5

Mangroves, Salt Marshes and Seagrass Beds

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Opposite page: Swamp mangrove near Quionga, North Mozambique. © José Paula.

Mangroves, salt marsh vegetation and seagrasses constitute true flowering plants in marine and estuarine habitats. While seagrass beds are found in temperate and tropical latitudes, saltmarshes are restricted to sub-tropical and temperate regions. Mangroves are a common feature of the coastlines of all the countries in the WIO region except Reunion (Figure 5.1). Saltmarshes are found almost entirely in South Africa due to its subtropical-temperate biogeographical location. It is common to find two or three habitats (mangroves, seagrass beds and salt marshes) co-occurring, however separation between these habitats is attributed to differences in salinity and depth preferences and or tolerances (Colloty and others, 2002). Mangroves, salt marshes and seagrass beds are ecologically and socio-economically important. They are easily impacted by human activities, resulting in habitat loss and a consequent reduction or total loss of the values associated with them.

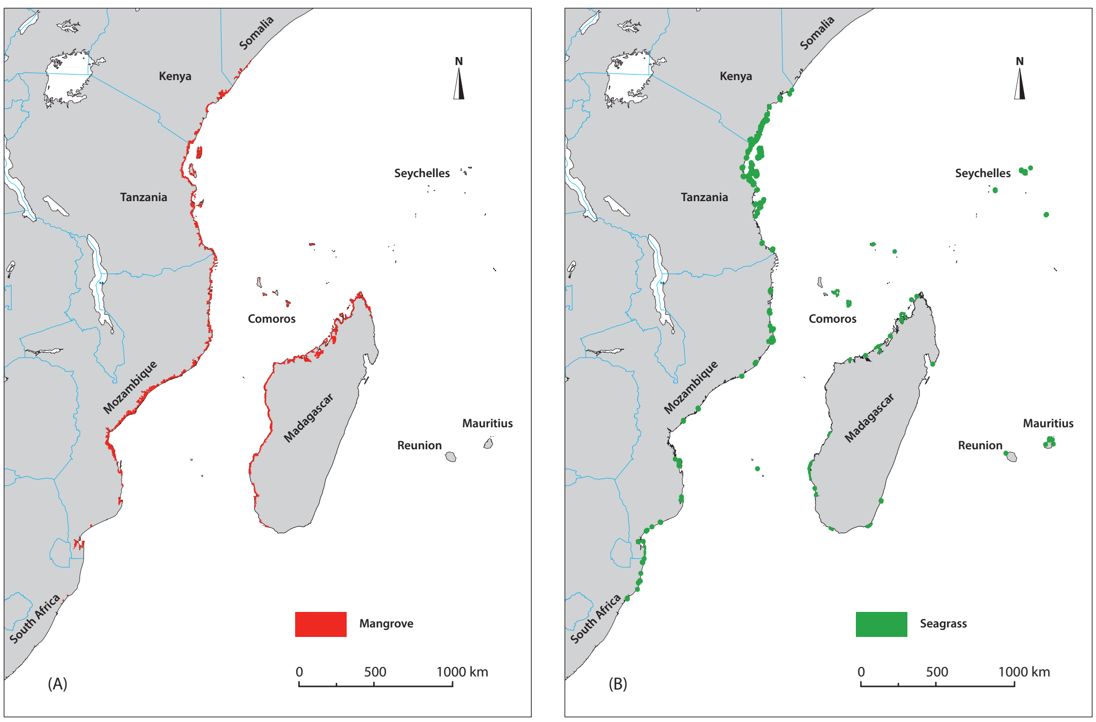

Figure 5.1. Map of mangrove and seagrass bed distribution in the WIO region. Source: http://data.unep-wcmc.org/datasets/10, accessed 16 August 2014.

BOX 5.1. MANGROVES AND THEIR IMPORTANCE

Mangrove forest in Ras Dege, Tanzania. © José Paula.

Mangroves are vascular plants that are capable of thriving in salt water and form a transition zone between land and sea. The term 'mangrove' includes trees, shrubs, palms or ground ferns generally exceeding half a metre in height, and which normally grow above mean sea level in the intertidal zone of marine coastal environments, or along estuarine margins (Duke, 2006). They are mainly found in estuaries, along riverbanks and in lagoons, and in gently sloping intertidal areas specially whenever there is freshwater seepage.

Mangroves provide breeding, spawning and nursery grounds for a variety of marine species including commercially important fish, shrimps and crabs, and are hence important for fisheries. Mangrove forests stabilize and protect shorelines, thereby reducing the impact of natural disasters such as tsunamis and cyclones. They form an important carbon sink (Donato and others, 2011).

Coastal communities use mangroves to supply local needs such as food, firewood, charcoal, timber, building materials and medicine. In Tanzania it is estimated that over 150 000 people in Rufiji make their living directly from mangrove resources (Taylor and others, 2003). Despite their socio-economic and ecological importance, mangroves constitute one of the most threatened tropical ecosystems (Valiela and others, 2001).

MANGROVES

Status And Trends

Coverage, distribution and composition

Their area in the WIO region is estimated at around 1 000 000 ha (Spalding and others, 1997). Over 90 per cent of these mangroves occur in the estuaries and deltas of four countries, viz. Mozambique, Madagascar, Tanzania and Kenya (Figure 5.2). Important mangrove forests occur in Boeny, Melaky and Diana (Madagascar), the Zambezi, Save to Púnguè and Limpopo Rivers (Mozambique), the Rufiji delta (Tanzania) and Lamu (Kenya). Ten species of mangroves are found in the region (Table 5.1). This list excludes two species, namely *Pemphis acidula*, the inclusion of which in the mangrove group is under debate, and *Acrostichum aureum*, which is considered a mangrove associate. *Rhizophora mucronata*, *Avicennia marina* and *Ceriops tagal* are most common. One species (*Ceriops somalensis*) is

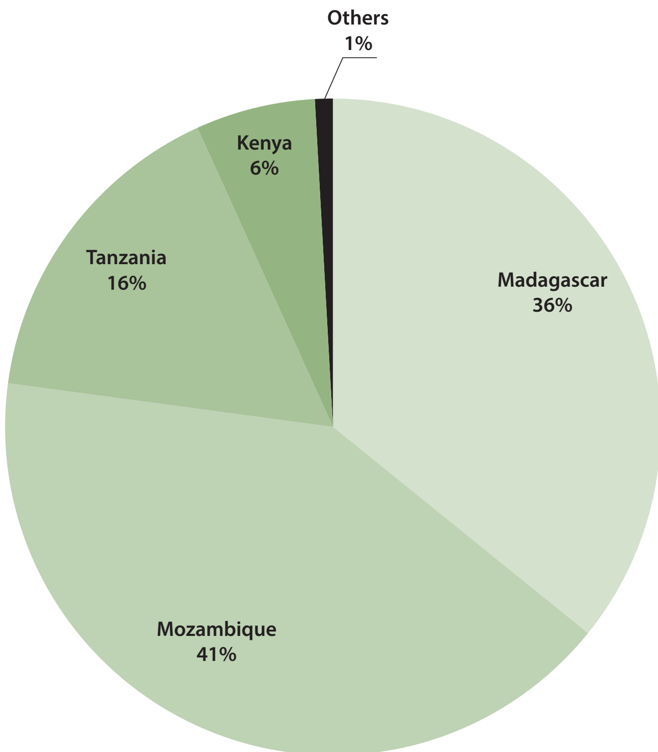

Figure 5.2. The relative extent of mangroves in the four countries with the greatest mangrove cover in the WIO region. (Source: FAO 2007, Giri and others, 2011).

Table 5.1. Mangrove species composition in different countries of the WIO region.

Species	*Avicennia marina*	*Bruguiera gymnorrhiza*	*Ceriops tagal*	*Ceriops somalensis*	*Heritiera littoralis*	*Lumnitzera racemosa*	*Rhizophora mucronata*	*Sonneratia alba*	*Xylocarpus granatum*	*Xylocarpus molucensis*	Total number of species
Somalia	X	X	X	X		X	X	X	X		**8**
Kenya	X	X	X		X	X	X	X	X	X	**9**
Tanzania	X	X	X		X	X	X	X	X	X	**9**
Mozambique	X	X	X		X	X	X	X	X		**8**
South Africa	X	X	X			X	X		X		**7**
Madagascar	X	X	X		X	X	X	X	X		**8**
Seychelles	X	X	X			X	X	X	X		**7**
Mauritius		X					X				**2**
Comoros	X	X	X		X	X	X	X			**7**

endemic to Somalia. Details of the status of individual countries are provided in the following sections.

The Comoros harbour about 120 ha of mangroves (FAO 2007), with about 75 per cent of these occurring on the south coast of Moheli Island, especially in the region of Damou and Mapiachingo. Other mangrove areas include Grande Comore and Anjouan. Seven species occur in the Comoros (Table 5.1), the most abundant being *R. mucronata* and *A. marina*.

The total coverage of mangroves in Kenya is estimated to range between 46 000 and 54 000 ha (FAO 2007, Kirui and others, 2012). Eighteen mangrove formations are found in Kenya, the largest occurring in the Lamu area (33 500 ha) and at the River Tana delta (Kirui and others, 2012). Other important mangrove areas include Vanga-Funzi, Gazi, Mida Creek and the Mombasa creeks such as Mwache. Nine species occur in Kenya (Table 5.1), with *R. mucronata* and *A. marina* being the most abundant.

Recent estimates indicate that Madagascar harbours about 278 078 ha of mangroves (Giri and others, 2011). This figure is smaller than earlier estimates of 303 815 ha (FAO 2007). The majority (98 per cent) of mangroves occur on the west coast. Important mangroves occur in Mahajanga Bay, Nosy Be and Hahavavy. A total of eight species of mangroves occur in this country (Table 5.1).

In Mauritius, mangroves only cover between 120 and 145 ha (FAO 2007). They are present in Rodrigues and in the Agalega Islands. Two species of mangroves, viz. *R. mucronata* and *B. gymnorrhiza*, are reported to occur here, with *R. mucronata* being the most dominant species.

Mozambique harbours the largest mangrove area of all the countries in the WIO, estimated to range between 290 900 and 318 800 ha (Fatoyinbo and others, 2008, Giri and others, 2011). These recent estimates are lower than earlier estimates (396 080 ha by Barbosa and others, 2001, and 392 750 ha in FAO 2007). The largest mangroves are in the Save-Zambezi River complex in the Sofala and Zambezia Provinces, with a total area of 190 000 ha (Fatoyinbo and others, 2008). A total of eight mangrove species occur in Mozambique (Table 5.1) with *A. marina*, *R. mucronata* and *C. tagal* being most dominant.

In the Seychelles, mangroves occur mainly on the four larger granitic islands, which include Mahé, Praslin, Silhouette and La Digue. Mangroves cover about 2 900 ha (FAO 2007). More extensive mangrove forests occur in the Aldabra and Cosmoledo Atolls, with Aldabra alone having about two thirds of the combined mangrove area of the Seychelles and these atolls (Taylor and others, 2003). Seven species of mangrove are found in the Seychelles (Table 5.1).

Mangroves in Somalia occupy an area of about 1 000 ha (FAO 2007), mainly in the Juba/Shebele estuary, along the creeks of Istambul, Kudha and Burgavo, and on the sheltered side of the barrier islands (ASCLME/SWIOFP 2012b). Another large mangrove forest occurs in the Bojun Islands (FAO 2005). Eight species of mangrove occur in Somalia (Table 5.1), including *Ceriops somalensis* which is endemic to Somalia.

Mangroves in South Africa are limited to the eastern coastline from the border of Mozambique at Kosi Bay in KwaZulu-Natal to Nahoon Estuary in East London (Eastern Cape). Mangroves cover between 1 660 ha and 3 000 ha (Ward and Steinke 1982, FAO 2007, Adams and others, in prep.). Six mangrove species occur in South Africa (Table 5.1), the dominant species being *A. marina*. About 80 per cent of mangroves of South Africa occur in Mhlathuze estuary (Taylor and others, 2003, Rajkaran and others, 2004).

Mangrove cover in the United Republic of Tanzania is estimated to range between 127 200-133 500 ha (FAO 2007, Semesi 1992, MTNRE 1991, Griffith 1949, 1950), the latter figure being officially considered the total extent of mangroves in the country (115 500 ha on the Tanzania mainland, 18,000 ha on Zanzibar). The largest continuous and well-developed mangrove forests in Tanzania are found in the major estuaries of the Pangani, Wami, Ruvu, Rufiji and Ruvuma Rivers. The Rufiji Delta has the largest stand of mangroves (53 000 ha) on the entire East African coast (Semesi 1989). In Zanzibar, well-developed mangroves occur on Pemba Island. Nine mangrove species occur in Tanzania (Table 5.1) with *R. mucronata*, *C. tagal* and *A. marina* dominating.

Trends

Establishing trends in mangrove area coverage for most countries in the WIO is constrained by lack of consistent data. Differences in assessment methods in some countries render estimates from different years incompatible (FAO 2010). Mangrove area coverage in most countries is, however, on the decline (Figure 5.3).

In Kenya, the total mangrove area has decreased gradually and it is estimated that, over about 25 years (1985 – 2010), Kenya has lost about 18 per cent of its mangroves at an average rate of 0.7per cent yr^{-1} (Kirui and others, 2012). In the United Republic of Tanzania the available information indicates a similar decrease of 18 per cent over 25 years (1980 – 2005) at a similar rate of 0.7 per cent yr^{1} (FAO 2007). If one considers the 1989 (115 500 ha) and 2003 (108 138 ha) estimates, the Tanzania mainland has lost about 6 per cent of its mangroves in 14 years (MTNRE 1991, Semesi 1992, Wang and others, 2003). Mangroves on Zanzibar also show a declining trend (refer estimates by Griffith 1949, 1950, Leskinen and Silima 1993, Leskinen and others, 1997).

Between 1990 and 1999-2002, the mangrove cover of Mozambique changed considerably, with a decrease of almost 27 per cent. The rate of mangrove deforestation was estimated at 1 821 ha yr^{1}, and was highest in Maputo and Beira (Barbosa and others, 2001). The mangrove cover has been decreasing especially in Sofala, Zambezia and Nampula, with the largest changes occurring in Zambezia which has lost almost half of its mangroves (Fatoyinbo and others, 2008). Mangrove cover has, however, increased in Maputo (by 600 ha) and Inhambane (by 1 300 ha) but remained stable in Cabo Delgado (Fatoyinbo and others, 2008).

Due to a paucity of recent countrywide estimates, trends in mangrove cover in Somalia, South Africa and the island states (Madagascar, Seychelles, Comoros and Mauritius) were derived from data provided by the FAO (2007) for the 25-year period of 1980–2005. South Africa lost about 14 per cent of its mangroves at a rate of 0.6 ha yr^{1}, while Somalia has lost about 23 per cent of its mangroves at a rate of 0.9 ha yr^{1}. Madagascar has lost about 9 per cent of its mangroves at a rate of about 0.4 ha yr^{1}, and the Comoros about 8 per cent at a rate of 0.3 ha yr^{1}. In the Seychelles, mangrove cover has remained stable, while in Mauritius mangrove cover has increased by about 167 per cent, possibly due to mangrove restoration initiatives.

Threats

Threats to mangroves are uniform across the WIO with varying degrees of intensity. They include overharvesting for firewood, timber and charcoal; clearing and conversion to other land uses such as agriculture, aquaculture, urban development, tourism and salt production; pollution; sedimentation and changes in river flow. Natural factors that contribute to mangrove decline include pest infestation, El Niño events and climate change-associated factors such as sea level rise, excessive flooding and increased sedimentation. Details, with examples from various countries, are provided in the following sections.

Overharvesting of wood to be used as firewood, charcoal and timber is the most common threat to mangroves in the region, particularly in urban and peri-urban areas. In Tanzania, intensive mangrove harvesting has been reported in Rufiji (Wagner and Sallema-Mtui 2010), and in Chwaka Bay and Maruhubi on Zanzibar. In Kenya, overharvesting for fuel wood, timber and fish traps has resulted in fragmentation of many mangrove forests (Mohamed and others, 2009). In Mozambique, two islands (Xefina Pequena and Benguelene) have respectively lost about 25 per cent and 40 per cent of their mangrove cover (LeMarie and others, 2006). In Madagascar, overexploitation of mangroves has been reported in the regions of Mahajanga and Toliara (ASCLME 2012i); overharvesting has also occurred in South Africa, Mauritius and the Comoros (Spalding and others, 2010, Taylor and others, 2003). Mangrove wood is further exploited for commercial purposes in Tanzania, Madagascar and Somalia (LeMarie and others, 2006, Semesi 1992, Jones and others, 2014). Debarking of *Rhizophora mucronata* for tannin production has been reported in Zan-

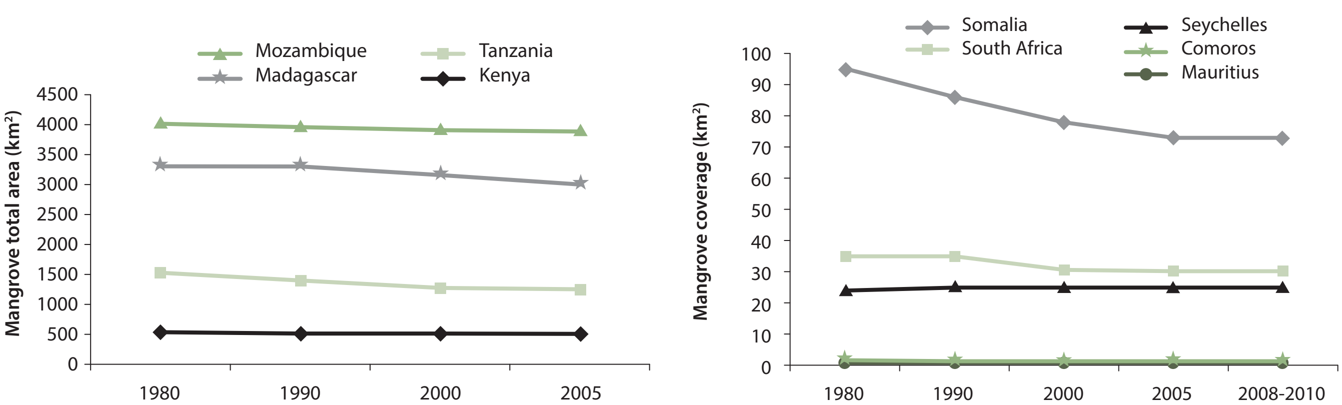

Figure 5.3. Trends in mangrove cover in WIO countries. (Data source: FAO 2007).

zibar (Wells and others, 2004).

Mangrove clearance for other land uses such as agriculture, solar salt production and coastal development is another important threat. Conversion for agriculture has been reported in Tanzania, Madagascar, Somalia, Mozambique and Seychelles (Semesi 1989, FAO 2005, Spalding and others, 2010, Taylor and others, 2003). Solar salt production has caused considerable mangrove loss in the region. For example, Kenya lost more than 500 ha of mangroves in Magarini District due to the construction of salt ponds (Ocholla and others, 2013). Solar salt production has also been reported in Somalia, Tanzania and Mozambique (ASCLME 2012a, ASCLME 2012c, ASCLME 2012d); however, the loss is rarely quantified.

Loss of mangroves due to coastal development is a common threat in the region. The problem is serious in the small island states due to their small size and that of their mangrove forests, the granitic nature of some islands and the constant need for land for human use. In the Seychelles, mangroves (eg on Mahé island) are cleared and sometimes drained (eg along the East Coast) for housing and hotels. Mauritius lost about 30 per cent of its mangroves between 1987 and 1994 (Turner and others, 2000), partly for tourism development (Spalding and others, 2010). Clearance for infrastructural development (eg at Iconi, Grande Comore and Anjouan Domoni) has resulted in considerable loss of mangroves in Comoros. This problem has also been reported in mainland states, including Tanzania, Mozambique and Somalia. Deforestation for shrimp ponds has also caused considerable mangrove deforestation in some countries such as Madagascar (Rasolofoharinoro and others, 1998).

Pollution from industries, agriculture and domestic runoff, and incidences of oil spills, are other important causes of mangrove loss in the region. About 200 ha of mangroves in Port Reitz Creek, Kenya, were totally destroyed by an accidental oil spill that occurred in 2005 (Kairo and others, 2005). In South Africa, oil pollution is prevalent in estuaries in large cities such as Richards Bay, Durban and East London, and in Somalia from tankers in shipping lanes along the Somali coast (ASCLME 2011). Oil pollution may be exacerbated by recent oil discoveries and the exploitation of new reserves in the region. Solid waste disposal is common in mangroves near urban areas. The use of DDT and other pesticides on rice farms also affects mangroves (Semesi and Mzava 1991).

Water abstraction has been reported to cause considerable mangrove loss in the region. In Mozambique, about 2 000 ha of mangroves were lost following the construction of the Cabora Bassa dam (Beilfuss and Brown 2006). This problem has been reported also in Tanzania (Semesi and Mzava 1991).

Sedimentation and coastal erosion is another major threat to mangroves. In Madagascar, between 40 and 50 million tonnes of sediments end up in mangroves every year, causing mangrove degradation (ASCLME 2012i). Sedimentation and coastal erosion also threaten mangrove ecosystems in Tanzania (Francis and others, 2001, Wagner and Sallema-Mtui 2010).

Other threats to mangroves recorded in the region include the El Niño incident of 1997/98, pest infestations and climate change-associated phenomena such as sea level rise, flooding and changes in hydrological regimes (Erftemeijer and Hamerlynck 2005, Diop and others, 2002). In Kenya the 1997/98 El Niño event caused a loss of at least 500 ha of mangroves, particularly in Mwache Creek. Predicted sea-level rise due to climate change is very likely to affect low-lying mangrove areas (FAO 2007, ASCLME 2012c).

SALT MARSHES

Status and trends

Coverage, distribution and composition

Saltmarshes occur almost exclusively in some estuaries and embayments along the coast of South Africa, particularly along the southeastern, southern and western coasts (a small saltmarsh is also reported to occur in Maputo Bay). They are distributed in the supratidal, intertidal and floodplain areas of the cool temperate, warm temperate and subtropical regions of the country. There is a temperate-subtropical gradient in the extent of the salt marshes; they are more extensive in the cool temperate region (52 per cent), followed by the warm temperate region (28 per cent) and last in the subtropical (WIO) region (20 per cent) (Adams and others, in prep).

Recent estimates (Adams and others, in prep) show that salt marshes in South Africa cover a total of 12 344 ha, with only about 2 517 ha (20 per cent) occurring in the WIO (subtropical) region. Here, extensive salt marsh communities occur in St. Lucia (2 222 ha). They also occur in Mhlathuze estuary (60 ha) and in Richards Bay (52 ha).

The species diversity in the saltmarshes is relatively low and often only a few species such as cordgrass *Spartina maritima*, the glasswort *Sarcocornia tegetaria* and the marsh

BOX 5.2. SALT MARSHES AND THEIR IMPORTANCE

A typical salt marsh ecosystem. © Janine Adams.

Salt marshes form an integral part of many estuarine and coastal ecosystems in South Africa (Bornman and others, 2002). These have been divided into intertidal marshes that occur from the mean neap high water mark to the mean spring high water mark, and supratidal marshes that occur above the spring high water mark. These two salt marsh types have different species composition (Adams and others, 1999). Salt marshes are reported to occur in the southern regions of Mozambique (adjacent to dwarf mangroves of Maputo Bay) but are poorly documented.

Salt marshes have a number of important functions, which include sediment stabilization and bank protection, filtration of sediment and pollution, and the provision of feeding areas and shelter for both marine and estuarine organisms. They serve as zones of nutrient capture and retention and are important inorganic and organic nutrient sources for estuarine ecosystems. Whilst some of the plant biomass trapped within these systems decays and enters the associated detritus food chain, much is retained as long-term carbon stores.

samphire *Salicornia meyeriana* are common (ASCLME 2012e). *Spartina maritima* commonly forms extensive monotypic stands in larger estuaries that are permanently open to the sea (Adams and Bate 1995). Three species, namely *Juncus kraussi*, *Sporobolus virginicus* and *Stenotaphrum secundata*, are widespread, occurring in more than half of the South African estuaries (Adams and others, in prep), probably due to their wide salinity tolerance.

The presence or absence of a particular species in a saltmarsh is related to patterns of tidal inundation and salinity. Each habitat supports a distinctive saltmarsh community consisting of one or a few species, resulting in clear zonation in some areas. The typical zonation of salt marshes along the intertidal gradient in South Africa is shown in Figure 5.4. The seagrass *Zostera capensis* Setchell occurs at the lower watermark, followed by cord grass (*S. maritima*). Above this zone, *Sarcocornia tegetaria* is replaced at higher levels by *Triglochin* spp., *Limonium scabrum* and *Bassia dif-*

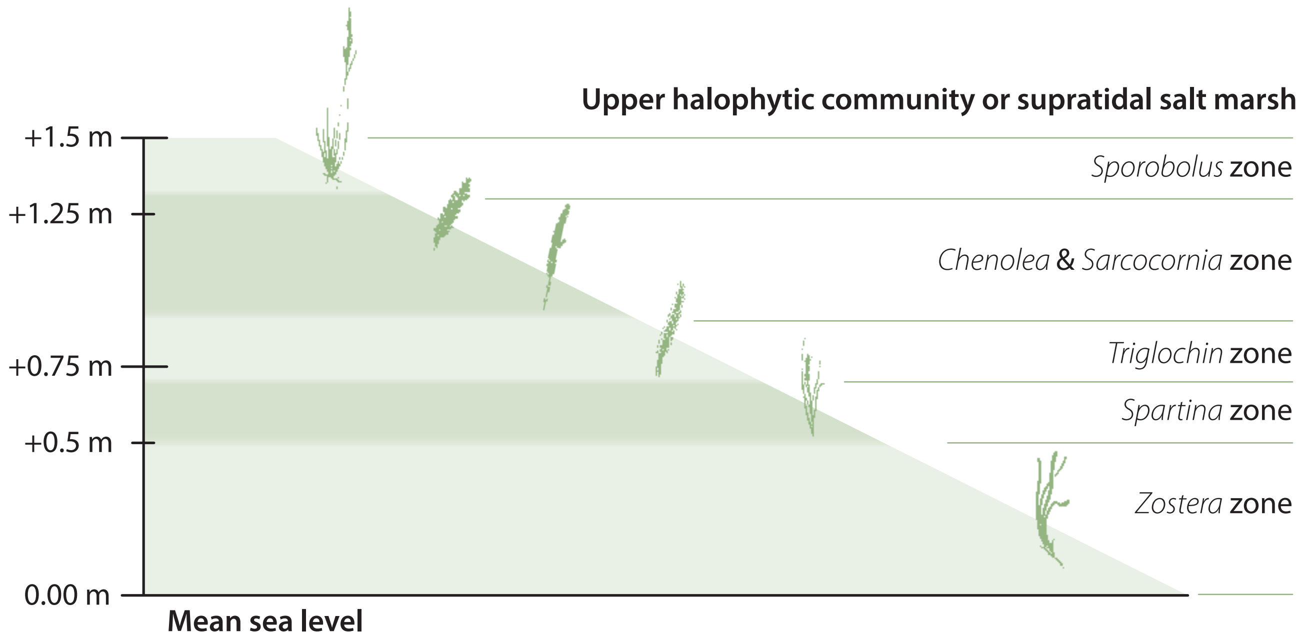

Figure 5.4. General zonation of salt marsh plants in South African estuaries. Adapted from: Adams and others, 1999.

fusa (Adams and Bate 1995).

The co-occurrence of salt marsh and mangrove habitats is common in some estuaries in the warm temperate and subtropical regions of South Africa. However, as one moves towards the subtropics, mangroves become more dominant. Examples of such 'transitional' estuaries include the St Lucia, Mlalazi, Richards Bay and Mhlathuze systems (Adams and others, in prep.). Outside the South African sub-tropical region, saltmarshes are poorly studied and understood in the WIO. However, there are anecdotal reports that they occur in several places between mangrove vegetation and marshland where they are dominated by succulent species such as *B. diffusa*, *Salicornia* sp., *Sesuvium portulacastrum* and *J. krausii*. Some of these species may occupy extensive areas between mangroves and terrestrial vegetation as observed in parts of Maputo Bay. Saltmarshes may also occur intermingled amongst mangroves depending on the extent of their degradation or the presence of extreme dwarf forms. Furthermore, coastal geomorphology may favour the occurrence of some saltmarsh species in north-eastern South Africa and subtropical southern Mozambique where there are numerous coastal lakes, almost all to some extent saline or brackish.

Threats

Saltmarshes in South Africa and elsewhere are threatened by both human and natural factors. Water abstraction, changes in hydrological flows and regimes, and the closure of river mouths are some of the main threats to saltmarshes in South Africa. Considerable water reduction from abstraction leads to massive dieback of salt marshes on floodplains. Other threats to salt marshes include urban and industrial developments, salt works, mining, boating, fishing, livestock grazing/trampling and siltation.

SEAGRASSES

Status and trends

Composition and coverage

Seagrasses are distributed throughout the WIO region; from north coast of Somalia to the north coast of South Africa, and in the island states (ASCLME 2012c). They are distributed from the intertidal zone down to about 40 m depending on water clarity, and often occur in close connection with coral reefs and mangroves. Twelve species belonging to three families, namely Zosteraceae, Hydrocharitaceae and Cymodoceaceae, occur commonly in the region, two species, *Halophila decipiens* and *Halophila beccarii*, being added recently (see Waycott and others, 2004, Bandeira 2011). This number excludes another two species: *Halodule wrightii*, which according to Ochieng and Erftermeijer (2003), Waycott and others (2004), and Bandeira (2011), does not occur in the region and is *Halodule uninervis* which was misidentified in the past, and *Halophila minor*, which is considered a member of the *Halophila ovalis* complex (Waycott and others, 2004). Kenya, Tanza-

BOX 5.3. SEAGRASSES AND THEIR IMPORTANCE

Dense mixed seagrass bed (left) and monospecific sparse stand of *Thalassia hemprichii* (right) at Inhaca Island, Mozambique. © José Paula and Salomão Bandeira, repectively.

Seagrasses are one of the most productive aquatic ecosystems on earth, and are widely distributed in both tropical and temperate coastal waters. They serve as critical nurseries and foraging grounds for numerous fishes and invertebrates. In the WIO region, seagrass habitats are known to support populations of two endangered species, the green sea turtle (*Chelonia mydas*) and dugong (*Dugong dugon*) (ASCLME/SWIOFP 2012b).

nia and Mozambique support the highest diversity of seagrasses (UNEP/ Nairobi convention secretariat 2009). Details of each country in the WIO are provided in the following sections.

Comoros: Eight seagrass species are found in the Comoros (Table 5.2). Extensive seagrass beds are found in the Mohéli Marine Park, which harbours almost 90 per cent of the seagrasses in the country (ASCLME 2012f). The remaining area is made up of seagrass beds located at Mitsamiouli, Malé and Ouroveni in Grande Comoro and at Bimbini and Ouani in Anjouan.

Kenya: Ten species of seagrasses are reported to occur in Kenya (Table 5.2), with *Thalassodendron ciliatum*, a species that usually forms monospecific stands, being dominant (Richmond 2011, Ochieng and Erftemeijer 2003). Seagrass beds in Kenya are estimated to cover an area of 3 400 ha (ASCLME 2012b, ASCLME/SWIOFP 2012b). Important seagrass beds in Kenya include Kiunga, Malindi, Mombasa, Diani-Challe, Gazi Bay and Mida Creek (Dahdouh-Guebas and others, 1999, ASCLME 2012b).

Madagascar: Madagascar harbours seven seagrass species (Table 5.2). Most seagrass beds are dominated by *T. ciliatum* and *Thalassia hemprichii* (Bandeira and Gell 2003); however, information on the seagrasses of Madagascar is limited.

Mauritius: Six seagrass species are known to occur in the Republic of Mauritius (Table 5.2). Rodrigues, in particular, has only two *Halophila* species (ASCLME 2012g). Seagrass beds cover an estimated area of 55 ha and 649 ha in Mauritius and Rodrigues, respectively (Turner and Klaus 2005).

Mozambique: Ten species of seagrasses are found in Mozambique (Table 5.2). Seagrass beds in this country are estimated to cover a total surface area of 43 900 ha (Bandeira and Gell 2003), with 2 500 ha at Inhassoro and Bazaruto Island, 3 000 ha at Mecufi-Pemba and 4 500 ha in the southern Quirimbas Archipelago (Green and Short 2003). Seagrasses were reported to cover half of the intertidal area around Inhaca Island (Bandeira 2002).

Reunion: In Reunion, monospecific stands of the seagrass *Syringodium isoetifolium* are dominant. They are mainly found in reefal lagoons (ASCLME/SWIOFP 2012a).

Seychelles: Seychelles is endowed with nine seagrass species (Table 5.2) (ASCLME 2012h). The total area covered is unknown, but *Cymodocea serrulata*, *S. isoetifolium*

Table 5.2. Seagrass distribution in different countries in the WIO region.

Families	Species	Somalia	Kenya	Tanzania	Mozambique	South Africa	Madagascar	Mauritius	Seychelles	Comoros	Reunion
Cymodoceaceae	*Cymodocea rotundata* Ehrenberg & Hemprich ex Ascherson	X	X	X	X	X	X		X	X	
Cymodoceaceae	*Cymodocea serrulata* (R. Brown) Ascherson	X	X	X	X	X	X	X	X	X	
Cymodoceaceae	*Halodule uninervis* (Forsskal) Ascherson	X	X	X	X		X	X	X	X	
Cymodoceaceae	*Syringodium isoetifolium* (Ascherson) Dandy	X	X	X	X			X	X	X	X
Cymodoceaceae	*Thalassodendron ciliatum* (Forsskal) den Hartog		X	X	X		X	X	X	X	
Hydrocheritaceae	*Enhalus acoroides* (L.f) Royle		X	X	X				X		
Hydrocheritaceae	*Halophila ovalis* (R. Brown) Hooker f.	X	X	X	X	X	X	X	X	X	
Hydrocheritaceae	*Halophila stipulacea* (Forsskal) Ascherson	X	X	X	X		X	X		X	
Hydrocheritaceae	**Halophila decipiens* Ostenfeld, 1902										
Hydrocheritaceae	**Halophila beccarii* Ascherson, 1871										
Hydrocheritaceae	*Thalassia hemprichii* (Ehrenberg) Ascherson	X	X	X	X	X	X		X	X	
Zosteraceae	*Zostera capensis* Setchell		X	X	X	X					
	Total number of species	**7**	**10**	**10**	**10**	**5**	**7**	**6**	**8**	**8**	**1**

*Recent documentation – exact location may be dependent of subtidal observation (Waycott and others, 2004, Bandeira 2011).

and *T. hemprichii* are generally dominant (Bandeira and Gell 2003). Seychelles possesses the deepest seagrass stands in the WIO as *T. ciliatum* was observed at 33 m (Titlyanov and others, 1995).

Somalia: Seven species of seagrasses have been identified in Somalia (Table 5.2), with *T. ciliatum* being abundant in most areas (UNEP/ Nairobi convention secretariat 2009, ASCLME 2012c). Seagrasses are limited in distribution from Adale to Ras Chiamboni and there are a few beds along the north coast (ASCLME 2012c).

South Africa: Seagrass beds in South Africa are limited to the sheltered waters of estuaries (ASCLME 2012e). South Africa hosts five seagrass species (Table 5.2). *Zostera capensis* is dominant in sheltered east coast estuaries with muddy bottoms, while *T. ciliatum* is dominant on the rocky shorelines. Information on the total area covered by seagrasses in the country is not available for most species, although that of the most common seagrass species (*Zostera capensis*) is estimated at 700 ha (Bandeira and Gell 2003).

Tanzania: Ten species of seagrasses (Table 5.2) occur in Tanzania. Dominant seagrasses include *T. hemprichii*, *S. isoetifolium* and *T. ciliatum* (ASCLME 2012a). One other species, *Z. capensis*, has also been reported to be present in the country (Bandeira and Gell 2003), although this has not been independently verified. The most extensive seagrass beds occur along the Tanga coast, in the deltas of the Ruvu, Wami and Rufiji Rivers, on Mafia Island, in the Songo Songo Archipelago and around Kilwa and Chwaka Bay (UNEP/Nairobi Convention Secretariat 2009, ASCLME 2012a). The area of the seagrass beds and the relative species densities are yet to be established in Tanzania. However in one area, Chwaka Bay, seagrasses are estimated to cover 10 000 ha (UNEP/Nairobi Convention Secretariat 2009).

Threats

Damage to seagrass beds in the WIO is rarely documented. As a result, the extent and severity of damage on most seagrass beds are difficult to estimate in the region given the lack of data. Threats to seagrass beds in the different countries are more or less similar and are mainly attributable to human activities, although natural factors also play an important role. Some examples are summarised in the following section.

Comoros seagrasses have been affected by sedimentation and climate change. For example, *T. ciliatum* beds in Mohéli Marine Park were destroyed by high sediment influx into the lagoon from upland deforestation, coupled with high rainfall, which took place between 1993 and 1998 (ASCLME 2012f). Some re-colonization has been reported. In Kenya, increased sedimentation (from some 58 000 tonnes per annum in 1960 to up 7-14 million tonnes per annum in Sabaki catchment) has significantly affected Kenyan seagrass beds (Katwijk and others, 1993). Beach seining in most intertidal seagrass beds and shallow water trawling are among the major threats to seagrass beds in Tanzania (Green and Short 2003). In Mozambique, *Z. capensis* has disappeared from the bay in front of Inhaca's main village due to trampling and the heavy concentration of fishing and tourist activities (ASCLME/SWIOFP 2012a). Moreover, digging in *Z. capensis* and related seagrass beds to collect bivalves, together with flooding, has dramatically depleted the seagrass cover at Bairro dos Pescadores near Maputo (Bandeira and Gell 2003). Mozambican seagrasses are also threatened by oil pollution (Munga 1993). Seagrass area loss in Mozambique is estimated at 2 755 ha (Bandeira and Gell 2003).

Natural threats to seagrasses include grazing by sea urchin as observed in Mombasa lagoon in Kenya (Alcoverro and Mariani 2002), and shoreline dynamics that cause sand deposition and removal.

DRIVING FORCES

The driving forces behind mangrove degradation and loss include rapid demographic growth, poverty, inadequate education and environmental awareness, inadequate law enforcement, economic growth and global market forces, and climate change (UNEP/Nairobi Convention Secretariat 2009, Wagner 2007).

On a decision-making level, a low level of knowledge and awareness of the real value of the goods and services provided by mangroves has contributed to poor decision-making, especially when choices between conservation and development have to be made (Lal 2002). A worst-case scenario occurred in Tanzania when, in 1998, the Government approved a shrimp farm project which, if not halted by the joint efforts of stakeholders, would have resulted in the clearance of about 19 000 ha of mangroves in the Rufiji delta (Bryceson 1998). Mangrove clearance in favour of tourism has occurred in many countries in the WIO and, if left to continue, could lead to severe consequences, including the complete elimination of mangroves, especially in the Small Island Developing States. Low levels of knowledge and awareness also contribute to weak enforcement of existing legislation, resulting in uncontrolled destructive practices (eg forest encroachment and waste disposal). For example, mangrove clearance for urban expansion has been one of the main threats to mangroves. Poverty translates into overdependence on natural resources by poor communities due to limited alternative sources of livelihood. For example, demand for firewood and charcoal as cheap alternative sources of energy has caused massive mangrove loss across the WIO region. Poverty underlies similar destructive drivers in salt marshes and seagrass ecosystems, which tend to be incidentally damaged during extraction of related resources such as fish.

IMPACTS

The greatest impact of the decline of these habitats is a loss of their nursery function with an associated reduction in fish catches. Other negative effects include a decrease in estuarine biodiversity, shoreline protection and the amount of organic carbon exported to the marine environment (Rajkaran 2011). Impacts on human well-being associated with the loss of these ecosystem goods and services include food insecurity and the loss of livelihoods.

RESPONSES

Mangroves

Background information on mangrove management in most WIO countries is provided by de Lacerda (2001). Basically, there is no legislation specific to mangrove management in almost all countries in the WIO. Mangrove management is instead included in other legislation and often more than one instrument and/or institution is involved.

In Kenya, Tanzania, Mozambique, South Africa and Madagascar, the management of mangroves is included in the management of terrestrial forests. In Kenya, the Forest Act of 2005 oversees the management of mangroves, while the Forest Act of 2002 (on the Tanzanian mainland) and the Forest Resources Management and Conservation Act of 1996 (on Zanzibar) are responsible for the management of mangroves in Tanzania. In Mozambique, a range of legislation governs mangrove management, including the Law of Forests and Wildlife of 1999, Land Law of 1997, Environmental Law and Tourism Law. In South Africa, the National Forests Act (No 84 of 1998), which controls the management of forestry in the country, also covers the management of mangroves. In addition, the Marine Living Resource Act (18 of 1998) covers the management of mangrove forests and associated biota (Rajkaran 2011). In Madagascar, the management of coastal plant resources is the responsibility of the Ministry of Environment and Forests, and the Ministry of Fisheries and Marine Resources (Andriamalala 2007).

In Seychelles, mangrove management is covered by the Environment Protection Act, EPA 1994, which deals with water bodies in general. The Seychelles National Wetland Policy also contributes to mangrove management. In Mauritius mangrove management is catered for by the Fisheries and Marine Resources Act of 1998 as well as the National Environment Policy (NEP) 2007. In the Comoros, an Environmental Action Plan governs the management of mangroves. Coastal and marine environmental governance in Somalia is generally very weak due to the absence of a strong central government. Specific policies and legislation to address environmental issues are generally lacking (ASCLME 2012c).

A mangrove management plan is vital for the successful conservation of mangroves. Most countries in the region (except Tanzania) do not have mangrove management plans. A mangrove management plan for Zanzibar was prepared in 2008-2009. The one for the Tanzania mainland was developed in 1991 and, although it was the first mangrove management plan within the region, the plan is now outdated and requires revision to include new and emerging issues in the sector.

While, in some countries (eg Kenya and Tanzania), mangroves have been declared forest reserves since the colonial era, mangrove forests are also included in protected areas in many countries within the WIO. The total mangrove area in these protected areas is, however, often small. The designation of areas containing mangroves as Ramsar Sites eg Port Launay in Seychelles (Taylor and others, 2003) and Rufiji-Mafia-Kilwa in Tanzania has also contributed to mangrove protection in the WIO region.

Mangrove restoration is a common management initiative in all countries within the region. The significant increase in mangrove area coverage in Mauritius (about 167%), due to restoration provides an example of a successful initiative. Community participation is a key to the successful management of mangroves. NGOs and CBOs in the region are active and most take part in the management of mangroves, including mangrove restoration initiatives.

Saltmarshes

Most saltmarshes occur in estuaries and are consequently included in the management plans of estuaries required by the Integrated Coastal Management Act in South Africa. The South African National Water Act (Act 36 of 1998) necessitates the determination of the ecological reserve for estuaries before abstraction of freshwater. This is the amount of water required by an estuary to maintain its structure and function within a particular health class (Adams and others, 1992).

Seagrasses

There is no legislation in place within the WIO region to protect seagrass beds. However, seagrass beds are covered under legislation that protects fishery resources. Seagrasses are also protected in marine protected areas (MPAs), although no MPA has been designed solely for this purpose. Even within MPAs that incorporate seagrass beds they do not receive special attention; as a result only a small fraction of seagrass beds are included in MPAs (Green and Short 2003). An accelerating decline in the extent of seagrass beds in the WIO region calls for more research to generate information needed for their sustainable management in the WIO (Gullström and others, 2002).

POLICY OPTIONS

Mangrove and salt marsh degradation in the WIO continues despite present management initiatives. The situation is worse for seagrasses, which lack a clear management framework. The following policy options are therefore proposed:

- A mangrove management plan for each country.
- Habitat mapping that would involve the use of old and new techniques to establish the compatibility of resource use of these resources.
- Ecosystem monitoring.
- Habitat restoration and rehabilitation, if possible supported by restoration guidelines or manuals,
- Integrated coastal zone management to control pollution and sedimentation from catchment areas.
- Raised awareness regarding the importance of mangroves, salt marshes and seagrasses.
- Enforcement of laws and regulations pertaining to the conservation of these habitats.
- A full economic valuation of mangroves, salt marshes and seagrasses, incorporating the full range of their ecosys-

tem services to allow their appropriate inclusion in coastal development planning.

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