

Chapter 5

Asia

VEGETATION AND SPECIES COMPOSITION

Asia has 25 countries with mangroves under a wide range of climatic conditions, from arid (the Arabian peninsula) to subtropical (China, Japan) to humid tropical (Southeast Asia). The considerable length of the coastlines and the multitude of islands, sheltered bays, alluvial flats, deltas and estuaries make this region a perfect habitat for mangrove development.

Asia has the largest mangrove area of any region, and the mangroves are exceptional for their high biodiversity (especially in South and Southeast Asia). As reported in Table 7, more than 50 mangrove species (the highest mangrove species diversity in the world) grow along its coasts, some of which (*Aegiceras floridum*, *Camptostemon philippinensis*, *Heritiera globosa*) are endemic to the region. Some of the species, even though relatively common in some countries, are considered rare in the region as a whole (e.g. *Ceriops decandra*, *Osbornia octodonta*, *Scyphiphora hydrophyllacea*, *Sonneratia ovata*). *Kandelia candel* is an interesting case: it is found as far north as Japan and is a common species in Hong Kong, but appears to be truly rare in Southeast Asia (FAO, 2006a).

The edaphic and coastal features of South and Southeast Asian countries, together with the high rainfall and significant riverine inputs, are particularly favourable to the development of well-structured mangrove forests. Along these coasts, trees may grow to a height of 20–30 m in Bangladesh, India, Malaysia or Thailand, or even to 50 m in Indonesia. This country harbours the highest biodiversity in the region – and in the world – with 43 different true mangrove species, followed by Malaysia and Australia. Other countries, such as New Zealand, Oman and Qatar, have only one mangrove species growing along their coasts.

Some of the largest mangrove forests in the world are found in Asia, the most well-known being the Sundarbans, a transboundary forest covering approximately 1 million hectares in Bangladesh and India. Some 60 percent of this forest is found in Bangladesh, where it is protected in the Sundarbans Reserved Forest, which is both a Ramsar site, since 1992, and a World Heritage site of the United Nations Educational, Scientific and Cultural Organization (UNESCO) since 1997. The creation of the reserve began in 1875, with some 542 000 ha legislated for protection. The physical boundary changed several times over the years, but definition of the protected area ended in 1932/1933 and since then the boundary has not changed. The remaining part is protected in the Sundarbans National Park in India (a UNESCO World Heritage site since 1987). The Indian Sundarbans, even though very rich in species, has a lower complexity and structure in comparison with the Bangladesh section, probably due to higher salinity.

The Matang Mangrove Forest Reserve, peninsular Malaysia, is another large forest in the region. This mangrove area is commonly known as the best-managed mangrove forest in Malaysia and among the best-managed worldwide. Sustainable production of fuelwood and poles from almost all the mangrove area began in 1902–1904, and the entire reserve came under intensive management by the Perak State Forest Department in 1908 (FAO and Wetlands International, 2006).

An example of a pristine and well-managed mangrove forest can be found in Ranong, Thailand (some 600 km southwest of Bangkok), a narrow coastal plain characterized by many waterways and well-structured mangrove forests, designated in 1997 as a Biosphere Reserve of UNESCO's Man and the Biosphere Programme. The people

TABLE 7
Mangrove species composition in Asian countries

Species	Bahrain	Bangladesh	Brunei Darussalam	Cambodia	China	India	Indonesia	Iran	Japan	Kuwait	Malaysia	Maldives	Myanmar	Oman	Pakistan	Philippines	Qatar	Saudi Arabia	Singapore	Sri Lanka	Thailand	Timor-Leste	UAE	Viet Nam	Yemen	
<i>Acanthus ebracteatus</i>			√	√			√				√					√		√		√				√		
<i>Acanthus ilicifolius</i>		√	√	√	√	√					√		√			√		√	√	√	√			√		
<i>Acanthus xiamenensis</i>				√																						
<i>Acrostichum aureum</i>		√	√	√	√	√			√		√	√ ^a	√			√		√	√	√	√			√		
<i>Acrostichum speciosum</i>			√	√			√				√		√			√		√			√					
<i>Aegialitis annulata</i>							√																			
<i>Aegialitis rotundifolia</i>		√				√							√								√					
<i>Aegiceras corniculatum</i>		√	√		√	√	√				√		√		√	√			√	√	√	√		√		
<i>Aegiceras floridum</i>							√				√					√								√		
<i>Avicennia alba</i>		√	√	√		√	√				√		√			√			√		√			√		
<i>Avicennia marina</i>	√	√	√	√	√	√	√	√	√	√ ^b	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
<i>Avicennia officinalis</i>		√	√	√		√	√				√		√			√			√	√	√			√		
<i>Avicennia rumphiana</i> ^c							√				√					√			√							
<i>Bruguiera cylindrica</i>			√		√	√	√				√	√	√			√			√	√	√			√		
<i>Bruguiera exaristata</i>							√																			
<i>Bruguiera gymnorrhiza</i>		√	√	√	√	√	√		√		√	√	√			√			√	√	√			√		
<i>Bruguiera hainesii</i>							√				√															
<i>Bruguiera parviflora</i>			√			√	√				√		√			√			√		√	√		√		
<i>Bruguiera sexangula</i>		√	√	√	√	√	√				√	√	√			√			√	√	√			√		
<i>Bruguiera sexangula</i> var. <i>rhyncoptala</i>					√																					
<i>Camptostemon philippinensis</i>							√									√										
<i>Camptostemon schultzei</i>							√																			
<i>Ceriops decandra</i>		√		√		√	√				√		√			√				√	√			√		
<i>Ceriops tagal</i>		√	√	√	√	√	√				√	√	√		√				√	√	√			√		
<i>Cynometra iripa</i>											√										√					
<i>Cynometra ramiflora</i>						√					√								√		√					
<i>Excoecaria agallocha</i>		√	√	√	√	√	√		√		√	√	√			√			√	√	√	√		√		
<i>Excoecaria indica</i>		√					√				√								√		√					
<i>Heritiera fomes</i>		√				√							√								√					
<i>Heritiera globosa</i>			√				√				√															
<i>Heritiera kanikensis</i>						√																				
<i>Heritiera littoralis</i>		√	√		√	√	√		√		√	√	√			√			√	√	√	√		√		
<i>Kandelia candel</i>		√	√		√	√	√		√		√		√			√			√		√			√		
<i>Lumnitzera littorea</i>			√	√	√		√				√		√			√			√		√			√		
<i>Lumnitzera racemosa</i>			√	√	√	√	√		√		√	√	√			√			√	√	√	√		√		
<i>Nypa fruticans</i>		√	√	√	√		√		√		√		√			√			√	√	√			√		
<i>Osbornia octodonta</i>							√				√					√										
<i>Pemphis acidula</i>					√		√		√		√	√				√			√	√						
<i>Rhizophora x annamalayana</i>						√																				
<i>Rhizophora apiculata</i>		√	√	√	√	√	√				√	√	√			√			√	√	√	√		√		

TABLE 7 (continued)
Mangrove species composition in Asian countries

Species	Bahrain	Bangladesh	Brunei Darussalam	Cambodia	China	India	Indonesia	Iran	Japan	Kuwait	Malaysia	Maldives	Myanmar	Oman	Pakistan	Philippines	Qatar	Saudi Arabia	Singapore	Sri Lanka	Thailand	Timor-Leste	UAE	Viet Nam	Yemen
<i>Rhizophora x lamarckii</i>						√					√					√									
<i>Rhizophora mucronata</i>		√	√	√	√	√	√	√			√	√	√		√	√	√	√	√	√	√		√		√
<i>Rhizophora stylosa</i>					√	√	√		√		√					√			√						√
<i>Scyphiphora hydrophyllacea</i>			√		√	√	√				√					√			√	√					√
<i>Sonneratia alba</i>			√	√	√	√	√		√		√		√		√				√	√	√	√		√	
<i>Sonneratia apetala</i>	√					√							√							√	√				
<i>Sonneratia caseolaris</i>	√	√	√	√	√	√	√				√	√	√		√				√	√	√			√	
<i>Sonneratia griffithii</i>						√					√	√									√				
<i>Sonneratia x gulngai</i>			√				√																		
<i>Sonneratia hainanensis</i>					√																				
<i>Sonneratia ovata</i>			√		√		√				√					√			√		√				√
<i>Sonneratia x urama</i>							√																		
<i>Xylocarpus granatum</i>	√	√	√	√	√	√	√				√		√		√				√	√	√	√		√	
<i>Xylocarpus mekongensis</i>	√				√	√					√		√		√				√		√				
<i>Xylocarpus rumphii</i>							√				√	√				√									
Total no. of species	1	23	28	16	28	32	43	2	11	1	41	14	29	1	4	35	1	2	32	22	34	11	2	27	2

^a Uncertain.

^b Introduced species.

^c Also referred to as *Avicennia lanata*.

living in the reserve depend primarily on fishing and shrimp farming. Ecotourism is increasing slowly, also owing to the presence and activities of the Ranong Mangrove Research Centre, which has a long history of scientific research in this area, with several research workers and students visiting yearly.

The delta of the Ayeyarwady River, Myanmar, is another large mangrove forest, which has, however, been degraded over time owing to overexploitation of the resource and to the conversion of land for rice fields, an activity promoted by the government as a way to ensure self-sufficiency in food production.

Other important forests in the region are found in Irian Jaya, Kalimantan and Sumatra in Indonesia, which is the country with the greatest extent of mangroves globally.

In western Asia and the Near East, the weather conditions are more arid, reducing biodiversity and forest complexity. Mangroves grow mainly as narrow stands in tidal areas, in seasonal river mouths and on off-shore islands, often represented by monospecific stands of *Avicennia marina* or *Rhizophora mucronata*. Coastal mangrove ecosystems are not present on the small Iraqi coastline and in Kuwait grow only as introduced species. Here experimental forests were planted to study the adaptability and growth performance of *Avicennia marina* in the harsh and extreme conditions of aridity and salinity.

MANGROVE RESOURCES: STATUS AND TRENDS 1980–2005

The mangrove area in Asia equals more than 5.8 million hectares and accounts for some 38 percent of global mangrove area, representing the highest percentage of mangroves worldwide (Table 8).

TABLE 8
Status and trends in mangrove area – Asia (1980–2005)

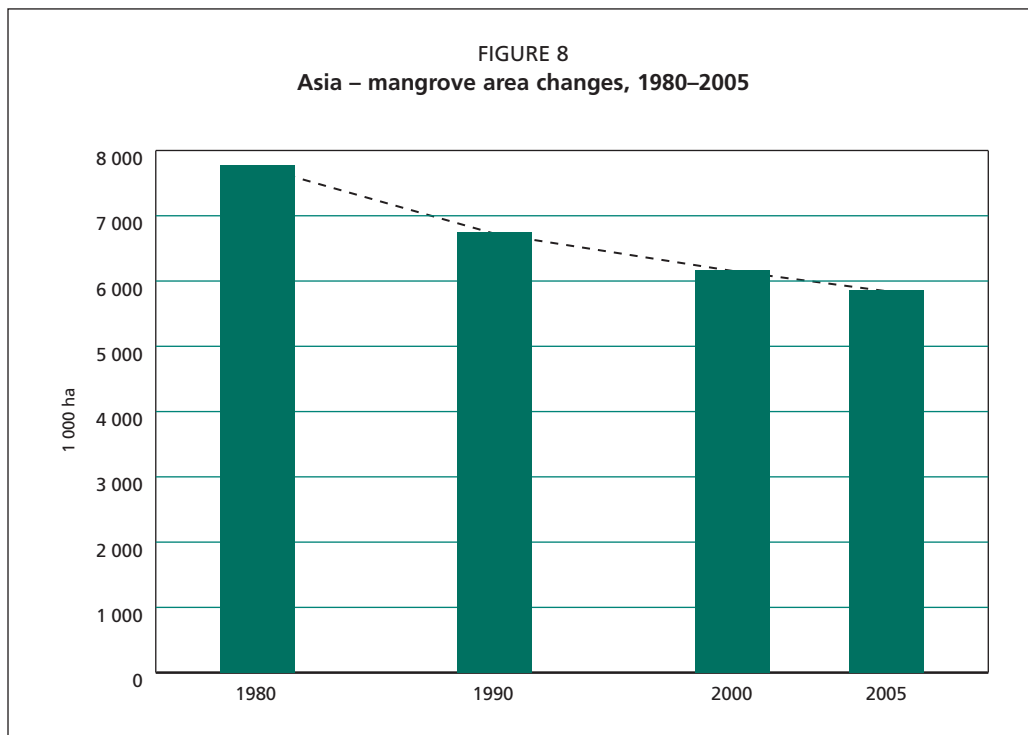
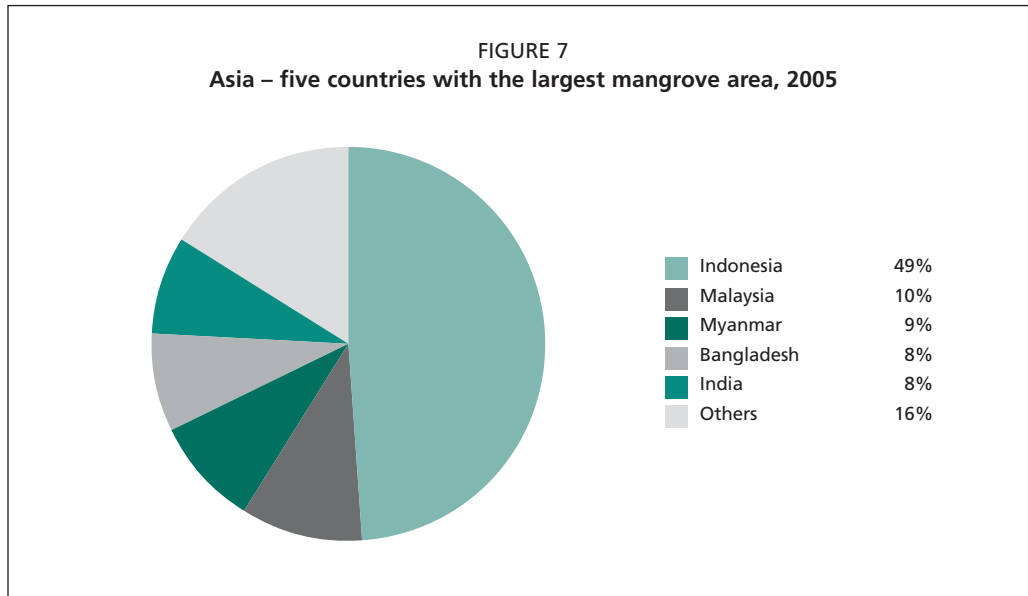
Country/ area	Most recent reliable estimate		1980 ha	1990 ha	Annual change 1980–1990		2000 ha	Annual change 1990–2000		2005 ha	Annual change 2000–2005	
	ha	Ref. year			ha	%		ha	%		ha	%
Bahrain	100	1992	150	100	–5	–4	90	–1	–1.0	90	0	0
Bangladesh	476 215	1995	428 000	460 000	3 200	0.7	476 000	1 600	0.3	476 000	0	0
Brunei Darussalam	18 418	1996	18 400	18 400	0	0	18 400	0	0	18 400	0	0
Cambodia	72 835	1997	91 200	82 400	–880	–1.0	73 600	–880	–1.1	69 200	–880	–1.2
China	22 480	2001	34 157	28 344	–581	–1.8	22 955	–539	–2.1	22 480	–95	–0.4
India	446 100	2003	506 700	467 000	–3 970	–0.8	448 200	–1 880	–0.4	448 000	–40	n.s.
Indonesia	3 062 300	2003	4 200 000	3 500 000	–70 000	–1.8	3 150 000	–35 000	–1.0	2 900 000	–50 000	–1.6
Iran, Islamic Republic of	19 234	1997	27 500	22 500	–500	–2.0	19 100	–340	–1.6	19 000	–20	–0.1
Japan	800	2005	800	800	0	0	800	0	0	800	0	0
Kuwait	5	2004	n.s.	n.s.	n/a	n/a	n.s.	n/a	n/a	5	n/a	n/a
Malaysia	564 971	2005	674 000	642 000	–3 200	–0.5	589 500	–5 250	–0.8	565 000	–4 900	–0.8
Maldives	n.a.	n.a.	n.a.	n.a.	n/a	n/a	n.a.	n/a	n/a	n.a.	n/a	n/a
Myanmar	518 646	1999	555 500	536 100	–1 940	–0.3	516 700	–1 940	–0.4	507 000	–1 940	–0.4
Oman	1 088	1995	2 000	2 000	0	0	1 000	–100	–6.7	1 000	0	0
Pakistan	158 000	2001	345 000	207 000	–13 800	–5.0	158 000	–4 900	–2.7	157 000	–200	–0.1
Philippines	247 362	2003	295 000	273 000	–2 200	–0.8	250 000	–2 300	–0.9	240 000	–2 000	–0.8
Qatar	500	1992	500	500	0	0	500	0	0	500	0	0
Saudi Arabia	20 400	1985	21 000	20 000	–100	–0.5	20 000	0	0	20 000	0	0
Singapore	500	1990	1 790	500	–129	–12.0	500	0	0	500	0	0
Sri Lanka	9 530	1996	9 600	9 300	–30	–0.3	9 000	–30	–0.3	8 800	–40	–0.4
Thailand	244 085	2000	280 000	250 200	–2 980	–1.1	244 100	–610	–0.2	240 000	–820	–0.3
Timor-Leste	1 802	2000	4 250	3 000	–125	–3.4	1 800	–120	–5.0	1 800	0	0
United Arab Emirates	4 000	1999	3 500	3 800	30	0.8	4 000	20	0.5	4 100	20	0.5
Viet Nam	157 500	2000	269 150	213 500	–5 565	–2.3	157 500	–5 600	–3.0	157 000	–100	–0.1
Yemen	927	1993	1 000	950	–5	–0.5	900	–5	–0.5	900	0	0
Asia	6 047 798	2002	7 769 197	6 741 394	–102 780	–1.41	6 162 645	–57 875	–0.89	5 857 575	–61 014	–1.01

Note: n.a. = not available; n/a = not applicable; n.s. = not significant.

As reported in Figure 7, Indonesia is the country with the largest extent of mangroves in the region (and in the world), accounting for about half the regional extent of mangrove area. Other Asian countries with a significant extent of mangroves are (in order of mangrove area) Malaysia, Myanmar, Bangladesh and India, which, together with Indonesia, account for more than 80 percent of total Asian mangrove area. The mangroves of these five countries also represent a high percentage of global mangrove extent – all of them are included in the ten countries with the largest extent of mangrove area worldwide (Figure 3, page 12).

Mangroves in these five countries have experienced intensive logging or conversion to other land uses (e.g. shrimp ponds or rice paddies), and the majority of them are no longer pristine. Human pressure on coastal areas and increasing demand for land for agriculture represent increasing threats to mangroves in these countries. However, in several localities they still form dense and well-structured ecosystems.

In this region some 1 900 million hectares of mangroves – or about 25 percent of the 1980 area – have been lost during the last 25 years (Figure 8). More than 90 percent of this loss has been caused by the major mangrove area changes in Indonesia, Pakistan, Viet Nam, Malaysia and India, which experienced a cumulative loss of more than



1 700 million hectares. The main causes of mangrove loss in Indonesia are conversion of land for shrimp farms (East Java, Sulawesi and Sumatra), excessive logging and, to a lesser extent, conversion of land to agriculture or salt pans (Java and Sulawesi). Other areas have been degraded by oil spills (East Kalimantan) and pollution. In Pakistan mangrove forests have been intensively used for fuelwood, poles, fodder and camel grazing. Overexploitation of these resources has led to the loss of nearly 190 000 ha. Industrial pollution and increasing salinity due to dam construction constitute other threats.

Malaysia lost about 110 000 ha of mangroves from 1980 to 2005. During the first decade (1980–1990), mangrove losses were primarily due to conversion of land for agriculture, shrimp ponds or urban development. Shrimp farming spread very quickly in the country, especially in peninsular Malaysia, leading to the clearing of large areas of forest.

However, awareness of the services and benefits provided by mangroves is growing and even though much remains to be done, conservation and restoration are being undertaken in many countries. For example, in 1990 a collaboration between the Government of Pakistan and the World Conservation Union (IUCN) facilitated the rehabilitation of 19 000 ha of *Avicennia marina* and *Rhizophora mucronata*. In 1999 about 17 000 ha were restored in the Indus delta thanks to the support of the World Bank.

Viet Nam is making a considerable effort to restore its forests; afforestation activities began in 1975, after the unification of the country, and were expanded in the early 1990s, when the Government of Viet Nam rehabilitated nearly 53 000 ha of mangroves. Various national and external NGOs have also supported rehabilitation projects, totalling some 14 000 ha of mangrove plantation in various provinces in the last decade. The success of rehabilitation efforts in Viet Nam is mainly due to the close cooperation between funding agencies, local authorities, the government and the people.

Even if the regional results indicate a major loss of mangroves over the past two decades (1980–2005), some countries, such as Brunei Darussalam, Japan, Qatar and Saudi Arabia, experienced limited or no significant change in the extent of their mangrove forests. In Brunei Darussalam, the lack of human pressure and the consequent low demand for wood products from the mangroves has left these forests virtually pristine, representing some of the best-preserved mangroves in Southeast Asia. In Japan natural regeneration and human-made reforestation have balanced the few changes occurring in the country due to traditional mangrove use, while in Qatar wood products are rarely extracted from mangroves. For Saudi Arabia, however, the status quo may be only apparent, since, even if only a very limited extent of mangroves has been lost, several sites have been degraded due to intensive camel grazing and oil pollution.

In the last five years, Bahrain, Oman, Singapore, Timor-Leste and Yemen have succeeded in slowing the negative trend in area changes. The modifications in resource management in Oman, for example, have helped reduce the negative annual change rate of the 1990s to zero. In the 1980s, Singapore experienced a relatively significant mangrove net loss rate, owing to the high demand for fuelwood and charcoal and to urban and shrimp-farm development. However, major efforts have resulted in conservation of the remaining area during the last ten years (1995–2005).

Positive change rates are found in Bangladesh, the United Arab Emirates and – although with only a limited mangrove area – Kuwait. These countries jointly reported an increase in extent of mangrove area of some 48 000 ha since 1980.

MAIN USES AND THREATS

Rural populations in Asia have traditionally used mangroves as a source of wood and non-wood forest products for the production of charcoal, fuelwood, and timber and poles for houses, boats and fish-traps. In Indonesia, for example, the commercial exploitation of mangrove wood has a long history, and has been important particularly for the production of wood chips, timber (now banned) and charcoal, including for export. In addition, poles extracted from the Rhizophoraceae are used for building foundations. Malaysia has a long tradition of production of mangrove charcoal for national and international markets.

Besides these exceptions, mangroves have generally been used for local needs. *Nypa fruticans* is a common species in most Asian countries, and it has often been used as thatching material for houses in Bangladesh, Brunei Darussalam, India, Indonesia, Malaysia, the Philippines and Viet Nam. Several fishing and rural communities depend on the fish and shellfish in mangroves as a source of income and food security; when mangrove forests are destroyed, a significant decrease in local fish catches may result. Indonesia, the Philippines and Thailand have major offshore fisheries, which represent a significant portion of national income and depend partly on mangroves.

Many rural communities have used mangroves to produce honey, tannins and traditional medicines. Ecotourism activities are increasing in the region, providing further sources of sustainable income to local populations and creating awareness of the services and benefits provided by mangroves.

Mangrove leaves are often used as fodder for camels, goats and sheep in the Near East, where mangroves are often the only coastal forest resource. However, overexploitation of the trees for this use may reduce mangrove growth and density, stunting trees and degrading stand quality. When the outer trees are overused, it is common practice to provide fresh, additional fodder for camels by opening the way to the inner mangroves. In some places this practice has affected the quality of the stand even if the mangrove area was not reduced significantly.

The main causes of loss of area in Asia have been overexploitation and the development of shrimp farms. Because of its high economic return, shrimp farming has been promoted to boost national economies, as a potential source of income for local communities and as a means of poverty alleviation. However, this activity may cause loss of habitat and of ecosystem services provided by mangroves, and may damage surrounding areas through pollution caused by the chemical products used.

In some countries (e.g. India and Myanmar) government policies have promoted self-sufficiency in food production through the conversion of mangrove lands to rice paddies, while in other countries (e.g. China, Indonesia, the Philippines and Viet Nam) mangrove areas have been used for salt production. In addition, some mangrove areas have been clear-cut for urban or tourist development or converted to agriculture. The decrease in freshwater input or the interruption of flows caused by the construction of dams and diversion of water for irrigation may increase soil salinity, damaging the surrounding mangroves, as has occurred in Singapore and Pakistan.

During the Viet Nam war (1962–1972), mangrove forests often served as bases for military operations, and were consequently highly damaged by chemical warfare (herbicides and napalm). Further losses have been caused by the conversion of mangrove land to other uses such as shrimp ponds, agriculture, salt pans and human settlements.

Among the current threats to mangrove ecosystems, the ever-increasing human pressure on coastal areas is one of the most serious. In addition to human-induced threats, natural hazards such as cyclones, storms and floods frequently occur in this region, threatening several coastal ecosystems, including mangroves. Trees in the front lines are often uprooted and damaged during these events. However, the loss of this ‘sacrificial belt’ (Takle, 2007) may contribute to the overall protective function of dense forests, as occurred during the cyclone in Orissa, India, in 1999. It is also reported that many people in Bangladesh were protected by mangroves during the tidal wave that hit the Chakaria Sundarbans in 1960 (which at that time was still covered by dense forests), and in Viet Nam, when typhoon Wukong hit three northern provinces in 2000, but left no damage to the dykes behind the regenerated mangroves (see ‘Functions and uses of mangroves’, page 4).

MANGROVE CONSERVATION AND MANAGEMENT

Threats to and losses of mangroves in Asian countries are still a problem, However, awareness of the importance of mangroves is growing also in this region, and several afforestation and rehabilitation efforts are being undertaken, especially for protection and conservation purposes.

The increasing well-being of many countries in the Near East – especially of those overlooking the Persian Gulf and the Straits of Hormuz – is alleviating the pressure on these ecosystems. On the other hand, the negative effect of this rapid economic growth is represented by the increased solid, industrial and oil pollution, which may threaten local flora and fauna, potentially leading to the death of mangrove trees (e.g. *Avicennia marina* in Qatar).

Bangladesh, Malaysia and Viet Nam have very long traditions of sustainable management, plantation and afforestation programmes in mangroves. Mangrove management and protection in Bangladesh, for example, started at the beginning of the twentieth century, with the preparation of forest management working plans and the creation of what is now called the Sundarbans Reserved Forest. Coastal afforestation programmes started in 1966, involving several districts.

Planting may be undertaken for production (wood and non-wood forest products), for environmental and/or for educational purposes (e.g. the Ishigaki and Iriomote islands of Japan). Experimental plantations have also been established successfully in extremely arid countries such as Bahrain, Kuwait and the United Arab Emirates. Many countries in Asia have been increasingly promoting establishment and maintenance of mangrove greenbelts as protection against natural hazards, especially those countries affected by destructive typhoons each year (e.g. the Philippines and Viet Nam). In China, strip forests, primarily of *Kandelia candel*, were reported to be effective in reducing the breaching and erosion of dykes during cyclones (Su Chunyu, unpublished, 2004). Other protection plantation activities are being undertaken in Bangladesh, Brunei Darussalam, India, Indonesia and Viet Nam.

Many countries have promulgated laws and regulations to protect remaining mangrove areas and mitigate widespread loss. Effective enforcement of this legislation is, however, often hampered by a lack of financial and human resources. Several Asian countries have ratified the Ramsar Convention on Wetlands (2004) and have designated mangrove areas as Ramsar sites or as national parks, reserves and wildlife sanctuaries.