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 km² (the southern portion of which is included in the region); Visayas, with an area of 56 000 km²; and Mindanao, with an area of 102 000 km² (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 Caimab 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 gulf. 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-
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 km² 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
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 km³. In 9 years out of 10, the annual run-off exceeds 257 km³ (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°C 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

### Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>Country area in the region (km²)</th>
<th>Country area total (km²)</th>
<th>Percentage of country in region (%)</th>
<th>Percentage of region in country (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>106,900</td>
<td>1,826,440</td>
<td>32.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Malaysia</td>
<td>60,220</td>
<td>328,550</td>
<td>18.1</td>
<td>18.3</td>
</tr>
<tr>
<td>Philippines</td>
<td>166,080</td>
<td>298,170</td>
<td>49.8</td>
<td>55.7</td>
</tr>
<tr>
<td>Total</td>
<td>333,200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Source: EROS Data Center 2003, ESRI 2002)
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 km²) in the Philippines part of the region are the Mindanao River Basin (23 169 km²) and the Agusan River Basin (10 921 km²), both on the Island of Mindanao. Overall, only 18 river basins have an area greater than 1 000 km²; 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 km².

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 km³, 360 km³ (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 km². 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 km² (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 km². 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 km². 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 km². 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 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...
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.

### 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 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 characteristics 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

<table>
<thead>
<tr>
<th>Country</th>
<th>Population in the country (million)</th>
<th>Population in the region (million)</th>
<th>Annual population growth (%)</th>
<th>Population density (inhab./km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>198.2</td>
<td>214.5</td>
<td>7.0</td>
<td>1.34</td>
</tr>
<tr>
<td>Malaysia</td>
<td>21.7</td>
<td>24.8</td>
<td>&lt;2.0</td>
<td>2.36</td>
</tr>
<tr>
<td>Philippines</td>
<td>71.5</td>
<td>81.5</td>
<td>25</td>
<td>2.30</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Table 3</th>
<th>The GDP and economic growth of each of the three countries that share the Sulu-Celebes (Sulawesi) region.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>Indonesia</td>
<td>GDP (billion USD)</td>
</tr>
<tr>
<td></td>
<td>GDP growth (%)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>GDP (billion USD)</td>
</tr>
<tr>
<td></td>
<td>GDP growth (%)</td>
</tr>
<tr>
<td>Philippines</td>
<td>GDP (million USD)</td>
</tr>
<tr>
<td></td>
<td>GDP growth (%)</td>
</tr>
</tbody>
</table>


**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 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 km² of forests remaining, with an annual deforestation rate of 1.4% (1990-2000). In total, Indonesia and Malaysia have 1 million km² and 192 800 km² 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 particularly important in the Philippines, with 13 million tourists arriving in 1990 and 192 800 km² of forests remaining respectively, and deforestation of 1.2% (World Bank 2003a).

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).

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Agriculture (% of GDP)</th>
<th>Industry (% of GDP)</th>
<th>Services etc. (% of GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>20</td>
<td>17</td>
<td>43</td>
</tr>
<tr>
<td>Malaysia</td>
<td>11</td>
<td>9</td>
<td>46</td>
</tr>
<tr>
<td>Philippines</td>
<td>17</td>
<td>14</td>
<td>31</td>
</tr>
</tbody>
</table>

Irrigation development in the Philippines was undertaken by rural communities (Banawa 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/m³. 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).