (the Bunaken National Park Office, the Bunaken Management Advisory Board, the North Sulawesi Watersports Association, WWF Wallacea and others) are having an immediate and very positive effect upon the reefs within the park. Besides the excellent physical conditions for coral growth in Bunaken (deep, clean water, frequent nutrient upwellings and strong currents), specific management initiatives that have likely contributed to the rapid recovery include a ban on anchoring by all tourism boats, a participatory zonation revision that includes very specific rules on activities that are allowed within individual zones, and a 24 hour community joint patrol system that enforces the zonation system and has virtually eliminated destructive fishing practices like cyanide fishing around Bunaken Island.

Increases in live hard coral cover were different among the various zones; the tourism use zones showed an average increase of 5.9% to reach 49.4% average live cover, while the community use zones showed the highest average increase of 7.7% to reach 45.2% average live hard coral cover. The core conservation zone (where no tourism or fishing activities are allowed) showed an average increase of 6.3% to reach 46.3% average live hard coral cover. Anecdotal evidence from repeat divers suggests that fish populations are also staging a comeback.

(Source: NRM Headline News 2001)

regards to controlling fishing pressure including destructive fishing. Examples include Apo Island (Russ & Alcala 1996a,b) and Danjugan Island (Sherwood 2002). The history of development of Danjugan Island Marine Reserve, the Philippines 'Best Managed Reef' in 2002 (Philippine Council of Marine and Aquatic Research Award) is noteworthy. In the early 1990s, the local community, Barangay Bulata, was suffering from deteriorating marine resources, with declining fish catches related to destructive and overfishing. With the help of local and international NGOs (Coral Cay Conservation Ltd. and World Land Trust) the local community improved their own self-government, developed conservation programmes (mangrove planting and shore clean-ups), alternative livelihoods (mud crab (*Scylla serrata*) and pig farming), and encouraged conservation through education and awareness raising. This has been a largely successful process and has encouraged other local communities to establish their own reserves (Sherwood 2002).

Thus, a variety of approaches to ameliorate habitat loss are being developed in the region, including initial attempts at improving the legislative framework, and implementation of large internationally funded protected areas and small community-based protected areas. These initiatives have a long way to go, and it is predicted that the environmental and socio-economic impacts of habitat loss will continue to deteriorate to 2020. Yet a considerable amount of expertise now resides in the region and with improved support there are also strong opportunities for future success (also see Policy options).

IMPACT Unsustainable exploitation of fish and other living resources

According to LME (2003) the Sulu-Celebes Seas Large Marine Ecosystem is considered an ecosystem with low productivity (<150 gC/m^2/year), based on SeaWiFS global primary productivity estimates. A major marine export industry is supplied by the coastal trawling for prawns, while different artisanal fishing techniques are used locally to catch fish which is the primary food resource in the region. The offshore waters are mainly unexploited while a majority of the fishing occurs in coastal areas (LME 2003). In Indonesia as well as in the Philippines most of the landings are from small-scale artisanal fisheries. Many fishing techniques are highly destructive; for example dynamite and cyanide is used when fishing on the reefs of the Philippines. Few countries in the region have implemented fisheries management plans and the exploitation of the resources of the reef is steadily increasing from the escalating number of illegal fishermen. There is indications that the total catches from the Sulu-Celebes LME have increased rapidly from about 30 000 tonnes in the 1950s to approximately 500 000 tonnes by 1975. The total cath of today is fluctuating around 800 000 tonnes annually (Figure 11). The catch of molluscs, crustaceans, sharks/rays and other finfishes, however, have shown relatively modest increase, remaining relatively stable or declining since the 1950s (LME 2003).

More than 2 500 species of fish occur in the region, many of which are exploited using a large variety of different gears and methods. For the Indonesian areas, government statistics indicate that North Sulawesi and East Kalimantan provide some 11% of the total national marine fishery landings (Kahn & Fouzi 2001). The fishery is comprised predominantly of pelagic species, mostly tuna (*Thunnus* spp.), skipjack

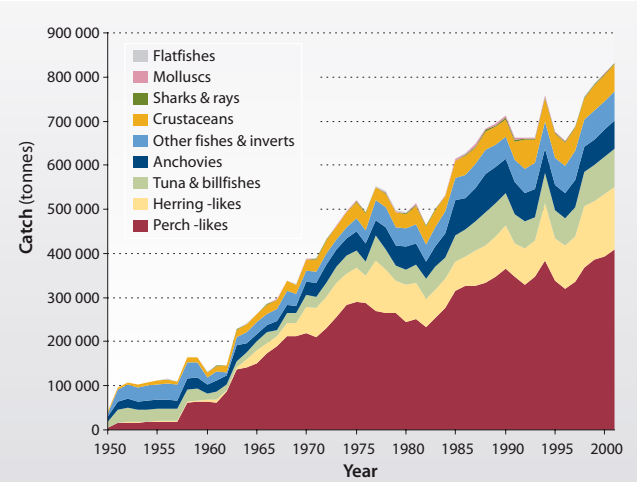


Figure 11 Catches of various fish resources in the Sulu-Celebes (Sulawesi) region.

(Source: University of British Columbia Fisheries Centre 2003)

(*Katsuanus* sp.), scads and sharks, representing some 80% and 60% of total production of North Sulawesi and East Kalimantan respectively.

Environmental impacts

Overexploitation

Overexploitation is having severe environmental impact with many demersal reef fish, holothurian, mollusc and crustacean stocks heavily overfished. About 70% of Philippine coral reefs are heavily overfished, producing less than 5 tonnes/km^2/year, with clear indications of 'trophic overfishing', in comparison with the remaining 30% of reefs which produce in the order of 15-20 tonnes/km^2/year (Licuanan & Gomez 2000). There is also overexploitation of sharks, tuna, bill-fish and other pelagic species. Sharks are also caught as by-catch of the trawl fisheries and the tuna long-line fishery. Benthic invertebrate fisheries, particularly sedentary species of holothurian sea-cucumbers (mostly *Holothuria* spp. (also known as 'trepang' or 'beche-de-mer'), trochus (Trochidae), green snails (*Turbo marmoratus*) and clams (*Tridacna* spp.), are overfished, mostly around the major coastal population centres. Crayfish (*Panulirus* spp.) are also overexploited in oceanic waters, sandy reef lagoons and flats and mangrove areas.

Large-scale commercial operations have targeted beche-de-mer and shark, and poison fishing for demersal reef fish to supply the live fish food trade in Hong Kong and China have burgeoned in the 1990s, with prices increasing but catch per unit effort (CPUE) declining sharply (Cesar et al. 2000). There has also been a significant increase in effort in the pelagic fisheries, with more than 500 boats working from Indonesian waters.

Surveys of the Calamianes Islands (northernmost section of Palawan province) found only one octopus from 38 sites surveyed over 16 days (Werner & Allen 2000). There were also very low numbers of spider shells (*Lambis* spp.), conchs (Strombidae) and abalone shells (*Haliotus* spp.), which indicates extraordinarily high fishing pressure. There were only a few commercially exploited seashells found and severe depletion of market-sized fishes, including a notable lack of large piscivorous species such as groupers, barracudas, jacks and sharks. Crayfish appear to have been fished to the brink of local extinction.

Figure 12 Skipjack tuna (*Katsuwonus pelamis*).
(Photo: B. Tenge, Regulatory Fish Encyclopedia)

Figure 13 Yellowfin tuna (*Thunnus albacares*).
(Photo: B. Tenge, Regulatory Fish Encyclopedia)

At present, neither the status nor the future viability of the fisheries are well understood, and for many fisheries, their status may be summarised as being illegal, unreported and unregulated (IUU). There have been increases in biomass of Skipjack tuna (Figure 12) of the order of 400 000 tonnes according to the Philippines Department of Agriculture Bureau, but this is in part related to reduction in biomass of Bluefin and Yellowfin tuna (Figure 13) stocks that previously occupied the niche in western and central Pacific, and possibly to ENSO effects also. Clearly, there are serious discrepancies in the different data available, with a total catch of some 500 000 tonnes for all marine products (as cited in the paragraph above) on the one hand, yet some 400 000 tonnes for Skipjack tuna alone. Notably, the Philippines Department of Agriculture Bureau statistics suggests that yields of some species have continued to increase, but that catch per unit effort has declined steadily, suggestive of 'Ecosystem Overfishing'. A similar situation exists for some Indonesian Government statistics, particularly in relation to Maximum Sustainable Yields (MSY), in part related to different assessment criteria and areas.

As noted by Kahn and Fauzi (2001): "Overall, the state of (environmental and socio-economic) assessment of Sulu-Sulawesi Sea…fisheries resources is not very accurate and there is a great amount of uncertainty. Based on the limited data available it can be concluded that some of the fisheries have already reached or surpassed their limits. For others, the total lack of information indicates that further expansion would be inappropriate…. It is estimated that 90% of the fishery effort in Indonesia is carried out by artisanal and subsistence fishermen whose catches go unrecorded by official government statistics and it is partly for this reason that government estimates of annual catches…are considered to be gross under-estimates".

Excessive by-catch or discard

There is little or no by-catch or discards in the region, as virtually all of the much-diminished catch, including turtles, sharks and even whales, is kept and eaten by local fishermen. Two exceptions to this are the by-catch produced by distant-waters fleets and through use of blast fishing and poisons. Discards from the foreign fleets include shark carcasses without fins; sharks are a major feature of by-catch in fisheries targeting tuna, swordfish, shrimp and squid; and carcasses are discarded after the removal of their fins (FAO 1998). There is also significant by-catch of rare and endangered species of turtles and marine mammals, such that the environmental impact of the issue is severe. Massive destruction of marine mammals, sea turtles and fish has been reported from trap nets placed in a pelagic migratory channel at Tangkoko Nature Reserve in the Manado area, North Sulawesi, Indonesia. Between March 1996 and February 1997, it is estimated that catches included some 1 424 Manta rays, 18 Whale sharks, 312 other sharks, 4 Minke whales, 326 dolphins, 577 Pilot whales, 789 Marlins, 84 turtles and 9 dugongs (Rossiter 2002). The illegal fishing is believed to be operated by a joint Taiwanese/ Indonesian venture, and has caused outrage among local people.

Destructive fishing practices

Destructive fishing is also having a severe impact in the region (Pilcher & Cabanban 2000). There is widespread habitat destruction of coral reefs from blast and poison fishing and damage to soft-bottom communities from trawling is extensive in the region; with widespread use of explosives (reef bombing), notably in the Tubbataha reefs south of Palawan, and use of cyanide for fishing (Figure 14). Increases in reef bombing have been attributed to increasing competition among fishers and corresponding declines in catches. Many reefs in the region have also been targeted for the lucrative live fish food trade in Hong Kong and mainland China (with prime live reef fish worth 100 USD/kg). Fish were collected initially using potassium cyanide or sodium cyanide and more recently also using poisons derived locally from plants (e.g. Johannes & Riepen 1995). Poison fishing has also been used in collection of ornamental reef fishes for the international aquarium trade (Johannes & Riepen 1995).

Decreased viability of stocks

Decreased viability of stocks through contamination and disease has caused only slight environmental impact. However, there are some developing problems arising from the increased occurrence of 'red tides', diseases in pilchards and diseases spreading from aquaculture farms in the Philippines. Tilapia culturing is being conducted in approximately 10% of the lakes in the Philippines, although there has been a marked decline in aquaculture production in some lakes.

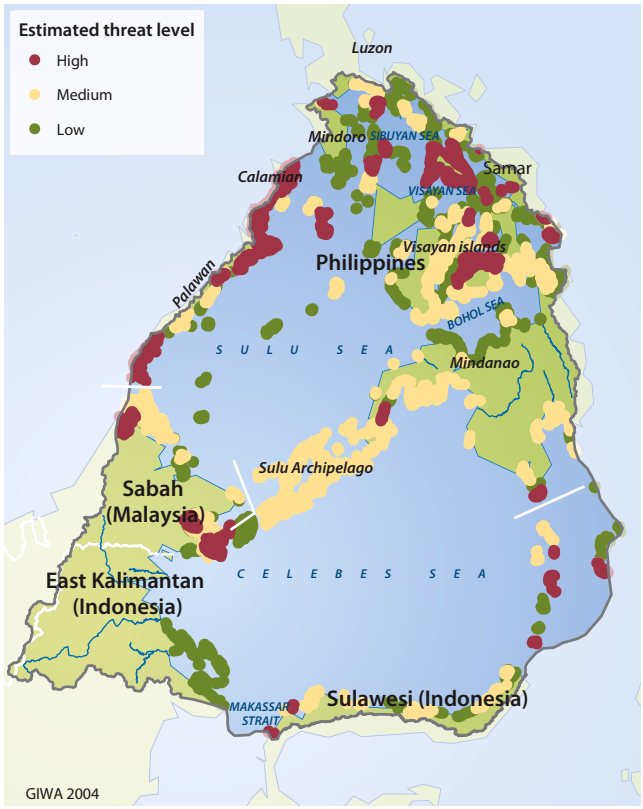


Figure 14 Reefs at risk due to destructive fishing practices in the Sulu-Celebes (Sulawesi) region.
(Source: Burke et al. 2002)

Impact on biological and genetic diversity

The present environmental impact on biological and genetic diversity is also severe because there have been extinctions of native species and local stocks as a result of introductions of Tilapia and African catfish and a clear decrease in heterozygosity in cultured fish stocks. The introduced fishes are eating and displacing endemic fishes in Lake Buhi and other areas, with corresponding changes in community structure and diversity.

Socio-economic impacts

Socio-economic impacts related to unsustainable exploitation of fish are already severe, particularly in the smaller islands and internal waters. In the Philippines, the fishing sector has the highest birth rate and population increase (more than 4%) and highest levels of poverty. In many areas, children within fisher families are malnourished as most fish are exported and fish consumption has declined from approximately 36 to 24 kg per/person/year, with concomitant decline in local rice production in recent times. There are few alternative options, particularly on the small islands, and the levels of poverty are such that many children are 'trapped' into becoming fishermen. There is currently

Figure 15 Sharks in a market, Sandakan, Malaysia.
(Photo: S. Palaniappan, ReefBase)

decreased catch per unit effort with most fishers having to spend longer hours to obtain the same catch (Cesar et al. 2000).

Commercial fishing boomed between 1970 and 1980 in the Philippines, with about 400 fishing units in Calamianes, which declined rapidly to only 10 units (Ingles 2000) due primarily to decreasing low returns from fishing. In the artisanal sector, the demand for seafood has led to an increase in small-scale commercial fisheries. In the Calamianes Islands, the growth in the number of fishers is much higher than that of the agricultural or other sectors (Ingles 2000). In Manila Bay (in GIWA region 57 Indonesian Seas), there are 246 fishers per km of coastline (Armada 1994). The socio-economic costs of destructive blast and poison fishing in Indonesia have been documented by WRI (2003) which estimates the cost to Indonesia from cyanide use at 46 million USD annually. By comparison it is estimated that the annual economic benefit to Indonesia from its reefs are 1.6 billion USD.

There are important gaps in socio-economic data, particularly in relation to commercial connections among population centres and peripheries in terms of resource extraction, traditional village engagement with the marine environment and the extent to which police and military are involved in resource extraction, both legally and illegally (Kahn & Fauzi 2001). Severe socio-economic impacts are also posed by foreign fleets that continue to threaten the region, both within and outside MPAs. For example, local fishermen in Bunaken National Park increasingly report conflicts with foreign tuna fishermen, and are now actively vandalising foreign fishing gears when they encounter them (such as long line radio buoys, fish aggregating devices etc.). The Bunaken fishermen face a double socio-economic impact, with Filipino boats actively poaching the waters just northwest of the park, while Taiwanese, Korean and Hong Kong boats (with official licenses) work the seas to the north and east of the park. The latter have greatly increased in number since the spread of violence in Ambon, when a number of foreign fleets

relocated from Maluku to Bitung as their home port. Unfortunately, as these bigger and more technologically advanced foreign fleets decimate North Sulawesi's stocks, the Bunaken fishermen must travel further and further to catch fish (often 3-5 hours travel outwards by wooden speedboat from the island), and now increasingly resort to spear fishing and gillnetting on Bunaken's heavily touristed reefs in order to catch fish to feed their families. Tourism and fishing, once compatible, are now increasingly at odds due largely to the activities of foreign fishing fleets.

Thus the key socio-economic impacts of unsustainable exploitation of living resources in the region include:

- Reduced subsistence food supply through reduced CPUE to small-scale local village fishermen throughout the Philippines and Indonesia;
- Reduced economic returns to small-scale local village fishermen throughout the Philippines and Indonesia;
- Loss of employment/livelihood among local village fishermen throughout the Philippines and Indonesia;
- Conflict between user groups for shared resources (e.g. among local village subsistence fishermen in Philippines and outsiders, notably foreign vessels and those involved in the live reef fish export trade);
- Loss of food sources (e.g. sources of protein) for human and animal consumption, throughout many parts of the Philippines;
- Reduced earnings in one area by destruction of juveniles and brood stock in other areas (migrating populations and/or life history stages);
- Loss of protected species (e.g. widespread local extinction of dugong from much of their traditional feeding grounds in Philippines);
- Increased risks of disease in commercially valuable stocks, including introduced diseases through increases in aquaculture;
- Inter-generational equity issues (access to resources) among poor local fisher families;
- Potential for human health impacts.

Conclusions and future outlook

For the GIWA concern of Unsustainable exploitation of fish as a whole, the present level of environmental impact is severe. Because of the increasing coastal population, greater commercialisation, decline in resources, lack of effective regulation and poor or non-existent enforcement, there is expected to be significant deterioration in all five issues by 2020, and environmental impact is expected to remain severe. Most coastal coral reef areas of the Philippines, particularly those fringing the northern Sulu Sea and those separating the Sulu and Celebes Seas, are at high level of threat from overfishing (Figure 8). Evidence over the past several decades from the region and elsewhere has changed the once widespread belief that reef and other fisheries were virtually inexhaustible. As Jackson et al. (2001) point out: "Overfishing is not a recent phenomenon. Ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems, including pollution, degradation of water quality, and anthropogenic climate change. Historical abundances of large consumer species were fantastically large in comparison with recent observations. Paleoecological, archaeological, and historical data show that time lags of decades to centuries occurred between the onset of overfishing and consequent changes in ecological communities, because unfished species of similar trophic level assumed the ecological roles of overfished species until they too were overfished or died of epidemic diseases related to overcrowding".

Many of the fringing coral reefs have been chronically overfished over the past several centuries, with major loss of production and serious adverse 'cascading' effects to other components of the ecosystems (Ormond et al. 1990, Hughes 1994, Jackson 1997, Carlton 1998, Jackson et al. 2001). In addition to the reduction in population sizes (e.g. major declines in Bluefin and Yellowfin tuna populations) and local extinctions, overfishing has led to:

- Decreased Catch per Unit Effort (CPUE);
- Smaller size fishes and reduced catch sold at markets;
- High by-catch of rare and endangered species;
- Decrease in commercially exploited seashells (e.g. spider shells);
- Degraded habitats through use of destructive fishing methods.

As noted above, about 70% of Philippine reefs are heavily overfished, producing less than 5 tonnes/km^2/year, with clear indications of trophic overfishing, in comparison with the remaining 30% of reefs which produce of the order of 15-20 tonnes/km^2/year (Licuanan & Gomez 2000). Some 64% of coral reefs are at medium or higher risk from overfishing, with 20% at high risk. Similarly, high levels of threat exist for destructive fishing, particularly around Palawan, other Philippine islands and northeast Sabah (Burke et al. 2002).

Data from reefs of the Philippines indicate that carnivorous families of reef fish will not fully recover their pre-fished levels of biomass for 20-40 years after effective protection has been implemented, when 20-25 kg of catch may be taken from 1 000 m^2 of reef area annually (equivalent to 20-25 tonnes per km^2) (Alcala pers. comm.). It is estimated that a 50% reduction in fishing effort will be needed to restore many fisheries to sustainable levels, particularly in the municipal coastal fisheries which, at present, are 90% artisanal and 10% commercial

(e.g. Kahn & Fauzi 2001). It is also predicted that there will be a 10-30% deficit in wild-caught fish production by 2010, to be supplemented by aquaculture.

All socio-economic indicators are also expected to deteriorate by 2020, with severe environmental, economic, social and community impacts associated with overexploitation of fish. This prediction may be ameliorated to some degree by improved enforcement of regulations (e.g. Philippines Fisheries Code) and through successful interventions by government and NGOs (see Policy options and Annexes III, IV). There is also strong potential for well-planned mariculture of some ornamental and food species, with the need for development of appropriate policy and legislation.

The management of fish stocks in the Indonesian parts of the region is overseen by the Directorate General of Fisheries under the Ministry of Fisheries and Marine Affairs (Kahn & Fauzi 2001) (see Annexes III-V), and is in accordance with national policies and objectives:

- To raise income and standard of living of small-scale fishermen and fish farmers;
- To increase productivity of fishing effort and to boost national fish production;
- To increase fish consumption;
- To increase export of fisheries products;
- To have better control of the utilisation and management of fishery resources.

In North Sulawesi, cooperation and coordination for managing marine resources were established through a dialogue forum, primarily to avoid conflict among user groups (Kahn & Fauzi 2001). In order to address overfishing and biologically critical areas, management is directed towards limiting entry and to development of non-marine activities (e.g. mariculture and brackish water ponds). Some regulations have been implemented including:

- Selective fishing gears;
- Establishment of fishing zones;
- Extension services for the utilisation of mangrove forest;
- Enforcement of regulations controlling illegal fishing;
- Establishment of no-take zones in MPAs (e.g. Bunaken National Park).

Despite these management measures, the region's fisheries stocks remain in urgent need of careful stewardship if their sustainable future utilisation is to be assured. This will primarily require a high degree of local intervention and community-based support, effective enforcement of fisheries regulations, and also reliable stock assessment and monitoring. These need to be founded in an improved understanding of the population biology of the target species and issues of ecological scale and connectivity in relation to replenishment. In particular, there is a lack of reliable data on:

- Catch volumes and CPUE;
- Traditional knowledge (e.g. locations of spawning aggregation sites of major commercial species), for development of protection measures;
- Natural changes in diversity, distribution and abundance of major commercial species, in relation to seasonality effects, predator-prey relationships and recruitment fluctuations (Kahn & Fauzi 2001).

Global change

At present, annual rainfall is greater than 1 000 mm in most parts of the region and annual minimum temperatures are less than 20°C other than in the highlands. Rainfall is highest on the upland areas, notably of central and northern Borneo, central Palawan, and central and eastern Mindanao, with more than 3 000 mm of rain annually. Some parts of the lowlands, coastal areas and other areas in rain shadows (less than 1 000 mm per year) may experience severe water shortages. The northern and central parts of the region are affected by revolving tropical storms (typhoons), bringing intense rains and destructive winds and swells to coastal areas. Passing from the Pacific into the South China Sea through the Philippines Archipelago, typhoons can deliver in excess of 1 000 mm of rain in less than one week, causing extensive flooding and loss of life in worst affected areas.

The region receives an influx of surface oceanic water from the North Equatorial Current, flowing into the area from the northeast through corridors in the Visayas and northern Mindanao, with sub-surface flow in the opposite direction. Additionally, waters from the South China Sea may flow seasonally into the Sulu Sea around the northern coast of Sabah, transporting sediment-laden waters from northwestern Sabah (Bate 1999). Surface waters of Sulu-Celebes (Sulawesi) Sea flow south out of the region through the Makassar Strait and also between Sulawesi and Morotai-Halmahera, contributing to the Indonesian through-flow.

The GIWA Task team identified the need to include an additional issue with major implications for coral reefs in the region: Changes in sea surface temerature. Criteria used for scoring this issue are appended in Annex VI.At the time of the assessment in 2001, there were no known environmental impacts associated with increased UV-B radiation and changes in ocean CO_2 source/sink function in the region.

Environmental impacts

Changes in hydrological cycle and ocean circulation

Changes in hydrological cycle and ocean circulation has had slight environmental impact, as expressed through changes in the local/regional water balance in recent decades, and increased variability of current regimes (including those caused by changes in ENSO events). There is oceanographic evidence for changes in internal waves in the Sulu Sea.

Sea level change

Sea level change has also had slight environmental impact, with limited evidence of recent and unprecedented flooding of Turtle Island and Tubbataha World Heritage Park.

Changes in sea surface temperature

Considering the abundance and importance of coral reefs to the region, an additional issue: Changes in sea surface temperature (also see Annex VII), was added to the assessment because of the major implications this factor has for these ecosystems.

Changes in sea surface temperature has had slight impact already, with changes in the structure of coral reef communities from elevated Sea Surface Temperatures (SSTs) during various coral reef bleaching events

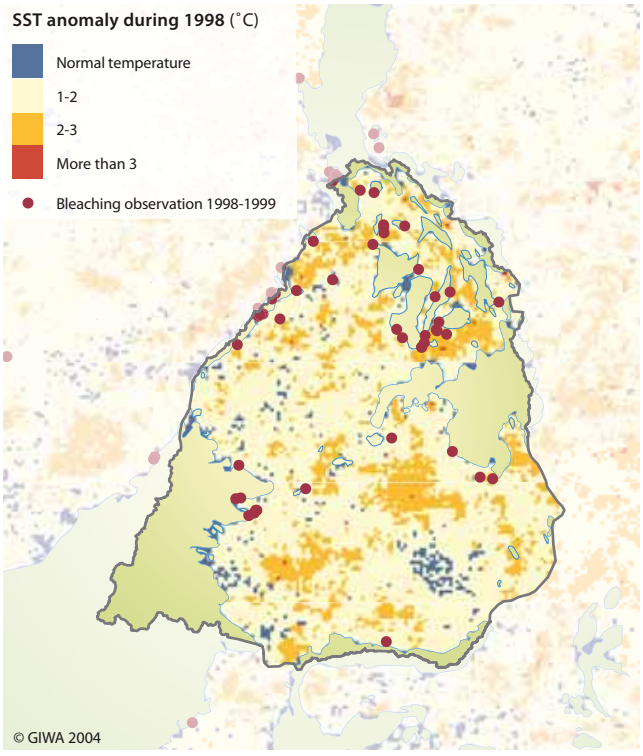


Figure 16 Sea surface temperature anomalities during 1998 in the Sulu-Celebes (Sulawesi) region.
(Source: NOAA/NESDIS 2003)

since 1983, notably during mid-1998 around Santa Cruz Island, Mindanao and Balayan Bay in the Philippines. Sea surface temperatures between May and August 1998 were up to 2°C above average (29-30°C) in areas of the Sulu-Celebes Sea and adjacent South China Sea (Figure 16), causing extensive bleaching in worst affected reefs. In Tubbataha National Park, mean live coral cover decreased by approx. 19% after bleaching in 1998, and has remained stable through 1999 to 2001 (Chou et al. 2002). There was good recovery of most other bleached areas and, on average, the bleaching events appear to have been less severe than those from some other countries (Wilkinson 2002), with the caveat that some of the data are anecdotal.

Socio-economic impacts

The socio-economic impacts associated with Global change are slight at present, although there have already been some economic and health effects. These have been caused by freshwater shortage and flooding, the former clearly linked with the ENSO. For example, major floods in Malaysia occurred in 1967, 1971, 1973 and 1983. Some 29 000 km^2 are considered as flood-prone areas, affecting about 2.7 million people. The average annual economic damage caused by floods was estimated at 40 million USD in 1980 (FAO AQUASTAT 2003). Other socio-economic problems include overextraction of freshwaters and salinisation of wells; and with linkages to habitat loss (clearing and forest fires). These key socio-economic indicators are adversely affected to greater or lesser degree, particularly into the future:

- Freshwater availability which is a food security issue, with some 20 million Filipinos having little or no access to secure potable water supply);
- Increased costs of human health care, particularly related to lack of water;
- Changes in productivity of agriculture, fisheries and forestry, particularly in relation to loss of terrestrial habitats through continued clearing and drought-induced forest fires, and coastal and marine habitats through land reclamation and destructive fishing;
- Changes in resources distribution and political jurisdiction;
- Response costs for extreme events, with potential increase in frequency and intensity of typhoons and droughts in different parts of the region (Figure 17);
- Loss of income and employment related to all of the above;
- Loss of income and foreign exchange from fisheries, as destructive and overfishing deplete resources (e.g. some 70% of Philippines coral reefs are already overfished) (see Unsustainable explitation of fish and other living resources);
- Loss of opportunity for investments (both domestic and foreign).

Figure 17 Typhoon Kujiraoff the coast of the Philippines, April 19, 2003.
(Photo: NASA)

Conclusions and future outlook

The GIWA concern of Global change has had only slight overall environmental impact at present. There is increasing per capita release of carbon dioxide and the increasing populations in both the Philippines and Indonesia will exacerbate local production of greenhouse gases over the next 20 years. However, there is considerable uncertainty in climate model predictions of changes in temperature and sea level. Additional uncertainty is caused by the region's complex geological dynamics, and also by the capacity for an unknown degree of acclimation and adaptation of species and ecosystems (e.g. see Done 1999 for coral reefs, and also Pilcher & Cabanban 2000). The climate change effects are and will be obscured by the continued effects of habitat destruction and overfishing. Given these uncertainties, environmental impacts of global change are expected to remain slight until 2020. There are, however, likely to be global change effects on freshwater shortage and oceanography (through predicted changes in frequency and intensity of ENSO), and on coral reef ecosystems through predicted changes in ocean chemistry (CO_2 source-sink function) and SST. Corresponding socio-economic aspects are expected to deteriorate over the next 20 years, with moderate levels of economic impact and slight health and other social and community impacts by 2020. The socio-economic impacts are likely to be similar those listed above.

Priority concerns

Future scenarios for the region suggest a human population increase of between 2-3% per year to approximately 50 million by 2020, with increasing urbanisation and increasing reliance on extractive industries. International trade is expected to triple by 2020 (Chua pers. comm.), with major expansion of international shipping through the ULCC route. There are likely to be significant increases in both artisanal and industrial fishing, mining and various forms of plantation agriculture and forestry, and limits on other sectors from freshwater shortage and other concerns.

There are trends of increasingly large-scale forestry, by both national and international commercial operators, increasing industrial fisheries and commercial agriculture. Large areas of the 'loggable (harvestable) forests' have already been logged and other areas have been assigned for logging, contributing to severe soil erosion. Large-scale sediment mobilisation from unregulated forestry and agriculture has already impacted on water quality of streams and rivers and ultimately on estuarine and coastal habitats (e.g. fringing reefs) and processes in much of the region. In the Philippines, of the order of 1 billion m^3 of sediment is lost to coastal waters annually, carrying high loads of particle-bound nutrients (e.g. see Burke et al. 2002). This is of particular

concern given that the timber industry has traditionally suffered from mismanagement and corruption, although there have been some recent improvements. Nonetheless, implementation of 'best-practice' forestry management, such as the retention of buffer zones along watercourses, is rarely enforced and violations are common. One exception is Palawan (Philippines), where logging was halted through effective implementation of legislation in the early 1990s (Annex V), providing a major reduction in sediment loss from the catchments and much needed protection for the fringing coral reefs and other coastal and marine habitats (Hodgson & Dixon 1992).

There is already significant offshore oil and mineral exploration, with potential for substantial expansion in coming decades. Exploitation of commercial pelagic fisheries for tuna and billfish is expected to increase by 2020. The industrial fishing fleets are expected to expand across the various ownership types, including private companies, joint corporations and state-owned enterprises, with currently more than 1 000 large foreign vessels operating in the Indonesian EEZ (Kahn & Fauzi 2001). There are also plans to expand aquaculture and mariculture operations substantially. In Indonesia, up to 1 million ha of land, mostly mangrove forests, were allocated by the government for the shrimp hatchery industry in the 1980s to 1990s. The World Bank was one of the major donors to the programme. By 2001, more than 70% of the shrimp farms had been abandoned, because the operators found them unsustainable due to the high concentrations of chemicals and the destruction of the mangrove habitat. Future protection of the remaining coastal habitats and adjacent coral reef areas will be important if these key habitats at the global centre of biodiversity are to be sustained.

Total pressures on international water resources are likely to increase moderately, causing significant deterioration in both the environment and socio-economic structures, despite improved regulation. The worst affected coastal areas in the Philippines face moderate to severe environmental impacts causing severe socio-economic hardship by 2020. There is a lack of capacity for effective policing or enforcement of regulations or for developing measures for alleviation of existing water-related problems, primarily because of low finance and a relatively small taxation base. For example, the Sulu-Celebes (Sulawesi) Sea is a tempting target for illegal fishing activities, including commercial fishers from throughout Southeast Asia and foreign fleets, many of which do not carry legal permits. Unfortunately, accurate data on the extent, number of vessels and their mode of operations are rare, although it is thought that such illegal activities have significant environmental and socio-economic impacts (Kahn & Fauzi 2001).

There are already serious health issues arising from episodic freshwater shortage in the Philippines. The rate of deterioration can be minimised by on-going and future planned interventions, including those at multi-lateral, national, provincial and local government levels and through the concerted efforts of several international NGOs. Nonetheless, continuing international assistance will be required in the short-term for major improvement in water-related issues and concerns.

There was an unambiguous overall prioritiation of the five GIWA concerns, when assigning equal weight to environmental, economic, human health and social and community impacts. The GIWA concerns are prioritised as follows:

1. Unsustainable exploitation of fish and other living resources
2. Habitat and community modification
3. Pollution
4. Freshwater shortage
5. Global change

Unsustainable exploitation of fish and other living resources has the highest priority, with severe present levels of environmental, economic, health and other social and community concerns. Habitat loss and community modification is an equal priority from an environmental, economic and other social and community impacts perspective, but of slightly less priority in terms of health impacts. Pollution is the third priority, with moderate levels of environmental and socio-economic impact. Freshwater shortage is the fourth priority, with moderate levels of environmental and economic impact, but only slight health and other social and community impacts at present. Global change is the fifth priority, with only slight present environmental and socio-economic impacts.

It is clear that the international waters environment and socio-economy of much of the region is already under severe impact, requiring continued concerted international intervention for any chance of amelioration in the short to medium-term. There is expected to be moderate to severe deterioration in most concerns, with consequent difficulties in prioritising those of most importance. With equal weighting applied to the four indicators, Unsustainable exploitation of fish and other living resources, Habitat loss and community modification and Pollution all scored the maximum value, and are all expected to have severe environmental and socio-economic impacts by 2020. Freshwater shortage is expected to have moderate environmental and socio-economic impact and Global change slight to moderate impact.

Habitat loss and community modification received highest priority ranking for the future, followed closely by Unsustainable exploitation of fish and other living resources and then Pollution. Freshwater shortage, the fourth priority, is expected to be under moderate environmental threat by 2020, with the possibility of an improving economic situation but deteriorating health and other social and community concerns. This concern is already being addressed at international and national levels (e.g. PhilWater Conference 2001), which may contribute to its amelioration by 2020.

Future impacts from Global change were sufficiently uncertain for it to be ranked as the least of the GIWA concerns for 2020, although potentially strong linkages with Freshwater shortage and Habitat loss and community modification were identified, complicating the prioritisation analysis. Global change effects on Freshwater shortage are likely to be manifested through changes in the frequency and intensity of ENSO events, typhoons and droughts. ENSO caused water shortages in some parts of the region and flooding in others during the 1990s, and future predicted increases in ENSO are likely to have major environmental and socio-economic impact, particularly given that the human population is expected to double by 2035. Global change effects on habitats are predicted to be manifested through both freshwater shortages and flooding, particularly in lowland stream, river, marshland and riparian communities. Potentially severe global change effects are also expected for coral reef habitats, through the synergistic effects of changes in ocean alkalinity affecting reef calcification processes (Kleypas et al. 1999), and through elevated SSTs causing widespread reef bleaching and death (Hoegh-Guldberg 1999). There are also expected to be severe consequences from complex linkages between habitat loss and fisheries, and pollution and fisheries. The fishing industry also interacts directly with other resource industries, including forestry, farming, mining and tourism, and these industries may also threaten the productivity of fishing grounds (Kahn & Fauzi 2001).

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details on the methodology, please refer to the GIWA methodology chapter.

Strong linkages were identified in the Assessment between Pollution (suspended solids) and Habitat and community modification, as well as between Habitat and community modification and Unsustainable exploitation of fish and other living resources (particularly overexploitaiton and destructive fishing practices), via benthic trawling and blast and poison fishing (with strong transboundary links through the live reef fish export trade to East Asia). The Causal chain analysis for Habitat loss and community modification thus focuses on these strong linkages.

System description

The key aspects of the system are described in detail in the Regional definition and Assessment above. The Sulu-Celebes (Sulawesi) region is located in the Indo-West Pacific centre of diversity and supports mega-diversity, located near the junction of three major biogeographic zones (Roberts et al. 2002, Cheung et al. 2002). The warm clear waters of the Sulu-Celebes Sea, its active underwater volcanoes, its seamounts, trenches, corals and inter-island passages, its currents and upwellings, constitute an exceptionally rich marine life hot spot. The region supports a significant proportion of the total coral reef area of the Philippines, with some 20 000 km^2 of coral reefs, and forms part of the 'coral triangle' of highest coral diversity with Indonesia and New Guinea containing more than 500 reef-building species. The Sulu-Celebes Large Marine Ecosystem support around 400 species of algae, 5 species of sea turtles, 22 species of marine mammals and over 450 types of coral (LME 2003). More than 2 500 species of fish occur in the region, many of which are exploited using a large variety of different gears and methods. The fishery is comprised predominantly of pelagic species, mostly tuna (*Thunus* spp.), skipjack (*Katsuanus* sp.), scads and sharks, representing some 80% and 60% of total production of North Sulawesi and East Kalimantan respectively.

For more than 10 000 years, the indigenous population of the region has harvested the sea's seemingly unlimited supply of marine life. The Tubbataha Reef and other coastal areas of the Sulu-Celebes Sea, while serving as important spawning grounds for the entire region, also provide a livelihood for the fishing communities crowding its shores. Population pressure in the local fishing communities, poverty, and a lack of economic alternatives all contribute to the problem. The resources of the region are a source of hard currency for the debt-burdened government. Tourism increases every year and contributes both to the local and to the national economy (LME 2003).

Methodology

The Causal chain analysis was based on the extensive background knowledge and publications of the GIWA Task team and additional information provided by various government agencies, academic institutions, NGOs and other agencies, as cited herein. Some large gaps in information remain. In particular, there is a serious lack of long-term socio-economic data on human resource use patterns.

Causal chain analysis

Figure 18 shows the causal links for habitat modification in the Sulu-Celebes (Sulawesi) region.

Environmental and socio-economic impacts

The key environmental and socio-economic indicators of Habitat loss and community modification are:

- Loss and/or fragmentation of forest cover (Drigo & Marcoux 1999, Burke et al. 2002);
- Loss and/or fragmentation of riparian vegetation and rivers, rice paddies;
- Loss and/or fragmentation of coastal habitats such as mangroves and seagrasses (Chou et al. 2002);
- Loss and/or fragmentation of coral reefs (Alcala & Gomez 1987, Chou et al. 2002, Wilkinson 2002, Burke et al. 2002);
- Increased siltation, with severe levels of suspended solids in coastal waters (Hodgson & Dixon 1988, Cesar 1996, Bate 1999, White et al. 1999, Talaue-McManus 2000, Chia & Kirkman 2000, Burke et al. 2002);
- Increased nutrients in run-off, with blooms of toxic dinoflagellates, linked with sediment-bound nutrient enrichment (Ludwig 1985, Gunnerson & Cuellar 1988, Werner & Allen 2000);
- Ecosystem productivity change including resource depletion, reduction in ecosystem services (e.g. forestry, fisheries), and depletion of targeted and non-targeted species (Atmadja & Man 1994);
- Change in community structure (Chou et al. 1994, Werner & Allen 2000);
- Excessive take of protected species e.g. marine mammals, turtles and giant clams (Rossiter 2002);
- Conflict among resource users (Rossiter 2002).

Immediate causes

Modification of terrestrial and coastal habitats

Suspended solids

Habitat loss and community modification caused by suspended solids are severe in rivers, streams and coastal waters throughout most of the region (Hodgson & Dixon 1988, 1992, Bate 1999, Talaue-McManus 2000, Chia & Kirkman 2000, Burke et al. 2002). This may be attributed to severely altered land cover, especially in the southern Philippines. This has been modelled by the Reefs at Risk in Southeast Asia Project (Burke et al. 2002), which estimated sediment risks (relative erosion rates) impacting coral

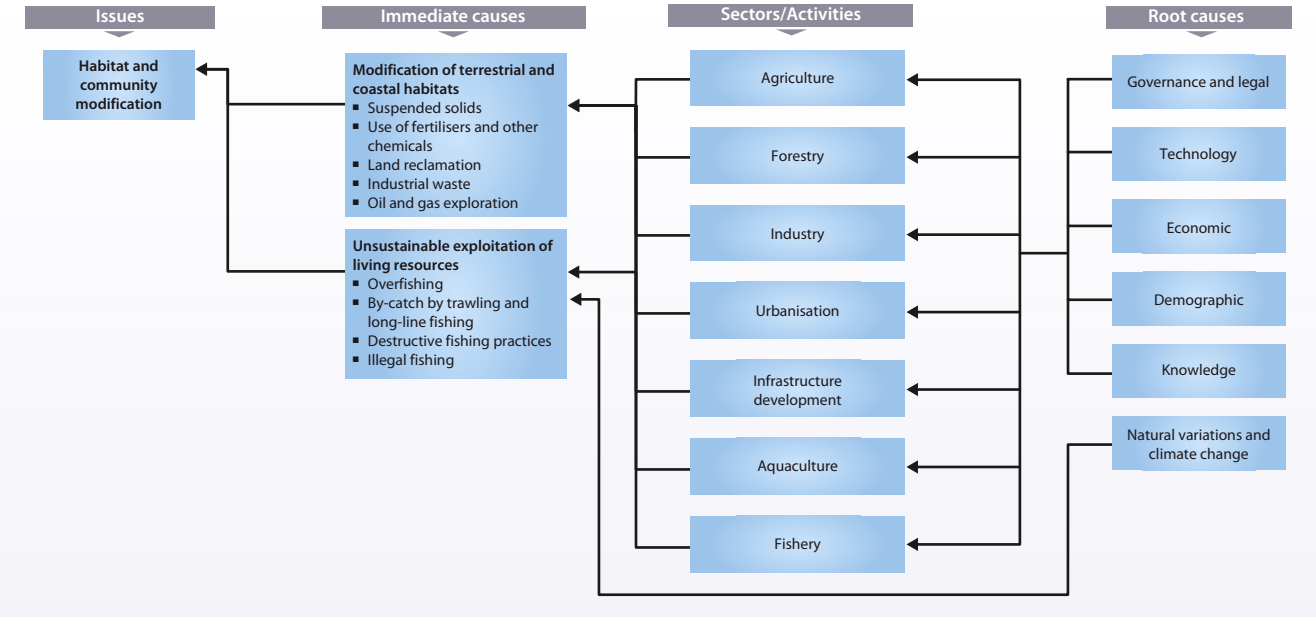


Figure 18 Causal chain diagram illustrating the causal links for habitat and community modification in the Sulu-Celebes region.

reefs, including observations from ReefCheck database, and ICLARM ReefBase (Figures 6 and 7 in the Assessment). Constructions on some shoreline areas, such as those along Alona Beach and other locations in Pangalo (Philippines), are causing shoreline erosion (White et al. 1999). The removal of portions of the structure of fringing reefs (e.g. corals for lime in cement production, dredging of lagoons etc.) has also resulted in greater erosion and sedimentation on a local basis (Cesar 1996). Excessive sedimentation (e.g. Sapian Bay, Philippines) has also been attributed to extensive mussel and oyster culture (Young & Serna 1982).

The common practice of slash and burn agriculture has depleted much natural forest, particularly in low-lying and coastal areas, exacerbating the impacts of land-based activities on coastal areas (FAO/UNDP/UNEP 1994). More than 80% of the original forest has been destroyed in large areas of the Philippines (Figure 7 in the Assessment) resulting in increased soil erosion and nutrient run-off.

The lack of balance between logging and replanting of trees, ultimately results in soil erosion and run-off, leading to increased suspended particulate matter in the waterways. The logging of rainforests (Drigo & Marcoux 1999) has contributed to major reduction in their cover, species population sizes and soil erosion, the latter leading to increased sediments and suspended particulate matter in waterways. In the Philippines, the loss of coral reefs was caused by huge quantities of silt linked directly to deforestation (Werner & Allen 2000). It is estimated that 60-80% or possibly more of the mangrove resources in the Philippines is lost (Atmadja & Man 1994).

Use of fertilisers and other chemicals

A related problem is chemical pollution, with chemical transported with sediments into waterways. The indiscriminate use of chemicals in the agricultural sector, including chlorinated pesticide residues from rice paddies such as Aldrin, Dieldrin, Lindane and Endrin, have led to high levels in the water column and sediments in Manila Bay (GIWA region 54 South China Sea) and Segara Anakan (GIWA region 57 Indonesian Seas), exceeding allowable limits set by national agencies (Gunnerson & Cuellar 1988, Ludwig 1985).

Land reclamation

Continuing developments along the watersheds and coastal zones are causing the loss of natural communities with permanent destruction having reduced the surface area of original land cover by more than 80% (Burke et al. 2002). Ports and harbour developments usually involves reclamation and channel dredging. Coastal reclamation and associated mangrove destruction are among the primary causes of loss of coastal habitats (Cesar 1996, White et al. 1999).

Mangrove forests, which are important nursery habitats, have been cleared for timber collecting and for use in prawn farming operations (Chua et al. 1989, FAO 2000). Aquaculture, including the shrimp farming industry (covering 500 000 ha) (Chua et al. 1989), has been one of the major causes of habitat modification and destruction in the region (Down to Earth 2001). In the Philippines, less than one-third of the original mangrove forests are now left (Chua et al. 1989). In Indonesia, up to 1 million ha of land, mostly mangrove forests, were allocated by the government for the shrimp hatchery industry. By 2001, about 70% of the shrimp farms had been abandoned because the operators found them unsustainable due to the high concentrations of chemicals and the destruction of the mangrove habitat.

Industrial waste

Industrial development affects marshes, swamps, rice paddies and riparian belts, and have led to more wastes being dumped into critical habitats, such as mangrove forests, contributing to the loss and fragmentation of 60-80% of Philippine mangroves.

Oil and gas exploration

Although not a major impact at present the potential for oil spills to adversely affect the ecosystems in the region is high. Caution and good management practice must be exercised in current and future exploration initiatives, including the Shell Company's multi-billion dollar Malampaya Gas Project (on Palawan province, Philippines) (Werner & Allen 2000).

Unsustainable exploitation of living resources

Overfishing

Overfishing impacts on habitat loss include widespread changes in community structure, widespread removal of brood stocks (FAO 2000), local extinctions, and has also contributed to fishers' incentive to use destructive methods (e.g. bombing) to catch the remaining fishes (Chou et al. 1994, Werner & Allen 2000). Most stocks have already been exploited beyond their maximum sustainable yield (Burke et al. 2002, FAO 2000, Wilkinson 2000). Sharks are also caught, erroneously depicted as by-catch, in trawling and long-line fisheries.

By-catch from trawling and long-line fishing

Although trawling was banned in Indonesia in 1980 (Sardjono 1980), with the ban successfully reducing overall fishing effort in western Indonesia and reallocating some of the inshore resources toward small-scale fisheries (Pauly 1989), it still is widely practiced in the region. This has caused extensive direct damage to rare and endangered species of marine mammals, including dugong, and turtles.

Figure 19 Nudibranches, Mabul Island, Malaysia.
Upper left: *Chromodoris coi*. Lower left: *Glossodoris stellata*. Upper right: *Hypselodoris* sp. Lower right: *Hypselodoris bullocki*.
(Photo: N. Coleman, ReefBase)

Destructive fishing practices

The widespread and repeated use of destructive material and equipment to fish for marine resources has caused severe ecosystem fragmentation, and has obliterated much of the marine life in many areas in the region (Johannes & Riepen 1995, Burke et al. 2002). The readily available material used to manufacture bombs and other destructive methods have contributed to their widespread use. Many fishers feel obligated to use dynamite and other destructive methods to catch the remaining fishes (Ming et al. 1994, Werner & Allen 2000). Trawling has negatively impacted seagrass beds, muddy and sand-gravel bottoms and fringing coral reefs. On Coron Island in the Calamain group (Philippines) over two-thirds of the island's coral reefs have been damaged by cyanide fishing, resulting in the people increasing their consumption of birds, monkeys and wild pigs (Werner & Allen 2000). The impacts of reef degradation on coral biodiversity have been documented by Edinger et al. (1998). The negative effects of muro-ami, blasting and poison fishing, have destroyed large areas of coral reef throughout the region (Pet-Soede & Erdmann 1999, Pet & Pet-Soede 1999, Burke et al. 2002).

Blast fishing is widespread (Alcala & Gomez 1987), and has reduced coral cover by 50-80% in Indonesia (Chou 2000). Similarly, in the Philippines, the strong decline in *Acropora* sp. coral is thought to be due primarily to human impacts, particularly blast fishing (Alcala 2000). A similar situation has occurred in Malaysia, where there may be more than four bomb blasts per hour in many offshore reef areas (Chou 2000). Reef bombing occurs regularly, and has been attributed to increasing competition among fishers and corresponding declines in catches. Alcala (2000) has provided an overview of blast fishing in the Philippines.

The full extent of poison fishing in the region is unknown (Johannes & Riepen 1995, Burke et al. 2002), because it targets some of the most pristine and isolated coral reefs where observations are limited. However, it is clear that many reefs in the region have been targeted for the live fish food trade in Hong Kong and mainland China, initially using potassium cyanide or sodium cyanide and more recently using poisons derived locally from plants. Weber (1998) assessed the status of some 200 fisheries around the world and concluded that the live reef fishery of Southeast Asia is one of the most threatened fisheries on the

planet. Live reef food fish trade is a lucrative industry where reef fish can fetch prices of up to 100 USD/kg. According to unpublished data from the International MarineLife Alliance, cyanide is widely used to capture both live reef food and ornamental aquarium fish. The ornamental and aquarium trade is an international, multi-million dollar industry with 36% of the global trade coming from Southeast Asia (Burke et al. 2002). Between 1996 and 1999, the share of the United States ornamental fish market coming from Southeast Asia increased from 67% to 78% (unpublished data from US Fish & Wildlife Custom declarations). The current harvesting practice of the trade is unsustainable (Burke et al. 2002). Cyanide fishing remains the predominant technique for fish capture in Southeast Asian countries. The economic benefits for fishers are minimal. In the Philippines, for example, fishers who supply the aquarium trade typically earn only about 50 USD per month (Spalding et al. 2001). Less destructive techniques, such as net capture, are on the rise as a result of retraining efforts but they have not yet overtaken cyanide fishing as the practice of choice (Burke et al. 2002).

Illegal fishing

Illegal tours by collectors have resulted in the marine environment being 'picked clean' of turtle eggs, giant clams and seashells. The Tubbataha Reef are not free from intrusion and destruction. Both Tubbataha Reef and Turtle Island have fallen prey to the destructive practices of people selling turtle eggs, thereby endangering the continuing existence of these turtles. Local extinction, according to the WWF, is imminent. In 1995, the Philippines Department of Environment and Natural Resources (DENR) revealed that coral cover and fish density in the reef are "decreasing at an alarming rate" despite the site's official status as a protected National Marine Park.

Massive destruction of marine mammals, sea turtles and fish has been reported from trap nets placed in the Manado area, North Sulawesi, Indonesia. The illegal fishing was believed to be operated by a joint Taiwanese/Indonesian venture. Between March 1996 and February 1997, it is estimated that catches included some 1 424 Manta rays, 18 Whale sharks, 312 other sharks, 4 Minke whales, 326 dolphins, 577 Pilot whales, 789 Marlins, 84 turtles and 9 Dugongs (Rossiter 2002). For more information on illegal fishing in Indonesia see Box 7.

Box 7 Illegal fishing by foreign vessels in Indonesia.

For decades now, Indonesia's rich and extensive marine natural resources have been plundered at will by foreign fishing vessels. Some operate under official licenses (purchased from Indonesian middlemen) and even fly the Indonesian flag, while others simply poach the vast archipelagic seas, bolstered by the slim chances of encountering Indonesian Navy vessels and the knowledge that they can usually pay their way out of any inconvenient situations that might arise if they do. Many are said to simply work with the various enforcement agencies that should be preventing their activities. As fish wars erupt between nations all over the world, Indonesia must realise and protect what is potentially its most sustainable and valuable natural resource, its fisheries. In acknowledgement of the importance of this issue, Minister Sarwono recently suggested that the losses in revenue accrued to the Indonesian economy as a result of foreign fish stealing may top 4 billion USD. In the case of North Sulawesi, while the Taiwanese trap net was eventually taken down (due to the actions of Minister Sarwono, then Minister of Environment), foreign fleets continue to threaten Bunaken National Park, albeit in a less direct manner. The Bunaken fishermen increasingly report conflicts with foreign tuna fishermen, and are now actively vandalising foreign fishing gears when they encounter them (such as long line radio buoys, fish aggregating devices, etc). The Bunaken fishermen face a double whammy, with Filipino boats actively poaching the waters just northwest of the park, while Taiwanese, Korean and Hong Kong boats (with official licenses) work the seas to the north and east of the park. The latter have greatly increased in number since the spread of violence in Ambon, when a number of foreign fleets relocated from Maluku to Bitung as their home port. Unfortunately, as these bigger and more technologically advanced foreign fleets decimate North Sulawesi's stocks, the Bunaken fishermen must travel further and further to catch fish (often 3-5 hours travel outwards by wooden speedboat from the island), and now increasingly resort to spear fishing and gill netting on Bunaken's heavily touristed reefs in order to catch fish to feed their families. Tourism and fishing, once compatible, are now increasingly enemies. In large part due to the activities of foreign fishing fleets.

(Excerpted from: NRM Headline News 2000)

Adequate policy but inadequate implementation/management, resources and capacity to execute the law

In Indonesia, Malaysia and the Philippines, marine resource management and exploitation are, in theory, already controlled by extensive policy and regulatory frameworks. However, several recent reviews have all indicated that the major problem is not lack of policy but lack of implementation, worsened by lack of coordination among agencies, ambiguity in policy statements and lack of a clear framework or support mechanisms to enable policies to be implemented effectively (e.g. Kahn & Fauzi 2001). This problem is common throughout many of the developing countries of Southeast Asia (Chua 1989), where regulating protected areas, forestry and fishery operations, including implementing sound management policies, is often hindered by lack of financial and human resources support for on-site management, surveillance/enforcement. Bunaken National Park offers a classic case-study (Box 8).

The typical chronic lack of surveillance and enforcement resources is exacerbated by the fact that many destructive activities are carried out in remote places, whereas enforcement capability is often based in urban areas. This has led to unregulated land-clearing, illegal use of pesticides and other chemicals in the agricultural sector, and to large-scale illegal commercial fishing operations, including those targeting reef fish, beche-de-mer and shark for cash sales to satisfy an increasing global market demand (Johannes & Riepen 1995, Cesar 2000).

Root causes

Governance and legal

Lack of stewardship

Although the 'tragedy of the commons' (Hardin 1968) is understood by regulators, the issue of property rights is unresolved in most areas and so the problems inherent in common property resource use remain unsolved, especially in remote areas. This is compounded by the next root cause.

Box 8 Lack of financial support for protected areas in Indonesia: Bunaken National Park.

After its establishment as a park, Bunaken National Park enjoyed initial support for five years (1992-1996) from the USAID-funded Natural Resources Management Project (NRMP). This initial support included development of a park management plan, stakeholder consultations, mooring buoy installation, several baseline biological and socio-economic surveys, and limited procurement including an office automobile and several patrol boats. The park has a management office with a staff of approximately 40 (including the park head, park rangers and administrative staff), and is under the authority of the Indonesian Department of Nature Conservation (PHKA) in the Ministry of Forestry. As a national park, it receives an annual operating budget that averages 75 000 USD per year, enough to pay for salaries, office operational costs and at most one water-borne patrol per month. Unfortunately, enforcement funding from the national park office was virtually non-existent during the latter half of the 1990s; the annual budget for the park included funding for a single half-day patrol per month. Despite the park's conservation status as a national park, it has continued to suffer a slow degradation over the last decade for a variety of reasons. As with almost all reefs in Indonesia, the park's reefs continue to be damaged by blast and cyanide fishing, destructive net fishing, live coral collection for house foundations, plastic trash accumulation, and anchoring. Additional enforcement problems in the park include tourist damage from reef walking and poor diving practices, mangrove cutting for sale of firewood, and violations of the zonation system (e.g. fishing in core conservation zones).

(Source: Excerpted from Erdmann & Toengkagie 2003, Erdmann et al. 2003)

Box 9 Lack of control of illegal fishing by foreign vessels in Indonesia.

Although the issue of foreign fleets either operating under license or poaching in Indonesian waters has been acknowledged as a problem for years, it seems that neither officials nor academics took this problem seriously until recently. This lack of concern apparently stems from a number of common misconceptions that many officials seem to harbour, including: Indonesian fishermen are too poor and ignorant and their fishing gears not advanced enough to effectively harvest fish stocks, Indonesian fishermen are ineffectual seamen and do not have what it takes to stay at sea and really fish; and Indonesian fishing boats are not advanced enough.

Combined with the idea that Indonesia's fisheries resources are underexploited, many fisheries officers and government officials seemed to feel that Indonesia might as well have foreign vessels help with fishing lest all those extra fish go to waste. These misconceptions were reinforced by consecutive Suharto-era Repelitas (five year plans) that inevitably called for more intensive fishing effort and official fisheries statistics that predictably showed a perfect increase in catches in line with the demands of the Repelitas. While it is not true that Indonesia's fishermen are unable to effectively harvest Indonesia's fisheries, it is true that they are generally at a great competitive disadvantage compared to foreign fleets who use high technology, unsustainable (and often illegal) fishing gears such as trawl nets, drift nets and massive long-lines to decimate pelagic and demersal fisheries throughout the archipelago.

Corruption, greed and government short sightedness has meant that foreign fleets are generally given the green light to plunder Indonesia's most valuable stocks (sharing a miniscule portion of their profits with a few corrupt government officials), while Indonesia's traditional fishermen are increasingly marginalised and left to fight for the scraps. This in turn has led to increased environmental degradation and a decreasing quality of life in many coastal villages as fishermen turn to destructive techniques to make a living and put some fish on their collective plates.

The grave situation in relation to illegal fishing of the region's fish stocks, particularly by foreign vessels occasionally utilising poor local fishers, has led to policy recommendations for total closure of Indonesia's seas to foreign fishers: close Indonesia's seas completely to foreign fleets and allow Indonesian fishermen only to catch Indonesian fish. After five years, the situation can certainly be reassessed. If there is strong scientific evidence for surplus fish production (i.e. underexploited stocks), then the issue of exports can be re-examined. But only in a sustainable manner in which Indonesian fishermen catch the fish that are exported. There is simply no justification for foreign fleets to operate in Indonesian waters. Bigger, more technologically advanced fishing fleets are not better only more efficient at speeding the collapse of a fishery.

(Source: Excerpted from: NRM Headline News 2000)

Unresolved issues regarding access to living resources

The views of local fishermen and foreign fishing fleets are often counter to those actions deemed necessary by government regulators, such as restricting license numbers, areas for fishing activities, and total allowable catch limits. Given the regional nature of the industry, restrictions by regulation can take considerable political will and stakeholder agreement on the scientific advice before they can be implemented. Again taking Bunaken National Park as an example, the majority of local fishermen are today small pelagics fishers, a situation that augurs well for conservation efforts within the park. Since these fishermen are not targeting reef fisheries, there is great potential for coexistence of fishing and marine ecotourism. Unfortunately, foreign fishing operations are threatening to damage both of these important sectors of the North Sulawesi economy. In 1997 and 1998, the now infamous 'Curtain of Death' Taiwanese trap net that stretched across the Lembeh Strait decimated migratory pelagic fish and marine mammal stocks in North Sulawesi (as discussed above). Not only did Bunaken fishermen see the effect in their daily catches, tourism also suffered with the number of sightings of dolphins, manta rays and other diver favourites plummeting. This led some of the local fishermen to an increased focus on reef fisheries and the use of illegal destructive methods. See also Box 9.

Technology

Technology developments

There have been major improvements in the technology available for commercial fishers, particularly foreign fleets, to increase effective fishing effort and exploit a wider range of marine habitats. These include employing more powerful vessels, better depth and bottom assessment systems, deeper towing of demersal trawl nets, and access to better meteorological information, both aerial and acoustic searching for fish schools and GPS position fixing. In some fisheries, such as long-lining, the practice of cooperative (or 'pack') fishing is also common.

Knowledge

Lack of education/awareness, conservation ethics and perceptions

Those who participate in habitat destruction often lack awareness and appreciation of the environment and its renewable services, attributable to both a lack of education, poverty, and/or desperation. In relation to destructive fishing, there is often a perception amongst fishers that the use of destructive methods is better because it yields a bigger catch for the least amount of effort. This has resulted in an increase of bombing, poison and other destructive methods. Alternatively, at the other end of the financial scale, extremely wealthy, unscrupulous persons and international fishing organisations are able to flout the law because of corruption, usually employing poor fishers to conduct the illegal activities. See also Box 9.

Inadequate investment in scientific assessments and management

As with most regions world-wide, there has traditionally been inadequate historical field data, particularly on fisheries impacts to ecosystems, CPUE, stock recruitment relationships and the life history characteristics of the target species and their role in the ecosystem, the 'synecology' of the fisheries (e.g. see Jackson et al. 2001). Coupled with the lack of field data have been serious inadequacies in the theory of both ecosystem and fisheries management, which are only now beginning to be addressed through an ecosystem based management approach.

Economic

Market demand

The ready available market demand for seafood may inadvertently create a group of willing fishers who will use any fishing methods to achieve goals of maximum yield at the minimal effort. Similarly, forest logging of tropical rainforest timbers is a highly lucrative export industry, bringing large amounts of foreign currency, and with high potential for misconduct among corrupt officials. This is in some cases also closely linked to urban and residential developments. As such, new buildings (commercial and residential) will often put demands on the industry to log more. The lack of accountability and responsibility in all parties exacerbates the situation.

The market demand for more fishes has also led to a change of focus for artisanal fishers, where they once concentrated on sustenance, they now rely on small-scale commercial fisheries for their livelihood (Ingles 2000), with positive and negative impacts on the environmental and socio-economic aspects of habitat loss and community modification.

Economic growth

Governments and private sector, particularly in developing nations, are often driven by the need for faster economic growth but at the expense of natural resources and the environment.

Demographic

Population growth and poverty

When coupled with other issues, such as rural 'landlessness', population growth will erode the gains obtained from conservation measures, such as banning illegal land clearing and fishing methods, within a few years if no provisions are made to provide for alternative income opportunities. Population growth has also increased coastal developments leading to beach erosion and high sedimentation (Burke et al. 2002), and needs to be addressed across all sectors.

Poverty, often associated with overpopulation, is a major root cause that drives most issues identified in this analysis. The dependence of millions of poor people in the region on their natural resources is so strong that every available resource will be extracted at all cost. Providing additional and/or alternative livelihoods is crucial but can be difficult as the people need to be convinced that they would get a better deal with a new initiative. An example of this is blast-fishing, whereby the fishers need to be convinced that a new (less destructive) method will yield the same if not better catch than blast fishing. Thus, extreme poverty has forced people to continue fishing despite resource depletion. As the situation worsens, fishers will resort to use of all methods to catch the remaining fishes, indicative of Malthusian overfishing (Pauly et al. 1998).

Natural variations and climate change

Major shifts in climate, such as ENSO, can cause changes of several orders of magnitude in breeding and recruitment success for many species, including commercial species. As global climate change accelerates, it is predicted that there will be wider fluctuations in climate with more intense drought periods followed by more intensive rain and storm events. Also, there is the possibility of shifts in ocean currents that could disrupt many breeding cycles.

Conclusions

The most significant root causes affecting Habitat loss and community modification in the region are population growth, poverty, economics and market trends. Population growth is impacting on migration, urbanisation, lack of employment and poverty, all of which, in turn, place greater pressure on services from the environment (e.g. fisheries) and contribute to increased pollution and damage to habitats. Lack of policies supporting sustainable development and/or lack of enforcement of those that are in place as well as corrupt and/or illegal practices also follow from population growth.

Economics and market trends drive the burgeoning and unsustainable use of resources and also influence corruption and illegal practices. Coupled with the population boom and migration to coastal and urban areas, market trends create a dangerous mix of driving forces that do not augur well for the future. Most importantly, the resource owners themselves must be persuaded that long-term sustainability is a much better option for the future development of the region, than short-term gains that are being made at the expense of irreversible damage to the environment.

Policy options

This section aims to identify feasible policy options that target key components identified in the Causal chain analysis in order to minimise future impacts on the transboundary aquatic environment. Recommended policy options were identified through a pragmatic process that evaluated a wide range of potential policy options proposed by regional experts and key political actors according to a number of criteria that were appropriate for the institutional context, such as political and social acceptability, costs and benefits and capacity for implementation. The policy options presented in the report require additional detailed analysis that is beyond the scope of the GIWA and, as a consequence, they are not formal recommendations to governments but rather contributions to broader policy processes in the region.

Definition of the problem

The foremost consideration is the tri-lateral, transboundary nature of the Sulu-Celebes (Sulawesi) Sea, with three different national jurisdictions, many transboundary issues, and many national, regional and international "players" actively pursuing initiatives concerned with sustainable development of the region (see Annexes III and V). Further, significant transboundary impacts can also originate from outside the region, such as from the GIWA regions South China Sea and Indonesian Seas. The present analysis is predicated on the fact that actions by one country invariably impact on the jurisdictions of another.

On land, massive land-clearing and conversion has destroyed or fragmented much of the original vegetation cover, with severe loss and modification of catchments and loss of sediments to coastal waters. In the sea, major overexploitation and destructive fishing have caused severe depletion of fish stocks, with associated habitat modification, in most areas of the region (e.g. 80% modification of original vegetation cover, 60% loss of mangroves, 50% of reefs degraded). As part of the three nations' international obligations under tri-lateral and United Nations Conventions and Treaties (e.g. Biological Diversity, World Heritage, MARPOL), the respective national governments, with international assistance, recognise the need to address these impacts in a coordinated manner. However, implementation of effective interventions is hampered by lack of capacity, corruption and ineffective legislation and/or enforcement. See also Box 10.

The overall present situation and future prognosis for the Sulu-Celebes (Sulawesi) Sea is that:

- There are already severe environmental and socio-economic impacts from habitat loss and community modification and unsustainable exploitation of fish and other living resources;
- These impacts are expected to continue to worsen over the next 20 years, with additional significant deterioration in impacts of

Box 10 The need for improved management and cooperation in conserving and protecting the Sulu-Celebes LME.

There is a pressing need for improved management and cooperation between countries in conserving and protecting the Sulu-Celebes Sea Large Marine Ecosystem. Enforcement, education and research are necessary measures, as are efforts to curb illegal fishing. In 1988, Tubbataha Reef was declared as the first National Marine Park in the Philippines. In 1993, the United Nations Educational Scientific and Cultural Organization (UNESCO) declared the reef a World Heritage Site. Turtle Island has also been declared a protected area. These declarations indicate the government's commitment to conserve the areas and have increased international awareness and support for their protection. When the government ran out of funds to carry out an action plan, international agencies such as the World Wildlife Fund (WWF) and GEF initiated some projects. It is clear that engaging the public is necessary, as well as developing livelihood alternatives for those communities that are affected. WWF's plan is to raise the communities' awareness level of the existing laws on fisheries and environmental protection. Other international groups that have committed to projects in the area are ASEAN and Conservation International. In 1996, an agreement was signed by Malaysia and the Philippines to protect two endangered turtle species, the Hawksbill and the Green Turtle. Although the Malaysian-Philippine agreement is a vital first step, all three governments in the region need to enforce sustainable ways of earning a living from the sea.

(Source: Excerpted from LME 2003)

pollution (becoming severe) and freshwater shortage (moderate);

- The human population is growing steadily with an expected doubling by 2035, although growth may slow slightly in the coming decades;
- Many people are at subsistence levels of agriculture and fisheries for survival, with approximately 60% of population at or below the poverty level;
- There is widespread continued use of inappropriate technologies and concern for the longer term sustainability of the production systems;
- Most laws and regulations are not well implemented or accepted by local populations;
- It will be possible to slow down the rate of increase of impacts, although, at present, environmental concerns are less important than development pressures, many of which have inappropriate environmental effects;
- The political situation is focused on the short-term (3-5 year cycles) with changes in officials, rather than on developing longer term strategies;
- There are concomitant significant deficiencies in vision, planning and implementation at political levels;
- A 'critical mass' of expertise and framework for change are developing, involving science, policy, private sector and government;
- There is a need to better integrate ocean-related sectors in policy, with linkages among food security, poverty, natural resources, environment pressures, market forces and governance;
- There is misallocation of significant amounts of local and international funds;
- There is a rapidly changing global situation with changes in funding priorities;
- There are major opportunities for improvement in both the political situation and from private sector and national/international NGOs;
- Better allocation of local funds and continued international donor funds are needed to alleviate present situation and to work towards improving future scenarios;
- Local and/or regional scale interventions by government, communities and NGOs (e.g. community-based management at Apo Island and Danjugan Island - WWF Sulu-Sulawesi Ecoregion programme) have the potential to slow the rate of deterioration significantly, provided these receive adequate political, fiscal and logistic support.

Construction of policy options

As noted above, the Philippines, Malaysia and Indonesia have adequate legislation to address most of the key issues and concerns raised in the Assessment (see Annex IV). These nations are also parties to most of the key international conventions and treaties. What is currently lacking is multi-lateral coordination and capacity to apply the existing legislation and to review and amend the legislation to improve its functionality, particularly cross-sectorally (Chua pers. comm.). There is a clear and pressing need for an integrated multi-national conservation and development approach for the Sulu-Celebes (Sulawesi) Sea, complemented by implementation of an effective strategy to address multi-lateral and international obligations under the various conventions and treaties (see Annex IV) (Chua pers. comm.).

Consolidation of national laws and multi-lateral agreements to encompass all sectors, with better coordination in management and much improved enforcement, with ongoing and expanded community education programmes are also needed. National and international surveillance strategies, with participation from all levels of government, NGOs and local communities may be the best way of bridging the gaps between formulation, legislation and enforcement of regulations. Towards some of these goals, UNEP and GEF have formulated a Transboundary Diagnostic Analysis and preliminary framework for a strategic action programme for the Sulu-Celebes LME (GEF 1999). The PDF-A has been completed and the PDF-B is currently in draft form. The success or otherwise of the PDF will greatly depend on how the participating governments engage.

Rather than re-evaluating the many and various options that have already received substantial analysis by these governments, donors, academia and NGOs in the region and elsewhere, a subset of recommended policy options are presented, arising from the various analyses conducted to date that were considered most appropriate. These options are focused initially at the broadest policy levels, becoming increasingly directed to finer scale policy and interventions. Relevant case studies are presented throughout.

Recommended policy options

Given that the region lies at the centre of global biodiversity with adjacent GIWA regions of Indonesian Seas and South China Sea, more extensive and intensive intervention is required immediately. At the broadest policy levels, recommended options include:

- Programmes to address population growth;
- Programmes to reduce poverty, including significant focus on alternative and/or additional income generation programmes (AIG);
- Direct on-the-ground community-based conservation programmes, particularly focused on improving management of and further development of protected areas, including AIG for locals, linked with:
  - Assessment programmes for identification of critical areas for biodiversity (e.g. through government agencies and NGOs;
  - Training programmes to build additional long-term capacity among government, NGOs, and communities;
  - Multi-lateral integration to maximise effectiveness of obligations under international conventions and treaties (e.g. CBD, WHA, UNCLOS, MARPOL, Ramsar, PEMSEA).

The Sulu-Sulawesi Marine Ecoregion (SSME) approach being developed by WWF and partners provides a useful model for policy development and implementation. The approach is two-pronged: conservation planning in the long-term, and implementation of immediate conservation actions in key sites. The SSME recognises that immediate interventions should be implemented in five priority areas:

- Bio-physical (biodiversity) and socio-economic research;
- Establishment of a network of protected areas;
- Development of sustainable livelihoods;
- Information/education/communication;
- Institution and capacity building including establishment of inter-governmental mechanisms.

At the finer scale of this GIWA analysis, the key recommended policy option is improved management and expansion of the protected areas network. In light of the strong linkages between Habitat loss and community modification and Unsustainable exploitation of fish and other living resources concerns, the ameliorative role of protected areas in both regards cannot be overemphasised.

There are insufficient resources for management and enforcement of fisheries and other regulations in many MPAs, which limit their effectiveness. By contrast, several small community-based management initiatives have proven very successful at protecting coral reefs and facilitating replenishment of reef-based fisheries e.g. Apo Island (Russ 1985, Russ & Alcala 1996a,b) and Danjugan Island (Sherwood 2002). Thus, several key examples of the successes, failures and lessons learned from previous attempts at improving management and expanding the MPA network in the region already exist (Annex X).

Box 11 Benefits of MPAs in Fisheries Management

Marine Protected Areas have the potential to play a much bigger role in the successful management and sustainable use of fisheries resources on coral reefs and associated ecosystems. In particular, participatory development of no-take zones and protection of essential fisheries habitat in the context of an ecosystem management approach should be encouraged, where appropriate, at both the community level and for larger areas. The designation of no-take marine reserves may be necessary for sustaining fishery yields over the long-term, due to their ability to preserve genetic variation in the expression of fish size and growth rates. This is because in exploited situations, the fishery selectively removes larger individuals, giving smaller, less fertile individuals a selective advantage.

Marine protected areas are most effective when they are established where vulnerable species usually live, breed, or feed, the committee said. Creating these areas has quickly restored populations of fish, snails, and crabs, reduced pollution, and provided habitats for other marine organisms in some regions, including the Philippine islands. Less than 0.25% of coastal sea areas are designated as marine protected areas. To ensure the greatest benefit to depleted fish stocks, many more protected areas should be set aside that are or once were active, productive fishing areas. Moreover, fishermen should be involved in planning and designating protected areas.

(Source: Dight et al. 1999, NRM Headline News 2002c, Roberts et al. 2002, The National Academies 1998)

In the protected zones around Apo Island (Philippines), CPUE has increased in two key families of reef fish, in response to effective protection and decreasing fishing effort (Russ & Alcala 1996 a,b). This is an excellent example of community-based management, but to date, despite good intentions by the relevant government agencies and NGOs, there has been a lack of implementation in many other areas. The Nature Conservancy has recently conducted a detailed analysis of the benefits of MPAs in fisheries management (see Annex VII) (Mous and Pet-Soede pers. comm.). The major recommendation is included in Box 11.

Expansion and improved management of protected areas

There are several hundred protected areas already designated in the region, representing a wide range of terrestrial, coastal and marine habitats and over 100 more are currently being gazetted (Spalding et al. 2001, Cheung et al. 2002, Uychiaoco et al. 2002, WRI 2003). Most protected areas are in the Philippines, notably the large Tubbutaha Marine Park. East Kalimantan in particular is under-represented in terms of MPAs, with only two small areas gazetted in the Berau barrier complex (total area of 500 ha), and several Nature Reserves on the coasts of Pulau Laut and the adjacent mainland (Kahn & Fauzi 2001). North Sulawesi has just the one marine park, Bunaken National Park, and a few coastal terrestrial reserves.

Specific policy recommendations for improving the management and coverage of the MPA network in the region include (after Alino et al. 2000, Cheung et al. 2002):

- Review the current administrative frameworks and design strategies to resolve overlapping legal authority and jurisdiction in MPAs;
- Identify which MPAs are working, which are not and why, and

document successful case histories of MPA management (see Annex IX);

- Where necessary, design management plans that include identified source(s) of operational funding (see Annex IX);
- Retain flexibility in management approach, recognising the value of co-management through small-scale local, community-based approaches and larger scale internationally-supported management initiatives (see Annexes IX and X);
- Design and foster implementation of a system whereby each municipality or village (e.g. Barangay in the Philippines) is empowered to assist in the management of (or manage) the local MPA;
- Conduct strategic assessment of human resource requirements, including day-to-day management, surveillance and enforcement on a case-by-case basis;
- Encourage government and private sector to carry out integrated coastal zone planning and management (including watersheds), and incorporate protection of critical land areas within the parks or as buffer zones;
- Set aside as much as practicable (at least 20%) of MPA areas as 'no take' zones for biodiversity conservation and fisheries replenishment;
- Ensure Environmental Impact Assessments (EIAs) are conducted prior to any development in or adjacent to MPAs, and wherever practicable, minimise all future development of land within and adjacent to MPAs;
- Establish and/or refine monitoring programmes and re-evaluate research priorities to best address bio-physical and socio-economic management concerns;
- Work through ASEAN and other multi-lateral, international agencies and organisations to develop joint programmes, including innovative sources of ongoing funding (see Annex IX). Merill (2001) states recommendations specifically for Indonesia's Protected Areas, but with relevance to the region as a whole, include development of:
  - Clear written policy in support of site-specific co-management of national parks and other protected areas in Indonesia provided by the Ministry of Forestry's Director General for Forest Protection and Nature Conservation. Such policy should delegate clear support and responsibility to all national park directors to develop flexible co-management structures that reflect the site-specific opportunities and constraints of their national park. Criteria for co-management include excellence in technical service delivery, professionalism and flexibility.
  - Relevant conservation user fees policies assessed and revised by the Ministry of Forestry and Ministry of Finance in order to clearly support local self-financing for conservation management. A national policy on protected areas conservation financing should ensure local collection and distribution of a majority of user fees, with only a minority going to the central government. All finances should be accounted for and booked at the national level. Transparent third party monitoring and evaluation on financial management as well as conservation management impact is essential.
  - Clear guidelines and standard operating procedures are necessary for both joint patrol systems and participatory zonation processes.

Box 12 Policy for collaborative management of Indonesia's National Parks.

The Ministry of Forestry's PHKA worked with NRM, TNC and WWF to bring together more than 120 government, non-government and community stakeholders from the national to local level to strengthen and clarify its policy in support of decentralised collaborative management of Indonesia's National Parks. Specifically regarding the legal aspects of collaborative national park management policy, PHKA will focus on short-, medium- and long-term targets. PHKA will facilitate the development of a ministerial decree supporting decentralised collaborative management. This will strengthen the impact of PHKA SK No. 1633/IV/KK-6/02, in effect since November 2002. Over the next two to three years, PHKA will facilitate the development of a presidential decree (Kepres) and joint ministerial decree (SKB) between Ministries of Forestry and Home Affairs. Finally, over the next five years, PHKA will facilitate a review and possible revision of Law 5/1990 (UU 5/90) on biodiversity and ecosystem conservation, then draft an implementing regulation for decentralised collaborative management of national parks. This strategy balances immediate policy creation with the timing to create the strongest possible legal basis for collaborative management. The Ministry of Forestry's commitment to decentralised collaborative management is a significant and broadly welcomed policy shift from its previously highly centralised approach to national park management. Experience showed that a centralised approach to conservation management was ineffective and costly. Innovative field approaches clearly demonstrated that collaborative management - the bringing together of relevant government, non-government, community and private-sector stakeholders - was more efficient in harnessing technical and financial resources as well as commitment for effective conservation management in the context of regional development.

(Source: Excerpted from NRM Headline News 2003)

Importance of co-management

Policy recommendations to better support approaches toward decentralised co-management include guidelines for co-management, conservation financing, joint patrolling and zonation (see Box 11). Co-management strengthens service delivery for conservation management. It enables national park managers to tap into the rich and diverse technical and financial resources available locally. Co-management offers flexibility. Site-specific in nature, co-management efficiently links available resources to address local constraints. From a financing standpoint, co-management provides flexibility for reaching beyond regular budget processes to tap necessary financial resources for unplanned problems. Financing co-management is possible though accessing into a range of local, site-specific financing opportunities. But such local self-financing mechanisms can only be sustained when there is a clear link to user fee collection with local conservation management initiatives. Joint patrol systems, including relevant government and community stakeholders, are effective in reducing illegal and

ecologically damaging activities in and around a protected area. Local stakeholders have a keen knowledge about the organisation of such activities. Local stakeholders appreciate the cessation of illegal activities as it supports their sustainable livelihoods. Participatory zonation is an effective strategy for balancing stakeholder aspirations with conservation management objectives of a national park. There should be monitoring and evaluation of participatory zonation agreements to ensure both objectives are met. (Merill 2001).

Notably, in a major boost of support for decentralised co-management of Indonesia's national parks, the Ministry of Forestry announced 2002 its support for the establishment of site-specific co-management forums for all the country's national parks. This policy announcement is also an indication of the growing importance of iterative, field-driven policy reform for decentralised natural resources management. Rather than relying on extensive academic studies and technical analysis, the Ministry of Forestry has taken on-going, Indonesian-based field initiatives to support national policy. Over the past few years, Ministry of Forestry officials have been able to learn about and witness positive conservation management changes, for example, in and around Bunaken National Park (Merrill pers. comm.). Ministry officials were thus able to recognise the value of supportive co-management policy in achieving their objectives of enhanced conservation management. This is a major, positive step in ensuring responsible decentralisation of Indonesia's protected areas and forest resources (see Box 9).

In the related case of the Philippines, the President of the Philippines noted in an address to the Second International Tropical Marine Ecosystem Management Symposium 2003 (also see Annex IV and VIII): "A significant Philippines national strategy is devolving management responsibility to the municipality and 'barangay' level under the Local Government Code passed by Congress in 1991… When communities are given the responsibility of managing their own resources with a little help from government and scientists, the damage to the reefs can be reversed… The Philippines Government is increasing sustainable management assistance to people who have a large dependence on these reef resources."

In light of the strong linkages between terrestrial habitat loss and land clearing, and sedimentation and suspended solids in Sulu-Celebes (Sulawesi) Sea, the ameliorative role of terrestrial protected areas also cannot be overemphasised. Bruner et al. (2001) found that the majority of parks are successful at stopping land clearing and, to a lesser degree, effective at mitigating logging, hunting, fire and grazing. The findings of this study suggest three basic conclusions.

First, the claim that the majority of (terrestrial) parks in tropical countries are "paper parks" (i.e. parks in name only) is not substantiated. Tropical parks have been surprisingly effective at protecting the ecosystems and species within their borders in the context of chronic underfunding and significant land use pressure. They have been especially effective in preventing land clearing, arguably the most serious threat to biodiversity. Second, despite their successes, there is a clear need to increase support for parks to improve effectiveness against all threats, perhaps especially against hunting.

Finally, these findings suggest that parks should remain a central component of conservation strategies. Both creating new parks and addressing the tractable problem of making existing parks perform better will make a significant contribution to long-term biodiversity conservation in the tropics. Clearly, developing additional protected areas must include extensive community and stakeholder consultation, education and regulations offering real protection, with agreement and strong support from the customary resource owners and users."

Performance of the chosen alternatives

The above policy recommendations should assist in the establishment of well-planned, well-funded, and well-implemented protected areas representing major terrestrial, coastal and marine habitats to serve as models (potential immediate coastal and marine examples include Tubbutaha, Bunaken and Turtle Island) for future protected area development.

Improved management and expansion of the protected area network is, however, only one of a suite of possible policy options that might be used to achieve conservation and fisheries management objectives (Rudd et al. 2003). Other options in relation to fisheries include effective licensing and quota systems, closed seasons, size and catch limits among many others. However, these and the multitude of other options are less likely to achieve success in the Sulu-Sulawesi (Celebes) Sea region in the short-term, largely because of the lack of capacity for their implementation and enforcement.

It is nonetheless crucial that further rigorous policy analyses that consider a full range of environmental and socio-economic costs and benefits, including the transaction costs of management be undertaken (e.g. see Annex IX). If credible analyses are not undertaken throughout the region and elsewhere, there is a danger that current

enthusiasm for protected areas may wane as economic performance fails to meet presumed potential. As Rudd et al. (2003) note, fully accounting for the value of ecological services flowing from protected areas requires consideration of increased size and abundance of focal species within reserve boundaries, emigration of target species from reserves to adjacent fishing grounds, changes in ecological resilience, and behavioural responses of fishers to spatially explicit closures. These analyses are in their infancy, and are only now beginning to be undertaken globally. Nonetheless, the data available generally do support the effectiveness, efficiency, equity, political feasibility and implementation capacity of protected areas in mitigating both habitat loss and overexploitation of fish (e.g. Roberts et al. 2002 and references therein). For the Sulu-Celebes (Sulawesi) Sea region, the policy option is considered to have:

Effectiveness

Low to medium, as the levels of environmental and socio-economic impact to habitats are expected to increase to 2020, despite presently planned interventions. Notably, the key root causes of overpopulation, poverty and market demand, compounded herein by intra- and international differences in cultural/religious beliefs, must be addressed. Effectiveness can be improved markedly with more equitable use of funds and continuing donor, government and NGO support. Effectiveness correlates with basic management activities such as enforcement, boundary demarcation and direct compensation to local communities, suggesting that even modest increases in funding would directly increase the ability of protected areas to protect tropical biodiversity and restore harvested species.

Efficiency

Medium, with clearly prioritised objectives and goals and the development of transparent systems for funding and implementation, but with major remaining impediments of corruption across all levels from local to national, and unresolved political instability (e.g. separatist movements) in parts of the region. Efficiency clearly is linked closely with effectiveness, and thorough evaluation of efficiency will require expansion of future policy assessments beyond standard cost-benefit analysis, particularly considering the impact of social capital on the costs of managing fisheries.

As Rudd et al. (2003) conclude: "In the short term, the amount of social capital that communities possess and the capacity of the state to support the rights of individuals and communities will affect the relative efficiency of marine reserves. Reserves may be the most efficient policy option when both community and state capacity is high, but may not be when one and/or the other is weak. In the longer term, the level of social capital that a society possesses and the level of uncertainty in ecological and social systems will also impact the appropriate level of devolution or decentralisation of fisheries governance. Determining the proper balance of the state and the community in tropical fisheries governance will require broad comparative studies of marine reserves and alternative policy tools".

Equity

Low to medium, with increasing stakeholder involvement and major education and awareness campaigns occurring. The special circumstances of local subsistence fishers are being addressed explicitly in policy.

Political feasibility

Low, with unresolved conflicts and gaps in jurisdiction among the various government levels placing serious impediments on resolution of some of the key environmental and socio-economic issues. These key issues are only now beginning to be addressed in a coordinated tri-lateral, national, state and local manner.

Implementation capacity

Medium, with developing capacity among the three national governments, NGO and community groups for effecting change, and with considerable international donor support. There is also increasing recognition among the communities themselves that interventions are crucial to their longer-term sustainability. However, the area is very large and poorly known, with insufficient biodiversity and fisheries assessments and monitoring undertaken to date. There remain serious deficiencies in capacity in on-the-ground implementation, including unresolved difficulties in effective surveillance and policing (see Annex IX), providing challenges for implementation and, at present, levels of funding for these initiatives are not assured.

WWF's Sulu-Sulawesi Marine Ecoregion Programme (SSME) programme is receiving some support from the governments of Indonesia (through their Ministry for Marine Affair and Fisheries (MMAF) coordinated by the MMAF Director General), and is also supported by the governments of the Philippines and Malaysia. Other global initiatives, including the International Coral Reef Action Network (ICRAN) and Millennium Ecosystem Assessment (MEA) have potential benefits for developing an integrated functional protected areas network in the region. ICRAN has chosen Bunaken National Park and Komodo National Park (in adjacent Indonesian Seas) as demonstration sites, while MEA (Sub-Global periodical meeting for 2003) has proposed two demonstration sites: Bunaken National Park and the Jakarta Bay Area (GIWA region Indonesian Seas). Bunaken National Park has already received substantial

support from the Government of Indonesia, USAID, WWF-Wallacea and other donors, and has been selected as one of four MPAs to participate in a pilot study to develop business plans for Asian MPAs under the auspices of the World Commission on Protected Areas South East Asia Marine (WCPA SEA Marine) working group. Its proposed selection as a demonstration site by MEA and ICRAN is also in accordance with the goals of the SSME Programme, providing a high degree of complimentarity in these policy initiatives. Bunaken National Park is providing a useful model for innovative self-funding mechanisms, among other management initiatives, likely to be applicable in other protected areas (Annex IX).

Conclusions

When effectively implemented and managed, a fully integrated network of protected areas can play a key role in minimising future habitat loss and restoring the region's fisheries stocks, which are in urgent need of careful stewardship if their sustainable future utilisation is to be assured. In addition to a high degree of local community-based support, success will require effective enforcement, particularly of poaching and fisheries regulations, and reliable biodiversity and harvested stock assessment and monitoring. These need to be founded in an improved understanding of the population biology of the target species and issues of ecological scale and connectivity in relation to replenishment. There is strong potential for well-planned mariculture of some ornamental and food species, with the need for continuing development of appropriate policy and legislation.

The refinement of these policy options will emerge during continuing development of the Sulu-Sulawesi Marine Ecoregion Program and GEF initatives. The identification of the issues and options above, however, may provide guidance beyond that already gathered in the GEF process. Without doubt, the Sulu-Celebes (Sulawesi) Sea must be a priority area for future GEF initiatives, including those of the International Waters community. The region is at the centre of the world's marine and terrestrial biodiversity, and is surrounded by a rapidly growing population and rapidly deteriorating ecosystems. The challenge of gathering the national and international, transboundary cooperation necessary for the sustainable development of this critical region is great, but not insurmountable.

References

Alcala, A.C. (2000). Blast fishing in the Philippines, with notes on two destructive fishing activities. Workshop on the Status of Philippine Reefs 24, January. Marine Science Institute, University of the Philippines.

Alcala, A.C. and Gomez, E.D. (1987). Dynamiting coral reefs for fish: a resource-destructive fishing method. p 50-61 In: Salvat, B. (ed.) Human Impacts on Coral Reefs: Facts and Recommendations. Antenne Museum, E.P.H.E., French Polynesia.

Alino, P.M., Arceo, H.O., Palomar, N. and Uychiaoco, A.J. (2000). Challenges and opportunities for community participation for the management of marine protected areas (MPAs) in the Philippines. Proceedings 9th International Coral Reef Symposium, Bali.

Armada, N. (1994). The fisheries of Manila Bay. The Bureau of Fisheries and Aquatic Resources, Philippines.

Atmadja, W. and Man, A. (1994). Threats and pressures on mangroves and current management practices. p 62-70 In: Wilkinson, C.R. (ed.) Living coastal resources of Southeast Asia: Status and Management. Report of the Consultative forum third ASEAN-Australia Symposium on Living Coastal Resources. Chulalongkorn University Bangkok, Thailand. May 1994. Australian Institute of Marine Science.

Bate, E. (1999). Biophysical assessment of the Sulu-Sulawesi Large Marine Ecosystem: Geology module. A report prepared for the Sulu-Sulawesi Marine Ecoregion Conservation Program Development, WWF-Philippines.

Bruner, A.G., Gullison, R.E., Rice, R.E. and da Fonseca, G.A.B. (2001). Effectiveness of parks in protecting tropical biodiversity. Science 291:125-128.

Bryant, D., Burke, L., McManus, J. and Spalding, M. (1998). Reefs at Risk. A map based indicator of threats to the world's coral reefs. WRI, ICLARM, WCMC and UNEP, Washington D.C.

Burke, L., Selig, E. and Spalding, M. (2002). Reefs at Risk in Southeast Asia. World Resources Institute.

Cabanban, A.S. (1998). Impacts of fish-bombing on the coral reef fish community of the Semporna Reef Complex, Sabah, Malaysia: Preliminary Results. p 89-93 In: Proceeding of APEC Workshop on the Impacts of Destructive Fishing Practices on the Marine Environment, 16-18 December 1997. Hong Kong.

Carlton, J.T. (1998). Apostrophe to the Ocean. Conservation Biology 12: 1165-1167.

Cesar, H.S.J. (1996). Economic Analysis of Indonesia Coral Reefs. World Bank, Washington, DC.

Cesar, H.S.J. (ed.) (2000). Collected Essays on the Economics of Coral Reefs. CORDIO, Department of Biology and Environmental Sciences, Kalmar University, Sweden.

Cesar, H.S.J., Warren, K.A., Sadovy, Y., Lau, P., Meijer, S. and van Ierland, E. (2000). Marine market transformation of the live reef fish food trade in Southeast Asia. p 137-157 In: Cesar, H.S.J. (ed.) Collected Essays on the Economics of Coral Reefs. CORDIO, Department of Biology and Environmental Sciences, Kalmar University, Sweden.

Cheung, C.P.S., Alino, P.M., Uychiaoco, A.J. and Arceo, H.O. (2002). Marine Protected Areas in Southeast Asia. ASEAN Regional Centre for Biodiversity Conservation, Department of Environment and Natural Resources.

Chia, L.S. and Kirkman, H. (2000). Overview of land-based sources and activities affecting the marine environment in the East Asian Seas. UNEP/GPA Coordination Office and EAS/RCU. Regional Seas Report and Studies Series 173.

Chou, L.M. (1997). Southeast Asia as the global center of marine biodiversity. Tropical Coasts 4:4-8.

Chou, L.M. (2000). Southeast Asian reefs - status update: Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam. p 117-129 In: Wilkinson, C.R. (ed.) Status of coral reefs of the world: 2000. Australian Institute of Marine Science.

Chou, L.M., Wilkinson, C.R., Gomez, E. and Suraphol, S. (1994). Status of coral reefs in the ASEAN region. p 8- 17 In: Wilkinson, C.R. (ed.). Living coastal resources of Southeast Asia: Status and Management. Report of the Consultative forum third ASEAN-Australia Symposium on Living Coastal Resources. Chulalongkorn University Bangkok, Thailand. May 1994. Australian Institute of Marine Science.

Chou L.M., Yuan V.S., Yeemin T., Cabanban A., Suharsono and Kessna, I. (2002). Status of the southeast Asia coral reefs. p 123-152 In: Wilkinson, C.R. (ed.) Status of coral reefs of the world: 2002. Australian Institute of Marine Science.

Chua, T.E. (1989). Will coastal area management programmes work in Southeast Asia? p 231-240. In: Chua, T.E. and Pauly, D. (eds.) Coastal area management in Southeast Asia: Policies, Management Strategies and Case studies. Association of Southeast Asian Nations/United States Coastal Resources Management project. Conference Proceedings 2.

Chua, T.E., Paw, J.N. and Tech, E. (1989). Coastal Aquaculture development in ASEAN: the need for planning and environmental management. p 57-70 In: Chua, T.E. and Pauly, D. (eds.) Coastal Area Management in Southeast Asia: Policies, Management Strategies and Case Studies. Association of Southeast Asian Nations/United States Coastal Resources Management Project Conference Proceedings 2.

DeVantier L., Alcala, A. and Wilkinson, C. (2004). The Sulu-Sulawesi Sea: Environmental and Socioeconomic status, future prognosis and ameliorative policy options. Ambio 33:8-97.

Dight, I., Kenchington, R., and Baldwin, J. (eds.) (1999). Proceedings of the International Tropical Marine Ecosystems Management Symposium. November 1998. Published by the Great Barrier Reef Marine Park Authority, Townsville, Australia.

Done, T.J. (1999). Coral community adaptability to environmental change at the scales of regions, reefs, and reef zones. American Zoologist 39:66-79.

Down to Earth (2001). The shrimp industry. No. 51, Nov. 2001. Retrieved Aug. 2003 from: http://www.dte.gn.apc.org/51srp.htm

Drigo, R. and Marcoux, A. (1999). Population dynamics and the assessment of land use changes and deforestation. Sustainable Development Department, United Nations Food and Agricultural Organization, Rome, Italy.

Edinger, E.N., Jompa, J., Limmon, G.V., Widjatmoko, W. and Risk, M.J. (1998). Reef degradation and coral biodiversity in Indonesia: land-based pollution, destructive fishing practices and changes over time. Marine Pollution Bulletin 36:617-630.

Erdmann, M.V. and Merrill, P. (2003). Multiple-use Zoning in Marine Protected Areas: Bunaken National Park case study (Indonesia). Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

Erdmann, M.V. and Toengkagie, A. (2003). The Bunaken National Park Joint Patrol System: Lessons Learned from a Multistakeholder Enforcement Initiative. Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

Erdmann, M.V., Merrill, P.R. and Arsyad, I. (2003). Developing a Decentralized User Fee System for Sustainable Conservation Financing of Bunaken National Marine Park. Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

Erdmann, M.V., Caldwell, R.L. and Moosa, M.K. (1998). Indonesian 'King of the Sea' Discovered. Nature 395:335.

EROS Data Center (2002). Hydro 1K. Retrieved Nov. 2003 from: http://edcdaac.usgs.gov/gtopo30/hydro/

ESRI (2002). Country borders. Data & Map CD-rom. Environmental Systems Research Institute, Inc.Redlands, California, US.

Etkin, D.S. (1997). Oil spill in East Asia: Over 220 million gallons spilled since 1965. Oil Spill Intelligence Report.

FAO (1998). FAO concerned about severe declines in shark stocks - international plan of action calls for sustainable management. FAO Press Release 98/61.

FAO (2000). Fishery Country Profile, Indonesia. Retrieved Aug. 2003 from: http://www.fao.org/fi/fcp/FICP_IDN_E.asp

FAO AQUASTAT (2003). United Nations Food and Agricultural Organization, Database. Retrieved Aug. 2003 from: http://www.fao.org/waicent/faoinfo/agricult//AGL/AGLW/aquastat/dbase/index.stm

FAO/UNDP/UNEP (1994). Land degradation in South Asia: its severity, causes and effects upon the people. World Soil Resources Report No. 78. United Nations Food and Agricultural Organization, Rome, Italy.

GEF (1999). Formulation of a TDA and preliminary framework of strategic action programme for the Sulu-Sulawesi LME. Global Environmental Facility.

Gunnerson, C.G. and Cuellar, M. (1988). Case studies: Manila Bay. p 307-317 In: Gunnerson, C.G. (ed.) Wastewater management for coastal cities. The ocean disposal option. World Bank Technological Paper No. 77. World Bank, Washington, D.C.

Hardin, G. (1968). The Tradgedy of the Commons. Science 162:1243-1248.

Hettige, H., Huq, M., Pargal, S. and Wheeler, D. (1996). Determinants of pollution abatement in developing countries: Evidence from South and Southeast Asia. World Development 24 (12):1891-1904.

Hodgson, G., and Dixon, J.A. (1988). Logging versus fisheries and tourism in Palawan. East-West Environment and Policy Institute. Occasional Paper No. 7.

Hodgson, G. and Dixon, J.A. (1992). Sedimentation damage to marine resources: Environmental and economic analysis. p 421-446 In: Marsh, J.B. (ed.) Resources and Environment in Asia's Marine Sector. Taylor and Francis, Washington.

Hoegh-Guldberg, O. (1999). Climate change, coral bleaching and the future of the world's coral reefs. Marine and Freshwater Research 50:839-866.

Hopley, D. and Suharsono. (2000). The status of Coral Reefs in Eastern Indonesia. Australian Institute of Marine Science.

Hughes, T.P. (1994). Catastrophes, phase-shifts and large scale degradation of a Caribbean coral reef. Science 265:1547-1551.

Ingles, J. (2000). Fisheries of the Calamianes Islands, Palawan Province, Philippines. p 45-64 In: Werner, T.B. and Allen, G.R. (2000). A Rapid Marine Biodiversity Assessment of the Calamianes Islands, Palawan Province, Philippines. RAP Bulletin of Biological Assessment 17. Washington DC. Conservation International.

Jacinto, G.S., Alino, P.M., Villanoy, C.L., Talaue-McManus, L. and Gomez, E.D. (2000). The Philippines. In: Sheppard, C.R.C. (ed.) Seas at the Millenium: An Environmental Evaluation. Vol. II Regional Chapters: The Indian Ocean to the Pacific. Pergamon Press, Elsevier.

Jackson, J.B.C. (1997). Reefs since Columbus. Coral Reefs 16:S23-S32.

Jackson, J.B.C., Kirby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.B., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A., Hughes, T.P., Kidwell, S., Lange, C.B., Lenihan, H.S., Pandolfi, J.M., Peterson, C.H., Steneck, R.S., Tegner, M.J. and Warner, R.R. (2001). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science 293:629-638.

Johannes, R.E. and Riepen, M. (1995). Environment, economic and social implications of the live fish trade in Asia and the western Pacific. Report to the Nature conservancy and Forum Fisheries Agency.

Kahn, B. and Fauzi, A. (2001). Fisheries in the Sulu Sulawesi Seas - Indonesian Country Report. Assessment of the state of biophysical, socio-economic, and institutional aspects of coastal and pelagic fisheries in the Indonesian part of the Sulu-Sulawesi Seas. WWF Sulu-Sulawesi Marine Ecoregion Fisheries Project.

Kleypas, J.A., Buddemeier, R.W., Archer, D., Gattuso, J-P., Langdon, C. and Opdyke, B.N. (1999). Geochemical consequences of increased atmospheric carbon dioxide on coral reefs. Science 284:118-120.

Licuanan, W.Y., and Gomez, E.D. (2000). Philippine coral reefs, and associated fisheries status and recommendations to improve their management. Global Coral Reef Monitoring Network. Australia Institute of Marine Science.

Ludwig, H.F. (1985). Final report of the consultant (phase I report). Segara Anakan Environmental Monitoring and Optimal Use Planning Project, Institute of Hydraulic Engineering, Bandung, Indonesia.

LME (2003). Large Marine Ecosystems of the World. LME #37: Sulu-Celebes. Retrieved Aug. 2003 from: http://www.edc.uri.edu/lme/text/sulu-celebes-sea.htm

Maclean, J.L. (1989). An overview of Pyrodinium red tides in the western Pacific. p 1-8 In: Hallegraeff, G.M. and Maclean, J.L. (eds.) Biology, epidemiology and management of Pyrodinium red tides. ICLARM Conf. Proc. 21: Fisheries Department, Ministry of Development, Brunei Darussalam, and International Centre of Living Aquatic Management, Manila, Philippines.

McManus, L.T. (2000). Transboundary Diagnostic Analysis of the South China Sea. UNEP/EAS/RCU, Bangkok, Thailand.

Merrill, R. (2001). Workshop among NRM/EPIQ, The Nature Conservancy, World Wide Fund for Nature Indonesia and the Ministry of Forestry's Director General for Forest Protection and Nature Conservation.

Ming, C.L., Wilkinson, C., Gomez, E. and Sudara, S. (1994). Status of coral reefs in the ASEAN region. p 8-12 In: Wilkinson, C.R. (ed.) Living coastal resources of Southeast Asia: Status and Management. Report of the Consultative forum third ASEAN-Australia Symposium on Living Coastal Resources. Chulalongkorn University Bangkok, Thailand. May 1994. Australian Institute of Marine Science.

MPP-EAS (1998). Marine pollution management in the Malacca/Singapore Straits: Lessons learned. MPP-EAS/Info99/195. GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas. Quezon City, Philippines.

NOAA/NESDIS (2003). NOAA Satellites and information. Retrieved Aug. 2003 from: http://www.osdpd.noaa.gov/PSB/EPS/SST/climohot.html

NRM Headline News (2000). Natural Resources Management Headline News. Information courtesy M. Erdmann, Bunaken National Park. Issue 12. Available at http://www.bunaken.info/nrm_news.html

NRM Headline News (2001). Natural Resources Management Headline News. Information courtesy M. Erdmann, Bunaken National Park. Issue 33. Available at http://www.bunaken.info/nrm_news.html

NRM Headline News (2002a). Natural Resources Management Headline News. Information courtesy Sri Hardiyanti Gunadi, Kim J. deRidder and Mark V. Erdmann. Issue 10. Available at http://www.bunaken.info/nrm_news.html

NRM Headline News (2002b). Natural Resources Management Headline News. Information courtesy William Faries. Issue 11. Available at http://www.bunaken.info/nrm_news.html

NRM Headlines (2002c). Natural Resources Management Program Headline News. Issue 4. Available at http://www.bunaken.info/nrm_news.html

NRM Headline News (2003). Natural Resources Management Headline News. Information courtesy of Idham Arsyad, NRM III Protected Areas Management Specialist and Reed Merrill, NRM III Protected Areas & Agriculture Advisor. Issue 4. Available at http://www.bunaken.info/nrm_news.html

Ormond, R.F.G., Bradbury, R., Bainbridge, S., Fabricus, K., Keesing, J., De Vantier, L., Medley, P. and Steven, A. (1990). Test of a model of regulation of crown-of-thorns starfish by fish predators. In: Bradbury, R.H. (ed.) Acanthaster and the Coral Reef: A Theoretical Perspective, Lecture Notes in Biomathematics 88. Springer-Verlag, New York.

ORNL (2003). Landscan 2002. Oak Ridge National Laboratory. Retrieved Nov. 2003 from: http://www.ornl.gov/gist

Pargal, S., Hettige, H., Singh, M. and Wheeler, D. (In preparation). Formal and informal regulation of industrial pollution: Comparative Evidence from Indonesia and the US. PRD Working Paper # 1797. World Bank Policy Research Working Paper Series.

Pauly, D. (1989). Fisheries resources management in southeast Asia: Why bother? p 1-9 In: Chua, T.E. and Pauly, D. (eds.) Coastal area management in Southeast Asia: Policies, management strategies and case studies. Proceedings of the ASEAN/US Policy Workshop on Coastal Area Management Johore Bahru, Malaysia. 25-27 October 1988.

Pauly, D., Saeger, J. and Prein, M. (1998). Malthus und die Kuestenfischerei der Tropen: eine philippinische Fallstudie. Entwickl. Laendlicher Raum 32(2):17-20. (In German)

Pet, J. and Pet-Soede, L. (1999). A note on cyanide fishing in Indonesia. SPC Live Reef Fish Bulletin 5:21-22.

Pet-Soede, L. and Erdmann, M. (1999). An overview and comparison of destructive fishing practices in Indonesia. SPC Live Reef Fish Bulletin 4:28-36.

Pilcher, N. and Cabanban, A. (2000). The status of coral reefs in eastern Malaysia. Australian Institute of Marine Science.

Pratt, V.R. (1996). The growing threat of cyanide fishing in the Asia Pacific Region, and the emerging strategies to combat it. Coastal Management in Tropical Asia 5:9-11.

Roberts, C.M. and Hawkins, J.P. (2000). Fully-protected marine reserves: A guide. WWF in Washington DC, US, University of York, York, UK.

Roberts, C.M., Colin, J.M., Veron, J.E.N., Hawkins, J.P., Allen, G.R., McAllister, D.E., Mittermeier, C.G., Svhueller, F.W., Spalding, M., Wells, F., Vynne, C. and Werner, T.B. (2002). Marine biodiversity hotspots and conservation priorities for tropical reefs. Science 295:1280-1284.

Rossiter, W.W. (2002). Fisheries conservation crisis in Indonesia. Massive destruction of marine mammals, sea turtles and fish reported from trap nets in pelagic migratory channel. Retrieved Sept. 2003 from: http://darwin.bio.uci.edu/~sustain/bio65/indonesia/indon97e.htm

Rudd, M.A., Tupper, M.H., Folmer, H. and van Kooten, G.C. (2003). Policy analysis for tropical marine reserves: challenges and directions. Fish and Fisheries 4(1):65.

Russ, G. and Alcala, A. (1996a). Marine reserves: rates and patterns of recovery and decline in abundance of large predatory fish. Ecological Applications 6:947-961.

Russ, G. and Alcala, A. (1996b). Do marine reserves export adult fish biomass? Evidence from Apo Island, central Philippines. Marine Ecology Progress Series 132:1-9.

Russ, G. (1985). Effects of protective management on coral reef fishes in the central Philippines. Proceedings 5th International Coral Reef Congress 4:219-224.

Sardjono, I. (1980). Trawlers banned in Indonesia. ICLARM Newsletter, 3(4):3.

Sherwood, K. (2002). Local commitment to conservation: A Philippine success story. p 143 In: Wilkinson, C. (ed.) Status of Coral Reefs of the World: 2002. Australian Institute of Marine Science.

Spalding, M., Ravilious, C. and Green, E.P. (2001). World Atlas of Coral Reefs. United Nations Environment Programme World Conservation Monitoring Centre.

Talaue-McManus, L. (2000). Transboundary Diagnostic Analysis for the South China Sea. EAS/RCU Technical Report Series No. 14, UNEP, Bangkok, Thailand.

The National Academies (1998). Fishing should be reduced substantially to protect marine ecosystems. Retrieved July 2002 from http://www4.nas.edu/news.nsf/isbn/0309055261?OpenDocument

UNEP/WCMC (2003). World Database on Protected Areas. UNEP Geo Data Portal. Retrieved Nov. 2003 from: http://geodata.grid.unep.ch

University of British Columbia Fisheries Centre (2003). Large marine ecosystems. Retrieved Aug. 2003 from: http://www.seaaroundus.org/lme/summaryinfo.aspx?lme=37#

USGS (2002). Global GIS database: Global Land Cover Characteristics. CD-rom. US Department of the Interior, US Geological Survey, Flagstaff, USA.

Uychiaoco, A.J., Alino, P.M. and White, A.T. (2002). Marine Protected Areas in the Philippines: Towards harmonizing goals and strategies. 4th IUCN/WCPA-East Asia Conference.

Valencia, M.J. (1989). Petroleum and minerals: Policy Issues. p 27-41 In: Chua, T.E. and Pauly, D. (eds.) Coastal Area Management in Southeast Asia: Policies, Management Strategies and Case Studies. Association of Southeast Asian Nations/United States Coastal Resources Management Project Conference Proceedings 2.

Veron, J.E.N. (2000). Corals of the World. 3 Vols. Australian Institute of Marine Science.

Weber, M.L. (1998). A Global Assessment of Major Fisheries at Risk, Relevant Management Regimes, and Non-Governmental Organizations. Prepared for the Pew Charitable Trusts.

Werner, T.B. and Allen, G.R. (2000). A Rapid Marine Biodiversity Assessment of the Calamianes Islands, Palawan Province, Philippines. RAP Bulletin of Biological Assessment 17. Washington DC. Conservation International.

White, A.T., Christie, P., Divinagracia, M.F., Apurado, J., Alvarado, A. and White E. (1999). Summary field report: coral reef surveys for conservation in southwest Bohol, Earthwatch Expedition to the Philippines, May 1-22, 1999. Coastal Resource Management Project, Sulu Fund and Earthwatch Institute, Cebu City.

Wilkinson, C. (ed.) (2000). Status of Coral Reefs of the World: 2000. Australian Institute of Marine Science, Townsville, Australia.

Wilkinson, C. (ed.) (2002). Status of Coral Reefs of the World: 2002. Australian Institute of Marine Science, Townsville, Australia.

World Bank (2003a). World bank data and statistics. Retrieved Aug. 2003 from: http://www.worldbank.org/data/countrydata/countrydata.html

World Bank (2003b). World bank's health, nutrition and population data. Retrieved Aug. 2003 from http://devdata.worldbank.org/hnpstats/

World Bank (2004). World Development Indicators Database. Retrieved Jan. 2005 from: http://devdata.worldbank.org/data-query/

WRI (2003). World Resources Institute. Retrieved Aug. 2003 from: http://www.wri.org/

WWF (2001). Sulu-Sulawesi Seas Ecoregion: Users, Uses and Threats. A report integrated by Raoul Cola for the Sulu-Sulawesi Marine Ecoregion Program, WWF.

WWF (2003). WWF International corals initiative - Sulu Sulawesi marine ecoregion. Retrieved Aug. 2003 from: http://www.panda.org/downloads/marine/wwfssme2.pdf

Young, A. and Serna, E. (1982). Country report: Philippines. p 16-19 In: Davy, B.F. and Graham, M. (eds.) Proceedings of the workshop on bivalve culture in Asia and the Pacific, 16-19 February 1982. International Development Research Centre of Canada. Singapore.

Personal communication

Alcala, A. (SUAKCREM Marine Laboratory, Dumaguete City, Philippines)

Chua, T.E. (PEMSEA (GEF/UNDP/IMO Regional Programme on Partnerships in Environmental Management for the Seas of East Asia), Philippines)

Lina, J. (Interior and Local Government Secretary, Philippines)

R. Merrill (Protected Areas & Agriculture Advisor NRM III, Jakarta, Indonesia)

Miclat, E. (SSME Program, WWF, Quezon City, Philippines)

Mous, P. (The Nature Concervancy, Indonesia)

Pet-Soede, L. (Fisheries Program Manager, WWF Indonesia - Wallacea Program, Indonesia)

Trono, R. (WWF-Philippines and SSME Program, WWF, Quezon City, Philippines)

Annexes

Annex I
List of contributing authors and organisations involved

Name	Institutional affiliation	Country	Field of work
Dr. Achmad Abdullah (deceased)	Past Director for Conservation and Marine National Parks, Ministry of Marine Affairs and Fisheries, Jakarta	Indonesia	Natural resources management and protected areas policy
Ms. Heni Augustina	Directorate for Marine and Coastal Degradation Control, Environment Impact Management Agency, (BAPEDAL), Jakarta	Indonesia	Coastal and marine pollution, health and EIA policy
Dr. Angel Alcala	SUAKCREM Marine Laboratory, Dumaguete City	Philippines	Coral reef ecosystems, fisheries assessment and management
Dr. Porfirio Alino	Marine Science Institute, University of the Philippines, Diliman, Quezon City	Philippines	Coral reef ecosystems -assessment and management, global change
Dr. Imam Bachtiar	Biology Dept., FKIP, Mataram University	Indonesia	Coral reef ecosystems, global change and fisheries
Mr. Ronald Bonifacio	Coastal Management Center, Manila	Philippines	Natural resources management
Dr. Annadel Cabanban	Borneo Marine Research Unit, University Malaysia, Sabah	Malaysia	Tropical coastal and marine ecosystems assessment and management
Ms. Catherine Cheung	International Conservation Union, Hanoi, Vietnam	Australia	Terrestrial and marine protected areas - assessment, planning, management and policy
Dr Laura David	World Fish Center (ICLARM), Penang, Malaysia	Philippines	Tropical coastal and marine ecosystems – connectivity, management
Dr. Lyndon DeVantier	International Marine Projects Activities Centre and CRC Reef Research Centre, Townsville, Qld	Australia	Coral reef ecosystems and marine protected areas
Ms. Rili Djohani	The Nature Conservancy Coastal and Marine Program Indonesia, Denpasar	Indonesia	Marine protected areas and fisheries - assessment, planning, management and policy
Dr. Mark Erdmann	Conservation International, Denpasar, Bali, Indonesia	Indonesia	Marine protected areas and coral reef biodiversity - assessment, planning, management and policy
Dr. Miguel Fortes	Marine Science Institute, University of the Philippines, Diliman, Quezon City	Philippines	Tropical coastal and marine ecosystems - assessment and management
Dr. Ed Gomez	Marine Science Institute, University of the Philippines, Diliman, Quezon City	Philippines	Tropical coastal and marine ecosystems - assessment and management
Dr. Kevin Hiew	National Programme Director, WWF Malaysia, Petaling Jaya Selangor	Malaysia	Tropical ecosystems policy and management
Dr. Jose Ingles	Sulu-Sulawesi Marine Ecoregion Program (SSME), WWF Quezon City	Philippines	Coral reef fisheries assessment and management
Dr. Gil Jacinto	Marine Science Institute, University of the Philippines, Diliman, Quezon City	Philippines	Tropical coastal and marine ecosystems - assessment and management
Dr. Roger Juliano	Coastal Management Center, Manila	Philippines	Coastal and marine environmental policy
Dr. Teng Seh Keng	Coastal Management Center, Manila	Philippines	Coastal and marine environmental policy
Mr. Maarten Kuijper	IOC/WESPAC Secretariat, Bangkok	Thailand	Coastal and marine environmental policy
Dr. David Lawrence	International Marine Projects Activities Centre, Townsville, Qld	Australia	Anthropology, socio-economics
Dr. Al Licuanan	Marine Science Institute, University of the Philippines, Diliman, Quezon City	Philippines	Coastal and marine environmental policy
Dr. Medel Limsuan	Department of Environment and Natural Resources, Quezon City	Philippines	Coastal and marine environmental policy
Ms. Evangeline Miclat	SSME Program, WWF, Quezon City	Philippines	Coastal and marine environmental policy

Dr. Peter Mous	The Nature Conservancy Coastal and Marine Program Indonesia, Denpasar, Bali, Indonesia	Indonesia	Tropical marine resources management and protected areas
Assoc. Prof. Cleto Nanola	University of the Philippines, Mindanao	Philippines	Coral reefs - assessment and management
Dr. Jos S. Pet	Program Manager, Southeast Asia Center for Marine Protected Areas, The Nature Conservancy	Indonesia	Tropical natural resources management, fisheries and protected areas
Dr. Lida Pet-Soede	Fisheries Program Manager, WWF Indonesia - Wallacea Program	Indonesia	Fisheries, tropical natural resources management and protected areas
Dr. Nicolas Pilcher	Technical Advisor, Community Conservation Network	Republic of Palau	Tropical coastal and marine ecosystems, Marine Turtles – assessment and management
Dr. Srihartiningsih Purnomohadi	Assistant Deputy Minister, The State Ministry for Environment, Jakarta	Indonesia	Coastal and marine environmental policy – socio-economics
Dr Ketut Sarjana Putra	Formerly of WWF Indonesia-Wallacea Bioregion Programme, Denpasar	Philippines	Coastal and marine environmental management
Prof. Robin South	International Ocean Institute Regional Centre for Australia, Townsville, Qld	Australia	Tropical coastal and marine ecosystems policy and management
Dr. Posa Skelton	International Ocean Institute Regional Centre for Australia, Townsville, Qld	Australia	Coral reef ecosystems – algal taxonomy and ecology
Dr. Jan Steffan	UNESCO, Jakarta, Indonesia	Indonesia	Tropical natural resources management, planning and policy
Dr. Chua Thia-Eng	GEF/UNDP/IMO Regional Programme on Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City	Philippines	Coastal and marine environmental management – planning, socio-economics and policy
Dr. Romeo Trono	Formerly WWF-Philippines and SSME Program, WWF, Quezon City	Philippines	Tropical natural resources management, planning and policy
Dr. Clive Wilkinson	International Marine Projects Activities Centre and CRC Reef Research Centre, Townsville, Qld	Australia	Tropical coastal and marine ecosystems – assessment, monitoring, management and policy

Annex II
Detailed scoring tables

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	2	N/a	Freshwater shortage	2
2. Pollution of existing supplies	2	N/a		
3. Changes in the water table	2	N/a		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small 0 1 2 3 Very large	2	N/a
Degree of impact (cost, output changes etc.)	Minimum 0 1 2 3 Severe	2	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/a
Weight average score for Economic impacts		**2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small 0 1 2 3 Very large	1	N/a
Degree of severity	Minimum 0 1 2 3 Severe	1	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/a
Weight average score for Health impacts		**1**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small 0 1 2 3 Very large	1	N/a
Degree of severity	Minimum 0 1 2 3 Severe	1	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/a
Weight average score for Other social and community impacts		**1**	

Note: N/a = Not applied

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	1	N/a	Pollution	2
5. Eutrophication	2	N/a		
6. Chemical	1	N/a		
7. Suspended solids	3	N/a		
8. Solid wastes	2	N/a		
9. Thermal	1	N/a		
10. Radionuclide	0	N/a		
11. Spills	1	N/a		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small 0 1 2 3 Very large	2	N/a
Degree of impact (cost, output changes etc.)	Minimum 0 1 2 3 Severe	2	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/a
Weight average score for Economic impacts		**2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small 0 1 2 3 Very large	2	N/a
Degree of severity	Minimum 0 1 2 3 Severe	2	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/a
Weight average score for Health impacts		**2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small 0 1 2 3 Very large	2	N/a
Degree of severity	Minimum 0 1 2 3 Severe	2	N/a
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/a
Weight average score for Other social and community impacts		**2**	

Note: N/a = Not applied

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	3	N/a	Habitat and community modification	3
13.Modification of ecosystems or ecotones, including community structure and/or species composition	3	N/a		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	N/a
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	N/a
Weight average score for Economic impacts		**3**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	N/a
Degree of severity	Minimum – Severe 0 1 2 3	2	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	N/a
Weight average score for Health impacts		**2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	N/a
Degree of severity	Minimum – Severe 0 1 2 3	3	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	N/a
Weight average score for Other social and community impacts		**3**	

Note: N/a = Not applied

IV: Unsustainable exploitation of fish and other living resources

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	N/a	Unsustainable exploitation of fish	3
15. Excessive by-catch and discards	3	N/a		
16. Destructive fishing practices	3	N/a		
17. Decreased viability of stock through pollution and disease	1	N/a		
18. Impact on biological and genetic diversity	3	N/a		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	N/a
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	N/a
Weight average score for Economic impacts		**3**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	3	N/a
Degree of severity	Minimum – Severe 0 1 2 3	3	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	N/a
Weight average score for Health impacts		**3**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	N/a
Degree of severity	Minimum – Severe 0 1 2 3	3	N/a
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	N/a
Weight average score for Other social and community impacts		**3**	

Note: N/a = Not applied

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	1	N/a	Global change	1
20. Sea level change	1	N/a		
21. Increased UV-B radiation as a result of ozone depletion	0	N/a		
22. Changes in ocean CO_2 source/sink function	0	N/a		
23. Increase in sea surface temperature	1	N/a		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small Very large 0 1 2 3	1	N/a
Degree of impact (cost, output changes etc.)	Minimum Severe 0 1 2 3	1	N/a
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	1	N/a
Weight average score for Economic impacts		**1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small Very large 0 1 2 3	1	N/a
Degree of severity	Minimum Severe 0 1 2 3	1	N/a
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	1	N/a
Weight average score for Health impacts		**1**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small Very large 0 1 2 3	1	N/a
Degree of severity	Minimum Severe 0 1 2 3	1	N/a
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	1	N/a
Weight average score for Other social and community impacts		**1**	

Note: N/a = Not applied

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score	Rank
	Environmental score		Economic score		Human health score		Social and community score			
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)		
Freshwater shortage	2	3	2	2	1	2	1	2	**1.9**	**4**
Pollution	2	3	2	3	2	3	2	3	**2.5**	**3**
Habitat and community modification	3	3	3	3	2	3	3	3	**2.9**	**2**
Unsustainable exploitation of fish and other living resources	3	3	3	3	3	3	3	3	**3.0**	**1**
Global change	1	1	1	2	1	1	1	1	**1.1**	**5**

Annex III
List of important water-related programmes and assessments

Major inter-governmental agreements and actors

UN Economic and Social Commission for Asia and the Pacific (ESCAP)

Within the Water Resources Programme under its Environment and Natural Resources Development Division, the UN ESCAP organises seminars and workshops on various issues relating to water resources, including: Water resources assessment; integrated water resources development and management; protection of water resources, water quality and aquatic ecosystems; river basin development and management; promotion of infrastructure development and investment for drinking water supply and sanitation; water pricing and promotion of private investment in the water sector; water demand management, water saving and economic use of water; and mitigation of water-related natural disasters, particularly flood loss reduction.

Association of Southeast Asian Nations (ASEAN)

ASEAN was established in 1967 and has 10 member countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. The ASEAN Declaration states that the aims and purposes of the Association are: to accelerate the economic growth, social progress and cultural development in the region through joint endeavours in the spirit of equality and partnership in order to strengthen the foundation for a prosperous and peaceful community of Southeast Asian nations, and to promote regional peace and stability through abiding respect for justice and the rule of law in the relationship among countries in the region and adherence to the principles of the United Nations Charter. In 1995, the ASEAN Heads of States and Government re-affirmed that "Cooperative peace and shared prosperity shall be the fundamental goals of ASEAN." See also ASEAN work on water conservation (incl. ANWRA) and seas and marine environment; ASEAN Network of Water Resources Agencies (ANWRA); the Strategic Plan of Action for the Environment (see below), adopted by the ASEAN Ministers of Environment; and ASEAN 1997 Jakarta Declaration on Environment and Development.

UNEP Regional Office for Asia and the Pacific (ROAP)

Working closely with the Division of Regional Co-operation and Representation in UNEP's Nairobi-based headquarters, the Regional Office for Asia and the Pacific (ROAP) looks to adopt global environmental policy to regional priorities and needs. It acts as a catalyst, coordinator, facilitator and mobiliser of resources. It puts particular emphasis on building partnerships with regional and regional inter-governmental fora, other UN agencies, national governments, NGOs, the private sector, academic and research institutions, civil society, and the media.

East Asian Seas Regional Coordinating Unit

Information on the UNEP East Asian Seas Programme can be found on the web site of the Coordinating Unit, which is located with ROAP. The Unit is the coordinating body for the East Asian Seas Action Plan (see below).

Financial institutions

Asian Development Bank (ADB)

The Asian Development Bank, a multilateral development finance institution, was founded in 1966 by 31 member governments to promote the social and economic progress of the Asia-Pacific region. It now has 58 member countries, 42 from within the region and 16 non-regional. ADB gives special attention to the needs of the smaller or less-developed countries, and to regional, sub-regional, and national projects and programmes. Promoting sustainable development and environmental protection is a key strategic development objective of the Bank. To fulfil this objective, the Bank: (i) reviews the environmental impacts of its projects, programmes and policies; (ii) encourages DMC governments and executing agencies to incorporate environmental protection measures in their project design and implementation procedures, and provides technical assistance for this purpose; (iii) promotes projects and programmes that will protect, rehabilitate, and enhance the environment and the quality of life; and (iv) trains Bank and DMC staff in, and provides documentation on, environmental aspects of economic development. The Asian Development Fund (ADF) is the concessional lending window of the Bank.

Action programmes, strategies and research

ASEAN Strategic Plan of Action on the Environment

The Strategic Plan of Action on the Environment for 1994-1998 has the following five objectives:

- To respond to specific recommendations of Agenda 21 requiring priority action in ASEAN;
- To introduce policy measures and promote institutional development that encourage the integration of environmental factors in all developmental processes both at the national and regional levels;
- To establish long-term goals on environmental quality and work towards harmonised environmental quality standards for the ASEAN region;
- To harmonise policy directions and enhance operational and technical cooperation on environmental matters, and undertake joint actions to address common environmental problems;

- To study the implications of AFTA on the environment and take steps to integrate sound trade policies with sound environmental policies.

Despite the impacts of the recent economic crisis on the natural resources and environmental conditions, the ASEAN Environment Ministers at their Fifth Informal Meeting in April 2000 discussed the importance of keeping their commitment to environmental protection and sustainable development. Hence, to move forward towards the future goals and directions that the ASEAN leaders expressed in ASEAN Vision 2020 and the Hanoi Plan of Action (adopted in 1997 and 1998 respectively) the Ministers adopted the ASEAN Strategic Plan of Action on the Environment (SPAE) for 1999-2004. It consists of the key activities to be implemented by ASOEN (ASEAN Senior Officials on the Environment) and its subsidiary bodies over the next five years, including the areas of coastal and marine environment, nature conservation and biodiversity, multilateral environmental agreements, management of land and forest fires and haze, and other environmental activities.

Partnership in Environmental Management for the Seas of East Asia (PEMSEA)

A GEF project, focusing on "building partnerships within and among governments of the region, as well as across public and private sectors of the economy. The goal is to reduce or remove barriers to effective environmental management, including inadequate or inappropriate policies, disparate institutional and technical capabilities and limited investment in environmental facilities and services". PEMSEA is based on two management frameworks developed and tested in an earlier GEF Project: integrated coastal management, addressing land-water interactions and the impacts of human activity in coastal areas; and risk assessment/risk management, applying to sub-regional sea areas and the impacts of human activities on marine ecosystems. PEMSEA web resources include Virtual ICM, a Legal Information Database Reference Catalogue, and a Directory of Research and Management Institutions in Southeast Asia, and a database of Good Practices. See also the PEMSEA Updates, a free online newsletter.

UNEP Regional Seas Programme

The Regional Seas Programme was initiated in 1974 as a global programme implemented through regional components. The Regional Seas Programme is UNEP's main framework in the field of the coastal and marine environment. It includes 14 regions and three partner seas, involves more than 140 coastal states, and focuses on sustainable development of coastal and marine areas. Each regional action plan is formulated according to the needs and priorities of the region as perceived by the Governments concerned. Regional conventions are in place for several areas.

East Asian Seas Action Plan

On the initiative of the five states of the East Asian region; Indonesia, Malaysia, Philippines, Singapore and Thailand, the Governing Council of UNEP in 1977 decided that "steps are urgently needed to formulate and establish a scientific programme involving research, prevention and control of marine pollution and monitoring" for a regional action plan in East Asia. An Action Plan for the Protection and Sustainable Development of the Marine Environment and Coastal Areas of the East Asian Region was adopted in 1981, with a decision making body, the Coordinating Body on the Seas of East Asia (COBSEA). A revised Action Plan and a Long-term Strategy for the COBSEA for the 1994-2000 period were developed in 1994 and Australia, Cambodia, China, Korea and Vietnam joined the Action Plan. A new East Asian Seas Action Plan "Leading the EAS Action Plan to the 21st Century" has been elaborated for the period 2000-2009.

State of the regional environment

GEO 2000 State of the Environment: Asia and the Pacific

Global Environment Outlook (GEO) is a global environmental assessment process, the GEO Process, that is cross-sectoral and participatory. It incorporates regional views and perceptions, and builds consensus on priority issues and actions through dialogue among policy-makers and scientists at regional and global levels. GEO outputs, in printed and electronic formats, including the GEO Report series. This series makes periodic reviews of the state of the world's environment, and provides guidance for decision-making processes such as the formulation of environmental policies, action planning and resource allocation. Other outputs include technical reports, a web site and a publication for young people.

GEF Projects in the region

Projects under implementation/UNDP - GEF - International waters:

Building Partnerships for the Environmental Protection and Management of the East Asian Seas

The objective of the project is to assist the riparian countries of the East Asian Seas to collectively protect and manage their heavily stressed coastal and marine environments through inter-governmental and inter-sectoral partnerships. These countries include the Republic of Korea which for the first time is a GEF recipient. Building upon the methodologies, approaches, typologies, networks and lessons learned from the pilot phase, the project would enhance and complement national and international efforts by removing or lowering critical barriers regarding policy, investment, capacity, which are having negative effects on the management of the coastal/marine environment in the region. Together with several water body-based projects in the area, these projects constitute GEF's programmatic

approach to these coastal and marine waters with globally significant ecosystems that are experiencing severe degradation.

Prevention and Management of Marine Pollution in the East Asian Seas

Development of policies and plans to control marine pollution from land-based and sea-based sources, upgrading of national and regional infrastructures and technical skills, and establishment of financing instruments for project sustainability. Project will include selection of demonstration sites, establishment of regional monitoring and information network, and involvement of regional association of marine legal experts to improve capacity to implement relevant conventions.

World Bank - GEF - Biodiversity:

Coastal and Marine Biodiversity Conservation in Mindanao, Philippines

In this project, the GEF would aim to finance the incremental costs of promoting coastal and marine biodiversity conservation and sustainable use in the coastal waters of Mindanao, Philippines. Mindanao has received little attention to date with regard to conservation of its marine biodiversity resources. The GEF-assisted Coastal and Marine and Biodiversity Conservation Component (CMBC) of the proposed Mindanao Rural Development Project (MRDP) will remove the barriers to mainstreaming marine and coastal biodiversity conservation in coastal zone development by: (a) establishing community-based management of marine sanctuaries; (b) strengthening local capacity to address marine ecosystem management issues; (c) enhancing the knowledge base for sound ecosystem management and decision-making, including monitoring and evaluation for sustainable long-term marine ecosystem management; and (d) developing policy and action plans for marine biodiversity conservation and mainstreaming it into coastal development plans.

The concept is based on the precept and the experiences that show that good marine management can simultaneously conserve and protect biodiversity and increase fisheries productivity. These activities would have considerable replication potential in Mindanao as part of the MRDP that would be an Adaptable Lending Program of 10-12 year duration. The lessons learned during the first three-year phase would be applied to subsequent phases when additional coastal provinces would be included under the MRDP with the cumulative experience strengthening implementation of the CMBC. These lessons would also have applicability in other regions of the Philippines and other tropical countries.

Project concepts in the pipeline / UNDP - GEF - Biodiversity:

Conservation of the Ecological Balance of the Sulu-Sulawesi Marine Ecosystems

The overall objective of the project is to ensure that the shared marine resources and key biological features and processes are conserved in the long-term. The PDF-B phase will focus on four components: (i) establish coordination and consultation mechanisms; (ii) undertake a preliminary diagnostic analysis of transboundary problems; (iii) prepare a full project brief and project document; and (iv) secure co-financing for the full project.

Other actors, initiatives and resources

WorldFish Center (formely ICLARM)

An international research organisation "devoted to improving the productivity, management and conservation of aquatic resources for the benefit of users and consumers in developing countries". ICLARM is one of the research centres of CGIAR, Consultative Group on International Agricultural Research. ICLARM, in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and other partners, and with support from the European Commission, has developed FishBase, a global information system on fishes for research scientists, fisheries managers, zoologists and many more. FishBase contains full information on 23 500 species. ICLARM has also developed similar systems on coral reefs and their resources (ReefBase) and management of fish stocks in Asia (TrawlBase).

International Coral Reef Initiative (ICRI)

An environmental partnership that brings stakeholders together with the objective of sustainable use and conservation of coral reefs for future generations. ICRI is an informal mechanism that allows representatives of over 80 developing countries with coral reefs to sit in equal partnership with major donor countries and development banks, international environmental and development agencies, scientific associations, the private sector and NGOs to decide on the best strategies to conserve the world's coral reef resources.

Coral Health and Monitoring Programme

The mission of the NOOA Coral Health and Monitoring Program is to provide services to help improve and sustain coral reef health throughout the world.

Long-term goals:

- Establish an international network of coral reef researchers for the purpose of sharing knowledge and information on coral health and monitoring.
- Provide near real-time data products derived from satellite images and monitoring stations at coral reef areas.

- Provide a data repository for historical data collected from coral reef areas.
- Add to the general fund of coral reef knowledge.

See also Global Coral Reef Monitoring Network (GCRMN).

The Sulu-Celebes Sea Large Marine Ecosystem

A Large Marine Ecosystem, LME, is a region of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundary of continental shelves and the seaward margins of coastal current systems. It is a relatively large region characterised by distinct bathymetry, hydrography, productivity, and trophically dependent populations. See also Rhode Island University map of LMEs.

Recent International meetings relevant to Marine Conservation and Integrated Coastal Management in Indonesia and the region

(information courtesy of Stacey A. Tighe, Senior Technical Advisor Proyek Pesisir)

- World Commission on Protected Areas (Bangkok, May 9-11, 2002),
- Coastal Zone Asia-Pacific (Bangkok, May 12-16, 2002)
- National Coastal Conference (KONAS III) (Bali, May 20-24, 2002)
- World Summit on Sustainable Development Prep Commission (Bali, May 27-June 7, 2002)

The Nature Conservancy (TNC), the World Wildlife Fund (WWF), and the U.S. Agency for International Development (through its Natural Resources Management Project and Proyek Pesisir) are collaborating and joining their efforts with their Indonesian partners to maximise the benefits and impacts for marine conservation derived from the conferences above. Indonesia has an excellent opportunity to make major advances in its strategic planning and capabilities in marine conservation and integrated coastal management by using the synergy and momentum of these four international conferences to focus attention on and support for evolving Indonesia's policies on these issues.

World Commission on Protected Areas

The objective of this meeting was to discuss the design and coordination of a regional network of marine protected areas (defined here as any officially designated marine area in which resource use is limited by specific regulations) for Southeast Asia. Experts from the region will share information on the economics, ecology, management, design and enforcement of MPAs and develop recommendations for a regional MPA network.

In support of MPAs in Indonesia:

- TNC will be supporting an environmental policy expert to participate and to then present the outcomes of the state-of-the-art of MPA design at a Pre-KONAS III Symposium on MPAs, as well as the presence of their staff who chairs the WPCA/Asia team;
- WWF is supporting the writing of a technical paper to summarise the most current knowledge on the economics of MPAs;
- NRM/EPIQ Program is supporting their coral reef expert to attend, present the economic paper and work with the Indonesian team;
- Proyek Pesisir is supporting an Indonesian marine resource economist from IPB to attend the meeting, learn the newest information on economics, and report back at the Pre-KONAS III Symposium. In addition, they are supporting two of their technical experts and four technical experts from the Ministry of Marine Affairs and Fisheries (DKP) to participate in the conference for Indonesia.

Coastal Zone Asia-Pacific

The objective of this first regional coastal meeting was to share information and to develop research and policy priorities for the regional scale issues. Approximately 250 coastal professionals from the region will attend. In support of Indonesia's new marine ministry, approximately 15 technical experts from DPK, including the Minister will be supported by Proyek Pesisir to attend. The DKP and Proyek Pesisir team of 4 staff and 3 regional counterparts will work with a facilitator to capture the information presented and its relevance to DKP and Indonesia's programmes. Five presentations from the Task team will be made at CZAP.

National Coastal Conference (KONAS III) and Pre-Conference Symposiums

The objective of the KONAS 4-day Conference is to share information on new developments in coastal zone management. All of the partners (CI, TNC, WWF, NRM/EPIQ Project and Proyek Pesisir) will be supporting several of their counterparts to attend and present papers at KONAS III. In addition, just prior to the Conference, there will be two half-day symposiums for national and regional decision-makers attending the Conference: one on Marine Protected Areas Science and Strategies, and the second on the new Coastal Zone Law under development. The objective of this half-day MPA symposium will be: to present the latest information on the science, economics and policies of MPAs to the audience of coastal decision-makers; to present a request from the WCPA for Indonesia to participate in a regional MPA network; and to present a Call to Action by the government lead agencies (Forestry, DKP) to expand and revise the national MPA strategy. Proyek Pesisir will be providing the venue for both Symposiums, WWF and NRM will be

moderating the meeting, TNC and Proyek Pesisir will be supporting speakers as a joint co-hosting. An output from the MPA Symposium will be a briefing document based on the presentations and discussions developed by the Task team. An additional event at KONAS will be the selection and announcement of Indonesia's new ICM logo, developed by an inter-agency and NGO team with support from Proyek Pesisir.

World Summit on Sustainable Development- Prep Commission

This event was a preparatory meeting for the World Summit on Sustainable Development (WSSD or Rio Plus 10) held in South Africa in September 2002. Environmental Ministers from around the world will be attending to discuss the text and policies to be finalised at Rio Plus 10. For this event, TNC will be supporting two initiatives that will be announced by DKP, a National Marine Whale Sanctuary proposal and the String of Pearls MPA programme. The MPA briefing document from the Pre-KONAS Symposium will be available for distribution, and the ICM Logo and Campaign can be presented and launched as well. WWF and ICRAN are presenting a coral reef exhibit in connection with the WSSD. Minister Rokhmin Dahuri of the Ministry of Marine Affairs and Fisheries will be hosting an event at their exhibit.

Annex IV
List of conventions and specific laws that affect water use

Key international conventions and treaties [1]

The Philippines, Indonesia and Malaysia are signatory to several international conventions and have enacted various national laws and regulations that are relevant to water-related issues in the region. For example, the three nations have ratified:

- Conservation on Biological Diversity (CBD);
- Convention on International Trade in Endangered Species (CITES);
- Ramsar Wetlands Convention;
- United Nations Framework Convention on Climate Change (UNFCCC);
- World Heritage Convention.

The Philippines and Malaysia have also ratified the UN Convention on the Law of the Sea. The three nations have sovereign rights to the 12 nautical mile limit and have also declared 200-mile Exclusive Economic Zones. The Philippines and Indonesia unilaterally use the 'Archipelagic Doctrine' to define their territorial waters. Several government sectors concerned with use of natural resources have proposed policies or legislation relevant to obligations under the various International Conventions. However, it is apparent that despite the ratifications, there has been little progress to date in implementation and the resolution of related problems. This has been attributed to the lack of action by the various governments in addressing their obligations under the Conventions. A recently developed 'Environmental Strategy for the Seas of East Asia' provides many pertinent recommendations and solutions to these problems

Key national legislation [2]

Environmental legislation in the Philippines

- 1964: National Water and Air Pollution Control Commission Act
- 1974: Revised Coast Guard Law
- 1976: Marine Pollution Decree
- 1976: National Pollution Control Commission
- 1978: The Water Code of the Philippines
- 1979: Environmental Impact Statement System
- 1980: Regulations for the Conservation of Marine Turtles
- 1981: The Coral Resources Development and Conservation Decree
- 1984: Environmental Impact Statement System-Areas/Types of Projects
- 1988: Small Scale Mining Law
- 1990: Philippine Environment Code
- 1991: Local Government Code
- 1992: National Integrated Protected Areas System
- 1992: Toxic Substances and Hazardous and Nuclear Wastes Control Act
- 1992: Strategic Environment Plan for Palawan Act
- 1995: Guidelines on Biological and Genetic Resources
- 1995: Philippine Mining Act
- 1995: The Water Crisis Act
- 1996: Preferential Treatment of Small Fisher folks
- 1997: Agriculture and Fisheries Modernization Act
- 1997: Philippine Environment Policy
- 1998: Philippine Fisheries Code
- 1999: Philippine Clean Air Act
- 2001: Wildlife Resources Conservation and Protection Act

Environmental legislation in Indonesia

- 1932 & 1941: Colonial Nature Protection Ordinances
- 1945: Constitution
- 1949: Independence
- 1971: Establishment of the Directorate of Nature Conservation and Wildlife
- 1980: Trawling Ban (Sardjono 1980)
- 1982: Basic Environmental Law
- 1985: Directorate General for Fisheries Law No. 9
- 1990: Conservation of Living Natural Resources and their Ecosystems Act
- 1992: (Act No. 24) Spatial Planning Act
- 1997: (Act No. 23) The Management of the Living Environment
- 1999: (Act No. 22) Decentralisation of authority from central government to provincial and district governments
- 1999: Creation of the Ministry of Marine Affairs and Fisheries

Environmental legislation in Malaysia and Sabah

- 1954: (Act 134, revised 1974) Aboriginal Peoples Act
- 1959: (Act 298, revised 1983) Protected Areas and Protected Places Act
- 1963: (Act 210, amended 1985 by Act 317) Fisheries Act
- 1972: (Act 76, revised 1976 and 1991) Protection of Wildlife Act
- 1974: (Act 127, amended 1985 by Act A636 and 1996 by Act A953) Environmental Quality Act
- 1976: (Act 171) Local Government Act
- 1980: (Act 226 amended in 1983) National Parks Act
- 1984: (Act 313) National Forestry Act

Environmental legislation in Sabah

- 1962: (amended 1996) National Parks Ordinance replaced by the National Parks Enactment (1977) and by Parks Enactment (1984)
- 1963: (amended 1979) Fauna Conservation Ordinance
- 1968: (amended 1984) Forests Enactment (Classified forests - Class V mangrove forest)
- 1997: Wildlife Conservation Enactment

[1] *Cheung et al. 2002* [2] *Chua Thia-Eng, PEMSEA pers. comm.*

Annex V
Sulu-Celebes Sea Large Marine Ecosystem

(Excerpted from: http://www.edc.uri.edu/lme/text/sulu-celebes-sea.htm)

The GEF/UNDP has funded a PDF-A for development of a Transboundary Diagnostic Analysis and preliminary framework of a Strategic Action Programme for the Sulu-Celebes Large Marine Ecosystem.

Brief description

The Sulu-Celebes Sea Large Marine Ecosystem is a semi-enclosed sea bounded by northern Borneo (Malaysia), the southwest coast of the Philippines, and Sulawesi Island (northern coast of Indonesia). It has an area of about 900 000 km^2, and is comprised of the Sulu Sea and the Celebes Sea (sometimes referred to as the Sulawesi Sea). Much of the LME has a depth greater than 3 000 m. The LME is oceanographically well defined, by the Palawan trough to the north, and by a promontory from Sulawesi Island to the south. There is a deeper area, and a chain of islands known as the Sulu Archipelago, separating the two seas. The Sulu Sea's surface currents come from the south in the summer, whereas the winter currents follow a counterclockwise gyre. The Celebes' strong currents, its deep sea trenches, seamounts and active volcanic islands result in a complex oceanography.

Productivity

The Sulu-Celebes Seas LME is considered a Class III, low productivity (<150 gC/m2/year), ecosystem based on SeaWiFS global primary productivity estimates. There are 1 800 species of fish, 400 species of algae, 5 species of sea turtles, 22 species of marine mammals and over 450 types of coral. There are orcas, whales, dolphins, and pelagic species such as tuna and marlin. In the Sulu Sea, Apo Reef and Tubbataha Reef have been shown to be at the centre of a system of currents distributing fish and lobster larvae throughout the area. For detailed information on the importance of coral reefs in this LME, see data collected by the University of British Columbia Fisheries Center. The warm clear waters of the Celebes Sea, its active underwater volcanoes, its seamounts, trenches, corals and inter-island passages, its currents and upwellings, constitute an exceptionally rich marine life hot spot. It is home to whales, sharks, dolphins, sea turtles, manta rays, marlin and other pelagic fish.

Fish and fisheries

Coastal trawling for prawn supplies a major marine export industry, while a variety of artisanal fishing methods are used to catch fish for local consumption, constituting a primary food resource for the region. The species fished include whale sharks, manta rays, billfish, prawns, yellowfin tuna, grouper and clams. Most of the fishing occurs in coastal areas, while the offshore waters are largely unexploited. Coastal trawling is aimed at prawn, a major export. Most of the landings in Indonesia and in the Philippines are from small-scale artisanal fisheries, using a variety of artisanal fishing methods to catch mostly finfish. This is a primary food resource for the region. Traditional fishing techniques include spider web fishing. Many fishing techniques are highly destructive: there is dynamite and cyanide fishing on the reefs of the Philippines, with fishermen coming from nearby Taiwan and Hong Kong. The number of illegal fishermen exploiting the resources of the reef is steadily increasing. Few countries in the region have implemented fisheries management plans. The University Of British Columbia Fisheries Center has detailed fish catch statistics for this LME.

Pollution and ecosystem health

Years of dynamite and cyanide fishing have taken their toll on the coral reefs of the Philippines. The country's marine resources are overstretched, as evidenced by the recent decline in tuna exports. The export and domestic markets continue to take no account of the ecological limits of the ecosystem. Damage to coral communities is caused by careless divers and by boat anchors. Illegal tours by collectors see the marine environment picked of turtle eggs, giant clams and seashells. The Tubbataha Reefs are not free from intrusion and destruction. Both Tubbataha Reef and Turtle Island have fallen prey to the destructive practices of people selling turtle eggs, thereby endangering the continuing existence of these turtles. Local extinction, according to the World Wildlife Fund, is imminent. In 1995, the Philippines Department of Environment and Natural Resources (DENR) revealed that coral cover and fish density in the reef are "decreasing at an alarming rate" despite the site's official status as a protected National Marine Park.

Socio-economics

For more than 10 000 years, the indigenous population of this area has harvested the sea's seemingly unlimited supply of marine life. But today the LME is under threat. The Tubbataha Reef and other coastal areas of the Sulu-Celebes Sea, while serving as important spawning grounds for the entire region, also provide a livelihood for the fishing communities crowding its shores. Short-term gain in the guise of uncontrolled exploitation is wrecking a habitat. At the same time, it is asking a lot to close these areas to fishing when communities need to fish in order to survive. Population pressure in the local fishing communities, poverty, and a lack of economic alternatives all contribute to the problem. The resources of the LME are a source of hard currency for the debt-

burdened government. Other economic activities are oil and gas production from offshore areas and tourism. Tourism increases every year and contributes both to the local and to the national economy.

Governance

There is a pressing need for improved management and cooperation between countries in conserving and protecting the Sulu-Celebes Sea Large Marine Ecosystem. Enforcement, education and research are necessary measures, as are efforts to curb illegal fishing. In 1988, Tubbataha Reef was declared as the first National Marine Park in the Philippines. In 1993, the United Nations Educational Scientific and Cultural Organization (UNESCO) declared the reef a World Heritage Site. Turtle Island has also been declared a protected area. These declarations indicate the government's commitment to conserve the areas and have increased international awareness and support for their protection. When the government ran out of funds to carry out an action plan, international agencies such as the World Wildlife Fund (WWF) and GEF initiated some projects. It is clear that engaging the public is necessary, as well as developing livelihood alternatives for those communities that are affected. WWF's plan is to raise the communities' awareness level of the existing laws on fisheries and environmental protection. Other international groups that have committed to projects in the area are ASEAN and Conservation International. In 1996 an agreement was signed by Malaysia and the Philippines to protect two endangered turtle species, the Hawksbill and the Green turtle. Although the Malaysian-Philippine agreement is a vital first step, all three governments in the region need to enforce sustainable ways of earning a living from the sea. Several species of whales are endangered. The GEF/UNDP has funded a PDF-A for development of a Transboundary Diagnostic Analysis and preliminary framework of a Strategic Action Programme for the Sulu-Celebes Large Marine Ecosystem.

Annex VI
Criteria for scoring environmental impacts

Issue 23: Changes in ocean surface temperature	
This refers to the impact on populations, species, and communities from changes in Sea Surface Temperature as a result of global change.	
Score 0 = No known impact	No measurable or assessed effects of SST increase.
Score 1 = Slight	Slight impact is determined when one or more of the following criteria are met or exceeded: Measured assessed effects of SST are causing a behavioral change in some species without affecting the viability of the population
Score 2 = Moderate	Moderate impact is determined when one or more of the following criteria are met or exceeded: Community structure is measurably altered as a consequence of changes in SST. Populations are declining.
Score 3 = Severe	Severe impact is determined when one or more of the following criteria are met or exceeded: Measured/assessed effects of changed SST are leading to massive loss of communities or a change in biological diversity.

Annex VII
Marine protected areas and benefits to the fishery

(Excerpted from a compilation provided by GIWA Task team members Dr. Jos Pet and Dr. Peter J. Mous .The Nature Conservancy, Indonesia Coastal and Marine Program)

Our relative inexperience in using marine reserves to manage living resources should not serve as an argument against their use. Rather, it argues that implementation of reserves should be incremental and adaptive, through the design of areas that will not only conserve marine resources, but also will help us learn how to manage marine species more effectively. The dual realities that the Earth's resources are limited and that demands made on marine resources are increasing, will require some compromise among users to secure greater benefits for the community as a whole. Properly designed and managed marine reserves and protected areas offer the potential for minimising short-term sacrifice by current users of the sea and maximising the long-term health and productivity of the marine environment. Based on evidence from existing marine area closures in both temperate and tropical regions, marine reserves and protected areas will be effective tools for addressing conservation needs as part of integrated coastal and marine area management (Committee on the Evaluation, Design, and Monitoring of Marine Reserves and Protected Areas in the United States, National Research Council 2001).

Even at a global level, it seems that fishery statistics should be interpreted with extreme care. It is shown that misreporting by countries with large fisheries, combined with the large and widely fluctuating catch of species such as the Peruvian Anchoveta, can cause globally spurious trends. Such trends influence unwise investment decisions by firms in the fishing sector and by banks, and prevent the effective global management of international fisheries (Watson & Pauly 2001).

Given the uncertainty in fishery statistics and the status of fish stocks, MPAs may provide a last line of defence against overfishing. It is important to consider the FAO code of conduct for responsible fisheries in this light. States and sub-regional and regional fisheries management organisations should apply a precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available. The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment (FAO 1995).

In principle, the objectives, policies and activities of the (Indonesian) Ministry of Marine Affairs and Fisheries are compatible with the development of a network of Marine Protected Areas.

Objectives are:

- Optimisation of the catch to increase welfare of the Indonesian people;
- Conservation of fishery resources.

Policies are:

- Control of fishing activities,
- Development of aquaculture,
- Improvement of quality.

Control of fishing activities is to take place through re-registration of fishing licenses and development of surveillance and law-enforcement capabilities (Undated leaflet from Ministry of Marine Affairs and Fisheries).

A recent report to the Indonesian Ministry of Marine Affairs and Fisheries says the following on Marine Protected Areas: It is definitively in the country's economic and environmental interests to set aside at least 10% of its 81 000 km coastline and 5.8 million km^2 marine territory as marine sanctuary or marine protected area and marine park to conserve and protect its remaining rich marine bio-diversity. There are clear benefits to be gained from investment in identifying, declaring and establishing more marine protected areas in Indonesian waters, not only as a tool to manage and conserve the fisheries and its rich genetic resources but also equally for aquaculture, in particular mariculture or sea farming as a source of seed and broodstock (Pacific Consultants International 2001).

Marine reserves and protected areas have received inadequate attention from fisheries managers in the region, at least they do not feature clearly in formal arrangements (Msiska et al. 2001).

According to Roberts and Hawkins (2000) Fully protected reserves: (i) enhance the production of offspring which can restock fishing grounds; (ii) allow spill-over of adults and juveniles into fishing grounds; (iii) provide a refuge for vulnerable species; (iv) reserves prevent habitat damage; (v) promote development of natural biological communities which are different from communities in fishing grounds; and (vi) facilitate recovery from catastrophic human and natural disturbances.

There is compelling, irrefutable evidence that protecting areas from fishing leads to rapid increases in abundance, average body size, and biomass of exploited species. It also leads to increased diversity of species and recovery of habitats from fishing disturbance. Reserves are often portrayed as working only on coral reefs. In fact, they have been successful in a wide range of habitats in environments ranging from tropical to cool temperate zones. Reserves are a valuable tool globally (Roberts & Hawkins 2000).

There is now compelling scientific evidence that marine reserves conserve both biodiversity and fisheries, and could help to replenish the seas, says a scientific consensus statement signed by 150 of the world's leading marine scientists (AAAS 2001).

"It's asking a lot to close areas to fishing when communities need to fish to survive, but it may be the only hope we have to replenish reefs that have been overfished for so many years." Commercial fisherman, Philippines (WWF N.d).

Major recommendation (Dight et al.1999): marine protected areas (MPAs) have the potential to play a much bigger role in the successful management and sustainable use of fisheries resources on coral reefs and associated ecosystems. In particular, participatory development of no-take zones and protection of essential fisheries habitat in the context of an ecosystem management approach should be encouraged, where appropriate, at both the community level and for larger areas.

The designation of no-take marine reserves may be necessary for sustaining fishery yields over the long-term, due to their ability to preserve genetic variation in the expression of fish size and growth rates (Conover & Munch 2002). This is because in exploited situations, the fishery selectively removes larger individuals, giving smaller, less fertile individuals a selective advantage. Marine protected areas are most effective when they are established where vulnerable species usually live, breed, or feed. Creating these areas has quickly restored populations of fish, snails, and crabs, reduced pollution, and provided habitats for other marine organisms in some regions, including the Florida Keys, the Philippine Islands, and the coast of Japan. Less than a quarter of 1% of coastal sea areas are designated as marine protected areas. To ensure the greatest benefit to depleted fish stocks, many more protected areas should be set aside that are or once were active, productive fishing areas. Moreover, fishermen should be involved in planning and designating protected areas (The National Academies 1998).

References

AAAS (2001). Press release. The Annual American Association for the Advancement of Science meeting, February 2001.

Committee on the Evaluation, Design, and Monitoring of Marine Reserves and Protected Areas in the United States, National Research Council (2001). Marine Protected Areas. Tools for sustaining ocean ecosystems. National Academy Press, Washington, D.C.

Conover, D.O and Munch, S.B. (2002). Sustaining Fisheries Yields Over Evolutionary Time Scales. Science 94-96.

Dight, I., Kenchington, R. and Baldwin, J. (eds.) (1999). Proceedings of the International Tropical Marine Ecosystems Management Symposium. November 1998. Published by the Great Barrier Reef Marine Park Authority, Townsville, Australia.

FAO (1995). Code of Conduct for Responsible Fisheries. Article 6, General Principles of the FAO code of conduct. Adopted by the Twenty-eighth Session of the FAO Conference on 31 October 1995. Retrived August 2003 from: http://www.fao.org/fi/agreem/codecond/ficonde.asp#6

Msiska, O.V., Jiddawi, N. and Sumaila, U.R. (2001). The potential role of marine reserves in selected countries in East and Southern Africa. p 121-130 In: Sumaila, U.R. and Alder, J. (eds.) Economics of Marine Protected Areas. Papers, Discussions and Issues: A Conference held at the UBC Fisheries Centre July 2000. Published by The Fisheries Centre, University of British Columbia, Vancouver, Canada.

Pacific Consultants International (2001). Study on Fisheries Development Policy Formulation. Volume I. White Paper. Report by Pacific Consultants International under Jakarta Fishing Port/Market Development Project (Phase IV: JBIC Loan No. IP-403).

Roberts, C.M. and Hawkins, J.P. (2000). Fully-protected marine reserves: A guide. WWF in Washington DC, US, University of York, York, UK.

The National Academies (1998). Fishing should be reduced substantially to protect marine ecosystems. Retrieved July 2002 from: http://www4.nas.edu/news.nsf/isbn/0309055261?OpenDocument

Watson, R. and Pauly, D. (2001). Systematic distortions in world fisheries catch trends. Nature 414:536-538.

WWF (N.d). Marine Reserves: Like Money in the Bank. WWF Endangered Seas Campaign, Washington DC (no date).

Annex VIII
Coral reef initiatives in the Philippines

(Source: The President of the Philippines at the Second International Tropical Marine Ecosystem Management Symposium 2003)

The Government of the Philippines, with assistance from the Government of Sweden and other sources, has responded to the plight of coral reefs outlined since the United Nations Conference on Environment and Development in 1992, and reiterated in Johannesburg at the World Summit on Sustainable Development in 2002. The Philippines and Sweden have combined to guide the Secretariat of the International Coral Reef Initiative (ICRI) in 2001 and 2002 with the goal of bringing developing and developed countries together to conserve coral reefs.

Coral reefs are being damaged by both natural and human pressures and unless we act now, it is predicted that over half of the world's coral reefs could be destroyed within a generation. Coral reefs can recover from natural threats, but recovery is slow from the direct and indirect damage that people do to reefs. Often that damage is inadvertent as people seek food or cultural items from the reefs, but unfortunately some of the damage is deliberate through constructing airports, ports and dredging channels. Damage is caused indirectly through poor land use practices that result in sediments and excess nutrients pouring over the reefs and through the release of sewage and industrial wastes that cause eutrophication. Even our excessive use of plastic bags ends up damaging coral reefs. The responses to these alarm calls have been the establishment of ICRI, the Global Coral Reef Monitoring Network, CORDIO (Coral Degradation in the Indian Ocean), Reef Check, ReefBase and the World Resources Institute Reefs at Risk project, to mention just some.

All people in the world are 'stakeholders' in coral reefs as we have inherited their wealth of biodiversity and natural beauty, therefore we all share the responsibility for conserving them. We now understand what damages coral reefs and the critical measures that users, local and national governments, international agencies and NGOs have to do in partnership to conserve reefs. There are many global and local initiatives being implemented to arrest and conserve coral reefs and establish more protected areas. One example is Apo Island, in the Philippines where the local university and the community have worked together to conserve their resources for the benefit of all. Another initiative is to ensure that the trade in live fish for restaurants and the aquarium trade is ecologically sustainable, and not damaging the reefs of Southeast Asia and the Pacific.

The Government of the Philippines, one of the founding countries of ICRI, hosted the first ICRI international workshop in Dumaguete City, Philippines in 1995, which outlined the pioneering global strategy for coral reefs through the ICRI Call to Action and Framework for Action. In March 2003, the Philippines hosted the 2nd International Tropical Marine Ecosystem Management Symposium (ITMEMS2) in Manila, another milestone conference to identify strategies on coral reef and associated ecosystems management when strong resolve is needed to respond to the WSSD Plan of Implementation. Then and now, the Philippines continues to be instrumental in bringing forth strategies and actions for implementation at global and national levels.

A significant Philippines national strategy is devolving management responsibility to the municipality and 'barangay' level under the Local Government Code passed by Congress in 1991. When communities are given the responsibility of managing their own resources with a little help from government and scientists, the damage to the reefs can be reversed. In addition, the Philippine Government has been proud to declare the large Tubbataha National Marine Park as a World Heritage Site. It is jointly managed by the Palawan Council for Sustainable Development and the WWF Philippines. Even more rewarding is the proof of the genuine concern that the Filipino people have to conserve and manage these reefs. Unfortunately, the same beauty is not seen in other Philippine reef areas that have the same potential. The Philippines Government is increasing sustainable management assistance to people who have a large dependence on these reef resources.

Annex IX
Models for development of a fully integrated PA network for Sulu-Celebes (Sulawesi) Sea

Marine Protected Area case study: Bunaken National Park, North Sulawesi, Indonesia

The continuing development of Bunaken NP provides important lessons for implementation of the recommended policy option in several key areas. For example, improved management capacity is crucial for overall success. Management of Bunaken NP has recently been reviewed and provides several useful case-studies.

Improving the capacity of the management advisory board

(from NRM Headline News 2002)

In late December 2000, the North Sulawesi government passed a Governor's Decree (SK Gubernor No 233/200) mandating the formation of the Bunaken National Park Management Advisory Board (BNPMAB). The main purposes of the board are: to manage the new entrance-fee system of the Bunaken National Park; to assist the Balai Taman Nasional Bunaken in developing, coordinating and funding conservation programmes; to facilitate and encourage community awareness and participation in the park management activities; and to instil sense of ownership by the local communities. The board was created with 15 equal seats, including seven government representatives and eight non-government representatives. This is an innovative system for managing and coordinating activities in a national park in Indonesia and the region. If successful, it will provide a best-practices example for coordinated multi-stakeholder marine park management in Indonesia and South East Asia. The board was granted a two-year trial period.

Long standing management challenges for Bunaken National Park include: cultural conflicts and mistrust amongst local stakeholders and managers; damaging fishing and land use practices; rapid and poorly planned coastal development; unethical business and political practices; corrupt law enforcement systems; and unorganised management strategies. Since the boards inception, management processes have become more transparent and participatory, and management outputs have increased dramatically. Despite the initial successes of the board and the new entrance-fee system, many management challenges remain. The current evaluation of the board will contribute significantly to its capacity and potential for improving management processes, coordinating management and conservation activities in the park and raising stakeholder awareness and participation in management.

Codification of the roles and responsibilities of the Park Management Advisory Board with regard to conservation of Bunaken National Park is an essential Best Practice to effective decentralised co-management. The document, Basic Regulations for the Bunaken National Park Management Advisory Board clarifies this effort. While it guides the day-to-day functioning of the Park Management Advisory Board, it is also of value to others exploring decentralised co-management of protected areas in Indonesia.

As with most Protected Areas in the Sulu-Celebes (Sulawesi) Sea, Bunaken NP is a multiple-use MPA, with different zones allowing and regulating different levels of exploitation and conservation. Initial difficulties in management arose from the initially complex zoning scheme, with a major revision recently undertaken. The rezoning provides useful lessons for policy implementation in the region.

Co-management

(from NRM Headline News 2001)

One of the most important initiatives has been the establishment of the Dewan Pengelolaan Taman Nasional Bunaken/DPTNB (Bunaken National Park Management Board), whose primary functions are to coordinate the policies and activities of all stakeholders with jurisdiction within the park and to plan and finance several conservation programmes at BNP, such as, a patrol system and a trash management system. In order to achieve these functions most effectively, the DPTNB is comprised of representatives from all major stakeholders in the park, including the local community, tourism sector, Balai Taman Nasional Bunaken (BTNB), environmental NGOs, universities, North Sulawesi province, Manado city and Minahasa regency government institutions. The DPTNB is the first of its kind in Indonesia, and is considered a two-year pilot project by the Ministry of Forestry.

Besides the DPTNB, a number of organisations are now helping with management issues in BNP. The Forum Masyarakat Peduli Taman Nasional Bunaken (FMPTNB) was established in October 2000 as a means of connecting and representing the management aspirations of the approximately 30 000 residents of the park. With three districts (north, south and surrounding islands) and representatives in all 21 villages within the park, the FMPTNB is slowly becoming an effective voice for the community in the management of TNB. Additionally, several environmental NGOs, including Yayasan Kelola, Forum Petuan Ketoupan, Yayasan Kendage URuata, WWF, and Yayasan Suara Nurani are working within the park on a range of environmental issues. Within the tourism sector, the North Sulawesi Watersports Association (NSWA) and Himpunan Pengelola Wisata Lokal Bunaken represent dive operators and cottage owners who are concerned about management

of BNP. The increasing cooperation within and between these groups is supporting the concept of a Bunaken National Park big family that supports sustainable natural resources management and utilisation.

Another exciting development for the management of Bunaken has been the introduction of a revolutionary new entrance fee system - the first in Indonesia. Unlike other national park entrance fees in Indonesia (where all money collected goes into the National Treasury), 80% of the Bunaken entrance fees are managed by the DPTNB to fund conservation programmes in the park. Since April 2001, over 8 000 local and international tourists have paid the entrance fee, amounting to over 360 million Rp in income for conservation programmes. The DPTNB has also received grants from WWF-Indonesia and USAID to help finance its conservation programmes. An example of an important programme currently being managed by the DPTNB is a joint patrol system. The patrol system is currently based on Bunaken Island and includes jagawana BTNB (rangers), SATPOLAIRUD, and community members who can be on a 24-hour patrol per day. This patrol system successfully apprehended more than seven groups of cyanide and bomb fishers who were operating illegally in the park. The patrol team also regularly conducts sweeping operations to ensure that all visitors have paid their entrance fees. Until now, much of focus of these programmes has been on Bunaken and the surrounding islands of Manado Tua, Mantehaga, Siladen and Nain. However, the DPTNB realises that it is extremely important to also include the northern and southern mainland sections of the park, including Tiwohu, Tongkeina, Meras, Molas, Teling, Kumu, Poopoh, Pinasingkulan, RapRap, Sondaken, Popareng dan Wowontulap.

Co-management initiative

(from Erdmann et al. 2003)

Since 1998, USAID's Natural Resources Management Program (NRM) has been working actively to implement a co-management initiative in the Bunaken National Park. Prior to this initiative, the management of BNP was centralistic and legally under the authority of the Ministry of Forestry's Bunaken National Park Office (BTNB). Local park users (particularly the fisher folk and the dive tourism industry) were not effectively involved in park management, and local government agencies were highly resentful of the management authority vested in the BTNB. Funding for conservation and management activities in the park was minimal, the enforcement system ineffectual, and the park zonation system was largely misunderstood and ignored by the local populace. In most respects, Bunaken National Park qualified as a "paper park".

Objective of initiative

The goal of the Bunaken National Park co-management initiative is to develop an effective and sustainably-financed Indonesian model of multi-stakeholder co-management of a national marine park which will thereby serve as a marine protected area (MPA) center of excellence for Indonesia and SE Asia. The key to achieving this goal has been a massive socialisation effort to draw the various stakeholders from the park (including 30 000 villagers, an active marine tourism industry, local conservation NGO's, academia, and three tiers of government agencies) into a single "community" with a strong sense of awareness and ownership of the valuable but threatened marine resources in the park.

Components of the co-management initiative

- Participatory zonation revision of BNP. NRM is assisting the BNP Office (BTNB) to work with the two primary park user groups (local villagers and the marine tourism sector) to revise the park's zonation system, realising that a well-designed, easy to understand and thoroughly socialised zonation system is the foundation for effective management of the park.
- Improved villager involvement in BNP management decisions through institutional development of the BNP Concerned Citizen's Forum (FMPTNB). The FMPTNB is now active in all 22 villages in BNP and serves to represent the aspirations of ~30 000 villagers in management decisions, as well as serving to socialise management policy to its constituents.
- Fostering private sector involvement in BNP management. NRM provides technical assistance to the North Sulawesi Watersports Association (NSWA) and actively fosters the involvement of other private sector groups (cottage owners, traditional fishers' association, and charter boat operators) in BNP management.
- Facilitation of multi-stakeholder co-management of BNP via institutional development of the BNP Management Advisory Board (DPTNB). NRM provides development support to the executive secretariat of the DPTNB, which consists of representatives from national, provincial and local government agencies, village stakeholders, the private tourism sector, academia, and environmental NGO's. The "crown jewel" of the Bunaken co-management initiative, the DPTNB represents a drastic departure from the traditional Indonesian model of top-down management of MPAs, and strives to make decentralised, participatory, transparent and accountable MPA management a reality.
- Development of a portfolio of sustainable conservation financing mechanisms for BNP. A ground-breaking decentralised park entrance fee system has now placed the DPTNB on the road to financial self-reliance. Other components in the developing financing portfolio include an international volunteers system to lower management costs, diversified government agency support, in-kind support from the local dive tourism sector, national and international grant support, visitor centre merchandising and a possible endowment fund.

- Development of an effective 24-hour patrol system for BNP. An experimental joint patrol system involving park rangers, water police officers and local villagers has proven highly effective in decreasing destructive fishing practices in the park.
- Institutionalisation of a scientific monitoring programme to monitor effects of management activities on park resources. In conjunction with WWF Wallacea, NRM is supporting park stakeholders in monitoring coral condition (using manta tows and line intercept transects) and reef fish stocks (visual census of select reef species and monitoring of grouper and Napoleon wrasse spawning aggregation sites).

Select accomplishments to date

- Participatory zonation revision completed for Bunaken, Manado Tua, Mantehage and Siladen Islands and ongoing in 14 remaining villages.
- Institutionalisation of the 15 seat multi-stakeholder BNP Management Board (DPTNB) and the 22 village BNP Concerned Citizen's Forum (FMPTNB) and widespread socialisation of these two institutions.
- Strong participation of private sector in management via the NSWA, which has instituted a programme of "three E's" (employment, education and enforcement) within the park
- Development of a decentralised park entrance fee system whereby 80% of the revenues are earmarked for BNP management programmes. The system succeeded in raising 42 000 USD in its first year of operation (2001) and 109 000 USD in 2002, and is eventually targeting up to 250 000 USD per year.
- Implementation of a joint patrol system that includes villagers and that has virtually eradicated blast and cyanide fishing from the park and greatly limited illegal coral mining and mangrove cutting.
- Multimedia park socialisation campaign to instil a sense of BNP community using posters, zonation calendars, town hall meetings, community information billboards, a 30 base station VHF community radio network, local television shows and local, national and international newspaper and magazine articles.
- Sharing of lessons learned from Bunaken with MPA managers from Bali Barat NP, Komodo NP, Wakatobi NP, Cenderawasih NP, Berau Islands and Tomini Bay in Indonesia and Hon Mun Marine Reserve in Vietnam.
- Recorded an 11% increase in live coral cover in a one and a half year period on the reefs which have already completed zonation revision and are protected by patrol system
- Selection as the Asian MPA ecotourism demonstration site for the International Coral Reef Action Network (ICRAN).

Selected lessons learned

Over the past five years, a number of important lessons have been learned in attempts to strengthen decentralised co-management of Bunaken National Park. While it is beyond the scope of this executive summary to discuss these in detail, the most important of these lessons learned in the hopes that they may be of interest to other tropical MPA managers currently utilising or considering a co-management approach are listed below:

- It is necessary to balance ecological values with socio-economic values to generate essential stakeholder political support for conservation of protected areas in regions with population pressures and/or priorities on economic growth and development.
- Building informed participation is a long-term process, requiring extensive capacity building and facilitation. Villagers, government and non-government stakeholders with long-term involvement in conservation management provide more innovative solutions and productive support for conservation management.
- Park managers and the rangers tasked with field management of the park commonly lack the community facilitation skills critical to ensuring broad stakeholder support and understanding of park management objectives. Training in facilitation skills for these park management personnel is an essential capacity-building measure before co-management can be effectively implemented.
- Co-management starts with the development of constituency-based partnerships, and then evolves to true co-management when the constituency-based partnerships then start working with each other. The evolution to co-management results in collaboration among often competing constituencies. Strong constituency partnerships provide a solid foundation for co-management.
- Community conservation campaigns through schools, mosques and churches can build effective local support for and pride in conservation initiatives. People will support conservation of their environment if they take pride in it. Of course, pride alone will not achieve conservation. Also important are economic incentives and enforcement of rules and regulations.
- Decentralisation of conservation management works when roles and responsibilities are clear, and when there is a shared vision of goals and objectives. Decentralisation does not work when there is competition over management authority or significant divergence in goals and objectives. Decentralisation also stimulates stronger grass-roots democracy and principles of good governance.
- Co-management requires active involvement of all relevant stakeholders. This is site-specific in nature. In Bunaken it includes dive operators, communities, different levels of government, universities and NGOs. Co-management must be inclusive, and must provide for reasonably equal voices for relevant stakeholder groups.

- The composition of multi-stakeholder co-management boards is absolutely critical to their success. The optimal ratio of governmental to non-governmental representatives and those advocating different functions of the protected area (economic development, conservation, sustainable resource use) will vary from site to site, but will have profound consequences for the effectiveness of these multi-stakeholder boards. There must be a balance between the competing interests represented, and this will not always entail equal numerical representation; in many cases the stakeholder group(s) that are the most hesitant to advocate strong positions may require a larger allocation of seats on a multi-stakeholder board to achieve truly equal representation.
- Community stakeholders support patrol and enforcement programmes, as they are directly linked to increased livelihoods. Many illegal activities within protected areas come from outsiders. Communities with a stake in conservation management or sustainable utilisation of park resources have a strong and rational interest in seeing rules and regulations enforced so natural resources are sustained.
- "Alternative livelihood programmes" aimed at stakeholders currently involved in destructive activities in the coastal zone are ineffective and largely rejected by local communities. Community conservation/improvement programmes should focus on rewarding those that have chosen sustainable livelihoods, while those that persevere with destructive activities should be dealt with by a strong enforcement system.
- Local self-financing mechanisms are key to providing local stakeholders with the fuel to manage local conservation interventions. Decentralised co-management requires the capacity to generate and then manage finances locally.
- Development-oriented stakeholders, particularly from government, support conservation when it can be linked to regional economic development. Conservation of protected areas is better described within the context or regional economic development than altruism.
- Involvement of the private sector in co-management of MPAs can be highly beneficial. Once potential business competitors focus upon the benefits of cooperating to protect the resources in the MPA upon which their income depends, they become one of the strongest proponents of good management and bring considerable financial and human resources to the table.
- Tourists are willing to pay reasonably high entrance fees as long as they see their money is resulting in visible conservation management. Willingness-to-pay for effective conservation management is high, but can only be sustained when tourists see results from their payments.
- Funding for conservation management needs to be diverse. Reliance on a single source like user fees is dangerous. This is demonstrated by the sudden drop-off in revenues from the Bunaken entrance fee system after September 11 and the Bali Bombing. Long-term sustainability requires significant financial diversification.
- Monitoring and evaluation are key to ensuring on-going success of conservation management interventions. This is important for convincing stakeholders that interventions are working and/or providing guidance on how to adapt interventions if they are not working well. This includes the use of both ecological as well as socio-economic indicators in an integrated management effectiveness monitoring system
- Multiple-use MPA zonation plans are valuable management tools for mitigating conflict among stakeholders and balancing effective conservation with sustainable development in developing country MPAs with large population pressures. These plans are most effective if based upon a combination of scientific/ecological considerations and input from a range of primary user groups who have received facilitation in understanding and accepting compromise.
- Zonation schemes should use a minimal number of zone types, with names that clearly indicate their purpose, explicit rules for allowed and disallowed activities, and clearly demarcated borders that utilise natural or otherwise well-known landmarks whenever possible.
- The use of focal interest group meetings instead of relying only on large village meetings is essential for ensuring broad-based community participation and equitable decision making. This ensures the involvement of many of the more marginalised or traditionally quiet community members.
- Representation of larger groups (villages, the private sector, etc.) in marine resource management decision-making is a new and poorly-understood concept in Indonesia. The individuals chosen to represent larger groups often neglect their responsibility to communicate actively with their constituents, while constituent groups often resent those chosen to represent them. This democratic principle needs continuous facilitation.
- Decentralised co-management supports the principles of good governance. Although it must be carefully managed (and well-designed at the outset in order to prevent dominance by any one stakeholder group), one of the greatest strengths of the co-management approach is in utilising the diverse interests and motivations of various stakeholder groups to prevent corruption, collusion or nepotism.
- Establishment of a sense of pride and ownership of local marine resources is a key step in generating strong support for

conservation measures. Even in the absence of traditional or legal marine tenure systems (where communities directly own resources), ownership of the management of those resources engenders strong conservation support.

- Human resource development and institutional strengthening is best achieved through long-term, learning-by-doing mentoring processes rather than short-term, highly specific technical training programmes. Technical training can meet specific needs, but broad-based capacity building for conservation is best achieved through long-term, medium-input mentoring.

More information on the Bunaken National Park co-management initiative can be found at www.bunaken.or.id and www.bunaken.info

Revised zoning

(from Erdmann & Merrill 2003)

Clearly a balance between inputs from science and stakeholder participation is necessary in producing a functional and enforceable multiple-use zonation plan. One additional element of the Bunaken zonation revision process that is strongly in need of improvement is the involvement of local park managers and/or rangers in the zonation facilitation process. Unfortunately, the participatory zonation process relies strongly upon excellent facilitation skills that are generally lacking in park management staff; training opportunities to acquire these skills are also noticeably absent. It is highly likely that this situation is endemic to developing country MPAs, and conservation and development aid organisations interested in promoting effective MPAs should pay particular notice to this widespread need for better community facilitation skills in park managers.

The actual location of individual zones was based upon a combination of scientific and stakeholder input and a commitment to include at least 20% of each island's reef area in "no-take" zones where fishing is not allowed (in accordance with the US Coral Reef Initiative and a number of other MPA design guidance papers). Both the strict conservation and tourism use zones are "no-take", and were sited to include known reef fish spawning aggregation sites, unique reef features and long-established dive sites. Village fishers were persuaded to agree to these 20% closures using careful explanations of the fisheries enhancing benefits of no-take zones.

In 2002, these revised zonation plans have been extremely successful in terms of compliance and the overarching objective of allowing multiple uses of this highly valuable national asset while preventing stakeholder conflict. The resource base has also shown marked improvements; on Bunaken Island alone, the reefs have shown an incredible 11.3% increase in live coral cover and significant increases in size and abundance of commercially valuable fish species in the two years since the zonation plan was agreed upon (Erdmann, unpub. data). This success has encouraged Indonesia's Department of Nature Conservation to use the Bunaken experience as a basis for their new national technical guidance paper on MPA zonation (PHKA 2002) (see Usher & Merrill 2000).

Lessons learned from the rezoning

(from Ermann & Merrill 2003).

A number of useful lessons learned that may have wider applicability (especially to developing country tropical MPAs) can be drawn from the Bunaken zonation experience. These include:

1. Multiple-use MPA zonation plans are an incredibly valuable management tool for mitigating conflict among stakeholders (e.g., tourism operators and local fishers) and balancing effective conservation with sustainable development in developing country MPAs with large population pressures. These plans are most effective if based upon a combination of scientific/ecological considerations and input from a range of primary user groups who have received facilitation in understanding and accepting compromise.
2. Zonation schemes should use a minimal number of zone types, with names that clearly indicate their purpose, explicit rules for allowed and disallowed activities, and clearly demarcated borders that utilise natural or otherwise well-known landmarks whenever possible.
3. The process of creating a multiple use zonation plan (including wide stakeholder participation, facilitated compromise between groups, and widespread socialisation of the eventual zonation plan) is as important as the actual details of the eventual zonation system in terms of building support for and compliance with the system. However, an adequately participatory process is often long (measured in years) and requires significant financial commitments and excellent facilitation skills on behalf of the implementing agency(s).
4. While stakeholder participation is essential, there is no one single best participatory approach to involving stakeholder groups in zonation plan development. The best participatory approach is one that has been carefully crafted to achieve maximum stakeholder involvement and acceptance based upon knowledge of the social dynamics of the individual user group targeted (which is often best gained from direct feedback from members of that group).
5. Widespread socialisation of zonation schemes using a variety of media is absolutely essential to their success, but is not sufficient to ensure compliance. A strong enforcement system is critical to an effective multiple-use zonation system.
6. A system which utilises relatively large contiguous zones rather than a series of many small zones is both easier to enforce and, in the case of no-take zones, likely provides greater conservation and fishery benefits.

7. The zonation process is best viewed as an iterative process that needs evaluation and revision on a regular basis.

Surveillance and enforcement

(from Erdmann & Toengkagie 2003)

Additional difficulties associated with surveillance and enforcement were addressed in early 2001, when the Bunaken National Park Management Advisory Board (DPTNB) initiated a joint patrol system that placed community members side-by-side with professional enforcement officers, to increase effectiveness of the patrol system.

Forty five villagers, 16 park rangers and 5 water police officers constitute the core of this multi-stakeholder patrol system, which is focused upon 4 primary activities: 24 hour routine water-borne patrols, entrance fee enforcement, socialisation of the park's rules to villagers and visitors, and routine beach cleanups. While the involvement of civilians in patrols has been at times controversial and posed a number of unique challenges, the joint patrol system has proven a tremendous improvement to the previous system and has resulted in a dramatic decrease in destructive resource uses such as blast and cyanide fishing, mangrove cutting and endangered wildlife capture.

The increased patrolling and stepped-up enforcement has led to a significant reduction in illegal fishing activities within the boundaries of the National Park. Live coral cover has increased by more than 11% over 2000 to 2002. Park communities are enjoying community development support from conservation revenues. This success is only possible through the commitment of Park Management Advisory Board members to good governance principles of transparency and accountability.

Lessons learned from a multistakeholder enforcement initiative

While the adaptive management process for the Bunaken joint patrol system is ongoing, already there have been a number of important lessons learned that may prove useful to MPA managers considering the involvement of community members in joint patrol systems. Among the more important are:

1. Involvement of villagers in a joint patrol system has associated costs and benefits, but benefits generally far outweigh the costs.
   Costs include:
   - Village patrol members require significant initial training;
   - Village patrol members have no authority to arrest or carry weapons;
   - Social jealousies can arise from villagers not involved in patrol system;
   - Occasional conflicts of interest arise when violations are committed by friends or family members.

   Benefits include:
   - Villagers are on the scene 24 hours/day, and have a vested interest in protecting "their" reefs for the future use of their children and grandchildren;
   - Village patrol members have intimate knowledge of local reefs and the people exploiting them (both sustainably and in a destructive manner), allowing them to quickly and effectively target those activities/user groups that cause most damage to the reefs, and allowing them to resolve resource use conflicts in a more consensual manner than rangers or police might;
   - Alternative employment for fishers who would otherwise depend on reef resources;
   - Extraordinarily effective socialisation of the conservation and sustainable use goals of the park - village patrol team members "socialise" the park even during their free time when interacting with other villagers on a social basis.
2. Involvement of a range of stakeholders (e.g. rangers, police, and villagers from several villages) in joint patrol teams can greatly decrease the likelihood of corruption, collusion or conflicts of interest in dealing with violations committed by friends and family members.
3. When developing an MPA multi-stakeholder patrol system that involves local community members, equal representation of all villages (and cultures/religions) within the MPA is an important precursor to acceptance and success of the patrols.
4. Most MPA stakeholders (villagers, tourism operators, and others) support rules and regulations as long as they are clear and equitably enforced. Clear rules are easily understood and clearly posted. Equitable enforcement means that all those that break the rules are treated the same way.
5. Community stakeholders support patrol and enforcement programmes, as they are directly linked to increased livelihoods. Many illegal activities within protected areas come from outsiders. Communities with a stake in conservation management or sustainable utilisation of park resources have a strong and rational interest in seeing rules and regulations enforced so natural resources are sustained. The overwhelming majority of villagers in BNP has voiced support for a strong patrol system, and actively assist the system as "reef watchers" using the park-wide VHF radio system.
6. Park managers and the rangers tasked with field management of the park commonly lack the community facilitation skills critical to ensuring broad stakeholder support and understanding of park management objectives. Training in facilitation skills for these park management personnel is an essential capacity-building measure.
7. When building a multi-stakeholder patrol system, it is imperative to appoint a strong leader who respects the other stakeholder groups

but maintains a clear vision for the overall patrol team. This lesson was abundantly clear when comparing the northern and southern patrol teams; the northern patrol team, while receiving the larger amount of funding and facilities, was continuously hampered by poor leadership from the field coordinator - leading to infighting and less than optimal performance. By comparison, the southern team, while operating on a smaller budget in an area with more hardened bomb fishermen, was highly successful, in large part due to an excellent field coordinator from the BTNB who maintained and nurtured the enthusiasm and commitment of the village patrol members.

8. It is extremely important to declare and treat marine resource crimes as serious offences, and to apply enforcement evenly across all levels of society (including villagers, tourists, outside military/police/government officials, etc). Public support for patrols will rapidly decline if powerful individuals are given "special treatment".
9. Indonesian courts typically treat destructive fishing and other marine resource crimes as light offences. Education of all levels of the enforcement/prosecution system is required to provide understanding that marine resource crimes rob future generations of their livelihoods and must be punished severely.
10. Enforcement is a continuous, ongoing need, there will always be individuals ready to engage in illegal (and profitable) activities if enforcement activities are decreased below effective levels.

Since its inception, the joint patrol system has consistently ranked the most expensive programme in the DPTNB annual budget. In 2001, the patrol system recorded 222.16 million Rp (~22 500 USD) in operational costs (including salaries for village patrol members and bonuses for rangers/police, as well as fuel, equipment maintenance, criminal investigation and court costs, and training), plus an additional 9 000 USD in equipment procurement (2 wooden boats with outboard engines). In 2002, with both northern and southern patrols operational for the entire calendar year, overall operational costs totalled 531 million Rp (~59 000 USD), plus an additional 29 000 USD in equipment procurement (VHF radio system, 2 engines and 1 boat). The 2003 DPTNB annual budget includes 673 million Rp (~76 500 USD) for patrol operational costs plus an additional 22 000 USD in equipment procurement (polyethylene hull speedboats with environmentally-friendly four-stroke engines). For all three years, operational costs were funded by entrance fee receipts and two grants from WWF-Wallacea, while equipment procurement was funded by USAID's NRM programme. While it is envisioned that equipment costs should be minimal in the foreseeable future, operational costs are projected to stabilise at the 2003 level. Using this projection, the BNP joint patrol system costs approximately 0.85 USD/ha/year.

It is important to note that while the overall percentage of the DPTNB budget devoted to the patrol system has dropped from over 50% in 2001 to roughly 15% in 2003, the costs have actually risen and there is no indication that these costs will decrease in the future. Unfortunately, even though broad socialisation of park rules has resulted in increased compliance, the economic incentive to illegally extract resources in the park only increases over time (as resources are overexploited outside of the park), necessitating a continuously vigilant patrol system. BNP experienced this firsthand in January 2003, when a temporary work strike by village patrol members resulted in an immediate spike in blasting and cyaniding activities within the park, in the space of two weeks.

Development and results of Bunaken entrance fee system (2001-2002)

(from Erdmann et al. 2003)

Since 2000, USAID's Natural Resources Management Program has been assisting the multi-stakeholder Bunaken National Park Management Advisory Board in developing a model entrance fee system under special "pilot project" status granted by the Indonesian national government. Based upon the highly successful Bonaire Marine Park entrance fee system, the Bunaken system successfully raised nearly 42 000 USD in its first year of operation in 2001. With the strong support of the local tourism sector, the fee for international tourists was doubled in 2002, raising ~110 000 USD from over 8 000 international and 17 000 Indonesian visitors. Revenues from the fee system now fund a park-wide joint ranger/police/villager patrol system, environmental education programmes, and village-level conservation and development programmes.

In its inaugural year, the BNP entrance fee system was quite successful, with total entrance fee receipts of 418 187 500 Rp (~42 000 USD) recorded during the period of 15 March to 31 December 2001. These fees were collected from a total of 15 055 visitors to the park (including 5 183 foreign guests, 8 387 adult Indonesians and 1 485 Indonesian students). Taking into account the late start of the entrance fee system and the effects of the 11 September 2001 terrorist attacks on tourism, the overall visitation for the park for 2001 was projected at the level of 25 000 visitors (15 000 Indonesians and 10 000 foreigners). Although they represented only 34% of visitor numbers, international guests generated almost 95% of the entrance fee receipts. In total, 37 countries were represented in the entrance fee database, with the top country of origin being the UK, followed closely by the USA, Italy, Holland, and Germany. A second tier was comprised of Singapore, Japan, France, Taiwan, Hong Kong, Switzerland, and Spain.

Of the revenue collected, 20% was distributed to the various levels of government as per provincial law. Approximately 50% of the proceeds

were used to fund the joint ranger/police/villager patrol system for BNP, while another 10% was used to purchase and install village information billboards in all 30 settlements within the park. The remaining 20% was set aside for use in the following year's BNPMAB budget.

Based upon the overall success of the fee system in 2001 and broad support from the tourism industry, the annual fee for international visitors was doubled in 2002, becoming 150 000 Rp (~17 USD). It is interesting to note that such a rapid raise in the fee is quite unusual for most MPAs and underlines the importance of working closely with the tourism sector; De Meyer and Simal (these proceedings) report that Bonaire tour operators have resisted a fee raise for over a decade. Additionally, a one-day ticket (50 000 Rp) for international guests was introduced at the request of the local cottage owners (see below). Despite a drastic decrease in international visitors following the Bali bombing incident on 12 October 2002, the BNPMAB managed to record total yearly receipts of 983 750 500 Rp (~110 000 USD). These revenues were generated from a total of 25 697 paying guests, composed of approximately 2/3 local Indonesian guests and 1/3 international visitors. Of the 17 435 Indonesian guests, most were adult guests (14 525), while 2 910 students also were recorded. By contrast, a total of 8 262 international guests were recorded from 48 countries. Most of these international guests (5 294) purchased one-year waterproof entrance tags, while an additional 2 968 visitors purchased single-day entrance tickets. Taiwan, Italy and the United Kingdom were the top three countries of origin for international visitors to BNP during 2002, with 1 431, 1 075, and 793 guests, respectively. The notable predominance of the Taiwanese and the significant drop in American visitors can be attributed to the introduction of direct international flights to Manado from Taiwan in early 2002 and the American reluctance to travel internationally in the wake of the 11 September 2001 terrorist attacks.

As with the 2001 revenues, 20% were allocated to national, provincial and local governments, with an additional 40% of the revenues spent on support for the joint patrol system. New in 2002 was an expenditure of over 30% of total revenues on village-level conservation and development programmes (including a 30-station park-wide VHF radio system, beach cleanups, construction of public toilet and water facilities and paved footpaths, and mangrove rehabilitation programmes). Additional expenditures for 2002 included support for a nascent biological monitoring programme and villager environmental education.

A key factor in the continued success of the BNP entrance fee system has been continuous engagement with all levels of the tourism sector to obtain feedback and adapt the system to any perceived shortcomings. One clear requirement from the tourism community has been the need for continuous socialisation of the fee system and full transparency regarding results. The BNPMAB regularly updates FAQ sheets and posts the results of the entrance fee system (monthly revenues and expenditures, etc) on websites, bulletin boards throughout the park, and via email lists. Brief updates on entrance fee results are also submitted to international dive and nature magazines. Another key area of improvement suggested by the tourism industry (and highlighted by the detailed statistics collected by the entrance fee system) was a new focus on meeting the demands of local Indonesian tourists. During the first year of the entrance fee system, the BNPMAB focused on foreign divers and snorkellers as primary customers, devoting most management efforts towards improving patrols and other activities to maintain and improve the quality of the reefs. However, it soon became evident that local tourists are far more numerous, and that they have quite different demands for a "quality MPA experience": clean beaches and public picnic and toilet facilities, with reef quality being largely irrelevant. More recently, the large increase in day-tripping Taiwanese snorkel tourists has required yet another management paradigm shift; unlike BNP's "normal" clientele of relatively experienced (and environmentally-enlightened) divers, this type of tourist requires specific education and patrol programmes to prevent reef trampling. With both of these situations, close monitoring of entrance fee data combined with continuous engagement with the tourism community has allowed adaptive management changes.

Yet another improvement to the fee system suggested by the tourism sector was the provision for an incentive system for tag sales to further prod uncooperative operators to participate willingly. Under this agreement, a 5% "commission" (7 500 Rp/tag) is offered by the

Table 1 Entrance fee schedule for Bunaken National Park as prescribed by North Sulawesi Provincial Law No. 9/2002.

Fee category	**Indonesian** (Rp)	**International** (Rp)
Visitor		
Yearly tag	No Data	150 000
Daily ticket	2 500	50 000
Student/child	1 000	No Data
Researcher		
1-7 days	45 000	100 000
8-30 days	75 000	200 000
1-6 months	125 000	400 000
.5-1 year	200 000	600 000
>1 year	250 000	800 000
Commercial Filmmaker		
Documentary film	2 000 000	3 000 000
Documentary video	500 000	1 000 000

Researcher and Commercial Filmmaker fees are charged in addition to applicable visitor fee. Residents of the 22 villages in the park and their Indonesian house guests are exempt from paying the visitor fee, while researchers from local provincial universities and institutions are exempt from the researcher fee

BNPMAB on all entrance tag sales. However, to promote institutional strengthening of the tourism sector and better cooperation, this incentive is not paid directly to individual tourism operators, but rather to the trade association of their choice (including the NSWA, the local cottage-owner association, the charter boat association, and the travel agents' association). Moreover, the commission is only paid on yearly entrance tags, in order to encourage operators to sell the tags instead of one-day tickets. This system has also improved compliance and cooperation, and allowed some interesting initiatives to develop; the NSWA uses the proceeds of these commissions to fund a scholarship fund for local high school students from within the park, and the cottage owner association uses their commissions to fund weekly beach cleanups by local villagers.

A final improvement suggested by the tourism community was the introduction of an entrance tag design contest open to all guests visiting the park. For the first two years, the tag design was decided internally within the BNPMAB. While the tag designs were enthusiastically received and the tags have in fact become a collector's item (the BNPMAB received several requests from abroad to purchase tags without visiting the park!), members of NSWA suggested that a tag design contest would only further promote the entrance fee system. The 2003 tag design contest was announced in June 2002, with a deadline of October 2002 to provide ample time to select and print the winning tag design by December 2002. Participants were allowed to submit up to three photographs or graphic designs each for consideration, with the winning prize being a return airfare from Singapore to Manado (donated by Silk Air) and a 5 day all-inclusive diving package at one of 6 participating dive resorts. Importantly, any submitted photos or designs become the non-exclusive property of the BNPMAB for use in printed conservation materials (posters, brochures, and calendars) for the park. The contest has proven very popular and is now in its second year.

Future plans

In the long run, the BNPMAB is targeting up to 250 000 USD per year from the entrance fee system. The projected increase in revenues is assumed to come from a combination of increased visitor numbers and eventual fee raises (both for local and international visitors). At the same time, NRM is now working with the BNPMAB and the tourism sector to set visitor carrying capacity limits and legislate these limits to prevent the onset of mass tourism. Increased user fees will likely be one tool that will be used in the future to limit visitor numbers to a sustainable level.

At the same time, the BNPMAB is also working to further diversify the BNP funding portfolio to prevent overdependence on the entrance fee system (which is subject to potentially large disturbances to international tourism). Specific targets include an international volunteers system to lower management costs, diversified government agency support, in-kind support from the local dive tourism sector, and national and international grant support. Two additional sources of funding that are currently under development include visitor center merchandising and a possible endowment fund. Finally, BNP has been selected as one of four MPAs to participate in a pilot study to develop business plans for Asian MPAs under the auspices of the World Commission on Protected Areas South East Asia Marine (WCPA SEA Marine) working group. With these initiatives well underway, the BNPMAB is targeting financial sustainability by 2005.

References

Erdmann, M.V. and Merrill, P. (2003). Multiple-use Zoning in Marine Protected Areas: Bunaken National Park case study (Indonesia). Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

Erdmann, M.V. and Toengkagie, A. (2003). The Bunaken National Park Joint Patrol System: Lessons Learned from a Multistakeholder Enforcement Initiative. Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

Erdmann, M.V., Merrill, P.R., Mongdong, M., Wowiling, M., Pangalila, R. and Arsyad, I. (2003). The Bunaken National Marine Park Co-Management Initiative. Proceedings Second International Tropical Marine Ecosystems Management Symposium, Manila, Philippines, April, 2003.

NRM Headline News (2001). Natural Resources Management Program Headline News Issue 30, 2001. Available at http://www.bunaken.info/nrm_news.html

NRM Headline News (2002). Natural Resources Management Program Headline News Issue 17, 2002, information courtesy of Nancy Dahl-Tacconi and Mark Erdmann. Available at http://www.bunaken.info/nrm_news.html

PHKA (2002). Technical Guidance on Zonation of Indonesia's Marine National Park System (In Indonesian; Pedoman Penataan Zona Taman Nasional Perairan Laut). Jakarta. 42 pp.

Usher, G. and Merrill, R. (2000). Bunaken National Park: Participatory Management in Zoning. p 247-252 In: Salm RV and Clark JR (eds) Marine and Coastal Protected Areas: A guide for planners and Managers. 3rd Edition. IUCN.

Annex X
Small versus large protected areas in tropical developing nations

(From NRM Headline News (2001). Natural Resources Program Headline News Issue 35, November 2001, courtesy M. Erdmann, Bunaken National Park).

Considerable recent debate has centred on the relative merits and drawbacks of small (less than 2 ha) community-based MPAs versus large (tens to hundreds of thousands of hectares), often centrally-managed MPAs, the marine equivalent of the well-known SLOSS (Single Large Or Several Small) debate in terrestrial conservation circles. This debate has particular relevance to Indonesia and the region as a whole at this time, when several large institutions appear to be favouring the small community marine reserve approach based upon an apparent belief that large MPAs are much more difficult to manage and often face significant public opposition. A good case study for Indonesia is the Philippines, where there are reportedly almost 100 small municipal MPAs and relatively few larger MPAs (with Tubbataha being a notable example). Indeed, the increasing prevalence of Philippines fish poachers in Indonesian waters suggests that the Philippines MPA strategy has not been altogether effective.

Several Philippines representatives at the UNEP-sponsored Workshop on Networking of MPAs in the East Asian Seas held in Kota Kinabalu, Malaysia from 8-12 October 2001 argued strongly for the small community reserve approach, citing the strong community support that is often achieved and the resulting efficacy of management. On the other hand, many marine scientists present at the meeting pointed out that current ecological theory on reef organism life histories and recruitment dynamics suggest that such small reserves, even if relatively high in number, cannot maintain viable populations of many important reef species. While small community reserves are an excellent MPA marketing tool to increase village awareness and participation in marine conservation and possibly to increase local fish catches, networks of large reserves (on the scale of tens of thousands of hectares) are critical for the survival of rare, widely-spaced or highly mobile reef species. A commonly-cited example are groupers (fish), which can travel up to 10 km or more to spawn in large aggregation sites. Without large reserves that include the entire home range of such groupers (including the spawning aggregation sites), there can be no effective protection of grouper stocks

It would seem appropriate that the debate raised at the Kota Kinabalu workshop should be revisited in Indonesia for the purpose of formulating this country's future MPA network strategy. The current focus on small community reserves is certainly important and should continue to be encouraged - but not to the exclusion of large reserves. These large MPAs, while often presenting a much more complex management situation, are an essential component of Indonesia's marine conservation efforts.

Annex XI
Managing overfishing in Indonesia

(Excerpted from Pet & Mous (1999), with direct quotes from their cited sources in normal font and the article conclusions in italics)

Already in the mid-nineties, there was a call for a change in the objective in fishery management: The major conclusion of this study is that a shift of objectives of fisheries management should occur. To assure that maximum benefits accrue from the fisheries, the objectives must change from increasing landings to assuring sustainable exploitation (Gillett 1996).

The tragedy is that Indonesian government officials misinterpret the conclusions from fishery scientists on the maximum sustainable yield. Whereas fishery scientists state that the current state of the fishery is at 60% of the maximum sustainable yield because the fishing effort is too high, many policy makers think that the fishery can be further optimised by increasing the effort. (Undated leaflet from the Indoensian Research Centre of Marine Technology, Ministry of Marine Affairs and Fisheries).

Whereas the concept of maximum sustainable yield is widely used in Indonesia, even a basic understanding of the rationale behind the concept is lacking with policy makers. Fishery scientists fall short in explaining the uncertainties, applicability and the take-home message in their reports. The following are excerpts from the recommendations in a recent FAO report: A major problem is the working concept that the difference between present fish catches and the potential yield represents a surplus which is available for harvesting by additional fishing effort. Although the concept of maximum sustainable yield (MSY) is widely used in Indonesia, as the fisheries develop and effort increases, the MSY concept becomes less relevant and information from the fishery assumes a greater importance in determining any remaining potential. Those individuals that make the resource estimates should also take on the responsibility of conveying to the users of the information an idea of how accurate the information is (Gillett 2000).

The Indonesia/FAO/DANIDA Workshop (Venema 1996) and the DGF/FAO Workshop on Strengthening Marine Resource Management (Gillett 1996) found that the system which is presently used to calculate the optimum effort in terms of numbers of licences (= number of active vessels per year) is incorrect and the expected effects are alarming to say the least.

A challenge for effective fishery management is that policy makers still perceive Illegal Unreported and Unregulated Fishing (there is even an acronym for this, IUUF) as the main concern, rather than overexploitation by 'legal' fishers. There is a strong focus within the Ministry of Marine Affairs and Fisheries to deal with this problem, whereas the establishment of Marine Protected Areas is not on the political agenda. For example, the Ministry did not even propose a single project in support of marine protected areas in its project portfolio presented at PrepCom IV. Hence, there is a niche for a conservation alliance to carry the concept of marine protected areas forward (Ministry of Marine Affairs and Fisheries 2002).

Although overfishing is mentioned as a real problem in general terms, one does get the impression that the main agenda remains to expand the fishery, in combination with curbing illegal fishing and making the domestic fishery more capital-intensive. It is also noteworthy that the Government of Indonesia formulates clear benchmarks for development of the fishery, whereas there is nothing concrete on conservation and how sustainability is being ensured. The following is an excerpt from a speech by the Minister of Marine Affairs and Fisheries: Indonesia's contribution of the fisheries sector to the national GDP is only about 2%, although the total length of the coastal line in South Korea and Japan is only 2 731 and 34 386 km respectively, the contribution of the fisheries sector to the national GDP already fetch 37% and 54% respectively. Likewise, although the total length of the coastal line in Thailand is only about 2 600 km, they manage to tap more then 5 billion USD of foreign-exchange earnings from fisheries export annually. For these obvious reasons, the Indonesian Government has decided to launch an integrated fisheries management programme to optimise the use of fisheries resources on a sustainable basis. Under this scheme, the contribution of fisheries export to the foreign-exchange earnings is projected to reach 5 billion USD and the share of the fisheries sector to the national GDP is expected to reach 5%. One of the main constraints to achieve the above objectives is the fact that artisanal fishermen, characterised as small-scale, low capital and labour intensive in nature, mostly dominate the Indonesian fisheries.

The widespread increase of Ilegal, Unreported and Unregulated fishing has also been incriminated for the severe damage of fisheries resources in the Indonesian waters as well as excessive loss of revenue. We need to work together to strengthen our capacity building and technical know-how. I would like to take this opportunity to seek the indulgence and cooperation of all stakeholders to assist Indonesia to overcome and gradually minimise illegal unreported and unregulated fishing. In this juncture, I would like to re-emphasise our desire to strengthen our capability and policy instruments and law enforcement against IUU fishing. (Official transcript of the keynote speech by the Minister for Marine Affairs and Fisheries at the International Seminar on Sustainable

Development in the EEZ and the EEZ as an Institutional for Cooperation or Conflict. Denpasar, Bali, June 4, 2002).

A recent address by the President of Indonesia shows that the Government of Indonesia seeks to expand the fishery in Indonesia's seas: President Megawati Soekarnoputri, while expressing concern about the environment, called on local businessmen to make more of Eastern Indonesia's waters, home to an abundance of fish and other marine life. "Most businessmen have been reluctant to open new ventures in this unexplored and rich marine resource area because they consider it technically and economically unfeasible," said the President. Participating in the conference and expo were delegates and fishing companies from 22 foreign countries, including Australia, the United States, Germany and France. "We now have to start thinking about how to wisely explore our rich and diverse marine resources, as well as to boost agriculture," she said (Widiadana 2002).

In a recent report to the Ministry of Marine Affairs and Fisheries, the need for better management rather than further expansion was noted again. More investments are needed to produce more fish. But such investments must not expand fishing capacity but to complement and supplement effort to manage the remaining fisheries resources (Pacific Consultants International 2001).

A recent report to the Ministry of Marine Affairs and Fisheries listed the following policy recommendation: Create, build and arouse awareness to change the perception and mindset of the people to stop romanticising that the country's seas have over-abundant or overflowing resources, in particular fisheries resources (Pacific Consultants International 2001).

It is not clear how the Government of Indonesia translates the advice offered through costly consultancies into management action, given the ubiquitous call for reduction of the fishery among experts and the equally ubiquitous call for intensification of the fishery among policy makers. Even consultants seem to have concerns about this issue, see the appeal at the end of the following excerpt from a recent three volume report commissioned by the Ministry of Marine Affairs and Fisheries to Pacific Consultants International: The former Directorate General of Fisheries, now restructured into the Directorate General of Capture Fisheries and Directorate General of Culture Fisheries, had tasked a project, Study on Fisheries Development Policy Formulation, as an integral part of the Jakarta Fishing Port/ Market Development Policy Formulation, as an integral part of the Jakarta Fishing Port/Market Development Project Phase IV under the Japan Bank for International Cooperation (JBIC Loan No. IP-403) to evolve and formulate a new and bold policy for Indonesian fisheries and aquaculture based on the principles of equity and sustainability, taking into account the needs of the vulnerable poor as well as to implement the Precautionary Approach to Management and the Code of Conduct for Responsible Fisheries, to which the country subscribes.

Today, management of Indonesian fisheries is no longer a matter of choice. There is no choice. Management is inevitable if the remaining fisheries are to be sustained for the present and future generations. With fisheries facing certain depletion and imminent collapse, not only in Indonesia but also throughout the world, a continuing emphasis on uncontrolled or unmanaged development and expanded production as had been pursued in the country over the last 30 years is clearly ill advised. To check further uncontrolled expansion and reverse overfishing, a different set of fresh policies and strategies is needed.

The country and its policy-makers and planners, as also its fisheries managers and fishers must rid themselves of their mental trap that every available resource in the country is still underutilised and huge potentials remain for its expanded exploitation and production. In a country as vast as Indonesia is and with over 200 million people and with a structurally-centralised governance system concentrated in Jakarta and Java, it cannot be that its natural resources are still underutilised. For Indonesian fisheries and its future sustainable development, we would like that our Study be on the list of `must read' reports for as many Indonesians as possible, especially those responsible for making policies, which provide the broad thrusts and direction, goals, signals, incentives, nuances and its wherewithals on how these remaining resources are used for nation building (Pacific Consultants International 2001).

In a report prepared by the Food and Agricultural Organization of the United Nations, the danger of the government focusing on increasing production is highlighted: Both individuals and the private sector can and do carry out action leading to increased production from fisheries resources. However, in many respects only the government can serve as a guardian of the fisheries resources to prevent overexploitation. If the staff of DGF (Indonesian Directorate General of Fisheries) are largely preoccupied with increasing fisheries production, there appears to be no government agency which has as its major concern the protection of fisheries resources (Gillett R. 2000).

To restore fish populations and protect ecosystems, fishery managers should develop policies aimed toward substantially reducing fishing, says Sustaining Marine Fisheries, a new report by a committee of the National Research Council. Management plans should include not only commercial fishing but also recreational and subsistence fishing. More coastal and ocean areas should be designated as protected,

where fishing would not be permitted. In addition, managers should consider taking action such as assigning exclusive fishing rights to individuals or communities, to discourage overfishing (The National Academies 1998).

References

Gillett, R. (1996). Marine fisheries resources and management in Indonesia with emphasis on the extended economic zone. Workshop Presentation Paper 1, Workshop on Strengthening Marine Resource Development in Indonesia, TCP/INS/4553.).

Gillett, R. (2000). FAO Technical Cooperation Programme. Assistance in marine fisheries legislation - Indonesia. Report reference TCP/INS/8922. FAO, Rome. 98 p.

Ministry of Marine Affairs and Fisheries (2002). Partnership/Initiative under World Summit on Sustainable Development, presented at PrepCom IV, Bali Indonesia, May 24-June 7, 2002.

The National Academies (1998). Fishing should be reduced substantially to protect marine ecosystems. 22 October. Retrieved July 2003 from http://www4.nas.edu/news.nsf/isbn/0309055261?OpenDocument

Pacific Consultants International (2001). Study on Fisheries Development Policy Formulation. Volume I. White Paper. Report by Pacific Consultants International under Jakarta Fishing Port/Market Development Project (Phase IV: JBIC Loan No. IP-403).

Pet J.S. and Mous P.J. (1999). Status of the coral reefs in and around Komodo National Park 1996-1998. Monitoring report by the Nature Conservancy Indonesia Coastal and Marine Program, Jakarta Indonesia.

Venema S. (1996). Resuls of surveys for pelagic resources in Indonesian waters with the RVLemuru December 1972 to May 1976. In: Pauly D. and Martosubroto P. (eds.)The fish resources of western Indonesia DGF, Indonesia, GTZ, Germany and international centre for living and aquatic resources management, Manila. ICLARM Stud. Rev. 23

Widiadana R.A. (2002). Businessmen urged to exploit RI's eastern waters. The Jakarta Post, July 18.

The Global International Waters Assessment

This report presents the results of the Global International Waters Assessment (GIWA) of the transboundary waters of the Sulu-Celebes (Sulawesi) Sea. This and the subsequent chapter offer a background that describes the impetus behind the establishment of GIWA, its objectives and how the GIWA was implemented.

The need for a global international waters assessment

Globally, people are becoming increasingly aware of the degradation of the world's water bodies. Disasters from floods and droughts, frequently reported in the media, are considered to be linked with ongoing global climate change (IPCC 2001), accidents involving large ships pollute public beaches and threaten marine life and almost every commercial fish stock is exploited beyond sustainable limits - it is estimated that the global stocks of large predatory fish have declined to less that 10% of pre-industrial fishing levels (Myers & Worm 2003). Further, more than 1 billion people worldwide lack access to safe drinking water and 2 billion people lack proper sanitation which causes approximately 4 billion cases of diarrhoea each year and results in the death of 2.2 million people, mostly children younger than five (WHO-UNICEF 2002). Moreover, freshwater and marine habitats are destroyed by infrastructure developments, dams, roads, ports and human settlements (Brinson & Malvárez 2002, Kennish 2002). As a consequence, there is growing public concern regarding the declining quality and quantity of the world's aquatic resources because of human activities, which has resulted in mounting pressure on governments and decision makers to institute new and innovative policies to manage those resources in a sustainable way ensuring their availability for future generations.

Adequately managing the world's aquatic resources for the benefit of all is, for a variety of reasons, a very complex task. The liquid state of the most of the world's water means that, without the construction of reservoirs, dams and canals it is free to flow wherever the laws of nature dictate. Water is, therefore, a vector transporting not only a wide variety of valuable resources but also problems from one area to another. The effluents emanating from environmentally destructive activities in upstream drainage areas are propagated downstream and can affect other areas considerable distances away. In the case of transboundary river basins, such as the Nile, Amazon and Niger, the impacts are transported across national borders and can be observed in the numerous countries situated within their catchments. In the case of large oceanic currents, the impacts can even be propagated between continents (AMAP 1998). Therefore, the inextricable linkages within and between both freshwater and marine environments dictates that management of aquatic resources ought to be implemented through a drainage basin approach.

In addition, there is growing appreciation of the incongruence between the transboundary nature of many aquatic resources and the traditional introspective nationally focused approaches to managing those resources. Water, unlike laws and management plans, does not respect national borders and, as a consequence, if future management of water and aquatic resources is to be successful, then a shift in focus towards international cooperation and intergovernmental agreements is required (UN 1972). Furthermore, the complexity of managing the world's water resources is exacerbated by the dependence of a great variety of domestic and industrial activities on those resources. As a consequence, cross-sectoral multidisciplinary approaches that integrate environmental, socio-economic and development aspects into management must be adopted. Unfortunately however, the scientific information or capacity within each discipline is often not available or is inadequately translated for use by managers, decision makers and

policy developers. These inadequacies constitute a serious impediment to the implementation of urgently needed innovative policies.

Continual assessment of the prevailing and future threats to aquatic ecosystems and their implications for human populations is essential if governments and decision makers are going to be able to make strategic policy and management decisions that promote the sustainable use of those resources and respond to the growing concerns of the general public. Although many assessments of aquatic resources are being conducted by local, national, regional and international bodies, past assessments have often concentrated on specific themes, such as biodiversity or persistent toxic substances, or have focused only on marine or freshwaters. A globally coherent, drainage basin based assessment that embraces the inextricable links between transboundary freshwater and marine systems, and between environmental and societal issues, has never been conducted previously.

The Global Environment Facility (GEF)

The Global Environment Facility forges international co-operation and finances actions to address six critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants (POPs).

The overall strategic thrust of GEF-funded international waters activities is to meet the incremental costs of: (a) assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them; (b) building the capacity of existing institutions to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns; and (c) implementing measures that address the priority transboundary environmental concerns. The goal is to assist countries to utilise the full range of technical, economic, financial, regulatory, and institutional measures needed to operationalise sustainable development strategies for international waters.

United Nations Environment Programme (UNEP)

United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP work encompasses:

- Assessing global, regional and national environmental conditions and trends;
- Developing international and national environmental instruments;
- Strengthening institutions for the wise management of the environment;
- Facilitating the transfer of knowledge and technology for sustainable development;
- Encouraging new partnerships and mind-sets within civil society and the private sector.

University of Kalmar

University of Kalmar hosts the GIWA Co-ordination Office and provides scientific advice and administrative and technical assistance to GIWA. University of Kalmar is situated on the coast of the Baltic Sea. The city has a long tradition of higher education; teachers and marine officers have been educated in Kalmar since the middle of the 19th century. Today, natural science is a priority area which gives Kalmar a unique educational and research profile compared with other smaller universities in Sweden. Of particular relevance for GIWA is the established research in aquatic and environmental science. Issues linked to the concept of sustainable development are implemented by the research programme Natural Resources Management and Agenda 21 Research School.

Since its establishment GIWA has grown to become an integral part of University activities. The GIWA Co-ordination office and GIWA Core team are located at the Kalmarsund Laboratory, the university centre for water-related research. Senior scientists appointed by the University are actively involved in the GIWA peer-review and steering groups. As a result of the cooperation the University can offer courses and seminars related to GIWA objectives and international water issues.

International call for action

The need for a holistic assessment of transboundary waters in order to respond to growing public concerns and provide advice to governments and decision makers regarding the management of aquatic resources was recognised by several international bodies focusing on the global environment. In particular, the Global Environment Facility (GEF) observed that the International Waters (IW) component of the GEF suffered from the lack of a global assessment which made it difficult to prioritise international water projects, particularly considering the inadequate understanding of the nature and root causes of environmental problems. In 1996, at its fourth meeting in Nairobi, the GEF Scientific and Technical Advisory Panel (STAP), noted that: *"Lack of an International Waters Assessment comparable with that of the IPCC, the Global Biodiversity Assessment, and the Stratospheric Ozone Assessment, was a unique and serious impediment to the implementation of the International Waters Component of the GEF"*.

The urgent need for an assessment of the causes of environmental degradation was also highlighted at the UN Special Session on the Environment (UNGASS) in 1997, where commitments were made regarding the work of the UN Commission on Sustainable Development (UNCSD) on freshwater in 1998 and seas in 1999. Also in 1997, two international Declarations, the Potomac Declaration: Towards enhanced ocean security into the third millennium, and the Stockholm Statement on interaction of land activities, freshwater and enclosed seas, specifically emphasised the need for an investigation of the root causes of degradation of the transboundary aquatic environment and options for addressing them. These processes led to the development of the Global International Waters Assessment (GIWA) that would be implemented by the United Nations Environment Programme (UNEP) in conjunction with the University of Kalmar, Sweden, on behalf of the GEF. The GIWA was inaugurated in Kalmar in October 1999 by the Executive Director of UNEP, Dr. Klaus Töpfer, and the late Swedish Minister of the Environment, Kjell Larsson. On this occasion Dr. Töpfer stated: *"GIWA is the framework of UNEP´s global water assessment strategy and will enable us to record and report on critical water resources for the planet for consideration of sustainable development management practices as part of our responsibilities under Agenda 21 agreements of the Rio conference"*.

The importance of the GIWA has been further underpinned by the UN Millennium Development Goals adopted by the UN General Assembly in 2000 and the Declaration from the World Summit on Sustainable

Development in 2002. The development goals aimed to halve the proportion of people without access to safe drinking water and basic sanitation by the year 2015 (United Nations Millennium Declaration 2000). The WSSD also calls for integrated management of land, water and living resources (WSSD 2002) and, by 2010, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem should be implemented by all countries that are party to the declaration (FAO 2001).

International waters and transboundary issues

The term "international waters", as used for the purposes of the GEF Operational Strategy, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems.

The term "transboundary issues" is used to describe the threats to the aquatic environment linked to globalisation, international trade, demographic changes and technological advancement, threats that are additional to those created through transboundary movement of water. Single country policies and actions are inadequate in order to cope with these challenges and this makes them transboundary in nature.

The international waters area includes numerous international conventions, treaties, and agreements. The architecture of marine agreements is especially complex, and a large number of bilateral and multilateral agreements exist for transboundary freshwater basins. Related conventions and agreements in other areas increase the complexity. These initiatives provide a new opportunity for cooperating nations to link many different programmes and instruments into regional comprehensive approaches to address international waters.

The conceptual framework and objectives

Considering the general decline in the condition of the world's aquatic resources and the internationally recognised need for a globally coherent assessment of transboundary waters, the primary objectives of the GIWA are:

- To provide a prioritising mechanism that allows the GEF to focus their resources so that they are used in the most cost effective manner to achieve significant environmental benefits, at national, regional and global levels; and
- To highlight areas in which governments can develop and implement strategic policies to reduce environmental degradation and improve the management of aquatic resources.

In order to meet these objectives and address some of the current inadequacies in international aquatic resources management, the GIWA has incorporated four essential elements into its design:

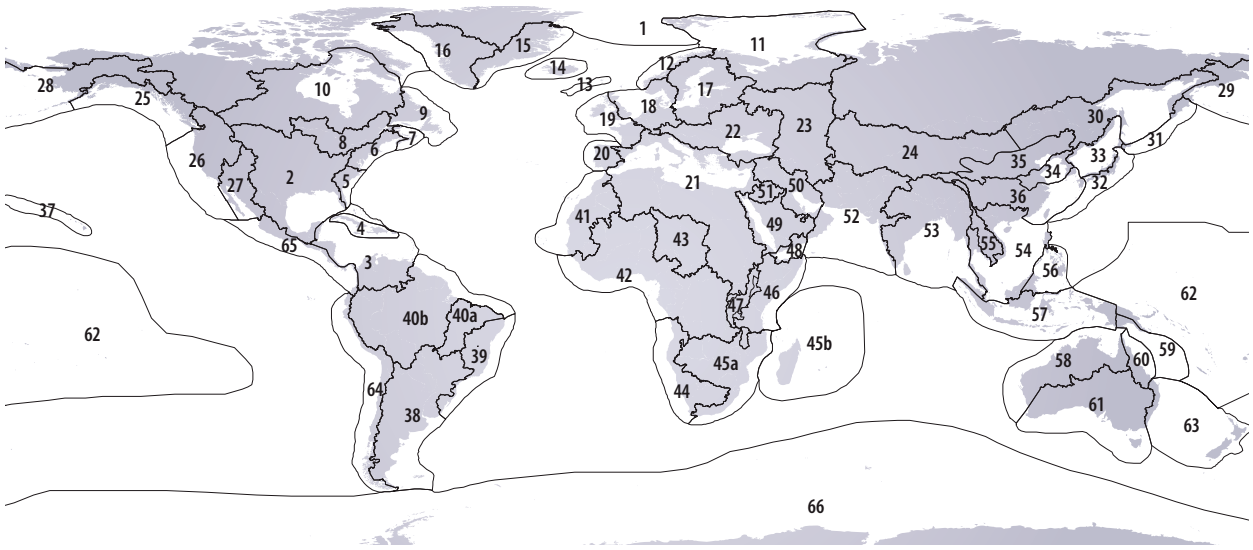
- A broad transboundary approach that generates a truly regional perspective through the incorporation of expertise and existing information from all nations in the region and the assessment of all factors that influence the aquatic resources of the region;
- A drainage basin approach integrating freshwater and marine systems;
- A multidisciplinary approach integrating environmental and socio-economic information and expertise; and
- A coherent assessment that enables global comparison of the results.

The GIWA builds on previous assessments implemented within the GEF International Waters portfolio but has developed and adopted a broader definition of transboundary waters to include factors that influence the quality and quantity of global aquatic resources. For example, due to globalisation and international trade, the market for penaeid shrimps has widened and the prices soared. This, in turn, has encouraged entrepreneurs in South East Asia to expand aquaculture resulting in the large-scale deforestation of mangroves for ponds (Primavera 1997). Within the GIWA, these "non-hydrological" factors constitute as large a transboundary influence as more traditionally recognised problems, such as the construction of dams that regulate the flow of water into a neighbouring country, and are considered equally important. In addition, the GIWA recognises the importance of hydrological units that would not normally be considered transboundary but exert a significant influence on transboundary waters, such as the Yangtze River in China which discharges into the East China Sea (Daoji & Daler 2004) and the Volga River in Russia which is largely responsible for the condition of the Caspian Sea (Barannik et al. 2004). Furthermore, the GIWA is a truly regional assessment that has incorporated data from a wide range of sources and included expert knowledge and information from a wide range of sectors and from each country in the region. Therefore, the transboundary concept adopted by the GIWA extends to include impacts caused by globalisation, international trade, demographic changes and technological advances and recognises the need for international cooperation to address them.

The organisational structure and implementation of the GIWA

The scale of the assessment

Initially, the scope of the GIWA was confined to transboundary waters in areas that included countries eligible to receive funds from the GEF. However, it was recognised that a truly global perspective would only be achieved if industrialised, GEF-ineligible regions of the world were also assessed. Financial resources to assess the GEF-eligible countries were obtained primarily from the GEF (68%), the Swedish International Development Cooperation Agency (Sida) (18%), and the Finnish Department for International Development Cooperation (FINNIDA)



1	*Arctic*	12	*Norwegian Sea (LME)*	24	*Aral Sea*	36	*East-China Sea (LME)*	46	*Somali Coastal Current (LME)*	58	*North Australian Shelf (LME)*
2	*Gulf of Mexico (LME)*	13	*Faroe plateau*	25	*Gulf of Alaska (LME)*	37	*Hawaiian Archipelago (LME)*	47	*East African Rift Valley Lakes*	59	*Coral Sea Basin*
3	*Caribbean Sea (LME)*	14	*Iceland Shelf (LME)*	26	*California Current (LME)*	38	*Patagonian Shelf (LME)*	48	*Gulf of Aden*	60	*Great Barrier Reef (LME)*
4	*Caribbean Islands*	15	*East Greenland Shelf (LME)*	27	*Gulf of California (LME)*	39	*Brazil Current (LME)*	49	*Red Sea (LME)*	61	*Great Australian Bight*
5	*Southeast Shelf (LME)*	16	*West Greenland Shelf (LME)*	28	*East Bering Sea (LME)*	40a	*Brazilian Northeast (LME)*	50	*The Gulf*	62	*Small Island States*
6	*Northeast Shelf (LME)*	17	*Baltic Sea (LME)*	29	*West Bering Sea (LME)*	40b	*Amazon*	51	*Jordan*	63	*Tasman Sea*
7	*Scotian Shelf (LME)*	18	*North Sea (LME)*	30	*Sea of Okhotsk (LME)*	41	*Canary Current (LME)*	52	*Arabian Sea (LME)*	64	*Humboldt Current (LME)*
8	*Gulf of St Lawrence*	19	*Celtic-Biscay Shelf (LME)*	31	*Oyashio Current (LME)*	42	*Guinea Current (LME)*	53	*Bay of Bengal S.E.*	65	*Eastern Equatorial Pacific*
9	*Newfoundland Shelf (LME)*	20	*Iberian Coastal (LME)*	32	*Kuroshio Current (LME)*	43	*Lake Chad*	54	*South China Sea (LME)*	66	*Antarctic (LME)*
10	*Baffin Bay, Labrador Sea, Canadian Archipelago*	21	*Mediterranean Sea (LME)*	33	*Sea of Japan/East Sea (LME)*	44	*Benguela Current (LME)*	55	*Mekong River*		
		22	*Black Sea (LME)*	34	*Yellow Sea (LME)*	45a	*Agulhas Current (LME)*	56	*Sulu-Celebes Sea (LME)*		
11	*Barents Sea (LME)*	23	*Caspian Sea*	35	*Bohai Sea*	45b	*Indian Ocean Islands*	57	*Indonesian Seas (LME)*		

Figure 1 The 66 transboundary regions assessed within the GIWA project.

(10%). Other contributions were made by Kalmar Municipality, the University of Kalmar and the Norwegian Government. The assessment of regions ineligible for GEF funds was conducted by various international and national organisations as in-kind contributions to the GIWA.

In order to be consistent with the transboundary nature of many of the world's aquatic resources and the focus of the GIWA, the geographical units being assessed have been designed according to the watersheds of discrete hydrographic systems rather than political borders (Figure 1). The geographic units of the assessment were determined during the preparatory phase of the project and resulted in the division of the world into 66 regions defined by the entire area of one or more catchments areas that drains into a single designated marine system. These marine systems often correspond to Large Marine Ecosystems (LMEs) (Sherman 1994, IOC 2002).

Large Marine Ecocsystems (LMEs)

Large Marine Ecosystems (LMEs) are regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margin of the major current systems. They are relatively large regions on the order of 200 000 km^2 or greater, characterised by distinct: (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically dependent populations.

The Large Marine Ecosystems strategy is a global effort for the assessment and management of international coastal waters. It developed in direct response to a declaration at the 1992 Rio Summit. As part of the strategy, the World Conservation Union (IUCN) and National Oceanic and Atmospheric Administration (NOAA) have joined in an action program to assist developing countries in planning and implementing an ecosystem-based strategy that is focused on LMEs as the principal assessment and management units for coastal ocean resources. The LME concept is also adopted by GEF that recommends the use of LMEs and their contributing freshwater basins as the geographic area for integrating changes in sectoral economic activities.

Considering the objectives of the GIWA and the elements incorporated into its design, a new methodology for the implementation of the assessment was developed during the initial phase of the project. The methodology focuses on five major environmental concerns which constitute the foundation of the GIWA assessment; Freshwater shortage, Pollution, Habitat and community modification, Overexploitation of fish and other living resources, and Global change. The GIWA methodology is outlined in the following chapter.

The global network

In each of the 66 regions, the assessment is conducted by a team of local experts that is headed by a Focal Point (Figure 2). The Focal Point can be an individual, institution or organisation that has been selected on the basis of their scientific reputation and experience implementing international assessment projects. The Focal Point is responsible for assembling members of the team and ensuring that it has the necessary expertise and experience in a variety of environmental and socio-economic disciplines to successfully conduct the regional assessment. The selection of team members is one of the most critical elements for the success of GIWA and, in order to ensure that the most relevant information is incorporated into the assessment, team members were selected from a wide variety of institutions such as universities, research institutes, government agencies, and the private sector. In addition, in order to ensure that the assessment produces a truly regional perspective, the teams should include representatives from each country that shares the region.

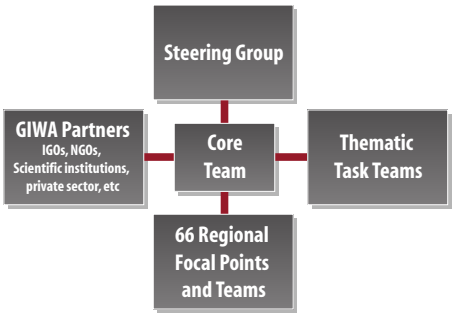


Figure 2 The organisation of the GIWA project.

In total, more than 1 000 experts have contributed to the implementation of the GIWA illustrating that the GIWA is a participatory exercise that relies on regional expertise. This participatory approach is essential because it instils a sense of local ownership of the project, which ensures the credibility of the findings and moreover, it has created a global network of experts and institutions that can collaborate and exchange experiences and expertise to help mitigate the continued degradation of the world's aquatic resources.

GIWA Regional reports

The GIWA was established in response to growing concern among the general public regarding the quality of the world's aquatic resources and the recognition of governments and the international community concerning the absence of a globally coherent international waters assessment. However, because a holistic, region-by-region, assessment of the condition of the world's transboundary water resources had never been undertaken, a methodology guiding the implementation of such an assessment did not exist. Therefore, in order to implement the GIWA, a new methodology that adopted a multidisciplinary, multi-sectoral, multi-national approach was developed and is now available for the implementation of future international assessments of aquatic resources.

UNEP Water Policy and Strategy

The primary goals of the UNEP water policy and strategy are:

(a) Achieving greater global understanding of freshwater, coastal and marine environments by conducting environmental assessments in priority areas;

(b) Raising awareness of the importance and consequences of unsustainable water use;

(c) Supporting the efforts of Governments in the preparation and implementation of integrated management of freshwater systems and their related coastal and marine environments;

(d) Providing support for the preparation of integrated management plans and programmes for aquatic environmental hot spots, based on the assessment results;

(e) Promoting the application by stakeholders of precautionary, preventive and anticipatory approaches.

The GIWA is comprised of a logical sequence of four integrated components. The first stage of the GIWA is called Scaling and is a process by which the geographic area examined in the assessment is defined and all the transboundary waters within that area are identified. Once the geographic scale of the assessment has been defined, the assessment teams conduct a process known as Scoping in which the magnitude of environmental and associated socio-economic impacts of Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, and Global change is assessed in order to identify and prioritise the concerns that require the most urgent intervention. The assessment of these predefined concerns incorporates the best available information and the knowledge and experience of the multidisciplinary, multi-national assessment teams formed in each region. Once the priority concerns have been identified, the root causes of these concerns are identified during the third component of the GIWA, Causal chain analysis. The root causes are determined through a sequential process that identifies, in turn, the most significant immediate causes followed by the economic sectors that are primarily responsible for the immediate causes and finally, the societal root causes. At each stage in the Causal chain analysis, the most significant contributors are identified through an analysis of the best available information which is augmented by the expertise of the assessment team. The final component of the GIWA is the development of Policy options that focus on mitigating the impacts of the root causes identified by the Causal chain analysis.

The results of the GIWA assessment in each region are reported in regional reports that are published by UNEP. These reports are designed to provide a brief physical and socio-economic description of the most important features of the region against which the results of the assessment can be cast. The remaining sections of the report present the results of each stage of the assessment in an easily digestible form. Each regional report is reviewed by at least two independent external reviewers in order to ensure the scientific validity and applicability of each report. The 66 regional assessments of the GIWA will serve UNEP as an essential complement to the UNEP Water Policy and Strategy and UNEP's activities in the hydrosphere.

Global International Waters Assessment

References:

AMAP (1998). Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

Barannik, V., Borysova, O. and Stolberg, F. (2004). The Caspian Sea Region: Environmental Change. Ambio, 33:45-51.

Brinson, M.M. and Malvárez, A.I. (2002). Temperate freshwater wetlands: types, status, and threats. Environmental Conservation, 29:115-133.

Daoji, L. and Daler, D. (2004). Ocean Pollution from Land-based Sources: East China Sea, China. Ambio, 33:98-106.

FAO (2001). Reykjavik conference on responsible fisheries in the marine ecosystem. Iceland, 1-4 October 2001.

IOC (2002). IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs). Fourth Session, 8-9 January 2002, Paris, France.

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. In: Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A. (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kennish, M.J. (2002). Environmental threats and environmental future of estuaries. Environmental Conservation, 29:78-107.

Myers, R.A. and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. Nature, 423:280-283.

Primavera, J.H. (1997) Socio-economic impacts of shrimp culture. Aquaculture Research, 28:815-827.

Sherman, K. (1994). Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. Marine Ecology Progress Series, 112:277-301.

United Nations conference on the human environment (1972). Report available on-line at http://www.unep.org

United Nations Millennium Declaration (2000). The Millennium Assembly of the United Nations, New York.

WHO-UNICEF (2002). Global Water Supply and Sanitation Assessment: 2000 Report.

WSSD (2002). World Summit on Sustainable Development. Johannesburg Summit 2002. Key Outcomes of the Summit, UN Department of Public Information, New York.

The GIWA methodology

The specific objectives of the GIWA were to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources that incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments, in order to enable the GEF to focus their resources and to provide guidance and advice to governments and decision makers. The coalition of all these elements into a single coherent methodology that produces an assessment that achieves each of these objectives had not previously been done and posed a significant challenge.

The integration of each of these elements into the GIWA methodology was achieved through an iterative process guided by a specially convened Methods task team that was comprised of a number of international assessment and water experts. Before the final version of the methodology was adopted, preliminary versions underwent an extensive external peer review and were subjected to preliminary testing in selected regions. Advice obtained from the Methods task team and other international experts and the lessons learnt from preliminary testing were incorporated into the final version that was used to conduct each of the GIWA regional assessments.

Considering the enormous differences between regions in terms of the quality, quantity and availability of data, socio-economic setting and environmental conditions, the achievement of global comparability required an innovative approach. This was facilitated by focusing the assessment on the impacts of five pre-defined concerns namely; Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources and Global change, in transboundary waters. Considering the diverse range of elements encompassed by each concern, assessing the magnitude of the impacts caused by these concerns was facilitated by evaluating the impacts of 22 specific issues that were grouped within these concerns (see Table 1).

The assessment integrates environmental and socio-economic data from each country in the region to determine the severity of the impacts of each of the five concerns and their constituent issues on the entire region. The integration of this information was facilitated by implementing the assessment during two participatory workshops that typically involved 10 to 15 environmental and socio-economic experts from each country in the region. During these workshops, the regional teams performed preliminary analyses based on the collective knowledge and experience of these local experts. The results of these analyses were substantiated with the best available information to be presented in a regional report.

Table 1 Pre-defined GIWA concerns and their constituent issues addressed within the assessment.

Environmental issues	Major concerns
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radionuclide 11. Spills	**II Pollution**
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**
14. Overexploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fish and other living resources**
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**

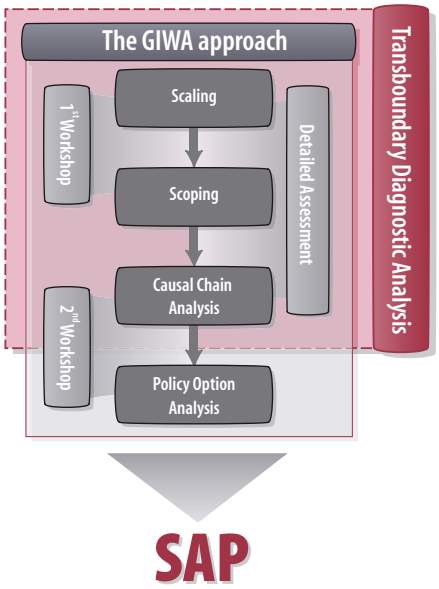


Figure 1 Illustration of the relationship between the GIWA approach and other projects implemented within the GEF International Waters (IW) portfolio.

The GIWA is a logical contiguous process that defines the geographic region to be assessed, identifies and prioritises particularly problems based on the magnitude of their impacts on the environment and human societies in the region, determines the root causes of those problems and, finally, assesses various policy options that addresses those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps, referred to as Scaling, Scoping, Causal chain analysis and Policy options analysis, are summarised below and are described in their entirety in two volumes: *GIWA Methodology Stage 1: Scaling and Scoping*; and *GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis*. Generally, the components of the GIWA methodology are aligned with the framework adopted by the GEF for Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programmes (SAPs) (Figure 1) and assume a broad spectrum of transboundary influences in addition to those associated with the physical movement of water across national borders.

Scaling – Defining the geographic extent of the region

Scaling is the first stage of the assessment and is the process by which the geographic scale of the assessment is defined. In order to facilitate the implementation of the GIWA, the globe was divided during the design phase of the project into 66 contiguous regions. Considering the transboundary nature of many aquatic resources and the transboundary focus of the GIWA, the boundaries of the regions did not comply with political boundaries but were instead, generally defined by a large but discrete drainage basin that also included the coastal marine waters into which the basin discharges. In many cases, the marine areas examined during the assessment coincided with the Large Marine Ecosystems (LMEs) defined by the US National Atmospheric and Oceanographic Administration (NOAA). As a consequence, scaling should be a relatively straight-forward task that involves the inspection of the boundaries that were proposed for the region during the preparatory phase of GIWA to ensure that they are appropriate and that there are no important overlaps or gaps with neighbouring regions. When the proposed boundaries were found to be inadequate, the boundaries of the region were revised according to the recommendations of experts from both within the region and from adjacent regions so as to ensure that any changes did not result in the exclusion of areas from the GIWA. Once the regional boundary was defined, regional teams identified all the transboundary elements of the aquatic environment within the region and determined if these elements could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately.

Scoping – Assessing the GIWA concerns

Scoping is an assessment of the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues (Table 1). It is not designed to provide an exhaustive review of water-related problems that exist within each region, but rather it is a mechanism to identify the most urgent problems in the region and prioritise those for remedial actions. The priorities determined by Scoping are therefore one of the main outputs of the GIWA project.

Focusing the assessment on pre-defined concerns and issues ensured the comparability of the results between different regions. In addition, to ensure the long-term applicability of the options that are developed to mitigate these problems, Scoping not only assesses the current impacts of these concerns and issues but also the probable future impacts according to the "most likely scenario" which considered demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment within the region by 2020.

The magnitude of the impacts caused by each issue on the environment and socio-economic indicators was assessed over the entire region using the best available information from a wide range of sources and the knowledge and experience of the each of the experts comprising the regional team. In order to enhance the comparability of the assessment between different regions and remove biases in the assessment caused by different perceptions of and ways to communicate the severity of impacts caused by particular issues, the

results were distilled and reported as standardised scores according to the following four point scale:

- 0 = no known impact
- 1 = slight impact
- 2 = moderate impact
- 3 = severe impact

The attributes of each score for each issue were described by a detailed set of pre-defined criteria that were used to guide experts in reporting the results of the assessment. For example, the criterion for assigning a score of 3 to the issue Loss of ecosystems or ecotones is: "*Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.*" The full list of criteria is presented at the end of the chapter, Table 5a-e. Although the scoring inevitably includes an arbitrary component, the use of predefined criteria facilitates comparison of impacts on a global scale and also encouraged consensus of opinion among experts.

The trade-off associated with assessing the impacts of each concern and their constituent issues at the scale of the entire region is that spatial resolution was sometimes low. Although the assessment provides a score indicating the severity of impacts of a particular issue or concern on the entire region, it does not mean that the entire region suffers the impacts of that problem. For example, eutrophication could be identified as a severe problem in a region, but this does not imply that all waters in the region suffer from severe eutrophication. It simply means that when the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected is considered, the magnitude of the overall impacts meets the criteria defining a severe problem and that a regional action should be initiated in order to mitigate the impacts of the problem.

When each issue has been scored, it was weighted according to the relative contribution it made to the overall environmental impacts of the concern and a weighted average score for each of the five concerns was calculated (Table 2). Of course, if each issue was deemed to make equal contributions, then the score describing the overall impacts of the concern was simply the arithmetic mean of the scores allocated to each issue within the concern.
In addition, the socio-economic impacts of each of the five major concerns were assessed for the entire region. The socio-economic impacts were grouped into three categories; Economic impacts, Health impacts and Other social and community impacts (Table 3). For each category, an evaluation of the size, degree and frequency of the impact was performed and, once completed, a weighted average score describing the overall socio-economic impacts of each concern was calculated in the same manner as the overall environmental score.

Table 2 Example of environmental impact assessment of Freshwater shortage.

Environmental issues	Score	Weight %	Environmental concerns	Weight averaged score
1. Modification of stream flow	1	20	Freshwater shortage	1.50
2. Pollution of existing supplies	2	50		
3. Changes in the water table	1	30		

Table 3 Example of Health impacts assessment linked to one of the GIWA concerns.

Criteria for Health impacts	Raw score	Score	Weight %
Number of people affected	Very small ... Very large 0 1 2 3	2	50
Degree of severity	Minimum ... Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short ... Continuous 0 1 2 3	2	20
Weight average score for Health impacts		**2**	

After all 22 issues and associated socio-economic impacts have been scored, weighted and averaged, the magnitude of likely future changes in the environmental and socio-economic impacts of each of the five concerns on the entire region is assessed according to the most likely scenario which describes the demographic, economic, technological and other relevant changes that might influence the aquatic environment within the region by 2020.

In order to prioritise among GIWA concerns within the region and identify those that will be subjected to causal chain and policy options analysis in the subsequent stages of the GIWA, the present and future scores of the environmental and socio-economic impacts of each concern are tabulated and an overall score calculated. In the example presented in Table 4, the scoping assessment indicated that concern III, Habitat and community modification, was the priority concern in this region. The outcome of this mathematic process was reconciled against the knowledge of experts and the best available information in order to ensure the validity of the conclusion.

In some cases however, this process and the subsequent participatory discussion did not yield consensus among the regional experts regarding the ranking of priorities. As a consequence, further analysis was required. In such cases, expert teams continued by assessing the relative importance of present and potential future impacts and assign weights to each. Afterwards, the teams assign weights indicating the relative contribution made by environmental and socio-economic factors to the overall impacts of the concern. The weighted average score for each concern is then recalculated taking into account

Table 4 Example of comparative environmental and socio-economic impacts of each major concern, presently and likely in year 2020.

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.3	2.3	2.7	2.8	2.6	3.0	1.8	2.2	**2.3**
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	**2.0**
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	**2.6**
Unsustainable exploitation of fish and other living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	**2.1**
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	**1.2**

the relative contributions of both present and future impacts and environmental and socio-economic factors. The outcome of these additional analyses was subjected to further discussion to identify overall priorities for the region.

Finally, the assessment recognises that each of the five GIWA concerns are not discrete but often interact. For example, pollution can destroy aquatic habitats that are essential for fish reproduction which, in turn, can cause declines in fish stocks and subsequent overexploitation. Once teams have ranked each of the concerns and determined the priorities for the region, the links between the concerns are highlighted in order to identify places where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

Causal chain analysis

Causal Chain Analysis (CCA) traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes. The GIWA CCA aims to identify the most important causes of each concern prioritised during the scoping assessment in order to direct policy measures at the most appropriate target in order to prevent further degradation of the regional aquatic environment.

Root causes are not always easy to identify because they are often spatially or temporally separated from the actual problems they cause. The GIWA CCA was developed to help identify and understand the root causes of environmental and socio-economic problems in international waters and is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. However, because there is no universal theory describing how root causes interact to create natural resource management problems and due to the great variation of local circumstances under which the methodology will be applied, the GIWA CCA is not a rigidly structured assessment but should be regarded as a framework to guide the analysis, rather than as a set of detailed instructions. Secondly, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA[1]. For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

Conceptual model

A causal chain is a series of statements that link the causes of a problem with its effects. Recognising the great diversity of local settings and the resulting difficulty in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and then only on those issues that were prioritised during the scoping assessment. The starting point of a particular causal chain is one of the issues selected during the Scaling and Scoping stages and its related environmental and socio-economic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the GIWA issue. For example, for the issue of eutrophication the immediate causes may be, inter alia:

- Enhanced nutrient inputs;
- Increased recycling/mobilisation;
- Trapping of nutrients (e.g. in river impoundments);
- Run-off and stormwaters

Once the relevant immediate cause(s) for the particular system has (have) been identified, the sectors of human activity that contribute most significantly to the immediate cause have to be determined. Assuming that the most important immediate cause in our example had been increased nutrient concentrations, then it is logical that the most likely sources of those nutrients would be the agricultural, urban or industrial sectors. After identifying the sectors that are primarily

[1] This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.

responsible for the immediate causes, the root causes acting on those sectors must be determined. For example, if agriculture was found to be primarily responsible for the increased nutrient concentrations, the root causes could potentially be:

- Economic (e.g. subsidies to fertilisers and agricultural products);
- Legal (e.g. inadequate regulation);
- Failures in governance (e.g. poor enforcement); or
- Technology or knowledge related (e.g. lack of affordable substitutes for fertilisers or lack of knowledge as to their application).

Once the most relevant root causes have been identified, an explanation, which includes available data and information, of how they are responsible for the primary environmental and socio-economic problems in the region should be provided.

Policy option analysis

Despite considerable effort of many Governments and other organisations to address transboundary water problems, the evidence indicates that there is still much to be done in this endeavour. An important characteristic of GIWA's Policy Option Analysis (POA) is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to create more effective societal responses to the extremely complex water related transboundary problems. The core of POA in the assessment consists of two tasks:

Construct policy options

Policy options are simply different courses of action, which are not always mutually exclusive, to solve or mitigate environmental and socio-economic problems in the region. Although a multitude of different policy options could be constructed to address each root cause identified in the CCA, only those few policy options that have the greatest likelihood of success were analysed in the GIWA.

Select and apply the criteria on which the policy options will be evaluated

Although there are many criteria that could be used to evaluate any policy option, GIWA focuses on:

- Effectiveness (certainty of result)
- Efficiency (maximisation of net benefits)
- Equity (fairness of distributional impacts)
- Practical criteria (political acceptability, implementation feasibility).

The policy options recommended by the GIWA are only contributions to the larger policy process and, as such, the GIWA methodology developed to test the performance of various options under the different circumstances has been kept simple and broadly applicable.

Global International Waters Assessment

Table 5a: Scoring criteria for environmental impacts of Freshwater shortage

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/ regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades."	■ No evidence of modification of stream flow.	■ There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin > 40 000 km^2); or ■ There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or ■ There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or ■ Change in the occurrence of exceptional discharges (e.g. due to upstream damming.	■ Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of >250 000 km^2; or ■ Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or ■ Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or ■ Significant saline intrusion into previously freshwater rivers or lagoons.	■ Annual discharge of a river altered by more than 50% of long term mean; or ■ Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or ■ Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or ■ Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources"	■ No evidence of pollution of surface and ground waters.	■ Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or ■ There have been reports of one or more fish kills in the system due to pollution within the past five years.	■ Water supplies does not meet WHO or national drinking water standards in more than 30% of the region; or ■ There are one or more reports of fish kills due to pollution in any river draining a basin of >250 000 km^2 .	■ River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion ■ Severe pollution of other sources of freshwater (e.g. groundwater)
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	■ No evidence that abstraction of water from aquifers exceeds natural replenishment.	■ Several wells have been deepened because of excessive aquifer draw-down; or ■ Several springs have dried up; or ■ Several wells show some salinisation.	■ Clear evidence of declining base flow in rivers in semi-arid areas; or ■ Loss of plant species in the past decade, that depend on the presence of ground water; or ■ Wells have been deepened over areas of hundreds of km^2;or ■ Salinisation over significant areas of the region.	■ Aquifers are suffering salinisation over regional scale; or ■ Perennial springs have dried up over regionally significant areas; or ■ Some aquifers have become exhausted

Table 5b: Scoring criteria for environmental impacts of Pollution

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	■ Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.	■ There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.	■ Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or ■ There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	■ There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or ■ There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	■ No visible effects on the abundance and distributions of natural living resource distributions in the area; and ■ No increased frequency of hypoxia[1] or fish mortality events or harmful algal blooms associated with enhanced primary production; and ■ No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and ■ No evident abnormality in the frequency of algal blooms.	■ Increased abundance of epiphytic algae; or ■ A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or ■ Measurable shallowing of the depth range of macrophytes.	■ Increased filamentous algal production resulting in algal mats; or ■ Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	■ High frequency (>1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or ■ Significant changes in the littoral community; or ■ Presence of hydrogen sulphide in historically well oxygenated areas.

Issue 6: Chemical pollution "The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating."	■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and ■ No fisheries closures or advisories due to chemical pollution; and ■ No incidence of fisheries product tainting; and ■ No unusual fish mortality events. If there is no available data use the following criteria: ■ No use of pesticides; and ■ No sources of dioxins and furans; and ■ No regional use of PCBs; and ■ No bleached kraft pulp mills using chlorine bleaching; and ■ No use or sources of other contaminants.	■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or ■ Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: ■ Some use of pesticides in small areas; or ■ Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or ■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or ■ Presence of other contaminants.	■ Some chemical contaminants are above threshold limits defined for the country or region; or ■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or ■ High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: ■ Large-scale use of pesticides in agriculture and forestry; or ■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or ■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or ■ Presence of considerable quantities of other contaminants.	■ Chemical contaminants are above threshold limits defined for the country or region; and ■ Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or ■ Large-scale mortalities of aquatic species. If there is no available data use the following criteria: ■ Indications of health effects resulting from use of pesticides; or ■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or ■ Known contamination of the environment or foodstuffs by PCBs; or ■ Known contamination of the environment or foodstuffs by other contaminants.
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	■ No visible reduction in water transparency; and ■ No evidence of turbidity plumes or increased siltation; and ■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	■ Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or ■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or ■ Extensive evidence of changes in sedimentation or erosion rates; or ■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	■ Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (i.e., grain-size composition/redox); or ■ Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	■ No noticeable interference with trawling activities; and ■ No noticeable interference with the recreational use of beaches due to litter; and ■ No reported entanglement of aquatic organisms with debris.	■ Some evidence of marine-derived litter on beaches; or ■ Occasional recovery of solid wastes through trawling activities; but ■ Without noticeable interference with trawling and recreational activities in coastal areas.	■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or ■ High frequencies of benthic litter recovery and interference with trawling activities; or ■ Frequent reports of entanglement/ suffocation of species by litter.	■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or ■ Trawling activities untenable because of benthic litter and gear entanglement; or ■ Widespread entanglement and/or suffocation of aquatic species by litter.
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	■ No thermal discharges or evidence of thermal effluent effects.	■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or ■ Evidence of reduced migration of species due to thermal plume.	■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or ■ Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	■ No radionuclide discharges or nuclear activities in the region.	■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	■ Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms but without situations or levels likely to warrant large scale intervention by a national or international authority.	■ Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or ■ Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	■ No evidence of present or previous spills of hazardous material; or ■ No evidence of increased aquatic or avian species mortality due to spills.	■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	■ Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or ■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or ■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

Table 5c: Scoring criteria for environmental impacts of Habitat and community modification

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 12: Loss of ecosystems or ecotones "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats over the last 2-3 decades."	■ There is no evidence of loss of ecosystems or habitats.	■ There are indications of fragmentation of at least one of the habitats.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30 % during the last 2-3 decades.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	■ No evidence of change in species complement due to species extinction or introduction; and ■ No changing in ecosystem function and services.	■ Evidence of change in species complement due to species extinction or introduction	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure; and ■ Evidence of change in ecosystem services[2].

[2] Constanza, R. et al. (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

Table 5d: Scoring criteria for environmental impacts of Unsustainable exploitation of fish and other living resources

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Overexploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	■ No harvesting exists catching fish (with commercial gear for sale or subsistence).	■ Commercial harvesting exists but there is no evidence of over-exploitation.	■ One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.	■ More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	■ Current harvesting practices show no evidence of excessive by-catch and/or discards.	■ Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	■ 30-60% of the fisheries yield consists of by-catch and/or discards.	■ Over 60% of the fisheries yield is by-catch and/or discards; or ■ Noticeable incidence of capture of endangered species.
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	■ No evidence of habitat destruction due to fisheries practices.	■ Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or ■ Trawling of any one area of the seabed is occurring less than once per year.	■ Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or ■ Trawling of any one area of the seabed is occurring 1-10 times per year; or ■ Incidental use of explosives or poisons for fishing.	■ Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or ■ Trawling of any one area of the seabed is occurring more than 10 times per year; or ■ Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	■ No evidence of increased incidence of fish or shellfish diseases.	■ Increased reports of diseases without major impacts on the stock.	■ Declining populations of one or more species as a result of diseases or contamination.	■ Collapse of stocks as a result of diseases or contamination.
Issue 18: Impact on biological and genetic diversity "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	■ No evidence of deliberate or accidental introductions of alien species; and ■ No evidence of deliberate or accidental introductions of alien stocks; and ■ No evidence of deliberate or accidental introductions of genetically modified species.	■ Alien species introduced intentionally or accidentally without major changes in the community structure; or ■ Alien stocks introduced intentionally or accidentally without major changes in the community structure; or ■ Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	■ Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or ■ Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	■ Extinction of native species or local stocks as a result of introductions (intentional or accidental); or ■ Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

Table 5e: Scoring criteria for environmental impacts of Global change

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 19: Changes in hydrological cycle and ocean circulation "Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO."	■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	■ Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or ■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	■ Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or ■ Extreme events such as flood and drought are increasing; or ■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	■ Loss of an entire habitat through desiccation or submergence as a result of global change; or ■ Change in the tree or lichen lines; or ■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or ■ Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or ■ Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	■ No evidence of sea level change.	■ Some evidences of sea level change without major loss of populations of organisms.	■ Changed pattern of coastal erosion due to sea level rise has became evident; or ■ Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).	■ Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or ■ Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.
Issue 21: Increased UV-B radiation as a result of ozone depletion "Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades."	■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	■ Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.	■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or ■ One or more aquatic populations are declining.	■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	■ No measurable or assessed changes in CO_2 source/sink function of aquatic system.	■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	■ Some evidences that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the region by at least 10%.	■ Evidences that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO_2 balance.

The Global International Waters Assessment (GIWA) is a holistic, globally comparable assessment of all the world's transboundary waters that recognises the inextricable links between freshwater and coastal marine environment and integrates environmental and socio-economic information to determine the impacts of a broad suite of influences on the world's aquatic environment.

Broad Transboundary Approach

The GIWA not only assesses the problems caused by human activities manifested by the physical movement of transboundary waters, but also the impacts of other non-hydrological influences that determine how humans use transboundary waters.

Regional Assessment – Global Perspective

The GIWA provides a global perspective of the world's transboundary waters by assessing 66 regions that encompass all major drainage basins and adjacent large marine ecosystems. The GIWA Assessment of each region incorporates information and expertise from all countries sharing the transboundary water resources.

Global Comparability

In each region, the assessment focuses on 5 broad concerns that are comprised of 22 specific water related issues.

Integration of Information and Ecosystems

The GIWA recognises the inextricable links between freshwater and coastal marine environment and assesses them together as one integrated unit.

The GIWA recognises that the integration of socio-economic and environmental information and expertise is essential to obtain a holistic picture of the interactions between the environmental and societal aspects of transboundary waters.

Priorities, Root Causes and Options for the Future

The GIWA indicates priority concerns in each region, determines their societal root causes and develops options to mitigate the impacts of those concerns in the future.

This Report

This report present the GIWA assessment of the Sulu-Celebes (Sulawesi) Sea region, which includes some of the land and sea areas of the three nations the Philippines, Indonesia and Malaysia. The region is situated in the centre of the world's marine biodiversity with many species of global significance and is surrounded by a rapidly growing population and rapidly deteriorating marine ecosystem. Habitat loss and community modification, having strong linkages with unsustainable exploitation of living resources and suspended solids in the drainage basins, were considered to have the most severe transboundary environmental and socio-economic impacts in the region. The past and present status and future prospects of these issues are discussed, and they are traced back to their root causes. Policy options to mitigate these problems are proposed that aim to provide solutions to these fundamental issues, in order to enhance the management of the region's aquatic environment.

UNEP

GEF

HÖGSKOLAN KALMAR UNIVERSITY