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 Indonesian Seas regional boundaries encompass most of the approximately 18,000 islands and territory of the Republic of Indonesia, being bounded on its western and northern extent by the adjacent GIWA regions of Bay of Bengal (GIWA region 53), South China Sea (GIWA...
region 54) and Sulu-Celebes (Sulawesi) Sea (GIWA region 56); on its southern extent by the North Australian Shelf (GIWA region 58); and northeastern extent by Pacific Islands (GIWA region 62). The region is composed of many smaller seas of diverse character; including the Jawa Sea, Bali Sea, Flores Sea, Sava Sea, Timor Sea, Banda Sea, Seram Sea, Maluku Sea, Halmahera Sea and Arafura Sea, and the Makassar Strait.

At its eastern extent, the regional boundary was extended to encompass all of Irian Jaya (Papua), Kepulauan Aru and Kepulauan Tanimbar, following the 200 m depth contour on the northern coast of Irian in the north and across the Arafura Sea on the Indonesia/Australia territorial boundary to the Irian Jaya/Papua New Guinea territorial boundary in the south (Figure 1).

On its western extent, the boundary includes the southwestern portion of Sumatra, its catchments, and islands of Kepulauan Mentawi and Nias. The region boundary includes all of southern and eastern Sumatra, following the central dividing range of Sumatra from Aceh in the north to Jambi in the central highlands, then northwards to the coast.

Exclusions of Indonesia’s territory from the region include the northeastern and central parts of Kalimantan facing the Malacca Strait as well as the western part of Kalimantan (including Indonesian West Kalimantan, Malaysian Sarawak and Sabah and Brunei). The north coast of Sulawesi, parts of East Kalimantan and the south of the Jawa Trench, Christmas Island and Cocos-Keeling Island (Australia) are also excluded.

International waters, in the sense of the GIWA definition, include the entire coastal and marine area; as this is a potential source or recipients of transboundary impacts, primarily from shipping, fisheries, pollution, introduction of alien species, riverine discharges, and law and order issues.

Given the major differences that exist in geomorphology, oceanography, bathymetry, climate, biodiversity, patterns of human demography, use and impact and transboundary issues within Indonesian Seas, the region was assessed as three sub-systems:

- Sunda (western part of the region);
- Wallacea (central part);
- Sahul (eastern part).

**Boundaries of the sub-systems**

The Sunda sub-system includes all the western islands and waters that are developed on the Sunda Shelf from the northern tip of Sumatra, southeast along the central range then northeast to include East Kalimantan, and southwards to Java and Bali in the east. The sub-system also includes the Indian Ocean waters of the Jawa Trench to
the south of Sumatra/Bali. The boundary between Sunda and Wallacea passes through Makassar Strait and Lombok Strait to the east of Bali.

Wallacea includes the central islands and waters of the region, extending eastwards from the Makassar and Lombok Straits to encompass Sulawesi, Lombok, Sumbawa, Flores, Sumba and the smaller islands of Nusa Tenggara, Ambon, Ceram, Buru and the other Maluku Islands, Halmahera and Morotai and the Kai, Aru and Tanimbar Islands in the east. The eastern boundary of Wallacea follows the border of the Sahul Shelf. Wallacea encompasses the area of transition of Asiatic and Australasian biodiversity initially noted by A.R. Wallace in the mid-1800s (‘Wallace Line’), and after which the sub-system is named. Boundaries of the Wallacea sub-system are also in close congruence with those of the WWF Wallacea Bioregion (see below).

Sahul includes Irian Jaya and the Rajah Ampat Islands of Pulau Waigeo and others, Pulau Misool and Kepulauan Schouten. The sub-system includes the major central mountain range of Pegunungan Maoke and major river systems of Mamberamo-Tariku-Van Daatan-Taritatu on the north coast and Digul and Pulau Vriendschaps on the south coast.

Physical characteristics

The Indonesian Seas region contains most of the land and seas of the Republic of Indonesia, which is the world’s largest archipelagic nation, with some 18 000 islands. The region is 6 million km² of which 1.43 million km² is land. The major islands in the region are Sumatra, Java, Nusa Tenggara, Kalimantan, Sulawesi, Maluku and Irian Jaya (Papua). Most of the major islands have a mountain range running for much of their length. The mountains are mostly of volcanic origin and in some cases remain active. The elevations of the islands range from 0 to 5 030 m above sea level.

Geologically, the Indonesian Seas region lies at the confluence of three tectonic plates: the Eurasian Plate, the Indo-Australian Plate and the Pacific Plate. The Island of Kalimantan (Borneo), the third largest island on Earth, lies on the Asian continental (Sunda) shelf, is physically stable and has been joined by a land bridge to the Asian mainland during Pleistocene and earlier periods of glaciation (Daws & Fujita 1999). Similarly, Papua lies on the relatively geologically stable Sahul Shelf, and the larger Island of Irian (New Guinea) has been joined to Australia during glacial falls in sea level. Sumatra and Java lie on the southeastern edge of the Sunda Shelf, and with many of Indonesia’s islands are subject to tectonic instability and volcanic activity (with numerous active volcanoes and earthquake occurrences). In total, Indonesia has some 129 volcanoes, 15 of which are considered critical and likely to explode, with three to five eruptions annually. Thus, most of Indonesian Seas are in a geologically active region.

Climate

The Indonesian archipelago stands between the Pacific and Indian Oceans and is heavily influenced by annual and inter-annual variations in surface temperature due to a reversing monsoonal system. The region lies within the sub-equatorial and equatorial zones (from latitudes 4° N to 10° S), and mostly lies under the influence of the seasonal monsoon winds. 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. Annual rainfall in excess of 1 000 mm occurs in many of the western and eastern areas and annual minimum temperatures are usually more than 20°C other than in the highlands. Rainfall in the region is highest on the upland areas, notably of central Kalimantan (Borneo), central Sumatra, Java and Papua. Some places receive more than 3 000 mm of rain annually. By contrast, parts of the lowlands, coastal areas and other areas in rain-shadows receive far less rain (less than 1 000 mm/year), and may experience severe water shortages. Examples include some of the islands of Nusa Tenggara, to the east of Bali and Lombok. The temperature ranges from 21 to 33°C, but at higher altitudes the climate is cooler. Humidity is mostly between 60 and 80% (FAO AQUASTAT 2003).

A recently discovered climate feature, the Indian Ocean Dipole (IOD), is linked with fluctuations in sea surface temperature (SST) within the region. For example, in 1997, anomalously cool SSTs occurred in the eastern Indian Ocean, affecting parts of the region, both in terms of environmental and socio-economic impacts (Abram et al. 2003).

River basins and water resources

The region includes the drainage basins of streams and rivers of most of Indonesia, some 5 590 rivers in all, and including the major river systems of the larger islands of Jawa, Irian, Sumatra and Kalimantan. The regional boundary was extended to include the major Mahakam River and catchment of East Kalimantan, flowing into the Makassar Strait. The Mahakam River drains almost one third of East Kalimantan, with a discharge of 1 500 m³/sec, a suspended sediment load of 80 mg/l, a sediment yield of up to 10 million tonnes annually, producing a plume for some 400 km to the southeast of the delta into Makassar Strait (Dutrieux 1991). South Kalimantan has many smaller rivers and streams, including the Negara, Medawai, Sampit, Pembuang, Arut and Lamandau rivers. Major rivers of southeast Sumatra include the Seputh,
Tulangbawang, Musi, Kamerining, Rawas and Hari rivers. On Jawa, major rivers include the Japat, Sadane, Tarujm, Kali Mas, Manuk, Serang, Solo and Brantas rivers flowing into the Jawa Sea on the north coast. In Papua, the major rivers include Digul and Vriendschaps.

There are also numerous smaller rivers and streams flowing from the mountainous interiors of most of the islands in the region. Although water resources are abundant, the seasonal and spatial variation in the rainfall pattern and lack of adequate storage create competition and conflicts among users. Most of the lakes in Indonesia are volcanic in origin. Lake Toba, Sumatra, is the largest volcanic lake in the world, with an average surface area of 1 100 km² and an average volume of 1 258 km³ (FAO AQUASTAT 2003).

Oceanography

The Indonesian Seas Large Marine Ecosystem (LME) has an area of 400 000 km² and extends from east to west across a distance of 5 000 km (LME 2003). The LME has strong tidal currents and the pattern of surface currents varies during the southeast and northwest monsoon. It also experiences annual and interannual variations in surface temperature. The warm ocean and its links to the atmosphere create the El Niño Southern Oscillation (ENSO) phenomenon. The influence of El Niño, La Niña and the Australian and Asian monsoons contribute to the unique climate conditions in this region, of major relevance to global climate and the subject of continuing climatological research.

The region has complex bathymetry, the western area lying on the Sunda Shelf, the central area forming a transition zone composed in part by the deep basins of the Flores and Banda Seas and the eastern area lying on the Sahul Shelf. Coastal waters of the Sunda Shelf, the Jawa Sea and the Sahul Shelf are shallow (<200 m depth) and influenced by both marine and terrestrial inputs. By contrast, the Banda Sea has depths greater than 4 500 m, the Flores Sea is deeper than 5 000 m and the Jawa Trench exceeds 6 500 m in depth. Most of these seas can be characterised as marginal seas, being enclosed by island landmasses, and with oceanic input from the Pacific and Indian Oceans in the Indonesian Through-flow. The Through-flow, the exchange of ocean water between the Pacific and Indian Oceans, is thought to be influenced by, and may influence in turn, ENSO.

The Indonesian Through-flow exports warm, relatively fresh (low salinity) thermocline water from the North Pacific, providing a major freshwater source for the Indian Ocean. Strong ocean mixing influences sea surface temperature and nutrient concentrations (LME 2003). This influx of Pacific oceanic waters moves into the area from the Sulawesi Sea via the Makassar Strait and through corridors between Sulawesi, Halmahera, Morotai and Papua and focused through the Lombok Strait (Bali-Lombok) and corridors around Timor. There is a general north-south through-flow, but with some (mostly sub-surface) flow in the opposite direction. Additionally, reversing seasonal surface currents driven by the monsoon winds bring waters from the South China Sea into and out of the Jawa Sea along the north coasts of Sumatra and Jawa and southern coast of Kalimantan. The Jawa coastal current flows eastwards to the south of Jawa/Sumatra. Local current patterns form complex eddies and counter-currents around most islands, and in places reach speeds of more than 5 knots.

The southern coastlines from Sumatra to Timor and northern coastlines of Halmahera, Morotai and Papua are under the influence of long period ocean swell that can exceed 5 m in height from the Indian and Pacific Oceans, generated by tropical-temperate storms, many of which are thousands of kilometres away. More localised severe waves (tsunamis) can be generated by tectonic activity, such as that which devastated southern Sumatra and northern Jawa following the Krakatau volcanic cataclysm of August 1883. By contrast, within the marginal seas of the Indonesian Archipelago, ocean swells are generally less than 2 m high and generated by local weather patterns and the trade winds of the monsoons, and sea conditions are often calm and referred to as “the doldrums”.

Coastal and marine ecosystems

Mangroves and seagrasses

Most of the region’s protected coastlines were originally fringed by mangrove forests and seagrass beds. Mangroves, with some 47 species known from Indonesian Seas, have an area estimated at between 2.49 million ha (Tomascik et al. 1997) and 4.25 million ha (Wilkinson 1994). Most mangroves are located in Papua (estimated at 29 000 km²), Sumatra (4 170 km²), Kalimantan (2 750 km²) and Jawa (343 km²) (Priyono & Sumiono 1997). This represents over two thirds of the area of mangroves in South East Asia. Seagrass beds are even more extensive (30 000 km² according to Tomascik et al. 1997) with 13 species developed in varied habitats from intertidal mudflats to shallow sandy beaches to coral reef flats. However, extensive cutting for timber, conversion for aquaculture and other forms of coastal development and extensive siltation/sedimentation have caused major fragmentation and reduction in the area of these habitats (see Assessment, Habitat and community modification).

Coral reefs

With a total estimated area of between 50 000 and 90 000 km², Indonesia’s coral reefs comprise more than 10% of the global total (Spalding et al. 2001). By contrast, an earlier official estimate for the area...
of coral reefs is just 7,500 km² (KLH 1992). However, another re-estimate by Tomascik et al. (1997), based on a longer figure for total coastline, is 85,707 km² which represents about 14% of the world total (Hopley & Suharsono 2000). 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 (~80%) are at extremely high risk of further damage from human activities (e.g. Bryant et. al. 1998, Burke et al. 2002) (Figure 2).

The coast under the immediate influence of the major river systems (e.g. Mahakam and Berau rivers, East Kalimantan) 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 and fringe much of the coastlines of the approximately 18,000 islands of the Archipelago. Some of the most widespread fringing reefs in Indonesia are in the turbid waters of the Aru Islands, which consist of six main islands and 79 smaller islands separated by long narrow channels (Tomascik et al. 1997, Hopley & Suharsono 2000). Offshore, series of large platform reefs and atolls are developed; the most famous being the Taka Bone Rate Atoll reefs of the Flores Sea. All major reef types; fringing, patch-platform (including barrier) and atolls, occur. Offshore in eastern Kalimantan, the better water quality has allowed the development of barrier reef systems.

The longest barrier reef in Indonesia, the Great Sunda Barrier Reef, runs inside the 200 m isobath at the margin of the Sunda shelf, some 60 km offshore, and has a length of 630 km. Smaller barrier reefs occur north of the Mahakam Delta. The Berau system is immediately north of the Berau Delta, in places only 10 km offshore, and has a length of 25 km. Parts of the Mangkalihat Peninsula are also bordered by a barrier reef. The most unique barrier system in Indonesia is the Banggai Barrier Reef running 175 km along the southern margins of the Banggai Islands. Part of this barrier consists of lagoonal ‘faro’ reefs very similar to those of the Maldives. North of the Mangkalihat Peninsula are three major reefs which Tomascik et al. (1997) term atolls, although Hopley and Suharsono (2000) consider that they are more likely to be large lagoonal shelf reefs rather than fulfilling the strict geological criteria for oceanic atolls with volcanic foundations. Similarly, Tomascik et al. (1997) describe 27 atolls in the waters around Sulawesi. Tomascik et al. (1997) and Hopley and Suharsono (2000) provide detailed analysis of the reef types and their distribution. Moosa et al. (2002) provide a recent overview of the status of research into Indonesia’s coral reefs.

Because of their rich biodiversity, diverse geo-morphology and great importance in providing sustenance for local human populations, the coral reef areas around much of Indonesia are recognised as being of exceptional conservation value. These include the patch reef complexes of northern Jawa, fringing reefs of Bali, fringing, patch and atoll reefs of Sulawesi (e.g. Taka Bone Rate, Tukang Besi Islands, Bay of Tomini, Bunaken), Nusa Tenggara, the Banda Sea and northern Papua (notably Rajah Ampat Islands and Teluk Cendarawasa).

Halimeda bioherms
A closely related habitat which requires similar management and conservation approaches to coral reefs is the major area of Halimeda algal bioherms, notably at the southern end of the Makassar Strait.
(Phipps & Roberts 1988, Hopley & Suharsono 2000). Associated with the Kalukalukuang Bank in particular, these algal ‘reefs’ also occur around the margin of the Sunda Shelf towards Kalimantan. Here algal growth is favoured over reef growth as nutrient rich deep Pacific water floods southwards through the Makassar Strait and upwells around the banks and shelf margin (Hopley & Suharsono 2000).

For further information and a detailed and informative description of the oceanography, biology and ecology of Indonesian Seas, see Tomascik et al. (1997).

**Biodiversity**

With the adjacent regions of Sulu-Celebes (Sulawesi) Sea and South China Sea, the region lies within the global centre of biodiversity for marine species (Table 1), supporting for example more than 500 species of reef-building corals, 2 500 species of marine fishes, 47 species of mangroves and 13 species of seagrasses (Veron 1995, Chou 1997, Tomascik et al. 1997, Veron 2000, Spalding et al. 2001). The exceptional biodiversity of marine flora and fauna is a result of its geographical and geologic history. The vast archipelago is a “melting pot of a number of biogeographic provinces” (Tomascik et al 1997), and includes seven of the eight first order biogeographic divisions of East Asian Seas (Hayden et al. 1984, Bleakley & Wells 1995). Indonesian Seas also include the deepest seas of South East Asia, and the pelagic realm is an important habitat, supporting high biodiversity of large and small migratory marine life, including a wide variety of cetaceans. The cetaceans, including the Blue whale (*Balaenoptera musculus*, considered endangered by the World Conservation Union IUCN) and the vulnerable Fin whale (*B. physalus*) and Humpback whale (*Megaptera novaeangliae*), and other migratory species, frequently use the marine corridors of the archipelago in migrations, particularly the deep seas of Maluku and the straits at Flores and Lombok (Kahn & Pet 2003, Kahn pers. comm.).

Marine species considered by the World Conservation Union (IUCN) as vulnerable, threatened or endangered that occur in Indonesian Seas include dugongs, turtles, whales and dolphins (29 species) (Moosa 1999). Under various Indonesian Government decrees, some 25 species, including the Dugong (*Dugong dugon*), six species of sea turtle, 12 species of mollusc and six species of whales are listed for protection (Cheung et al. 2002).

The distribution of dugongs is fairly widespread, from sheltered to highly wave-exposed coasts (e.g. South Bali) although mostly occurring in low numbers as a result of hunting and accidental catch (Cheung et al. 2002). The major populations occur in western Cenderawasih in Papua and Kepulauan Aru in the Arafura Sea (Husar 1978). More than 140 turtle nesting sites are known (Salm & Halim 1984, Soehartono 1994), although the degree of usage by large nesting populations remains unclear, and it is thought to be declining because of widespread habitat destruction, targeted and accidental capture and other disturbances (Cheung et al. 2002).

Biodiversity and endemism is particularly high on the Island of Sulawesi (Wallacea sub-system), formed from three different land masses (Daws & Fujita 1999). On neighbouring Kalimantan (Sunda sub-system), there are some 10 000 species of flowering plants, 222 mammals, including primates (e.g. orang-utan), 420 birds, 166 snakes, 7 100 amphibians and 390 freshwater fishes (with 1 400 freshwater fish species for Indonesia as a whole). A.R Wallace first described in the 1880s the major faunal discontinuity between Asia and Australasian that divides the archipelago into two major faunal realms, subsequently named “Wallace’s Line”

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**Table 1** Diversity of selected groups of marine organisms in Indonesia.

<table>
<thead>
<tr>
<th>Major group</th>
<th>Group forms</th>
<th>Range recorded*</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green algae</td>
<td>1</td>
<td>196</td>
</tr>
<tr>
<td></td>
<td>Brown algae</td>
<td>1</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Red algae</td>
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<td>452</td>
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<td></td>
<td>Seagrasses</td>
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</tr>
<tr>
<td></td>
<td>Mangrove</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>Corals</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scleractinians</td>
<td>2</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>Soft corals</td>
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<td>210</td>
</tr>
<tr>
<td></td>
<td>Gorgonians</td>
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<td>350</td>
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<tr>
<td>Sponges</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Desmospongia</td>
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</tr>
<tr>
<td></td>
<td>Gastropoda</td>
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<td>1 500</td>
</tr>
<tr>
<td>Mollusca</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brachiopods</td>
<td>1</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>Brachyura</td>
<td></td>
<td>1 400</td>
</tr>
<tr>
<td>Crustacea</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Cephalocarida</td>
<td>2</td>
<td>91</td>
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<tr>
<td></td>
<td>Asteroidea</td>
<td>2</td>
<td>87</td>
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<td></td>
<td>Ophiuroidea</td>
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<td></td>
<td>Echinidea</td>
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<td></td>
<td>Holothuroidea</td>
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<tr>
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<td></td>
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<tr>
<td></td>
<td>Marine fishes</td>
<td>1</td>
<td>2 140</td>
</tr>
<tr>
<td>Reptiles</td>
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<td></td>
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<td></td>
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<td></td>
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<td>Mammals</td>
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<td></td>
<td>Whales &amp; dolphins</td>
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</tr>
<tr>
<td></td>
<td>Dugong</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note:* 1 = Specifically Indonesia; 2 = Indonesia and adjacent waters. ND = No Data.
**Socio-economic characteristics**

Indonesia has a population of some 200 million people, which is comprised predominantly by peoples of Indo-Malay and Melanesian origin (Irian). Peoples of other ethnic origins are also present, some forming ancestral tribal groups, particularly in Kalimantan (Borneo), Sumatra and adjacent islands (e.g. Nias and Kepulauan Mentawi), 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 Islam, but with areas of Christianity (notably Ambon, North Sulawesi and parts of Kalimantan), Hinduism (notably Bali) and Buddhism (parts of Jawa and Bali). There has been broad acceptance of different religious viewpoints in the past, and Indonesia's guiding principle is 'Unity through Diversity'. However, racial, cultural and religious tensions have been building in recent times, concomitant with the economic difficulties of the late 1990s. For example, parts of Sumatra, Jawa, East Kalimantan and the Moluccas (Ambon) have experienced civil instability and clashes between different religious and political groups. The recent independence of East Timor created civil unrest and armed clashes requiring the intervention of an UN-led international peacekeeping force. Secessionist movements, groups seeking autonomy or semi-autonomy, are also active in Northern Sumatra (Aceh area) and Irian.

**Population**

In 1996, the total population in Indonesia was about 198 million inhabitants (63.6% rural), with a growth rate of 1.7% (FAO AQUASTAT 2003). By 2000, this had grown to more than 206 million, and by 2001 to 209 million (World Bank 2003).

More recent estimates suggest a total population of 230 million in Indonesia as a whole, with most (200 million) residing in the GIWA region Indonesian Seas, and some 140 million living within 60 km of the coast (UN 2002). In 1996, the average population density was 105 inhabitants per km², increasing to 112 per km² by 1998 (FAO AQUASTAT 2003). The population is unevenly distributed with about 60% living on the Island of Jawa, which has an average population density of over 800 inhabitants per km², among the highest population density of any island on Earth. Another 20% of the population live on the Island of Sumatra, with a population density of 77 inhabitants per km². Kalimantan supports another 10 million, with a density of less than 17 inhabitants per km². By contrast, some of the smaller islands of Nusa Tenggara are sparsely populated, in part because of water shortages, while to the east, the comparatively large area of Papua supports less than 10 million people, almost entirely of Melanesian ancestry. Of the three sub-systems, approximately 150 million live in Sunda, some 35 million in Wallacea and less than 10 million in Sahul (Figure 3).

The population is distributed in the larger urban settlements and throughout thousands of villages spread along the coast, across the lowlands and into the highlands, usually concentrated on the watercourses. The larger urban centres include Jakarta (>10 million), Surabaya eastern Jawa (>4 million), Bandung Jawa (2.5 million), Semarang Jawa (2 million), Makassar Sulawesi (4 million), Denpasar Bali (1 million), Mataram Lombok (0.5 million), Palu (300 000), Kupang Timor (300 000), Ambon city Ambon (300 000) and Jayapura Papua (300 000). With very few exceptions the major cities, towns and villages are all developed on rivers, with concomitant water-related issues of use and pollution. The rivers passing through the major cities and adjacent

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**Figure 3** Population density in the Indonesian Seas region.
(Source: ORNL 2003)
coastal waters are in most cases badly polluted by sewage, heavy metals and other industrial and agricultural waste products.

Some areas are also experiencing substantial immigration of the order of 4% annually through a transmigration project developed to ease population pressures in Jawa. It is predicted that the population of the region will reach 300 million by 2020 and double to 400 million by 2035 (UN 2002). Levels of literacy have been relatively stable over the past decade, at greater than 85%.

**Economic activities**

Indonesian Seas support a wide range of economic activities, from subsistence agriculture and artisanal fisheries to high technology industries (Table 2). The region has various forms of traditional land-ownership customs and systems of natural resource use. Economic development and a tremendous growth in population have taken place in this coastal country. The climatic fluctuations within the Asian-Australian monsoon region have important implications for the society and the economy. Indonesian waters play a major role, providing food resources for millions of people, as well as a mode of transportation and area of exploration and production of minerals and natural gas. The coastline areas are sites for industrial and other economic activities. Ports of importance are Ujung Pandang (Makassar), Kalianget, Surabaya, Jakarta, Arjuna, Cirebon, Tegal and Semarang. Tourism is an important economic activity.

Gross National Product (GNP) in 1997-1998 was estimated at 130.6 billion USD, with a negative annual growth rate of -16.7%, and international rank of 30th. Per capita GNP was 640 USD, with a negative growth of -18% and international rank of 198th (World Bank 2003).

Overall effects of globalisation in the region are not well understood, but may be exacerbated over the next few years by the unstable global situation. Large gaps remain in reliable socio-economic data at the scale of the sub-systems. This is in part because of government restrictions on data access, and in part because of the lack of accurate census information from the widespread human populations.

**Agriculture**

The agriculture sector provides employment for 49% of the population. In 1995, the total cultivated area was estimated to be 35 579 000 ha. Of the cultivated area, 13 836 000 ha were under permanent crops such as rubber, coconut, coffee, cocoa and palm oil (Figure 4). Annual crops such as rice, maize, soybean, sugar cane and tobacco were grown on 21 743 000 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, value added to GDP from agriculture in Indonesia averaged approximately 16-17% from 1997 to 2001 (World Bank 2003).

**Fishing**

Subsistence farming and fishing are the major activities of large numbers of people outside the main urban centres. Most of the approximately 6 000 regional coastal communities are directly dependent on the sea as their primary source of both food and income (Dahuri & Dutton 2000), with some 16.5 million fishermen. Domestic agricultural and artisanal fisheries production (15.5 kg per person per year) are very important, with increased fisheries production required to meet the increase in domestic demand from the growing population (Talaue-McManus 2000). During the 1980s and 1990s, there were major increases in aquaculture (notably Tilapia in lakes and inland waters) and mariculture (shrimps) in coastal ponds, to supply both domestic and international consumption, concomitant with major expansion in reef fisheries to supply the live fish trade to Hong Kong, China and Japan.

<table>
<thead>
<tr>
<th>Socio-economic indicator</th>
<th>1997</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>198 200 000</td>
<td>206 300 000</td>
<td>209 000 000</td>
</tr>
<tr>
<td>Illiteracy (%)</td>
<td>15.1</td>
<td>13.2</td>
<td>12.7</td>
</tr>
<tr>
<td>GDP (billion USD)</td>
<td>215.7</td>
<td>152.2</td>
<td>148.3</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>4.7</td>
<td>4.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Value of GDP added in Agriculture (%)</td>
<td>16.1</td>
<td>17</td>
<td>16.4</td>
</tr>
<tr>
<td>Value of GDP added in Industry (%)</td>
<td>44.3</td>
<td>47</td>
<td>46.5</td>
</tr>
<tr>
<td>Value of GDP added in Services (%)</td>
<td>39.6</td>
<td>35.9</td>
<td>37.1</td>
</tr>
<tr>
<td>Value of GDP added in Exports (%)</td>
<td>27.9</td>
<td>42.4</td>
<td>41.1</td>
</tr>
<tr>
<td>Value of GDP added in Imports (%)</td>
<td>28.1</td>
<td>31.7</td>
<td>32.6</td>
</tr>
</tbody>
</table>

At present, mariculture is largely dependent on wild stocks, although hatcheries are being developed. The estimated contribution of the fisheries sector to the national GDP is about 2%. However, a significant proportion of total catch is illegal and unreported.

Live reef fish export operations have increased since the 1980s. This has caused the loss of large numbers (thousands of tonnes) of demersal coral reef fishes from many reefs in Indonesia - even in remote areas. Poison fishers mostly use two forms of cyanide (sodium and potassium cyanide) but there have been recent shifts toward locally produced and inexpensive vegetable poisons (Johannes & Riepen 1995). Collecting of ornamental reef fishes and other organisms for the global aquarium market is also widespread and is expanding in the region. It has already caused serious damage to reefs in some areas, through use of destructive techniques of poison fishing and/or coral breakage.

Forestry
Forestry is a major industry, particularly in Kalimantan, Sumatra and Papua, and less so in many other areas, where much of the harvestable forests has already been exploited. Much of the land area of the region was originally covered by diverse tropical forest. However, as noted above, substantial deforestation of dipterocarps and other commercial timber species has taken place since the colonial era and continuing logging is further reducing the original forest cover. Fertile lowlands and hill areas have been extensively developed for rice production, as paddy fields and upland terraces. Lowland areas and river flood plains also support mixed agriculture. In total, Indonesia has 1 million km² of forests remaining, and an annual deforestation rate of 1.2% (World Bank 2003).

Oil and mining
Oil production, mostly offshore in the Jawa Sea, supplies the large domestic market and also provides export earnings. Indonesia is one of the world’s major oil producers, with 1.36 million barrels per day in 1997 from 8,535 wells and much if this is from Sunda (Edinger & Browne in press in Hopley & Suwarsono 2000). Another major producing area is off the coast of East Kalimantan, particularly the Mahakam Delta. Bontang Bay in south Kalimantan is a major producer of liquified natural gas. Mining for gold, copper, zinc and other minerals, notably in Papua and Sulawesi, is another major export earner.

Shipping
The northern Jawa Sea and Makassar Strait/Lombok Strait form part of major oil tanker routes (the Main route and ULCC route respectively) between Japan and the greater Pacific Ocean and the Indian Ocean and west Asia-Europe. Minor routes pass between Jawa and Sumatra and through the Jawa Sea to the east via the Arafura Sea. These shipping routes all have associated risks of collisions and spills (Etkin 1997, MPP/EAS 1998).

Secondary industries
These include natural resource processing and light manufacturing, and are also of growing importance, particularly in the major urban centres of north Jawa. Service industries, including tourism, were expanding during the 1990s and make a substantial contribution to GDP, contributing between 37-40% of GDP from 1997-2001. Tourism, centred on Bali but with expansion during the 1980s and early to mid-1990s throughout much of western and central Indonesia, has increased annually. However, the Asian financial crisis and growing civil unrest, combined with the recent upsurge in international terrorism and concern over epidemic diseases (e.g. Severe Acute Respiratory Syndrome, SARS), 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.

Exports
The major export earners include commercial exploitation of natural resources; particularly mining (Papua, Kalimantan, Sulawesi, Sumatra, Jawa Sea), forestry (mostly in Sumatra, Kalimantan, Papua), pelagic and demersal reef fisheries, aquaculture and mariculture, oil palm and other forms of plantation agriculture. Crop production and livestock contribute approximately 18% of GDP (World Bank 2003).

In 1992, exports yielded Indonesia a profit of more than 1 billion USD, accounting for about 2% of the global total. Imports at the time accounted for some 60 million USD, less than 1% of the global total (Talaue-McManus 2000). In the mid-1990s, GDP for Indonesia as a whole was estimated at 160 billion USD, with a growth rate of approximately 79 million USD per year in 1995-1996, prior to the economic crisis of the late 1990s. Output and consumption varies in relation to the degree of industrialisation. In 1995/1996, the percentage GDP industry growth rate was about 38% per year, compared with the agriculture growth rate of 13% per year, with a per capita GNP of about 1,000 USD per year (Talaue-McManus 2000). GDP and economic growth have been declining over the past several years (Table 2).

Overall effects of globalisation in the region are not well understood, but may be exacerbated over the next few years by the unstable global situation. Large gaps remain in reliable socio-economic data at the scale of the sub-systems. This is in part because of government restrictions on data access, and in part because of the lack of accurate census information from the widespread human populations.
Governance

The Republic of Indonesia gained independence in 1948 and has been governed since then from the capital city of Jakarta on Jawa. Indonesia is a constitutional democracy, with the President elected for five year terms. Indonesia has a three tiered system of government, with national (central), provincial and district levels. In addition, there are two further levels, sub-district level and village level, which are not considered autonomous because they do not have a local house of representatives. The provincial district, sub-district and village levels are coordinated by the Ministry for Home Affairs (Hopley & Suharsono 2000).

Indonesia has undergone extensive political reform since 1997 and currently pursues a policy of decentralisation and regional autonomy. There is a growing trend for decentralisation of political and administrative activity, and after Jakarta much of the political life is focused in the provinces, cities, towns and villages. For administrative purposes Indonesia is divided into 26 provinces. Overall planning and implementation of government policies follow five year terms or ‘Repelita’ with Repelita VI covering the period 1994-999 and Repelita VII from 2000-2004. These Repelita are in turn within a larger 25 year development period ‘Pembangunan Jangka Panjang I’ (PIP I), the first phase of long-term development (FAO AQUASTAT 2003).

Indonesia has sovereign rights to the 12 nautical mile limit and has also declared a 200 nautical mile Exclusive Economic Zone (EEZ). Several different schemes and doctrines with different geographic, political and legislative relevance are considered in relation to Indonesia’s area and waters including internal, archipelagic, territorial (12 mile limit), Exclusive Economic Zone (200 nautical mile limit), High Seas, continental shelf, internal seas and seabed, and Contiguous zone.

The Indonesian Government has declared its commitment to sustainable development in the oceans by ratifying a number of conventions and formulating programmes and projects that aim to defend and conserve the environment. Indonesia has gazetted 331 terrestrial protected areas covering some 19 253 000 ha and representing some 10% of total land area of 1.9 million km². Indonesia also has 102 gazetted marine protected areas (MPAs) e.g. Laut Banda, Bunaken and Taluk Cendraw, five biosphere reserves (1 329 000 ha), three World Heritage sites (2 845 000 ha) and two wetlands of international importance (243 000 ha). Thus, Indonesia has many legally designated protected areas including coastal and marine habitats and has a target of developing a network of MPAs encompassing some 30 million ha. In total, there are estimates of between 34 and 50 protected areas in the region containing coral reefs (Hopley & Suharsono 2000, Spalding et al. 2001), with a total area estimated at 4.6 million ha. The effectiveness of many MPAs is limited at present by insufficient resources for management and enforcement of regulations. Many of the protected areas are not well managed, despite ongoing efforts, and the ecosystems that sustain this rich biodiversity are under severe threat in much of the region (e.g. Chia & Kirkman 2000).

However, several large government initiatives and smaller community-based management programmes are helping to protect coastal and marine habitats. Several such projects have been implemented by the Indonesian Government since the 1990s, including the Marine and Coastal Resources Management Project (MCREP) and the Coral Reef Rehabilitation and Management Project (COREMAP) (see also Annex III). MCREP, a large coastal and marine management project focused on 15 of Indonesia’s provinces, has been operational since the early 1990s and is now in its second phase. COREMAP has also been operational since the mid-1990s, the initial phase documenting reef resources and management capacities of reefs in 10 provinces, while latter phases are focusing on developing ecologically sustainable management, under international funding from the World Bank and Asian Development Bank. Other projects are being coordinated by various NGOs including World Wide Fund for Nature (WWF), The Nature Conservancy (TNC) and Conservation International.

International treaties and conventions

With its neighbouring nations, Indonesia forms part of the Association of South East Asian Nations (ASEAN), with strong multi-lateral links at political and trade levels. As noted above, Indonesia is signatory to several international conventions and has enacted various national laws and regulations that are relevant to water-related issues in the region, including:

- United Nations Convention on the Law of the Sea (UNCLOS);
- International Convention on the Protection of Pollution from Ships (MARPOL);
- United Nations Convention on 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 relevant government departments have proposed policies or legislation in relation to obligations under the various international conventions. However, it is apparent that, despite the international ratifications of the conventions, there has been only modest progress to date in their effective implementation and the resolution of related
problems. This has been attributed to the lack of action by different
government departments 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.).

Recently, Indonesia has taken steps at the community (local), provincial
and national levels, including implementation of legislation, to provide
a modern framework for sustainable resource management. Indonesia’s
Constitution provides the legal basis for development of legislation
relevant to use and management of water resources. The Constitution
is expected to undergo major review in the near future.

**Legislative instruments and integration**

At international and national levels, a raft of legislation addressing resource
management and protection has been developed. However, there are
inefficiencies related to the transfer and application of international and
national legislation at provincial and local levels, with large inter-provincial
and local differences in efficiency and success of such application.

Some national and provincial laws relevant to different sectors such as
fisheries, mining, forestry and environmental protection, are not
fully integrated, and have legislation that does not refer specifically to
particular sectoral or environmental systems, causing uncertainty in
application of legislative instruments. This has provided ‘loop-holes’
for exploitation and caused confusion over which laws have priority,
which departments or agencies hold responsibilities for management,
and the rights of stakeholders and interest groups. Some government
departments are hampered by a lack of qualified and experienced
staff, and also by funding shortfalls and cutbacks. There is also a lack of
awareness and acceptance of some laws among local populations, and
insufficient capacity for dissemination of information and enforcement of
regulations and quotas. Thus, the lack of understanding and adherence
to laws and regulations among local communities is compounded by
insufficient communication of information and the lack of surveillance
and enforcement, which provides complex management challenges.

These difficulties notwithstanding, there have been major advances
since the 1980s in regional capacity for development of policy and
legislation based in sound science. This has relevance to international
waters assessment and monitoring and implementation of measures
to promote sustainable development and conservation. For example,
a critical mass of regional expertise now resides in government, inter-
governmental agencies, academic institutions and NGOs, including:
- Directorate for Marine and Coastal Degradation Control,
- Environmental Impact Management Agency (Bappedal);
- Conservation and Marine National Parks, Ministry of Marine Affairs
  and Fisheries;
- The State Ministry for Environment;
- Directorate General of Forest Protection and Nature Conservation,
  under the Ministry of Forest and Crop Estates;
- Research and Development Centre for Oceanology (Pusat Perelitian
dan Pengembangan Oseanologi, LIPI), Indonesian Institute of
  Science;
- Universities throughout Indonesia;
- United Nations - UNEP (Regional Seas and Regional Organization
  for Asia and Pacific);
- IOC Sub-Commission for teh Western Pacific (IOC-WESTPAC);
- GEF/UNDP/IMO Regional Programme on Partnerships in
  Environmental Management for the Seas of East Asia (PEMSEA);
- World Wide Fund for Nature (WWF);
- The World Conservation Union (IUCN);
- The Nature Conservancy (TNC);
- Conservation International (CI).

**Legal and institutional framework regulating biodiversity and the environment**

*(also see Annexes III-V)*

The Ministry of Environment is the key national body for coordinating
sustainable development, with the National Clearing House on
Biodiversity and a National Coordinating Body on Biodiversity being
established to supervise and plan activities relating to the conservation
and sustainable use of biodiversity. The Ministry of Forestry, specifically
its Directorate General for Forestry Protection and Nature Conservation
(formerly PHPA now PKA) and the Ministry of Agriculture also play
important roles in coastal environmental matters (Cheung et al. 2002).

The Ministry of Marine Affairs and Fisheries may in future prove to be
most relevant for coastal and marine environmental issues. There are
two Directorates within the PKA, one dealing with Nature Conservation
and one with National Parks and Recreation Forest. The Directorate for
Nature Conservation provides overall planning of the terrestrial and
marine protected areas network, drafting of conservation legislation
and the proposal, establishment and management of protected areas.

The Directorate of National Parks and Recreation Forest oversees the
development of the national parks programme. The regional planning
boards (BAPPEDA) work with the provincial offices of PKA. In 1990, the
“Conservation of Living Natural Resources and their Ecosystem Act”
became the chief legislative tool for the management of protected
areas. Based on this Act, the various MPAs fall under four categories
corresponding with IUCN classifications (see Cheung et al. 2002 for
details).
Other government departments and agencies concerned with marine conservation and protected areas include the Ministry of State for Population and Environment, through the Environmental Impact Management Agency (BAPEDAL), the Department of Agriculture’s Directorate of Fisheries, the Department of Communications’ Directorate of Marine Communications and the Indonesian Institute of Science (LIPI). The Bappedal coordinates coastal zone management and assesses development projects through the Analysis of Environmental Impacts (Amdal), while LIPI’s Research and Development Centre for Oceanology provides scientific advice to other agencies (Cheung et al. 2002).

**Legal and institutional framework regulating the water sector**

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:

- Law on water resources development No. 11 (1974).
- 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);
- 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, operation and maintenance (O&M), 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.