Appendix VI. Results of the National Scoping Exercise

MAC01 Water Quality Degradation

1.1. Alteration of natural river flow and changes in freshwater input and sediment load

Comoros: The islands have very variable drainage systems; there no permanent water systems in Grande Comore because of the high permeability of the soils, but there are complex and dense drainage systems on Anjouan, Mayotte and Moheli. There has been a reduction in quantity and quality of flow in these rivers and streams over the past two decades. This has resulted in difficulties in the provision of water for domestic uses and irrigation, hydroelectric generation and increased prevalence of water- and vector-borne diseases (as a result of stagnation) (Comoros MEDA, 2012).

Kenya: There are two major river systems, the Tana and Athi-Sabaki rivers, which drain into the Indian Ocean in the northern region of the Kenya coast, and numerous other small semi-perennial rivers draining into the Indian Ocean (Ramisi, Umba, Mwache, Mkurumuji, Rare and Kombeni). Modification of freshwater river flow and sediment transport budgets, have impacted creeks, deltas and estuaries and contributed towards the degradation of coastal habitats and coral reef associated ecosystems (Kenya MEDA, 2012).

Madagascar: There are numerous rivers and streams that flow into the sea on the east (Mananara and Mangoro, Maningory, and the Bemarivo, Ivondro and Mananjary) and west coast (Sambirano, Mahajamba, Betsiboka, Mania, south and north Mahavavy, Mangoky and Onilahy) (Madagascar MEDA, 2012). The largest river on the island is the Ikopa River, which crosses Antananarivo and feeds into Betsiboka River in the east. Flows in the Mandrare in the south, which is the driest part of the island, are intermittent. Flood flows of these rivers are usually very high because of the steep topography and sedimentation is common. In the Betsiboka estuary, huge quantities of reddish orange silt are transported and deposited in large quantities as the flow slows when the river meets the sea. Changes in sediment transport patterns have contributed towards both the modification of shorelines and silting of reef flats and mangrove forests (Bemiasa 2009, Madagascar MEDA, 2012).

Mauritius: On Mauritius there are 25 major river basins and 21 minor ones, whereas on Rodrigues there are 20 major river basins and 10 minor ones. Almost all rivers on both islands are perennial with most of the streams having their sources in the central higher areas. On both islands, base flow rates of these rivers are typically low due to low levels of infiltration, due to the low retention capacity of the soil and porous basaltic rock. Flows rates can however increase from a few litres per second to more than 500 m^3/s during floods. During floods sediments are carried out to a distance of over 5 km to sea.

Mozambique: There are 100 principal river basins and a number of international rivers (Rovuma, Zambezi, Save, Limpopo and Imcomati). River runoff has decreased and there has been modification of stream flow leading to freshwater shortage/reduction or excessive runoff and flooding in certain periods of the year. The rivers are the main source of sediments and dissolved inorganic nutrients in coastal zones. Shoreline stability in the estuaries and adjacent coast is mostly dependent on the input of sediments from rivers. Freshwater shortages and reduced river flows has led a reduction in sediment transport and resulted in coastal erosion.

Seychelles: There are several freshwater sources on Mahé (38 catchments), Praslin (11 catchments) and La Digue (8 catchments), and the catchments interconnect with numerous rivers and streams. The rivers are typically ephemeral with very few perennial ones. The islands steep topography and the low retention capacity of the soil means that stream are typically swift flowing, during the rainy season and low flow volumes during the drought season. Although rainfall is high (average 2,362mm/yr over the last 37 years), only a small percentage is retained (2%). Despite this river run-off and siltation of drainage systems has increased due to increased development (areas of hard standing and houses). The siltation of drainage systems has reduced their capacity and resulted in flooding in coastal areas during heavy rains. This situation is likely to worsen if rainfall increases with climate change (Seychelles MEDA, 2012).

Somalia: The country is semi arid but there are two major rivers contributing to perennial surface flow in southern Somalia: the Juba and the Shabelle, which originate from Ethiopian Highlands. The rest of the country is crossed by ephemeral streams, which remain dry for most of the year except during major rainfall events. About two-thirds of the Juba Shabelle catchments lie outside Somalia, mostly in Ethiopia, and part of the Juba catchment lies in northern Kenya. The Laag Dheera catchment is another transboundary catchment, three-quarters of which is in Kenya. This joins the Juba catchment in the lower reaches through a natural depression. In the central and northern regions of Somalia, there is very little surface runoff since most of rainwater either evaporates or infiltrates into the porous soil. Most of the other rivers only flow after flash floods during rainy seasons. Siltation of the rivers as a result of poor land use practices has led to the modification in the configuration of coastal habitats, shifting accretion and erosion patterns and associated ecosystems are changing (UNEP 2009).

South Africa: There are numerous rivers and estuaries that feed into the coast of South Africa. These rivers deliver large sediment loads to the coast. Modified river flows have however resulted in changes in estuarine mouth dynamics, with negative consequences for mangroves and salt marshes and fisheries. Increased sediment loads have also caused the estuaries to become shallower and have altered the characteristics of river mouths (South Africa MEDA, 2012).

Tanzania: The coastal region of Tanzania has several rivers that discharge into the Indian Ocean, with a drainage system which covers about 20% of the country. The Rufiji is the largest river, which contributes 50% of the total fresh water discharges to the sea. Other important rivers include the Ruvuma, the Wami, the Ruvu and the Pangani. Other rivers such as the Matandu, Mbwemkuru and Lukuledi are considered to be relatively less important in terms of freshwater discharges to the Indian Ocean. River flows have reduced over the years, and the quality of water has also reduced, with subsequent environment and socio-economic impacts including social conflicts in some regions (Tanzania MEDA, 2012).

1.2. Degradation of ground and surface water quality

Comoros: In Grande Comore, the total absence of surface water means that potable water comes from groundwater and cisterns. Groundwater is however being affected by salt water intrusion and at risk of pollution due to high soil porosity (Comoros MEDA, 2012). Other water sources are located in the mountains of the Grid and Mbadjini, while these have low water storage capacity, they provide good quality potable water. The crater lakes at high altitude fill with fresh water, but those located near the shores are contaminated with salt water. In Moheli, there has been groundwater depletion in the dry season (Comoros MEDA, 2012).

Kenya: There are various lakes found in the coastal region of Kenya include oxbow lakes such as Lake Bilisa and Lake Shakababo in the Tana Delta. Some of these lakes are threatened by heavy discharge of sediments from rivers draining into it, while others are relatively clean with low levels of pollution (Kenya MEDA, 2012).

Madagascar: Salinisation of soils is already one of the main problems encountered.

Somalia: Salinisation is a serious problem in the irrigated areas along the Jubba and Shabelle river valleys. Both rivers have high salt content even during periods of high flows (Markakis 1998), which limits the extent to which the waters can be used for irrigation. Changes in land-use patterns in the Ethiopian Highlands can interfere with the flow of the two rivers, which severely impacts Somalia. River embankments are used for agriculture which causes frequent flooding (FAO – SWALIM 2009). The major flood channels that the former Government used to maintain have also fallen into disrepair during the civil war increasing the possibility of flooding especially in the lower and middle Shabelle valleys (FAO – SWALIM 2009). People are also settling in flood prone areas due to increased population pressure. This is increasing the vulnerability of the local communities to flooding with high possibility for loss of life and property during flood events (FAO – SWALIM 2009). Little research has however been carried out on the hydrology of Jubba and Shebelle rivers and as such there is very limited data and information on the ground water aquifers.

Mauritius: Pollution of ground and surface water is a concern in Mauritius. There are five main groundwater basins in Mauritius, with coastal aquifers at the terminal part of the aquifers. The water table in the aquifers normally corresponds to the sea level, and coastal groundwater is normally brackish due to sea water intrusion. The extent of seawater intrusion depends on the structural context of coastal aquifers (Giorgi et al., 1999). In Rodrigues, there are also several aquifers and reservoirs, the volume of which has reduced over the years due to siltation. There is groundwater seepage around the islands as freshwater percolates through the volcanic rock into the sea (Mauritius MEDA 2012).

Mozambique: There is little information on the quality of surface and groundwater in Mozambique. There has however been an increase in the frequency of extreme events such as floods and droughts in Mozambique. Heavy rainfall in the central part of the country which is low-lying causes flooding (Mozambique MEDA 2012).

Seychelles: Rainfall is high (average 2,362mm/yr over the last 37 years), but only a small percentage is retained (2%), so the volume that seeps into groundwater aquifers and rivers and streams is generally low (Seychelles MEDA 2012). There are catchments that are exploited on each of the islands. Freshwater shortages are now a common issue. Sea-level rise is expected to result in saltwater intrusion in rivers, marshes and wetlands adversely affecting the habitats of certain species of fish; it would also impede the ability of coastal shellfish to relocate.

Somalia: While there are short streams which flow throughout the year due to subsurface flows and groundwater recharge, most freshwater in Somalia is obtained from boreholes or shallow wells which are often polluted due to bad water systems (Somalia MEDA 2012).

1.3. Degradation of coastal and marine water quality

1.3.1 Microbiological contamination from land-based (domestic, industrial, agriculture and livestock) and marine (mariculture, shipping) sources

Comoros: There is no sewerage, drainage or wastewater treatment in the Comoros (Comoros MEDA, 2012). Households typically use pit latrines which can leak and contaminate groundwater and coastal and marine environments. The entire rural population, more than two thirds of the population, relies on rain, surface and ground water supplies. No water quality monitoring and control mechanisms exist, and only a few occasional salinity tests are done. On some islands, such as Ngazidja, there is a massive risk of groundwater pollution by septic tanks and their seepage.

Kenya: Microbial water quality studies have now been completed in a number of locations (Mwangi 1997, Mwanguni 2002, UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009, Kenya MEDA 2012). In Mombasa, microbial pollution levels near urban centres were several orders of magnitude higher than in coastal waters in rural areas (Mwanguni 2002). Over 50% of all reported diseases in Kenya have been attributed to poor water quality associated with inadequate wastewater management, although the source of the microbial contamination, whether from drinking contaminated water or coastal recreational, was not always clear (Mwanguni 2002, Kenya MEDA 2012).

Madagascar: Studies conducted around Taolagnaro measured high *E. coli* counts (13300 counts/100 ml) in coastal waters. High counts of enterococci and total coliforms were reported from Mahajanga and Nosy Bé. The high levels of faecal contamination were attributed to defecation on the beaches as well as inappropriate treatment of municipal wastewater (Mong et al. 2009). Over a 5 year period (1993 and 1998) there were 18 cases of human illness caused by ingestion of contaminated seafood (Mong et al. 2009), which included illness resulting from eating marine turtles (seven cases), sharks (eight cases), fish (one case) and molluscs (two cases). WIO-LaB water and sediment quality monitoring surveys confirmed that microbial pollution is an ongoing problem in some Madagascan coastal areas (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Mauritius: At present, 73% of the households use cesspits or septic tanks whilst 2% use pit latrines; so most of the effluents are discharged directly to the sea or are carried to the sea by runoff and rivers with higher potential for microbial pollution, particularly after heavy rains (Mauritius MEDA 2012). Total and faecal coliforms are monitored monthly at public beaches at Flic en Flac, Albion, Pointe aux Sables, Trou aux Biches, Mon Choisy, Le Goulet, Grand Baie and Blue Bay (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009). The Ministry of Fisheries reported that waters at most beaches were within recommended guidelines for contact recreation in Mauritius in 2004 (counts of total coliforms < 1000 per 100 ml and faecal coliforms < 200 per 100 ml). Good water quality was confirmed by quarterly monitoring of waters in 2007 through the WIO-LaB project. The highest levels of faecal and total coliforms were recorded at Pointe aux Sables, near Port Louis, where the beach is closed to swimming (Dulymamode et al. 2006, UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Mozambique: There is only one sewage treatment plant in Mozambique, located in Maputo City, which treats about 50 % of the city's sewage (Mozambique MEDA 2012). Faecal coliform, faecal streptococci and *E. coli* were detected both in marine waters and shellfish tissues in Maputo Bay. Some places in Maputo Bay, particularly where the discharge of sewage takes place, such as Miramar at the entrance of the Maputo Estuary, are not safe for swimming. Faecal coliform counts in the water within the channel near the Infulene River were high (460,000 bacteria counts per 100 ml) and values exceeded 2,400 bacteria counts per 100 ml in the river mouth. The bacteria *Vibrio parahaemolyticus* and *V. mimicus* have been found in clams at the Incomati River mouth and near Matola in the Maputo estuary. *Vibrio* spp. is the cause of severe gastro-intestinal illnesses (Fernandes 1996). High levels of microbial pollution have also been found at Beira and Nacala Bays, although the concentrations are low as compared to those observed in Maputo Bay (Motta *et al*., 1998).

Seychelles: Coastal waters of Seychelles are generally good quality, except during the rainy season, when areas with significant river inflows have higher microbial quantities. Effluent from wastewater treatment plants discharged directly into the ocean was found to contain between 2000 and 5000 total coliform counts per 100 ml, far above the recommended standards of 500 per 100 ml (Antoine et al. 2008). During a monitoring survey conducted during 2007, high microbial counts were recorded at Beau Vallon Bay during the rainy season. These were mostly associated with runoff from non-point sources such as rivers and small streams (Antoine et al. 2008). Outbreaks of water- and insect-borne diseases usually occur during the rainy season and are mainly associated with defective on-site wastewater disposal systems (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Somalia: Only one part of Mogadishu has a sewerage system. All other towns and cities in Somalia typically use septic tanks as the most common mode of human waste disposal. Coastal municipalities also lack the capacity to treat wastes. Sewage and solid wastes containing organic materials, nutrients, suspended solids, parasitic worms and benign and pathogenic bacteria and viruses are discarded directly into the ocean (Somalia MEDA 2012).

South Africa: Since about 1985, the design of offshore sewage outfalls in South Africa has followed the receiving water quality objectives approach where effluent quantities and composition must be within limits that meet site-specific Environmental Quality Objectives, as recommended in the South African Water Quality Guidelines for Coastal Marine Waters (South Africa MEDA 2012). Long-term environmental monitoring programmes at these outfalls have indicated no detrimental impact related to chemical and microbiological contamination on the marine environment or its beneficial uses. There is however a rapid increase in discharges to less dynamic and sensitive areas such as surf zones and estuaries, where effluents from malfunctioning or overloaded treatment facilities are adversely affecting the marine environment and its beneficial use, albeit in a localised manner (RSA DWAF 2004a, b ,c). In Cape Town (South Africa) an extensive monitoring programme for microbiological contamination (using *E. coli* as an indicator organism) found that 80% of stations sampled complied with the South African guidelines for contact recreation. The stations that did not comply (*E. coli* exceeded 200 counts per 100ml in 80% of samples in one, and 2000 counts per 100 ml in 95% of samples in the other) were in highly developed and urbanised sections of the coastline (City of Cape Town 2005).

Tanzania: Raw sewage is directly released into estuaries and other coastal habitats and away from coastal towns. High counts of faecal coliform and total coliform bacteria of up to several thousand per ml of seawater were also recorded in Zanzibar, Tanzania (Mohammed 2001). High counts have prompted health concerns and warnings of health risks to swimmers, and some beaches on Zanzibar and the mainland in Dar es Salaam (e.g. Ocean Road and Banda beaches) have been closed for swimming and other recreational activities due to microbial contamination (Mohammed et al. 2008). WIO-LaB monitoring conducted in 2007 showed contamination of waters around Dar es Salaam as well as Stone Town.

1.3.2 Nutrient enrichment from land-based (domestic, industrial, agriculture, livestock) and marine (mariculture) sources

Comoros: The islands are situated in one the most prolific "upwelling" regions of the Western Indian Ocean which naturally enhances nutrient levels and drive strong bloom of phytoplankton. Nutrient patterns have yet to be determined in the waters around Comoros (Comoros MEDA 2012).

Kenya: Coastal waters in Kenya receive nutrient inputs from agricultural run-off (fertilizers), untreated waste water or sewage and from atmospheric sources from the burning of fossil fuels. Nutrient enrichment events have been reported to trigger massive algal blooms. Along the Kenya coast, studies have reported an increase growth of epiphytic algae on seagrass and the dominance of the green algae (*Ulva* and *Enteromorpha* sp.), and in areas adjacent to dense tourism developments epiphytic cover reached 60 % (Uku 1995, 2005, Uku and Björk,2005, UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009). This is a common impact of nutrient enrichment on seagrass beds which can lead to a phase-shift, as the algae smothers the blades of the seagrass, blocking the light necessary for the seagrass to photosynthesize, and ultimately resulting in mortality or a shift in species composition.

Madagascar: The rivers draining the Madagascan Highlands are important sources of nutrients brought to the coast, and some lagoons have variable but high concentrations of nutrients (ammonium, nitrate and nitrite) throughout the year (Lope 2009). Nutrient enrichment is due to the use of fertilizers in agriculture and accelerated soil erosion within the river basins due to deforestation (Mozambique MEDA 2012). Flooding of the Ifaho River in Madagascar results in a peak in nitrate concentrations, 200 - 400 times higher than the minimum values in the lagoons (Mozambique MEDA 2012). The periodic draining of wastewater ponds in fish farms in Madagascar is another source of nutrient enrichment as this water is rich in phosphates, nitrates and organic matters and may also contain pathogens, antibiotics and pesticides, and can cause eutrophication and harmful algal blooms (HABs) (Mozambique MEDA 2012).

Mauritius: Over use of fertilizers in agricultural practices (both intensive and small scale market gardening, and livestock rearing), poses a serious threat to coastal ecosystems and give rise to algal blooms and red tides. Mass fish mortality events have become quite common in recent years and this has been attributed to discharge of untreated effluents as well as pesticides and uncontrolled use of fertilizers from coastal agricultural activities. High nitrate concentrations introduced into lagoon systems through agricultural return flows have been associated with algal proliferation in the lagoons of Belle Mare/Palmar, and many hotels have had to remove algal deposits from the shoreline on a weekly basis (Dulymamode et al. 2002). At Flic en Flac, black anoxic sands, smelling of hydrogen sulphide, have been observed at the low water mark and are associated with organic enrichment from wastewater discharges (Prayag et al. 1995). High levels of nitrate and phosphate and associated proliferation of algal growth have been recorded at both Belle Mare and Flic en Flac (Prayag et al. 1995, Botte 2001). Nutrient enrichment of lagoon waters also results in increased algal growth over corals, affecting their biology and the coral reef ecosystem as a whole (Botte 2001). High concentrations of phosphates (relative to other WIO countries) were confirmed from sampling conducted as part of the WIO-LaB project (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Mozambique: The main sources of the dissolved inorganic nutrients in coastal zones of Mozambique are the rivers (Hoguane, 2007; Gammelsrød and Hoguane, 1987, 1996 and Sætre and Silva, 1979). The Sofala Bank, which is influenced by the discharges from the Zambezi, Pungué, Buzí and Save rivers, is one of the most productive shelf regions of Mozambique (Lutjeharms 2006, Barlow, 2007, 2008). However agricultural activities within the coastal region and in the hinterland areas also contribute contamination of the coastal and marine environment, through sediments and use of pesticides and fertilizers. High levels of BOD and COD, and low content of dissolved oxygen have been detected downstream of the factories and the presence of water hyacinth and *Pistia* is a clear evidence of nutrient rich water (Mozambique MEDA 2012).

Seychelles: The coastal waters of Seychelles are generally low in nutrients, with the exception of areas which receive significant inputs from food processing factories in the vicinity of Port Victoria (Seychelles MEDA 2012). In the rainy season, areas where there are significant river inflows influence the microbial quality and community structure in the coastal waters. Department of Environment (DoE) has a nutrient monitoring programme. There is however a significant gap with regards understanding the effects of rapid coastal and upland development on nutrient loading, including the implications for water quality and coastal habitats (see Littler et al., 1991; Grandcourt, 1995, Seychelles MEDA 2012).

Somalia: The coastal waters of Somalia are subject to intense upwelling during the south-west monsoon as the 'Southern Gyre' and 'Great Whirl' moves northwards up the coast. Nutrient enriched water brought to the surface with the upwelling, increases primary and secondary productivity and is the main driver in terms of the fisheries productivity along this coast. In addition to this the rivers also contribute large amounts of nutrients and fresh water (Ngasaru et al., 2004). Phosphorous and other nutrients are introduced to the ocean from the Juba and Shebelle rivers during the rainy season and phosphorous concentrations show a peak just after the start of the Southeast monsoon (Somalia MEDA 2012). Coastal municipalities lack the capacity to process wastes and human activities related to food and energy production have greatly increased the amount of nutrient pollution entering the marine environment, causing localised eutrophication of coastal waters and degradation of fisheries habitats. Increasing levels of fertilizers used along river courses also result in eutrophication of lower reaches and excess nutrients being released into the oceans (Somalia MEDA 2012).

South Africa: Riverine input of nutrients peaks in mid- to late austral summer, and is maximal in the north-east of the country (South Africa MEDA 2012). Estuaries act as nutrient-purifying systems, where nutrients from catchments are absorbed, resulting in cleaner water entering the sea. This is particularly evident during low flow periods (dry seasons) when river runoff entering the estuaries may have higher nutrients levels due to agricultural irrigation return flows. High nutrients levels in estuaries can also result from longer residence times during weak neap tides when tidal exchange is reduced (Taljaard et al. 2006). Urban estuaries on the KwaZulu-Natal coast are increasingly showing signs of excess nutrient and organic loading from surface drainage and, possibly, malfunctioning sewage reticulation systems. This has contributed to recent fish kills in several estuaries in the

Thekwini municipality and the Port of Durban (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Tanzania: Raw sewage is directly released into estuaries and other coastal habitats and away from coastal towns; nutrients also enter the marine environment as fertilizer run-off from areas of intensive farming through mouths of major rivers and streams (Tanzania MEDA 2012). In the Tanga area of Tanzania, macroalgae has proliferated due to nutrient loading from municipal wastewater and industrial discharges, particularly from a fertiliser factory (Munissi 1998). Munissi (2000) also demonstrated the association of *Ulva* spp. and *Enteromorpha* spp. with nutrient input from sewage pipes. In Zanzibar, the release of inorganic nutrients from domestic sewage has been identified as one of the main causes for a decrease in coralline algae which are sensitive to phosphate and are disappearing from phosphate-enriched areas (Björk et al. 1996, Tanzania MEDA 2012).

1.3.3 Chemical contamination (excluding oil spills) from land-based (domestic, industrial and agricultural) and marine (shipping, dumping at sea) sources

Comoros: Two types of Persistent Organic Pollutants (POPs) were reported in 2006: polychlorinated biphenyls (PCBs) and dioxins/furans. PCBs were used as heat exchange fluids and insulators (dielectric) in electrical transformers used by power companies. Although only 6% of transformers on Comoros had PCBs, 84 % were contaminated with PCB (National Implementation Plan of the Union of Comoros, PNM, 2004). Dioxins and furans are produced during incomplete combustion or some industrial processes. Over 77% of dioxins and furans emissions come from uncontrolled combustion processes, and on Comoros these originate primarily from the uncontrolled burning of household waste. The national contribution to the global emissions of dioxins and furans in 2006 amounted to 24.196 g TEC/year (PNM, 2004). No quantitative study has yet been made of persistent inorganic pollutants, but it is known that this pollution consists of plastic bags, batteries, electronic waste, glass, motor oil and metals that most often end up in the sea (UNEP/Nairobi Convention Secretariat, CSIR and WIOMSA, 2009).

Kenya: Some significant concentrations of pesticide residues have been reported in Kenya (Sabaki and Ramisi River) (Wandiga 2005; Wandiga et al., 2002) and from fish samples (Tana, Athi-Sabaki rivers and estuaries) (Lalah et al., 2003; Mugachia et al., 1992; Munga, 1985). Studies also found elevated levels of copper, cadmium, iron and zinc heavy metals (in Kilindini and Makupa Creeks Mombasa, Kenya) although the levels were substantially lower than those recorded in other polluted coastal areas (Kamau 2001). Monitoring of sediment concentrations of cadmium, copper, lead and zinc in the Sabaki estuary/Malindi Bay complex and Kilindini/Port Reitz Creek were found to be above recommended WIO guidelines (United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009).

Madagascar: Chemical contamination occurs due to industrial, agricultural, port and mining activities. Most pollutants are biodegradable but there are also persistent organic pollutants including highly toxic insecticides such as DDT and phenols from wood industries (Madagascar MEDA 2012). Effluents from the oil refinery at Toamasina and the shipyard at Antsiranana contain naphthenic pollutants, sulphides and thiophenols and pollutants from mining zones (mica, quartz, iron, chromium, and graphite) are made up of solid waste and sludge mineral suspensions (Madagascar MEDA 2012). WIO-Lab surveys found that sediment heavy metals concentrations were the highest reported for the WIO region (United Nations Environment Programme/Nairobi

Convention Secretariat and CSIR 2009). The highest levels were generally reported in closest proximity to sewage outfall points (Mong 2008).

Mauritius: Historically, steel mills, galvanizing, electroplating and battery factories, released their wastes directly into rivers (Grand River North West and St. Louis River) which empty into marine systems. Estuarine habitats such as Tombeau Bay and Poudre d'Or Estuary have been exposed to untreated industrial wastes since the 1980s (Ramessur 2002). Today chemical pollution in Mauritius arises from the use of pesticides and fertilizers, the textile industry and port activities. Heavy metals, particularly chromium (from textile industries), zinc and lead (from industrial effluent, sewage sludge and landfill leaches) are potentially problematic (Ramessur 2002). Despite this, coastal systems in Mauritius appear relatively unpolluted compared with more industrialised countries (Ramessur 2004, Anon Mauritius 2007). Heavy metals (copper, zinc, lead, cadmium, mercury) and the pesticides atrazine, diuron and hexazinone were not detected in water samples taken from the river mouths (Grand River North West, Pointe Roches Noires, Grand River South East, Mahebourg, l'Escalier, Baie du Cap, Tamarin and Rivière Lataniers), and chromium, lead and zinc in sediments were well below contamination levels quoted by Van Veen and Stortelder (1988, 24% clay and 10% organic matter) (United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009). There are however, indications of elevated levels of zinc and lead in urban estuaries, and this is cause for growing concern (Ramessur 2004, United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009).

Mozambique: Sources of pollution are land-based, particularly those associated with domestic and industrial waste from coastal cities and from the activities such as agriculture, industries, mining and operation in Ports. Most industries are concentrated around the coastal cities of such as Maputo, Matola and Beira. The industries discharge un- or undertreated effluents directly into the tidal channels or in coastal waters (Mozambique MEDA 2012). Heavy metals particularly lead have been found within the Port of Maputo, in the mouths of Matola and Maputo rivers and in Nacala Bay (Fernandes 1995, Anon Mozambique 2007). Agricultural activities within the coastal region also contribute towards chemical pollution through the use of pesticides and fertilizers. Pesticides found included 2,4,5-TCB, p,p'-DDT, p,p'-DDE, p,p'-DDD, lindane and HCB. Even though DDT is officially banned, it is still used in Mozambique and neighbouring countries (Massinga and Hatton 1997). While concentrations of DDT were found to be low, very high concentrations of HCH, likely from the use of the pesticide lindane, were recorded (Ogata et al. 2009, United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009).

Seychelles: Port Victoria in Seychelles has been affected by industrial pressure, especially with the fishing industry, the tuna canning factory and the loading, unloading and transhipment of goods (Seychelles MEDA 2012). Analysis of heavy metals in coastal sediments in Seychelles has however shown that concentrations are quite low, with the exception of chromium, copper, lead and zinc, specifically in Port Victoria (Radegonde, 2008). Similarly, agricultural activities in Seychelles are generally small scale, so pollution from pesticides and fertilizers are minimal. DTT was historically used as a pesticide, but POPs such as DDT and Aldrin were banned in Seychelles. Stockpiles of these chemicals were disposed of, but there is a possibility of leaching from landfill sites. The analysis of coastal sediments for chlorinated pesticides such as Aldrin, Lindane, Dieldrin, pp'- DDT and the breakdown products of DDT (pp'-DDD and pp'-DDE), has shown that the concentrations of these chemicals are very low in Seychelles (United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009).

Somalia: Fish factories, tanneries and slaughterhouses contribute to pollution of the marine environment in Somalia. Maritime activities also contribute to pollution through the release of (oil and ballast waters and) soluble PCBs (UNEP 2009). Noxious oils, organic and inorganic chemical wastes are also dumped into the sea on a regular basis and seepage from dump sites contain significant amounts of dissolved toxic metals and organic chemicals (Somalia MEDA 2012). The leachates from municipal waste disposal sites pose a serious pollution problem during the rainy season (UNEP 2009).

South Africa: Municipal and industrial wastewater discharges are regulated and licensed, and monitoring and assessment studies conducted in and around the offshore outfalls appear to indicate that these systems are helping to reduce the amount of contaminants entering marine waters (CSIR 2004, McClurg et al. 2007). Persistent organic and inorganic pollutants have however been measured in fish (e.g. Grobler et al. 1996), sharks (e.g. Watling et al. 1981), seals (e.g. Stewardson et al. 1999, Vetter et al. 1999), dolphins (e.g. Cockroft et al. 1991; de Kock et al. 1994, Vetter et al. 1999) and birds (e.g. Evans and Bouwman 2000) from South African coastal waters (South Africa MEDA 2012). Persistent organic pollutants have been found in the tissue of mussels collected near stormwater discharges and pose a potential human health risk (e.g. CSIR 2008a).

Tanzania: Alarming levels of PCBs were found in the Dar es Salaam harbour areas (Machiwa 1992 and Mwevura et al. 2002). Heavy metals such as lead (Pb), zinc (Zn), cadmium (Cd), chromium (Cr), mercury (Hg) and copper (Cu) have also been found in sediments samples and associated biota from waters within Dar es Salaam harbour and nearby coastal areas (Machiwa, 1992; Kondoro 1997; Muzuka, 1997). Concentrations were three-fold higher than in other areas. Monitoring conducted as part of the WIO-LaB project in 2007 found high concentrations of copper in sediments (United Nations Environment Programme/Nairobi Convention Secretariat and CSIR 2009).

1.3.4 Suspended solids in coastal waters due to human activities on land and in the coastal zone

Comoros: Erosion of the catchment areas, due to deforestation, has increased the sediment load entering coastal waters. This has led to sedimentation and siltation of the reefs, smothering the corals, especially on the reef flat. The high sediment influx into the lagoon coupled with the effects of global changes (ENSO 1994 and 1998), also resulted in the disappearance of *Thalassodendron ciliatum* seagrass beds (Comoros MEDA, 2012).

Kenya: Increased discharge of sediment loads in Malindi Bay (GOK 2008) affected the coral reefs in the Malindi National Park and Reserve (McClanahan and Obura 1997, Kazungu *et al.* 2002, Kitheka et al. 2003a) and resulted in a decrease in the number of seagrass species, from four to two species (Wakibia 1995). Poor land use practices and an increase in development activities in the Athi-Sabaki River Basin resulted in higher sediment fluxes and a reduction in the depth of the photic zone and productivity in coastal water. High sediment loads in the Athi-Sabaki and Tana estuaries have led to very high turbidity of waters in Ungwana Bay (Kitheka et al. 2003a, b, Kitheka et al. 2005). Sedimentation has resulted in significant impacts on mangrove areas, smothering the root systems of trees and causing die-back of these forests (Kitheka, et al. 2005). Heavy sedimentation in Mwache Estuary has also led to degradation of a large expanse of mangrove forest located in the estuary

(Kitheka et al. 2003b). Sediment deposition and beach accretion (e.g. in Malindi Bay) have resulted in the loss of beach frontage from some hotel and resort developments in Kenya, with a consequent loss of tourism revenue and employment (Kazungu et al. 2002, Kitheka et al. 2003a, b). The Port of Mombasa requires regular dredging of the navigational channel to maintain the depth required for shipping activities contributing further to high loads of suspended solids (Kazungu et al. 2002).

Madagascar: Sediment loads from river catchments are recognised as a major concern. The major source of suspended solids originates from the Ifaho River, and particle charge and turbidity decrease depending on the distance from the mouth. Discharge of suspended solids from the Toliara Water Basin has been estimated at approximately 6 million tons per year (Musyoki and Mwandotto 1999 cited in Payet and Obura 2004). Sedimentation has resulted in significant impact on mangrove areas, smothering the root systems of trees and causing die-back of these forests (Mong et al. 2009). Mining activities also contribute to an increase in suspended solids through the discharge of sludge mineral suspensions (Anonymous 2003).

Mauritius: Coastal waters around Mauritius are normally crystal clear apart from during heavy rains when river flooding is a common occurrence. Large amounts of debris and soil are discharged into the lagoons leading to seawater turning from blue to red brown (Mauritius MEDA 2012). High sedimentation and associated high turbidity have also been reported in the lagoon at Rodrigues, some of the bays are silted and channels have been constructed to facilitate the movement of boats (Mauritius MEDA 2012).

Mozambique: The excessive inflow of sediments in the coastal and marine environments of Mozambique is due to bad land-use practices which, among others, include poor farming practices and deforestation in the coastal and hinterland areas. Shoreline stability in the estuaries and adjacent coast is mostly dependent on the input of sediments from rivers. Given that sediment dynamics is governed by the river runoff, freshwater shortages lead to a sediment deficit, and coastal erosion. In Maputo and Beira harbour the siltation is further aggravated by the systematic dredging of the navigational channels (FAO 1999).

Seychelles: Construction and development activities in the upper regions of Seychelles have also resulted in disturbances of soil materials, which are deposited into the lower areas, where the flow of water slows down. This has resulted in excessive silting of the lower part of rivers occurs (Seychelles MEDA 2012).

Somalia: Poor farming practices upstream increase in the siltation of the rivers (UNEP 2009). Destruction of mangrove forests is also leading to heavy offshore siltation and alteration of nutrients pathways for offshore species. Municipal wastes containing organic materials and suspended solids and other contaminants are released directly into the sea as there is no capacity to treat wastes in the coastal municipalities. Mining and dredging also increase in siltation of the rivers in Somalia. Limestone mining of fossil coral reefs (beach rock) occurs in the south, in towns such as Marka and Barawe. The lime is used in house construction, whitewashing and decoration. The mining for limestone degrades the coastal landscape and leads to coastal inundation, sedimentation and erosion. The main threats to coral reefs and seagrass include smothering due to siltation (Somalia MEDA 2012).

South Africa: Sand mining activities in South Africa modify flows, produce high suspended solid loading and destruct riparian and in stream habitats (South Africa MEDA 2012).

Tanzania: Seagrass beds and coral reefs in Tanzania are threatened by various natural and human activities including excessive sedimentation, increasing turbidity and reducing light penetration and shoreline dynamics involving sand deposition and removal (Whitney et al. 2003, Wells et al., 2004, Tanzania MEDA 2012).

1.3.5 Solid wastes / marine debris (plastics etc.) from marine and land-based-sources

Comoros: Due to the lack of an effective waste collection, processing and disposal system the population indiscriminately dispose of their garbage along the road, in the sea along the coast, in a river or near their homes (Comoros MEDA 2012). This results in an accumulation of garbage and degradation of urban and coastal and marine habitats. With the rapid population growth, uncontrolled urbanization, household waste production, as well as other potentially more dangerous medical waste, will continue to increase. Uncontrolled open air waste incineration causes toxic fumes, which include dioxins and furans emissions and foul odours that in turn cause allergies and lung diseases. These conditions are unhealthy for the local communities and a deterrent for tourism (Comoros MEDA 2012).

Kenya: Dumping of solid wastes in Kenya occurs around urban areas and tourism centres (Kenya MEDA 2012). High population concentration along the coast is leading to increased generation of waste and waste management is a major challenge for most of the main urban coastal centres. Garbage collection services only cover only 50% of the population. Dumpsites are located and managed poorly. Municipalities do not have adequate budgets hence the available staff are poorly paid and not motivated to work, and garbage collection vehicles are not adequate. The private sector operates on a localised scale, while small-scale solid waste management groups lack means of transport. Solid waste on the public beach is now a major problem, even in areas where there are official waste bins (Kenya MEDA 2012).

Madagascar: There are inadequate collection systems and safe modes of disposal or litter treatment systems. Incinerators, treatment equipment are run-down and insufficient. There is a widespread use of traditional techniques/technologies such as garbage embankment fills, burial of hospital litter, open-air burning and open dumpsites. About 10% of household waste is disposed at authorised sites; while 40% goes to inadequately managed sites and 50–70% is illegally dumped. Mining activities also contribute to an increase in solid waste. There is concern that marine wastes such as plastic bags are a threat to turtles which feed on jellyfish (Hirama and Witherington 2006) and abandoned fishing gear such as cast nets can also trap and drown all species of turtles. Seabirds can also be affected by marine debris and can become be entangled in nets and other discarded fishing gear. Population pressure has increased the number of settlements in the vicinity of mangrove forests, and led to dumping of garbage and other waste into mangrove forests leading to their degradation (Madagascar MEDA 2012).

Mauritius: The waste disposal infrastructure is adequate and facilities exist for collection and disposal. Waste is collected and brought directly through the four transfer stations to a landfill site. Solid waste and marine litter in the marine environment does however need to be better addressed

(Mauritius MEDA 2012). Garbage from fishing boats is one of the main sources of pollution in Port Louis harbour waters (Mauritius MEDA 2012).

Mozambique: The municipalities do some waste removal, but this needs improvement (Mozambique MEDA 2012). Tourism operators and environmental non-governmental organisations do almost all of the beach clean-ups with limited support from the municipalities or government institutions. Efforts at the central level currently need to be directed towards the creation of and upgrading of waste reception facilities at the main ports (Mozambique MEDA 2012).

Seychelles: Over 90% of the solid waste stream is collected, treated and disposed of in an environmentally acceptable manner (Seychelles MEDA 2012). There are also regular and frequent cleaning programmes for all the rivers and beaches in the Seychelles, and also in the sea and yacht basin. On the outer islands, debris and marine litter from the sea is the main cause of pollution (Department of Environment 2009) and there have been various instances where marine debris has been swallowed by turtles or found entangled around the animals (Seychelles MEDA 2012).

Somalia: The expansion of urban areas has increased solid waste generation and dumping of garbage directly onto the sea shore. Due to lack of regulation, almost all the coastal cities and towns use the beaches as garbage dumping sites. Over the years, a huge volume of garbage has accumulated on the beaches, and plastics are a major concern on turtle beaches in Somalia (Somalia MEDA 2012).

South Africa: Port reception facilities are adequate in the commercial ports, but not in fishing and recreation harbours (South Africa MEDA 2012). On land, solid waste collection services and disposal sites are currently largely adequate, except for informal settlements. Compacting, landfill and incineration are used, but this is not sustainable and pressure is mounting to reduce the waste stream. Effective storm water screening devices have been developed and tested but not yet installed in most places (South Africa MEDA 2012).

Tanzania: There is insufficient equipment for the collection of waste, and for covering waste dumpsites (Tanzania MEDA 2012). All dumpsites are open, no treatment is done, and hence litter is easily blown by the wind and transported by water to stormwater drains and rivers and eventually into the ocean. Most recyclable items, such as plastic bottles, containers and bags, are scavenged from the waste collection points and dumpsites. Tourist hotels generate large quantities of solid wastes (Tanzania MEDA 2012).

1.3.6 Oil spills (drilling, exploitation, transport, processing, storage, shipping).

Comoros: Over 30% of the world's oil production passes the Comoros, representing more than 5000 tanker trips per year, and the risk of accidents increases during the cyclone season. To date, only one accident has occurred, when the *Taurus* boat caught fire in March 2007 near the port of Moroni with 60 tonnes of diesel on board. There have been smaller spills when ships empty their ballast water at sea, or during the transhipment of oil products in ports and oil depots (Comoros MEDA 2012).

Kenya: Kenya has a downstream oil industry, and East Africa’s only refinery, which produces 1.6 million tonnes annually in Mombasa. Spillage from the British tanker *Cavalier* caused considerable damage to mangrove forests in Mombasa in 1972. This coastline has since been subject to a further five severe spills, resulting in mangrove dieback, especially in Mida Creek where the effects of oil spills were still evident 10 years after the last oil spill incident (Abuodha and Kairo 2001). A spill in Makupa Creek during 1988 caused massive death of mangroves. Seagrass habitats have also been impacted (Abuodha and Kairo 2001). Dispersants commonly used to clean up oil spills contain toxic solvents which penetrate the protective waxy cuticles of seagrass blades. This affects the biological functioning of cellular membranes and chloroplasts, thereby causing plant loss and as well as harmful effects in other benthic biota (Ellison and Farnsworth 1996, Abuodha and Kairo 2001). Kenya has demarcated 17 blocks for petroleum rights negotiations, all offshore exploration is currently being undertaken by the private-sector. The current expansion of Kilindini Port and the development of Lamu as a free port bring increased risks of oil pollution and consequent impacts (Kenya MEDA 2012).

Mozambique: More than 16,000 tonnes of heavy fuel-oil were spilled by the *Katina P* tanker in 1992 threatening the coastal and marine ecosystems, and extensive areas of mangrove forest near Maputo were destroyed (Munga 1993). The port of Beira has the largest petroleum refinery (with a capacity of nearly 110,000 m^3) and a pipeline which pumps 1 to 1.5 million tons of petroleum to Zimbabwe every year. There are more ports in the country with oil storage facilities from or to which oil is pumped with associate risks for oil spills during the course of the operation. The prevailing winds (South-easterly trade winds) make the Mozambican coast vulnerable to spills in the Mozambique Channel, as evidenced during the *Katina-P* oil spill in 1992 near Maputo Bay (Massinga and Hatton 1997, Mozambique MEDA 2012).

Seychelles: There has not been a major oil spill reported in the Seychelles and, although there are incidents or minor spills, understanding of diffuse and non-point sources in the marine environment is limited (Seychelles MEDA 2012). The downstream oil sector is a vital component of the Seychelles economy, with fuel and liquefied petroleum gas accounting for over 25% of total imports in the country. Oil sector activities include importation and distribution of refined oil and liquid petroleum gas, storage and marketing of petroleum products, marine bunkering, aviation refuelling, bulk storage and transhipment and transportation of petroleum products by tankers. Oil exploration efforts commenced in 1969, but significant reserves have yet to be discovered. The government of Seychelles is keen to encourage foreign oil companies to partake in further hydrocarbon exploration survey through the Petroleum Mining Act of 1976 (Seychelles Investment Bureau 2009). The potential side-effects of offshore oil exploration, particularly on marine ecosystems have also been highlighted as a threat in the future (Seychelles MEDA 2012).

Somalia: In the vicinity of coastal cities, municipal waste, noxious oils, organic and inorganic chemical wastes is dumped into the sea on a regular basis. Maritime activities also contribute to pollution through the release of oil and ballast waters and soluble PCBs from these products (UNEP 2009). The coast has not yet been subject to extensive oil and gas exploration and several areas with world-class potential remain to be tested. Prior to the onset of the civil war in December of 1990, several concessions were held by major international petroleum companies and at least three key wells were scheduled to be drilled. Some large multinational oil companies were interested in exploring different sedimentary basins of Somalia. However, due to political instability and war, no further work in this area has been done despite the high potential for discovery of deposits (Somalia MEDA 2012).

South Africa: There have already been a number of spills in South African waters. The *Kapodistrias* ran aground off Cape Recife, Eastern Cape in 1985 (Randall and Randall 1986) and at least 137 penguins died from oiling and 1,043 oiled penguins were rescued for rehabilitation. After the *Treasure* oil spill of 2000, more than 40,000 African penguins were caught for rehabilitation, relocation (to Cape Recife) or captive rearing during (Crawford et al. 2000). Oil and gas exploration commenced in 1967 and about 300 petroleum wells have been drilled (Broad et al. 2006) centred on the commercial oil fields of the Outeniqua Basin with the Transkei, Zululand and Durban Basins receiving considerably less attention. The petroleum industry contributes 2% to GDP. The country produces 35,000 bbl/d of oil, with proven reserves estimated to be 15 million barrels, and also produced 115 billion cubic feet of gas in 2008, with reserves estimated to be 320 billion cubic feet. South Africa also has Africa's second largest oil refinery system, comprised of four refineries and two synfuel plants producing 692,000 barrels per day (bbl/d) in 2008. Around 19 million tons of crude oil is imported into South Africa annually, while approximately 120 million tons pass South African coasts bound for world markets, hence there is a significant risk of an oil spill incident. Furthermore, the increase in shipping traffic due to the piracy taking place off the Somalia coast, and port expansions now pose a new concern (South Africa MEDA 2012).

Tanzania: An increase in oil operations (drilling, exploitation, transport, processing, storage, etc) in Tanzania is predicted to increase oil spill risks. Oil and gas production commenced recently in the Songo Songo archipelago, off the southern Rufiji delta, and Mnazi Bay, and both pose a threat to marine biodiversity due to general disturbance (e.g. pipe laying) and oil/gas leaks. Numerous companies are currently exploring potential oil reserves, and 13 offshore blocks are expected to be conceded in the near future. The old refinery in Dar es Salaam was closed in 1999, but this is still the centre for downstream activity, as it handles imports of liquid petroleum gas (LPG), stores oil products, receives gas from the 230 km pipeline connected to Songo Songo, supplies Burundi, Uganda, Rwanda and Eastern Conco and transports crude oil through a pipeline to the Indeni oil refinery in Zambia. There are also plans to construct a new oil refinery in Dar es Salaam, as well as upgrading of oil storage capacity in Dar es Salaam and increasing of capacity at the Songo Songo gas field, all of which should be conducive to growth in the sector. However there are concerns as the country has weak petroleum regulations, human capacity constraints, and an inconsistent EIA framework. Increases in oil operations, both upstream and downstream, will intensify the risk of spills and accidents (Tanzania MEDA 2012).

MAC02 Habitat and Community Modification

2.1. Shoreline change, due to modification, land reclamation and coastal erosion

Comoros: There are no official and reliable data sources on the extent of coastal erosion in the Comoros other than the observations (Comoros MEDA 2012).

Kenya: Shoreline changes (erosion and accretion) have occurred due to changes in sediment loads from rivers, increased wave climate and coastal development. Erosion as a result of sand and coral mining could also become problematic in Kenya if not attended to. Vulnerability assessments have been used as a tool to identify and map areas that need management attention against occurrences of floods, erosion and oil spill (Kenya MEDA 2012).

Madagascar: Coastal erosion is particularly noticeable at Morondava, Manakara and Mahajanga (Madagascar MEDA 2012). Morondava and neighbouring areas on the west coast have long been affected by high rates of coastal erosion, and breakwaters were constructed on the beach. In the cases of Manakara and Mahajanga, coastal erosion is a more recent phenomenon (Madagascar MEDA 2012). The east coast of Madagascar has also been affected, and the avenue bordering the beach of Toamasina city has been destroyed. Ports, cultural and historical sites located along the coast and tourist beaches are exposed to higher risks of loss due to coastal erosion (Tsangandrazana 2007). Coastal retreat due to wave erosion was estimated between 5.71 m and 6.54 m in 1997, and estimated to reach approximately 225 m by year 2100 (Madagascar MEDA 2012).

Mauritius: Enhanced coastal erosion due to human activities only become noticeable a few decades ago. Hard structures placed too near the shoreline gave rise to localized erosion. Seawalls built to contain the erosion gave rise to further erosion downstream and other protection measures were taken (Mauritius MEDA 2012). Cyclonic waves are however also a contributory factor responsible for removing large quantities of sand from the beach and lagoons (Mauritius MEDA 2012). Tropical cyclones will most likely become more intense and higher waves will be formed and as a consequence, coastal erosion will be enhanced. Coastal erosion also occurs due to waves, “raz de marée” (tidal surges) in the winter and transitional months, which can result in coastal flooding. Accelerated sea level rise has been recorded in Mauritius, Rodrigues and other islands in the West Indian Ocean (Ragoonaden 2006). This is a matter of serious concern in the event that the trend continues. Coastal erosion is expected to worsen threatening more coastal infrastructure and settlement (Mauritius MEDA 2012).

Mozambique: Coastal erosion is recognised as an important issue. More than 90 % of the coastline erosion is due to natural processes that occur as a consequence of tropical cyclones and sea level rise, resulting in retreat of the coastline (Mozambique MEDA 2012). The instability of the coastline in Mozambique is however thought to be due to the deposition of materials brought by rivers currents, as well as erosion due to the strong currents toward the mouths of the rivers especially during floods. The maximum erosion values occur in the southern border beach-dune system (Ponta do Ouro) due to disturbance of the dune systems from construction by the recent tourism activities in the region (Mozambique MEDA 2012).

Seychelles: Major reclamation works were carried out off the east coast of Mahé in Seychelles to meet flatland demands for additional development and urbanization (Bijoux et al. 2008, Seychelles MEDA 2012). These resulted in the loss of coral reefs and shoreline change. Coral rubble was used as fill during the reclamation, and this resulted in erosion on one side and accretion on the other, damage to the benthic habitat and altered the coastal and nearshore hydrodynamics (Pulfrich et al. 2006). Other contributory factors include changes in wind and wave patterns during the monsoons as well as unregulated coastal development. Synergistic interactions of spring tide and surges further exacerbate coastal erosion. The prevalence of coastal erosion is more likely to follow the existing trend and further escalate as a consequence of global and local natural and anthropogenic changes (Seychelles MEDA 2012).

Somalia: Most of the Somali coastline has been seriously affected by coastal erosion, especially in the eastern and southern regions (Somalia MEDA 2012). Coastal erosion is an issue of major concern in view of its impacts on valuable land, loss of vegetation in addition to destruction of infrastructural facilities and properties. Poor farming practices upstream cause an increase in the siltation of the rivers in addition to mining, urban development and dredging. As a consequence, the coastal configuration, accretion and erosion patterns and associated ecosystems are changing (UNEP 2009). Sand mining is very popular in all coastal towns and fishing villages. It is mixed with cement, coastal soil and gravel to make bricks. This destabilizes the coastal sand dunes, which already caused severe coastal erosion (Somalia MEDA 2012).

South Africa: Bridges and causeways for coastal roads and railway lines have disrupted estuarine floodplains in many areas, aggravating floods, increasing sedimentation and limiting seawater exchange, which has a range of ecological impacts including coastal erosion. The Durban harbour, Africa's busiest port, interrupted the natural northerly pattern of sediment drift and affected wave refraction, resulting in beach erosion to the north. Durban's beaches are therefore artificially maintained by a sand-pumping scheme that replenishes some 280,000 cubic metres of sand every year (South Africa MEDA 2012). The harbour development at Richards Bay has also interrupted the natural sediment drift pattern, causing sand to accumulate against the southern breakwater (South Africa MEDA 2012). It has also destroyed the dune-field where much of the northward-moving windblown sand would have naturally accumulated (South Africa MEDA 2012). Estuaries and rivers are exploited by a number of sand-winning operations.

Tanzania: The problem of shoreline changes, particularly coastal erosion has increasingly become one of the major issues of concern and has been a recurrent problem in many coastal areas, including the islands of Zanzibar (Tanzania MEDA 2012). Coastal erosion problems are mainly caused by wave action on the shoreline. Between 1981 and 2002, between 2.04 ha and 2.60 ha of the beach near Dar es Salaam were eroded by wave action (Makota et al. 2004). Recently, Almström and Larsson (2008) concluded wave generated longshore transport is the governing process for moving sediments along the Kunduchi beach area. Lwiza (1994) also recognised the influence of waves on coastal erosion in Tanzania (Tanzania MEDA 2012).

2.2. Disturbance, damage and loss of coastal, watershed and upland habitats

2.2.1. Disturbance, damage and loss of upland / watershed habitats (>10 m elevation)

Comoros: Due to the high population density (300 inhabitants/km²), the lack of land use planning and the land tenure policy, there is uncontrolled land clearing and deforestation for agricultural purposes, and logging. Deforestation has led to increased siltation and a reduction in groundwater supplies. To control deforestation, different projects have focussed on sustainable techniques for forest restoration and better agricultural practices have been undertaken. However, the migration of farmers between islands is increasing and necessitates the expansion of farming areas.

Kenya: Land use change has had significant impacts on the coastal and marine environment (UNEP/Nairobi Convention, 2010). Construction activities, poor agricultural practices and deforestation in the river basins have intensified habitat destruction and soil erosion resulting in high sediment load into the coastal water. This has the effect of reducing the depth of the photic zone thus limiting productivity of the marine ecosystems (Kenya MEDA 2012). Poor land use practices in the Athi- Sabaki River Basin for instance, has resulted in the increased discharge of huge volume of sediments in Malindi Bay with far reaching ecological and socio-economic consequences. Massive sedimentation interferes with growth of mangroves and also smothers coral reefs and sea-grass beds (GOK, 2008).

Madagascar: The destruction and burning of vegetation in the Highlands of Madagascar causes massive erosion and an estimated 40 to 50 million tons of topsoil are carried to the seas every year (Rabesandratana 1984). This results in hyper-sedimentation in coastal zones. For example, poor cultivation techniques used by rice growers along the river banks resulted in hypersedimentation around the Onilahy river mouth in the 1990s. The proliferation of invasive insects, leading in turn to the reduced variety of insects, following bush fires and deforestation, were considered to be factors which contributed to the high erosion rates (CNRE/CNRIT/IHSM 2000) (Madagascar MEDA, 2012).

Mauritius: Upland watershed habitats were drastically modified by the early settlers. The first settlers on Mauritius exploited the ebony forests and introduced alien species, which severely damaged the islands ecosystems and indigenous species through over- grazing and predation. Cheke (1987) described the ecological history of the Mascarene Islands, and documented deforestation and change in land use. On Mauritius, natural vegetation cover reduced to less than 1% of original cover, with most clearance having taken place between 1773 and 1835, and a similar pattern of change in natural vegetation occurred later on Rodrigues. On Reunion, however, the rugged volcanic topography preserved more of the natural vegetation. Sugar cultivation on Mauritius and Reunion began under French governance in the 1720s and this period was characterized by establishment of the agricultural economy and motivation to sustain and increase productivity of the land, using slave labour (Turner and Klaus 2005). Free-roaming livestock and poor agricultural practices continue on Rodrigues, contributing to degradation of terraces, increases soil erosion.

Seychelles: Early settlers caused considerable damage to the natural vegetation cover on some of the inner islands of the Seychelles. Since then due to both the inner islands' geomorphologic features (mountainous with coastal plateaus) and the protection plan (mountainous parts normally falling into National Parks), much of the development for local residences or rural expansions are taking place along the coast. The participants at the National CCA Meeting therefore identified this issue as 'Not Relevant'. The MEDA goes onto discuss how, this albeit, non urban and controlled expansion should still be taken into account for it could cause additional stress on the coastal areas if not monitored and controlled accordingly (Ministry of National Development 2009). Increases in urban development have been shown to cause an increase in the volume of water flowing into the lower drains, with the potential for coastal flooding. Furthermore the introduction of invasive plants also causes habitat modification in Seychelles. For example, populations of *Sterna fuscata* (Sooty Tern) have suffered declines due to the replacement of indigenous vegetation on the islands where they breed with copra plantations, for the coconut *Cocos nucifera* (Feare et al 1997).

Somalia: Floodplains are being urbanised as population pressure increases (FAO – SWALIM 2009). Heavy rains are intensifying catchment soil erosion and desertification is increasing due to increased frequency of extreme droughts (Somalia MEDA 2012).

South Africa: Land degradation and erosion in inland areas, associated with unsustainable intensive commercial land uses (i.e. forestry, sugarcane and livestock) and in the poverty-stricken communal areas, heavy grazing pressures and poor land use management practices, result in high levels of land degradation and erosion.

2.2.2. Disturbance, damage and loss of coastal forest habitats

Comoros: Poor agricultural and forestry practices such as burning, clearing of the forest, are an issue of concern (Comoros MEDA 2012).

Kenya: Coastal forests in Kenya cover 139,000 ha and important areas include Arabuko Sokoke, Diani, and the Shimba hills (Kenya MEDA 2012). These unique lowland tropical forests are known locally as Kayas. The Kaya forests are distributed in few remaining patches along the coast which have a high cultural significance to the local Mijikenda community who have traditionally used them for religious and spiritual rituals (Blackett, 1994). The sacred values associated with these forests have contributed to their conservation and growth of forest tourism in the coast region. However, cultural belief associated with the Kayas is progressively being eroded which is threatening the traditional management and conservation of these important indigenous forests. Coastal populations are highly dependent on forest resources for their daily needs (food, medicines, and general livelihoods). Degradation of coastal forests impacts upon these communities and the marine environment through clearing of buffer vegetation in environmentally sensitive areas close to shorelines, resulting in increased erosion and sedimentation (Kenya MEDA 2012).

Madagascar: Heavy dependence on subsistence agriculture, and particularly traditional tavy agriculture, has caused massive deforestation and threatens to continue to do so due to high poverty levels, rising population growth and limited non-agricultural income-generating opportunities. Madagascar has also lost much of its forests due to illicit logging and agriculture, which has had a serious impact on adjacent ecosystems. The degradation is particularly severe near Toliara, where forest land was largely eliminated. Continental forests along the coast are rapidly declining and as a result, and now mangroves are also being increasingly exploited for its timber and energy resources as a result (Madagascar MEDA).

Mauritius: Although there are still small pockets of forest (40 km^2) on Mauritius and Rodrigues, very little of the native forests remain. The first settlers on Mauritius exploited the ebony forests and introduced alien species, which severely damaged the islands ecosystems and indigenous species through over- grazing and predation (Turner and Klaus 2005). In Rodrigues, clearance by fires for agriculture and introduction of cattle began in the early 1800s and continued through the 1900s (Turner and Klaus 2005). Replantation work by the Mauritian Wildlife Foundation, has been attempting to re-introduce native species and improve forest cover. At the National CCA Meeting, participants identified this issue as 'Not relevant'.

Mozambique: The utilization of cropping, as well as firewood and charcoal production, to supply urban centres has resulted in extensive deforestation of coastal forests. The forestry sector is estimated to contribute between two and three percent to total GDP in Mozambique (Suich 2006). In excess of 70% of the value added of forestry and forestry products is thought to be accounted for by subsistence production with the remainder consisting of market fuelwood production, industrial roundwood and processed wood production (Suich 2006), only part which will be from activities within the coastal zone.

Seychelles: Much of the upper mountainous slopes of the inner Seychelles are protected. There are few land-based opportunities in Seychelles, thus, agriculture and forestry contributes far less economically than the more dominant tourism and fisheries sectors. Subsistence agriculture and forestry does however, contribute 6% to GDP and agriculture alone employed nearly 6% of the labour force in 1995. Traditional exports of cinnamon and copra have also recently been revived, as the government continues to provide incentives to the sector to increase productivity.

Somalia: The MEDA does not discuss coastal forests.

South Africa: The southern Cape has remnants of Afromontane forest, while the Eastern Cape has large areas of subtropical thicket. The high-lying interior is dominated by grasslands, while KwaZulu-Natal has lush subtropical forests interspersed with savannah, which also occurs in the far north of the country. Coastal habitats, including coastal forests, are vulnerable to the increasing pressure of increased population density and the associated development, mining, agriculture and afforestation, habitat fragmentation and alien plant invasion (South Africa MEDA, 2012).

Tanzania: Coastal forests are now recognised as a key resource under threat by the Government. Fuelwood and charcoal are the main sources of energy for most people in the coastal region of Tanzania. The lack of an alternative energy for cooking has resulted in unsustainable harvesting and imposed severe demands on forest resources. In addition there is a major threat posed by the demand for land for export oriented production, including bio-fuels, which without careful management, will be detrimental rather than being beneficial to coastal livelihoods. The promotion of participatory forest management by the government and international NGOs such as WWF have focused on the empowerment of local communities to manage their own resources. Likewise, alternative sources of income generation, such as beekeeping, honey production, and tree nursery management have highlighted potential substitutes in this sector (Tanzania MEDA 2012).

2.2.3. Disturbance, damage and loss of coastal habitats (beaches, dunes, coastal vegetation and flood plain habitats to 10 m elevation)

Comoros: Many natural beaches are currently degraded due to the removal of sand and dumping of garbage (Comoros MEDA 2012).

Kenya: The sand beaches of Kenya are a major tourist attraction. Other coastal habitats include fossil reef intertidal flats and as backshore raised reef limestone, forming cliffs which are 12- 15 m high, sand dunes, mud-flats, and rocky shores bordered by cliffs (Kenya MEDA 2012). In the last decade, there has been rapid and unmanaged transformation of the coast land with a consequent loss of critical coastal habitats. Most settlements, commercial developments and tourist beach hotels are found within a few hundred metres from the sea. This makes such developments vulnerable to sea-level rise (UNEP/FAO/PAP/CDA, 2000) but also contributes towards the degradation of these habitats. Other impacts include increased sediment loads from the major rivers have resulted in accretion of beaches in Malindi and Ungwana bays (GOK, 2008). Loss of bird habitats emanating from unsustainable human activities threatens the Kenyan avifauna and, populations of shorebirds and seabirds have undergone a general decline along the coast over the past decade.

Mozambique: The accelerated growth of the tourist industry along the coast promotes very high disturbance levels and represents a serious threat to the status of these habitats and the conservation of shore birds. Exploitation of littoral organisms by the local population, a very common activity along the Mozambican coast, also represents a potential threat to their conservation (Mozambique MEDA 2012).

Mauritius: Coastal habitats include sand beaches, rocky shores, and fossil reef beach rock. Most of the pristine coastal sites, often adjacent to expansive sand beaches, have been exploited and now hotel planners are examining areas less touched by the imprint of change. Urban developments in floodplains areas, which are actually below mean sea level (e.g. Flic en Flac), have created drainage problems. In Mauritius, cyclonic waves are responsible for removing large quantity of sand from the beach and lagoons. Mauritius also suggests that ocean acidification threatens coral reef growth around the island and may therefore reduce the supply of sand to the lagoon and beaches.

Madagascar: Coastal habitats include sandy beaches, coastal dune systems, pebble beaches and rocky outcrops. Climate change related intensification of winds could result in dune systems becoming more dynamic and significant, leading to the silting of back mangroves and shallow ecosystems such as lagoons and reef. Recent observations in the Southwest suggest that many ancient turtle nesting beaches identified by Rakotonirina (1989) are no longer in use. This reduction may be due to increased light disturbance due to the increased number of beach hotels, as the presence of lights on the beach can induce females to leave without laying eggs and affect new hatches, inducing them to approach the light instead of moving toward the horizon to the sea.

Seychelles: The most threatened habitats are found around the inner islands which are the most populated. Various development pressures along the coast, especially for tourism purposes are currently posing threats to diverse marine habitats. The inner islands' geomorphologic features (mountainous with coastal plateaus) and the protection plan (mountainous parts normally falling into National Parks), are such that the majority of the developments for local residences or rural expansions are taking place along the coast. This albeit, non urban and controlled expansion should still be taken into account for it could cause additional stress on the coastal areas if not monitored and controlled accordingly (Ministry of National Development 2009). Increases in urban development have been shown to cause an increase in the volume of water flowing into the lower drains, with the potential for coastal flooding.

Somalia: The expansion of urban development in the coastal zone and the expansion of the cities increase garbage dumping on the sea shore. Due to lack of environmental governance, almost all the coastal cities and towns use the beaches as rubbish dumping site. Sand mining is also very popular in all coastal towns and fishing villages in Somalia. It is mixed with cement, coastal soil and gravel to make bricks. This destabilizes the coastal sand dunes, which already caused severe coastal erosion.

South Africa: Coastal development in South Africa includes development activities such as infrastructure (harbours and launch sites, cities, towns, housing, roads and tourism), as well as dredging activities and the disposal of sediments. These developments pose a major threat to many components of the marine environment, owing to their cumulative effects, which are often not taken into account by impact assessments. Five types of mining are currently considered to threaten marine biodiversity: sand-winning; mining for titanium; diamonds; fossil fuels; and phosphate.

Tanzania: Coastal habitats found include sand beaches, intertidal mudflats and rocky cliffs and intertidal beach ridges and marine terraces. Beach ridges and marine terraces are among the most prominent backshore features along the coast of Tanzania. A wide variety of coastal birds and seabirds are found particularly in mangrove forests, intertidal flats and on rocky cliffs. Waders and shorebirds visit Tanzania in large numbers each year between August and May to feed on intertidal flats during low tides. 10 Important Bird Areas (IBAs) have been designated by Birdlife International along the coast of Tanzania. Loss of bird habitats emanating from unsustainable human activities threatens the existence of the Tanzanian avifauna, populations of shorebirds and seabirds have undergone a general decline along the coast over the past decade.

2.2.4. Disturbance, damage and loss of wetland habitats

Comoros: The participants at the National CCA Meetings identified this issue as being 'Not Relevant'.

Kenya: The largest and most important coastal wetlands in Kenya is the Tana Delta. The Tana River is the largest and longest river in Kenya (nearly 1,014 km long); the Delta covers about 130,000 ha and supports 100,000 people, consisting mostly of farmers, pastoralist & fishermen. The Tana Delta presents true features of a typical delta, characterised by several distributaries that discharges turbid water into Ungwana Bay. While there are some important coastal lakes, some of the oxbow lakes are also wetlands (e.g. Lake Mahe in Umba flood plain, and Ziwa la Chakamba and Ziwa la Ndovu in Tana flood plain see also Kitheka, 2002). The shores of both deltas and estuaries are characterized by the presence of mangrove forest ecosystem (Kokwaro, 1985). The Tana River volume has fallen by 20% in 10 years. The Kenya MEDA (2012) recognised that climate change and natural variability is already influencing rainfall patterns and the flow patterns of rivers, impacting on floodplains, deltas and coastal ecosystems and; that there was limited knowledge and information on the hydrological functions of coastal wetlands.

Madagascar: The west coast of Madagascar is particularly important for wetland birds. Coastal wetlands are being impacted by both human and natural factors (Madagascar MEDA 2012).

Mauritius: Mauritius has an extremely rich coastal zone consisting of near shore wetlands and mangroves, lagoon coral, fringing coral reef. The Rivulet Terre Rouge Bird Sanctuary in Mauritius is the largest estuarine delta covering about 26 hectares and is an important wintering ground and refuge for migratory birds escaping the rigorous winter months of the northern hemisphere.

Mozambique: There are four coastal regions identified which include the coral reef coast, the mangrove coast, the delta coast, and the parabolic sand dune coast. The second coastal habitat is dealt with under a separate issue (Mozambique MEDA 2012). The Mozambique MEDA does not however specifically discuss issues related to wetlands.

Seychelles: On the inner granitic islands the ever growing human population coupled with the tourism industry (Rocamora and Skerrett, 2001) leads to land clearing and drainage of wetlands for developments such as housing. This can be exacerbated by the additional threat from global warming and sea level rise which can particularly affect the outer low-lying coralline islands.

Somalia: Six main types of wetlands in Somalia have been described (Hughes and Hughes 1992): (i) Tidal wetlands in bays in the East of the country and in the Gulf of Aden where they form a continuous salt-marsh developed on sediment washed down from the Ogo Mountains. (ii) Wetlands of the Shabelle-Jubba Rivers, where the whole sub-coastal valley of the Shabelle is characterized by the presence of swamps with peripheral floodplains. The river divides into three channels and crosses a swamp which spans 25 km and stretches 150 km along the coast, covering an estimated 300,000 ha. Where the two rivers meet there is a floodplain after which they cross marshy land and drain into a mangrove fringed estuary at Jumba. (iii) Wetlands of the Lachs District: occur where temporary large water courses (*lachs*) drain into southern Somalia, and become floodplains during rainy seasons. (iv) Bullehs, Tugs and Dholos: A bulleh is a small endorheic depression filled by runoff after a storm; these have distinct soil types which retain moisture and as a result have richer vegetation than surrounding areas. Tugs are small temporary watercourses with low gradient, which flood and spread over a wide area causing broad alluvium deposits. Tugs often end in inland deltas which are known as dholos. (v) The Central Districts: where there are sink holes and a small lake. Several large pans also exist towards the coast, which seldom hold water and when they do it is only for a brief period. (vi) Artificial Impoundments: 240 reservoirs have been constructed to water livestock (Somalia MEDA 2012).

South Africa: Saltmarshes occur mainly in temperate areas, so in South Africa they are found in suitable estuarine habitat along the Cape's west coast, south coast and south-east coast. Further up the east coast, in the sub-tropical parts of the Wild Coast and KwaZulu-Natal, they are replaced by mangroves. True salt marshes are found in approximately 70 of the Cape's 155 estuaries, the most extensive in the ASCLME region being the 1,800 ha in the Knysna Lagoon on the south coast. Common species include the cordgrass *Spartina maritima*, the glasswort *Sarcocornia perennis* and the marsh samphire *Salicornia meyeriana*.

Tanzania: The Rufiji-Mafia-Kilwa Marine RAMSAR Site is located across the three named districts, within the coastal and Lindi regions of southeast Tanzania. It has an area of 596,908 ha (URT 2009). According to the Directory of Wetlands of International Importance, this site is a representative wetland of East Africa as it contains a large diversity of wetland types, which are ecologically interlinked, and includes the threatened estuarine, coastal and marine wetland habitats (Directory of Wetlands of International Importance 2004).

2.2.5. Disturbance, damage and loss of estuarine habitats

Comoros: During the National CCA Meetings, attendees identified this issue as 'Not Relevant'.

Kenya: One of the biggest estuaries is the Athi-Sabaki Estuary in Malindi; the distributaries within the Tana Delta such as Kipini and Mto Kilifi are also estuaries in their own right (Kitheka, et al., 2003). Other estuaries include those at the mouths of Mwache, Kombeni, Ramisi and Umba. The shores of estuaries are characterized by the presence of mangrove forest ecosystem (Kokwaro, 1985). Changes in land and water-use practices, poor agricultural practices, deforestation in the catchment areas, are leading to alteration of river freshwater flow and increased soil erosion, increasing sediment loads in creek, deltas and estuaries, causing the degradation of mangrove forests, coral reefs and seagrass beds. The Athi-Sabaki estuary is characterised by highly turbid water that limits primary productivity and resulted in accretion of beaches in Malindi and Ungwana bays (GOK, 2008). Fish samples in the Athi-Sabaki Rivers and estuaries have also been found to have residue concentrations of pesticides (Lalah et al., 2003; Mugachia et al., 1992; Munga, 1985). There is however limited monitoring of estuaries and a limited knowledge of the flora and fauna (Kenya MEDA 2012).

Madagascar: The most spectacular areas of shoreline change are due to sedimentation often observed in estuaries and mouths of major rivers. The Bay of Betsiboka is an example of an estuary with serious sedimentation problems. The river carries huge quantities of silt which is deposited in large quantities at the bay. In the Southwest, the same heavy sedimentation occurs at the mouth of the river Fiherenana, resulting in smothering of reef flats and mangrove forests (Bemiasa 2009). Gill nets and fish barriers are used across rivers and estuaries (Madagascar MEDA 2012).

Mauritius: Small estuaries and deltas are observed in a few places mainly at Grand River North West, Grande Riviére Noire in the west and Baie du Cap in the south. During the National CCA Meetings, attendees identified this issue as 'Not Relevant'.

Mozambique: The estuaries of big rivers such as the Zambezi, Púnguè, Buzi and Save are all in the central part of Mozambique. These provide important habitat for mangroves; the Zambezi delta mangroves extend 50km inland. These areas are also important fishing grounds, where small pelagic and demersal fish and crustaceans of estuarine waters are dominant. The semi-industrial prawn fishing areas are located along the navigation channels of Maputo Bay and in the estuaries of the Maputo and Nkomati rivers (at depth between 10 and 20 meters). Estuaries are often centres for development. For example, due to the low lying coastal plain, most of the ports (with exception to Pemba and Nacala) have been developed in shallow bays and estuaries and this poses a problem for handling large modern ocean-going vessels. The high costs of maintenance dredging are constraints in port development. There is a gap in the understanding of the coupled river basin and coastal systems, including the main drivers of ecological, hydrodynamics and morphodynamic changes in the estuaries (and coastal waters) and a gap in knowledge on the influence of nutrients inputs through rivers and rainfall in the biogeochemical processes in estuaries (and coastal waters).

Seychelles: During the National CCA Meetings, participants identified this issue as 'Not Relevant'.

Somalia: Where the Shabelle and Jumba rivers meet there is a floodplain, after which they cross marshy land and drain into a mangrove fringed estuary (Hughes and Hughes 1992). The Shebelle river mouth is one of the priority seascapes mentioned in the Eastern Africa Marine Ecoregion. The area has been proposed for protection as it is not only the most northern estuary in eastern Africa, but it is also the largest estuarine-offshore 'mud ecosystem' and the only permanent estuarine system in Somalia. Sea level rise could cause flooding of estuaries, placing most coastal cities at risk (Somalia MEDA 2012).

South Africa: South Africa's estuaries are relatively small and mean annual runoff for the country's rivers is variable. These characteristics, coupled with extreme environmental conditions, such as droughts, have led to a number of different definitions for South African estuaries (Day 1980; Heydorn 1989). Depending on the definition used, there are more than 258 systems with total coverage of 75 000 ha of which about 60 000 ha, more than 80%, occur in the ACMLE (Van Niekerk unpublished data). River inflow to the estuaries is determined by the different climatic conditions in different parts of the coast, as well as the size and shape of the catchment. Poorly regulated activities upstream have destroyed many estuarine habitats. These include infra-structural developments such as mouth stabilisation, low lying developments, canalisation, land reclamation, harbour development, pollution and dredging. The degradation of such intertidal estuarine habitats is particularly problematic for over-wintering Palaearctic migrant bird species and could result in a drastic reduction in the numbers and even extinction (South Africa MEDA 2012)

Tanzania: Rivers such as Pangani, Wami, Ruvu, Rufiji, Matandu, Mbemkuru, Lukuledi and Ruvuma all flow to the Indian Ocean. The mouths of most of these rivers are characterized by productive brackish water environments in estuaries, deltas and mangrove forests (Francis and Bryceson, 2001). Tidal inlets, estuaries and creeks are characteristically sites of urban and port development, for example Tanga and Dar es Salaam, which can lead to nutrient enrichment and other forms of pollution. Sand mining in estuaries also causes direct impacts resulting in loss of aesthetic value and ecosystem degradation, as well as secondary threats to the long-term sustainability of the coastal sand resource and stability. Increased economic activities and expanding populations in the growing coastal towns have resulted in production of large amount of waste, and raw domestic sewage and industrial effluents are directly released into the nearby estuaries (Tanzania MEDA 2012).

2.2.6. Disturbance, damage and loss of mangrove habitats

Comoros: Mangroves are found throughout the archipelago, covering an estimated 115 to 117 ha (FAO 2007), with more significant coverage on Mohéli (91 ha), with less on Grande Comoro (18 ha) and Anjouan (8 ha) (Comoros MEDA, 2012). There are 5 mangrove species known to occur, the most common of which are: *Sonneratia alba, Avicennia marina* and *Rhizophora mucronata*. The forests are mostly situated on the south side of the islands, due to exposure patterns and rainfall distribution. At the water's edge other species such as: *Pandanus sp, Hibiscus tillaceus, Ipomea pescaprae*, *Rhizophora mucronata*, *Bruguiera gymnorrhiza, Avicennia.sp.* and *Lumnizera sp.*

Kenya: Mangrove forests in Kenya are estimated to cover 50,000 ha (FAO 2007) with nine mangrove species that include *Rhizophora mucronata* and *Ceriops tagal* which are the dominant species represented in almost all mangrove formations (Kenya MEDA 2012). The rare species include *Heritiera littoralis* and *Xylocarpus moluccensis*. Mangroves have been impacted by human activities particularly through removal of wood products, conversion to other uses and pollution. Recent estimates suggest a 20% decline in mangrove cover over the last two decades (Kenya MEDA 2012), although this is higher than the 10% estimated loss from FAO (2007). Reduction in river flow has increased erosion of the delta mouth, and through increased salt-water intrusion, lead to a reduction of downstream habitats for mangroves and other species. Conversion of mangrove areas has also contributed to mangrove degradation in Kenya, for example more than 5000 ha of mangroves at Ungwana Bay have been cleared to pave way for solar salt works and aquaculture (Abuodha and Kairo, 2001).

Madagascar: Mangrove coverage is the second highest after Mozambique: estimates range from 278,078 ha (Giri et al., 2011) to 300,000 to 400,000 ha (FAO 2007, Mozambique MEDA 2007). There are reportedly 8 (9) species found including: *Acrostichum aureum, Avicennia marina, Ceriops tagal, Heritiera littoralis, Lumnitzera racemosa, Rhizophora mucronata, Sonneratia alba* and *Xylocarpus granatum* (and possibly *Bruguiera gymnorrhiza*) (FAO 2007). Mangrove resources were traditionally used for timber for house and boat construction, in traditional medicine against stomach ulcers, for the collection of crabs and fish and for firewood. Rapid population growth in coastal areas has resulted in increased exploitation for urban fuelwood, charcoal and timber. Fishing in mangroves is mainly artisanal but fishing companies operating in the northern areas tend to be industrial and shrimp aquaculture in mangrove areas is being encouraged in certain areas. Increased sediment loads, due to deforestation upland and changes in rainfall patterns is resulting in hypersedimentation and smothering of mangroves. Sedimentation at the mouth of the river Fiherenana, for example, is silting the nearby mangrove. Overharvesting of the mangrove crab *Scylla serrata,* is common in the mangrove areas near coastal cities, while more remote areas still support fishable stocks.

Mauritius: Mauritius only hosts two species of mangrove, namely *Rhizopora mucronata* and *Bruguiera gymnorhiza,* and as such is the most species poor country in the ASCLMEs. The mangroves form a narrow fringe, and the extent of mangrove cover around the islands has significantly decreased (2000 ha in 1987 to 1400 ha in 1994) due to overcutting for firewood, construction purposes and for clearing boat passages. The figures reported in the MEDA are an order of magnitude larger than those reported by FAO (2007) which reported a coverage of 45 ha in 1980 and 120 ha in 2005. Furthermore, the total area of mangrove cover in Mauritius is now reported to be 23 ha (Mauritius MEDA 2012). In response to the decline in mangrove habitat, the Fisheries and Marine Resources Act of 1998, makes provision for the protection and the conservation of mangroves. A Mangrove Propagation Programme was initiated in 1995, with an objective of restoring denuded areas with mangroves. Since 1995, a total of 214,800 of mangrove seedlings were planted in an area of 12.95 ha, with an overall survival rate of 78 % (Mauritius MEDA 2012).

Mozambique: Mangroves occur along almost the entire coast of Mozambique mostly in sheltered shorelines and estuaries, covering an estimated 396,080 ha (Barbosa et al., 2001) to 390,200 (FAO 2007), which is the largest area coverage for all the countries in the region. Mozambique also hosts the highest species richness, with a total 10 species of mangrove, including *Bruguiera cylindrica,* which is only found in Mozambique. Mangroves are being depleted at a rate of 4 % (Mozambique MEDA, 2012). The growth of population in coastal regions, associated with the developing tourism has increased the depletion rate and between 12,300 ha (FAO 2007) and 15,000 ha (Mozambique MEDA 2012) has been degraded across 7 provinces. The northern sector has numerous islands (mainly Quirimbas archipelago) which help to provide protection to mangroves. The mangroves of Zambezi delta extend 50 km inland. This mangrove zone is continuous from the south up to Quelimane covering close to 180 km of coastline. This zone is one of the largest extents of mangrove forests in Africa representing close to 50 % of Mozambique mangroves (Barbosa et al., 2001). The southern sector has extensive mangroves in Morrumbene estuary, Inhambane bay, Maputo bay and Inhaca Island. Maputo bay with its four main rivers inlets in the bay is one of the major mangrove areas in southern Mozambique (Barbosa et al., 2001). Some of the major threats to mangroves in Mozambique include: uncontrolled exploitation for firewood, charcoal and pole production; clearance for agriculture and salt production; uncontrolled influx of people from mainland to the coast leading to increased overexploitation of mangroves and pollution. Degradation of mangroves is also caused by changes in river flow rates, and particularly by a reduction of freshwater flow to mangroves due to dam construction (Barbosa e*t al*., 2001).

Seychelles: Mangrove forests are found within the inner granitic and outer islands. They occupy a total surface area of 2,900 ha (Seychelles MEDA, 2012) to 2,500 (FAO 2007) and there are a total of eight species, namely *Rhizophora mucronata, Bruiguiera gymnorhiza, Ceriops tagal, Sonneratia alba, Lumnitzera racemosa, Avicennia marina, Xylocarpus granatum* and *Xylocarpus mulocuensis* (Seychelles MEDA, 2012). There is some discrepancy between this list and the species reported in FAO (2007), which lists 9 species, including *Pemphis acidula,* which is reported to only be found in the Seychelles, and *Acrostichum aureum* but which does not include *Xylcocarpus mulocuensis*. At Port Launay in Mahé, all eight species of mangroves are found in an area that has been designated a RAMSAR site. The Seychelles reported that on Curieuse there is a problem with insufficient sewage and waste water treatment which leads to pollution of the mangroves and the beaches.

Somalia: Mangroves are mainly found along the south-west coast although isolated pockets of *Avicennia marina* grow on the northern coast behind sand spits and along the Gulf of Aden (Carbone and Accordi 2000; Khalil 2004). Tree growth is reportedly restricted due to cold upwelling waters (Taylor *et al*., 2003), although salinity is also another factor known to stunt growth in some regions.

Coverage was reported to be 10,000 ha in 1975 (FAO 2007) and is currently estimated to be between 7300 ha, representing a loss of 2,200 ha. Somalia reported six mangrove species: *Avicennia marina, Bruguiera gymnorrhiza*, *Ceriops tagal*, *Lumnitzera racemosa, Rhizophora mucronata,* and *Sonneratia alba* (Somalia MEDA 2012). *B. gymnorrhiza*, *C. tagal*, *L. racemosa* and *R. mucronata* are common along the Indian Ocean coast, *Sonneratia alba* occurs in some estuaries in the south, and *Avicennia* and *Rhizophora* grow on intertidal flats facing the channels. FAO (2007) reported the presence of 8 species, including *Xylocarpus granatum* and *Ceriops somalensis*, the latter of which is an endemic species (although it is not entirely clear if these species are found on the Indian Ocean coast). Mangroves are found in the intertidal zone of the coast south of Kisimayo and extensive mangrove forests are found in the creeks of Istambul, Kudha and Burgavo and on the sheltered side of the barrier islands (Carbone and Accordi 2000). The Shebelle river mouth, which includes the area where the Juba and Shebelle meet, is one of the priority seascapes mentioned in the Eastern Africa Marine Ecoregion and should also be considered for protection as it is not only the most northern estuary in eastern Africa, but it is also the largest estuarine-offshore 'mud ecosystem' and the only permanent estuarine system in Somalia. In this area there is mangrove fringed estuary at Jumba (Hughes and Hughes 1992). There is systematic over-harvesting of mangrove wood for building, charcoal, firewood and trade purposes, as well as conversion of mangrove habitat for agricultural, residential use and salt and lime production. Destruction of mangrove forests is also leading to heavy offshore siltation and alteration of nutrients pathways for offshore species with concomitant reduction in fish catches. This is contributing towards the decline in artisanal fishery resources including the giant mangrove mud crab *Scylla serrata*.

South Africa: Mangroves occur in estuaries along the east coast of South Africa from Kosi Bay in the north to Nahoon River at East London. Two species, the Tagal mangrove *Ceriops tagal* and Kosi mangrove *Lumnitzera racemosa*, extend no further south than the Kosi system, while the red mangrove *Rhizophora mucronata* and black mangrove *Bruguiera gymnorrhiza* reach their limits on the Wild Coast, together with the mangrove associate *Acrostichum aureum*, a halophytic fern. The white mangrove *Avicennia marina* extends to East London (Steinke 1995). Mangroves cover some 2.20 km2, within the Kosi Bay system supporting the three most common South African species (*Avicennia marina, Brugueira gymnorrhiza* and *Rhizophora mucronata)* as well as two species at the southernmost limit of their distribution (*Ceriops tagal* and *Lumnitzera racemosa)*. Mangrove trees (white, red and black mangrove) are harvested for their wood, which is very durable. Mangrove cutting is considered a problem in many of the Wild Coast estuaries Mngazana, Mtata, Xora and Mntafufu (Sink et al. 2004). At Kosi Bay mangroves are harvested for building materials and for construction of fish traps, and there is some harvesting in Richards Bay.

Tanzania: Mangroves are found in various locations including the mouths characterized by the presence of deltas, estuaries and mangrove forests, covering an estimated 127,200 ha, the third largest coverage within the ASCLMEs. The Rufiji delta is home to the largest estuarine mangrove forest in East Africa, with an estimated surface area of 53,200 ha, it constitutes approximately 46% of total mangrove forest cover in Tanzania (Tanzania MEDA 2012). A total of 8 species of mangrove are found in mainland Tanzania (*Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Heritiera littoralis, Lumnitzera racemosa, Rhizophora mucronata, Sonneratia alba* and *Xylocarpus granatum*) and *Xylocarpus mulluccensis* occurs in Zanzibar (Ngusaru et al, 2001). This is contrary to FAO (2007) which only reported the presence of 5 species (*Acrostichum aureaum, Avicennia marina, Ceriops tagal, Lumnitzera racemosa and Rhizophora mucronata*). *Xylocarpus mulluccensis* is not a species reported to be found in the WIO. The mangrove ecosystem in Tanzania is under huge pressure due to high demand for mangrove products (firewood, charcoal, building and boat making), as well as commercial cutting and over harvesting, coral burning, lime production, salt making, clear-cutting for building sites, solar salt pans, clear cutting for construction and agriculture,), and for paddy farming and illegal harvesting (Shunula and Whittick, 1996; Francis et al., 2001; Sallema, 2003; Wagner, 2003). In the Rufiji delta, the mangrove forests have declined slightly from 49,799 ha in 1990 to 49,032 ha in 2000, in part due to flooding of Rufiji River (Wang et al. 2003). In Zanzibar, mangrove threats also include debarking of *Rhizophora* sp. for tannin production (Wells et al. 2004). The other main threats to the mangroves include coastal erosion and pollution. The use of DDT and other pesticides on rice farms and the construction of dams and major irrigation schemes upriver are also posing a threat to the mangroves (Semesi and Mzava, 1991).

2.3. Disturbance, damage and loss of subtidal benthic habitats

2.3.1. Disturbance, damage and loss of coral reef habitats

Comoros: Fringing reefs form a narrow platform without a lagoon. Coral cover is dominated by branching and tabular colonies (*Acropora, Pocillopora* and *Pavona* genera), massive colonies (*Favia* and *Porites* genera) as well as encrusting and foliaceous colonies (*Montipora* and *Turbinaria* genera). Reefs occupy about 60% of Grande Comoro's coast, 80% of the Anjouan coast and 100% of Mohéli's coast. The lack of a continental shelf has resulted in weak reef development around Grande Comoro. Currently, the status of the Comorian coral reefs is poor, consisting of 60% dead coral and 40% live coral. In some sites, the proportion of dead coral reaches between 80 and 90%. Repeated coral bleaching has been observed, probably due to seawater temperature. Other pressures include: the use of dynamite, uncontrolled anchoring, trampling, global warming observed in all oceans, fishing pressure, the dumping of garbage directly into the sea and terrigenous deposits linked to land erosion.

Kenya: The coral reefs of Kenya are estimated to cover 63,000 ha and host 220 coral species (GOK 2008). Dominant species in Kenya include *Porites lutea, Galaxea astreata*, and a broad diversity of species in the genera *Acropora, Pocillopora, Favia, Favites* and others (Hamilton and Brakel, 1984). The best reef development is found in the fringing reefs in the southern part of Kenya at Diani-Chale and Kisite- Mpunguti MPA. Reduced reef development in the northern part of the Kenya coast is attributed to the large areas of loose sediment and significant fresh water inputs from Tana and Athi-Sabaki rivers (Spalding, et al., 1997). Fringing reefs are also found off Lamu Archipelago and along many of the barrier islands to the north. Coral reefs support artisanal fishery dominated by local and migrant fishers. Currently it is estimated that over 10,000 fishermen are directly engaged in artisanal fishing in the Kenyan coast (Ochiewo, 2004). The landing from artisanal fisheries ranges from 5,000 - 8,000 tonnes per year which is about 95% of the total marine catch.

Madagascar: Coral reefs extend along the coast with an estimated surface area of 240,000 ha (Cook et al., 2000) and host approximately 323 species (McKenna et al., 2003), and 8 species of antipatharian (Pichon 1978, Vasseur 1981, Randriamanantsoa and Brand 2000). Coral reefs are currently under severe pressure due to overfishing, trampling, sedimentation, pollution, coral mining (for lime and coral blocks), coral harvesting for the jewellery trade, as well as cyclones and coral bleaching. The majority of most accessible coral reefs are already damaged (Maharavo, 2009) but there are a few areas with higher coral cover, usually in deeper waters (20 m). Trampling during collection of *Eucheuma* algae during low tides can have a large impact, with an estimated 36 persons per km^2 (Randriamanantsoa 1997). Silting of reef flats causes high mortality of species (Bemiasa 2009). Coral bleaching in 1998 had devastating effects in the south-west (Maharavo 2010). Overfishing is thought to cause an imbalance in the functioning of the reef ecosystem as a whole, for example when herbivores, that play an important role in controlling the proliferation of algae, are removed resulting in the smothering of corals with algae (Anonymous 2009). It is thought that simultaneous effects of ocean warming and overexploitation/physical damage will probably result in the gradual disappearance of many reef areas in Madagascar (Anonymous 2009).

Mauritius: There are five types of reef around Mauritius: fringing reefs, patch reefs, atolls, reef flats and barrier reefs. The 1998 coral bleaching event caused approximately 50% of the corals in Mauritius to bleach although mortality as a result of this event was not severe (Turner et al., 2000). In 2009 there was more extensive bleaching which resulted in extensive mortality of the corals around Mauritius (Pascal-Quod pers comm.; Bhaghooli and Sheppard 2012). Impacts on coral reefs include climate change and over-exploitation and destructive fishing practices, sedimentation, contamination from land-based sources and outbreaks of Crown-of-Thorns starfish (Turner and Klaus 2005).

Mozambique: The coastal fringing reef is only intercepted by large river outflows and is more extensive where the shelf broadens around islands. Fringing reefs extend from the northern coast and extend south to Mocambo Bay. From Moma southwards to the South African border, rocky reefs with scattered coral are extensive but at only few places are they attached to islands or the mainland. Most of them occur offshore at 3-30 m depth. The largest gap in coral distribution is in the Sofala Bank, with its widest shallow continental shelf and turbid waters associated with the discharge of Zambezi River. Inhaca Island is reported to be the southernmost coral reef of the African mainland, although coral communities extend southwards into South Africa. Mozambique corals are were subject to extensive coral bleaching due to an increase in temperature during the 1997-1998 El Nino (Schleyer *et al*., 1999, Motta *et al*., 2002). Other threats to reefs include coral mining (for house building), sedimentation, flooding, beach seining, fishing nets, trampling and more recently inappropriate development of the tourism industry. COTS outbreaks also occurred in 1995-1996 and extensive reef damage was found at Bazaruto (80%) and Inhambane (95-98%).

Seychelles: Coral reefs cover approximately 1,690 km^2 of which only 40 km^2 are found within the inner islands. The reefs around the inner islands are usually relatively narrow as compared to those found in the outer islands. The reefs can be classified into 2 main types: (i) granitic reefs, which consist of corals growing over large granite boulders, and (ii) carbonate reefs which are further divided into fringing reefs, atolls and platform reefs (Stoddart, 1984). The main threats to the reefs in the Seychelles are from climate related changes such as increases in sea water temperature. During the 1997/1998 event the degree of coral bleaching was highly variable with the inner islands being much more affected by the bleaching event than the outlying islands (Spencer et al. 2000; Turner et al. 2000). Live coral cover was reduced by 90% in the inner islands (Turner *et al.,* 2000). This warming also significantly affected reefs in the outer islands, although to a lesser extent (Spencer et al. 2000; Bijoux *et al.*, 2008). Other impacts include destructive fishing practices, coastal development activities, dredging and flat-land reclamation.

Somalia: Coral reefs are widely distributed along the Indian Ocean coastline between Adale and the Somalia-Kenya border and around the Bajuni Archipelago. Coral communities are well developed and consist of 27 genera and 63 species. The main threats to coral reefs are the use of destructive fishing practices, over-fishing, global warming, and smothering due to sedimentation and pollution. Limestone (coral reef) mining exists mainly in southern towns such as Marka and Barawe, where it is used for house building as well as for whitewashing and house decoration. The coral reefs of the northern coast east of Berbera suffered extensive coral bleaching, with some reefs suffering almost total mortality (Schleyer and Baldwin 1999).

South Africa: Coral reefs occur as far south as Cape St Lucia, while some of the southernmost corals in the world are found on the Aliwal Shoal. The main area of coral reefs occurs in the northern KwaZulu-Natal. North of the St Lucia estuary there are three major reef areas: the northern complex of relatively unexplored reefs off Kosi, the central complex just north of Sodwana Bay, and the southern complex of Red Sands Reef and Leadsman Shoal in the marine sanctuary between Cape Vidal and Sodwana Bay. The corals do not form their own reefs, but are Indo- Pacific species that have colonised a submerged outcrop from the late Pleistocene (Ramsay & Mason 1990). Corals were less affected by the 1998 bleaching event, however monitoring studies at Sodwana Bay during 2000 and 2001 showed that bleaching had increased from <1% in 1998 to 5-10% in 2002. Aliwal Shoal is subject to periodic turbidity due to riverine input (Schleyer 1995b) and discharges from the SAPPI-SAICCOR pipeline, which cause discoloured plumes of water to drift over the Shoal.

Tanzania: The use of destructive methods such as dynamite and seine nets poses a threat to coral reefs. Dynamite fishing in Tanzania has degraded the coral reefs to such an extent that only two of the eight coral reef sites recommended for marine parks in 1968 had intact coral reefs (Salm, 1983); the rest of the reefs have been reduced to rubble. Pollutants destroy sensitive ecosystems including coral reefs, and pollution is also one of the main threats to coral reefs in Tanzania. A great deal of damage to the intertidal and near shore areas is caused by ambulatory fishers collecting shells or octopus or algae. They trample the seabed, break corals and overturn rocks and stones. Significant coral bleaching was documented between March and September 1998 when live coral cover was reduced from 52% before bleaching to 27% after the event (Wells et al. 2004). Outbreaks of Crown-of-Thorns starfish (COTS) have also affected coral reefs in Tanzania.

2.3.2. Disturbance, damage and loss of seagrass habitats

Comoros: Relatively little is known about the distribution of seagrass beds within the Comoros. Being located less than 400 kilometers east of the coastline of Mozambique and sharing a similar climate, these islands are likely to support similar seagrass meadows to those of northern Mozambique.

Kenya - Seagrass beds cover a surface are of about 3360 ha, with the most important sites in the region between Lamu and Kiunga, Malindi, Mombasa, Gazi Bay (800 ha), and Mida Creek and Diane-Chale lagoon (450 ha) (Dahdouh-Guebas et al., 1999; Ochieng and Erftemeijer, 2003). Twelve species of seagrass are found, with the most common being *Thalassodendon ciliatum, Halodule wrightii* and *Halophila minor* (see Obura, 2001; Gulstrom et al., 2002). There has been significant loss of seagrass along the coast, which was largely due to increased sediment loading of rivers causes degradation of seagrass habitats through smothering. Another cause of seagrass loss is an increase in the abundance sea urchin populations. In Diane-Chale lagoon for instance, preliminary studies indicate that *T. ciliatum* beds experienced a loss of more than 50 % of cover. These degraded sites were also found to have a density of the sea urchin *Tripneustes gratilla* of more 37 individuals/m², while healthy sites had a density of 4 individuals/m² (Uku, 2006). The degradation of seagrass habitats also has implications for other species that are dependent on these habitats, such as dugong. Dugong populations have declined, and a herd of 500 individuals reported on the south coast in 1967 has been reduced to 8 in 1975, 10 in 1994 and only 6 individuals in 1996.

Madagascar: Little is known about the relative dominance of seagrass species though it is likely that in southwest Madagascar they are similar to the species from the limestone areas of Mozambique with most meadows being dominated by *Thalassodendron ciliatum* and *Thalassia hemprichii* (Bandeira and Gell, 2003). Seaweeds are also a common feature in intertidal and subtidal seagrass areas of Madagascar (Rabesandratana, 1996). Seagrass habitats are heavily used by fishers (beach seines, trampling for the collection of invertebrates shrimp trawling). Trawling, which is mainly practiced on the west, northwest and northeast coasts of Madagascar, can cause mechanical damage to seagrass beds.

Mauritius: Seagrass beds cover an estimated surface area of 55 ha and 649 ha respectively on Mauritius and Rodrigues (Turner and Klaus, 2005). The most abundant species in Mauritian lagoons is *Syringodium isoetifolium*, with other species present being *Thalassodendron ciliatum, Halophila ovalis, H. stipulacea, Halodule uninervis* and *Cymodocea serrulata* (Montaggioni and Faure, 1980; Database of Marine Organisms of Mauritius, 2007). Seagrass beds are found both as extensive beds of mixed species and monospecific stands constituting natural habitats for a diverse group of organisms in these lagoons. The Saya de Malha bank also supports extensive stands of seagrass (REF). Species which depend on seagrass, such as dugongs which were once common in the lagoons, are now extinct.

Mozambique: Seagrass beds are estimated to cover a total surface area of 439 km^2, 25 km^2 around Inhassoro and Bazaruto Island, 30 km^2 at Mecúfi-Pemba and 45 km^2 in the southern Quirimbas Archipelago (Bandeira and Gell, 2003). The largest seagrass beds occur at Fernão Veloso, Quirimbas and Inhaca-Ponta do Ouro (Bandeira and Gell, 2002). Pioneer species observed in Mozambique include *Halophila wrightii, H. ovalis* and *Cymodocea serrulata*. The first two species occur in exposed sandy areas close to the coastline (den Hartog, 1970), whereas *C. serrulata* is a pioneer species in silted channels (Bandeira, 2002). Seagrasses abound in the sandy and limestone areas of Mozambique with the three dominant mixed-seagrass communities on the sandy substrates of southern Mozambique comprised of *Thalassia hemprichii, Halodule wrightii, Zostera capensis*, *Thalassodendron ciliatum* and *C. serrulata* (Bandeira, 1995). In contrast, the seagrass communities of the more northerly limestone areas are quite different, with seagrasses tending to occur intermingled with seaweeds species (Bandeira and António, 1996). Macroalgae such as *Gracilaria salicornia, Halimeda* spp. and *Laurencia papillosa* occur mixed with *T. hemprichii*, and *Sargassum* spp. with *T. ciliatum* (Bandeira and Antonio, 1996; Bandeira, 2000). Elsewhere, *Zostera capensis* and *Halodule wrightii* also form mixed beds (Bandeira, 2000; Bandeira and Björk, 2001; Massingue and Bandeira, 2005). *Enhalus acoroides, Halophila stipulacea* and *H. minor* were only found in northern Mozambique. Sedimentation and degradation of seagrass beds due to farming practices and deforestation is also common in Mozambique (Wells et al. 2004). Dugong populations in Mozambique occur mainly in areas with mixed seagrass species in intertidal areas and subtidal seagrass species dominated by broad-leafed species such as *Thalassodendron ciliatum* (see Bandeira and Gell, 2003).

Seychelles: A total of 8 seagrass species occur in the Seychelles, typically mixed with more than 300 species of macroalgae. The total area covered is not known, but in general, *Cymodocea serrulata, Syringodium isoetifolium* and *Thalassia hemprichii* are dominant (Ingram and Dawson, 2001). The clear waters of Seychelles have supported the deepest known seagrass distribution within WIO, with *Thalassodendron ciliatum* occurring up to 33 meter depth (Titlyanov, 1995). The structure of the Aldabra Atoll differs considerably from some of the other island groups, since its coasts are built primarily of dead consolidated corals and are steeply undercut with overhangs. Four seagrass species (*T. ciliatum, T. hemprichii, H. uninervis* and *S. isoetifolium*) and 119 algal species occur both. However, Mahé Island supports the highest recorded seagrass diversity for the archipelago (seven species), with *C. rotundata* inhabiting a narrow band along the shore, which is then replaced by *T. ciliatum* occupying the entire area exposed at low waters. The clearing of seagrass beds is neither encouraged nor practiced extensively in the Seychelles. Exceptions have however been made for the removal of small patches of seagrasses to create bathing areas close to a few hotels.

Somalia: Seagrass beds are threatened by fishing methods such as beach seining and shallow water trawling as well as regular anchoring of boats, and drag nets threaten seagrass beds. Dugongs are threatened by seagrass damage from trawlers and seine nets.

South Africa: Seagrass beds are only found along the east coast of South Africa, where they cover about 7 km^2, with the largest concentration in the St. Lucia estuary of 1.81 km^2 (Colloty, 2000). *Zostera capensis* is the most widespread and one of the dominant seagrass species in the country, occurring mostly in estuaries from Kwazulu-Natal to Western Cape region. Other important seagrass habitats are around the rocky headlands of KwaZulu-Natal, where they are mostly dominated by *Thalassodendron ciliatum*, which is well adapted to rocky habitat, and found together with seaweeds (Barnabas, 1991). *Ruppia maritima* is the dominant species within estuaries, especially St Lucia (Short and Coles, 2003).

Tanzania: Major seagrass beds are found around Pemba, Unguja and Mafia Islands (Ochieng and Erftemeijer, 2001). One of the best described Chwaka Bay, Unguja Island, Zanzibar (de la Torre e Castro, 2000; Gultröm et al., 2006). Here, two types of seagrass habitats can be found: shallow beds in marine embayment, far away from coral reefs and adjacent to mangroves and mud flats, and shallow seagrass beds situated on the shallow continental shelf adjacent to coral reefs and far away from mangroves and mud flats (Dorenbosch *et al.*, 2006). Seagrasses are present in most places of the tidal zone, but are more abundant in the western part of the bay. There are about 11 species, the dominant include *T. hemprichii, E. accoroides* and *T. ciliatum* (de la Torre e Castro and Ronnback, 2004; Eklof *et al.*, 2005). Since 1990s, the island have become an important site for seaweed farming, which is being reportedly negatively affecting seagrass beds (de la Torre e Castro and Ronnback, 2004; Eklof et al., 2005).

2.3.3. Disturbance, damage and loss of macroalgal habitats

Comoros: Primary production during the monsoon is characterized by an increase in macroalgae such as *Turbinaria* and *Sargassum*, as well as phytoplankton and sea grass beds. Some common species of algae include *Gracillaria Jania, Lithothamnium, Padina, Ulva, Codium, Halimeda,* and *Porolithon*. There were no particular issues identified in the Comoros MEDA (2012).

Kenya: There were no particular issues identified in the Kenya MEDA (2012). There are however exotic marine species reported as occurring in Kenya which include the red algae *Acanthophora spicifera* and *Gracilaria salicornia*. The status of their invasiveness is however unknown.

Madagascar: The Mozambique MEDA (2012) does not discuss macroalgal communities. However there is mention of the exploitation of *Euchema* around Toliara. Large numbers of fishermen (150 000) have destroyed the corals due to trampling during collection of *Eucheuma* algae during low tides (Mozambique MEDA 2012).

Mauritius: Mauritius has a rich algal flora with floristic records dating back to 1875. The Mauritius herbarium has a collection of more than three hundred marine algae. Over 160 genera of marine algae have so far been identified in coastal waters. However species records do not reflect this diversity as only 36 species of algae have been identified from Mauritius and 104 species from Rodrigues. Some species of seaweeds commonly found in Mauritius are *Enteromorpha* sp., *Ulva* spp., *Sargassum* spp., *Caulerpa* spp. *Padina* spp. and *Halimeda* spp. There were no particular issues identified in the Mauritius MEDA (2012).

Mozambique: The Mozambique MEDA does not discuss macroalgal communities. There is however farming of exotic species (*Kappaphycus alvarezii* and *Eucheuma spinosum*), which were introduced from Zanzibar, Tanzania in the late 1990s (FAO 2006-2009). These species are farmed in Northern Mozambique (Cabo Delgado and Nampula Provinces) in shallow areas close to the shore. In 2008 the total production of seaweed was about 70 tonnes (INAQUA 2008). There were no particular issues identified in the Mozambique MEDA (2012).

Seychelles: The Seychelles MEDA (2012) does not discuss macroalgal communities or macroalgal habitats.

South Africa: Kelps are the largest and fastest-growing algae, and support a rich community of organisms. Four species occur in South Africa – sea bamboo *Ecklonia maxima*, spined kelp *Ecklonia radiata*, split-fan kelp *Laminaria pallida* and bladder kelp *Macrocystis angustifolia*. Of these, only the spined kelp is common in the ASCLME region, as the others occur west of Cape Agulhas. It is found in deep rock pools and gullies, and seldom forms solid stands. Although herbivores such as limpets, abalone and sea urchins are able to graze on kelp, most of the animals in kelp forests are filter-feeders such as mussels, which are in turn eaten by commercially valuable rock lobster. In South Africa, siltation as a result of poor catchment management causes smothering of benthic algal communities.

Tanzania: Several studies have been conducted on the impacts of heavy metal on flora and fauna in polluted habitats in Dar es Salaam coastal areas (Mwandya, 1996; Wekwe *et al.* 1989). The environmental impacts of Pb, Hg and Cd on calcification rates of the reef building calcareous algae *Amphipora tribulis* have been investigated in Dar es Salaam (Kangwe, 1999). Effluents from a fertilizer factory, municipal sewage and sisal decortications plants have enriched coastal waters causing proliferation of macroalgae in Tanga coastal waters (Munisi, 1999; Shilungushella, 1993).

2.3.4. Disturbance, damage and loss of soft sediment habitats

Kenya: The continental shelf is relatively narrow and sedimentary in nature, dominated by fine sands, silt and mud derived from terrigenous sources (Obura, 2001). Beyond the shelf, the seabed slopes away to depths in excess of 4,000 m (UNEP, 1998). The physical dragging of fishing nets, trawling for prawn and other species, can disturb these habitats as can dredging for shipping channels. The discharge of sediment laden low salinity water derived from the main estuaries and rivers also influences the quality of nearshore sediment environments. Sediments contaminated with POPs have been recorded in Makupa Creek, Port Reitz and Port Tudor although the distribution and persistence of POPs in the Kenyan environment has not been studied extensively.

Madagascar: Shrimp trawls in mud flats leads to the destruction of bottom micro-habitat, affecting ecological niches and therefore the diversity of fish communities and other species. Trawls have been used in Madagascar since 1967, and this has modified the majority of natural habitats and replaced them with muddy habitats that are poor in biodiversity and a decline in catches. The creation of closed areas is important in that it would allow assessment of the impacts of trawling.

Mauritius: Following a recognised increased in the severity of coastal erosion, the Government implemented a ban on sand mining in the lagoons, which came into force in October 2003. The abyssal benthic fauna of Mauritius is quite rich and its abundance and distribution follows similar pattern reported earlier from central Indian Ocean and other seas. Polychaetes show continuous distribution and are recorded at all depths. Impacts on soft sediment habitats include dredging.

Mozambique: The beach seine fishery and gillnet fishery are concentrated on sedimentary habitats, as are the shrimp trawling fisheries.

Seychelles: Dredging and reclamation in the marine environment has been and still is a controversial issue. A large part of Victoria is built on reclaimed land and there has been extensive reclamation since the early 1980s on the east coast of Mahé to create flat.

Somalia: There is little mention of soft sediment habitats in the Somalia MEDA (2012).

South Africa: Muddy areas of the continental shelf support sole fisheries and the shelf break on the west and southern Cape coasts support trawl and demersal longline fisheries targeting hake but with a bycatch that includes kingklip, monk, jacopever and angelfish. In other soft sediment habitats, local meiofauna is continuously affected by disturbances such as chemical pollution, dredging and landscape alterations resulting in changes in diversity patterns often accompanied by changes in abundance and biomass. Other impacts on sediment habitats include dredging. For example Durban's harbour is currently being deepened and the entrance widened (scheduled completion date was April 2010), and some 10 million cubic metres of rubble will be moved to a designated deep-water dump site offshore. There is also concern about the impact of trawling on soft sediment habitats and it is thought that all trawlable grounds on the west and south coast have already been damaged.

Tanzania: The information on sea bottom sediment composition, distribution and morphology is generally scarce apart from limited studies conducted in the Zanzibar channel and between Pangani and Wami rivers (Shaghude et al. 1998, Shaghude 2003, 2004a, 2004b). Dredging is a particular concern in Tanzania, where the predominant effect is the burial of the resident fauna.

2.3.5. Disturbance, damage and loss of deep water habitats (including sea mounts)

Madagascar: Exploratory fisheries surveys on shelf and slope in the 1970s and 1980s discovered >50 species (FAO 1998). A new industrial fishery was launched by a South African company using deepwater trawling techniques to catch alfonsino (*Beryx splendens*). This fishery was able to catch 7 tonnes with a single vessel within a period of several months. The fishing site included seamounts to the south of Madagascar (Centre de Surveillance des Pêches 2007). There is concern about the impact of the deepwater gear on these habitats (Madagascar MEDA 2012).

Mauritius: There is interest in the potential for exploiting deep water fisheries resources, which include the deep water shrimp with an estimated Mean Sustainable Yield (MSY) of 200 tonnes (Mauritius MEDA 2012).

South Africa: Shelf habitats include deep reefs, banks that support deepwater coral and sponge communities, and unconsolidated sediments of sand, gravel, mud and various intermediate and mixed sediments (Sink & Attwood 2008). The shelf break is a distinct habitat and is incised by submarine canyons. There are also several seamounts. The deep reefs are the habitat of many commercial linefish species including several endemic and threatened species. Rocky areas of the upper slope support rock lobster trap fisheries and muddy offshore banks on the east coast support a crustacean trawl fishery. Seamounts are productive habitats that support diverse fish communities that include valuable commercial species such as Orange Roughy. The demersal trawl fishery, which is the most valuable fishery, targets deep-water and shallow-water hake. Deepwater trawls targeting the newly found deepwater species have a unique set of biodiversity impacts and significant bycatch. Disposal of deepwater marine effluent and dredged spoils are monitored off the east coast, and although water, sediment and/or biological tissue in these waters is at times contaminated by various metals and persistent organic pollutants, the magnitude and spatial extent of this contamination is usually low and temporally variable (South Africa MEDA 2012).

Tanzania: Exploitation of deep-water lobsters (*Linuparus somniosus* and *Metanephrops andamanicus*) takes place in depths of 250 to 320 m in the southern end of the Zanzibar Channel. Tanzania has formed Deep Sea Authority (DSA), which is a corporate body with powers to regulate and control fishing activities in the country's Exclusive Economic Zone (EEZ) (Tanzania MEDA 2012).

2.4. Disturbance, damage and degradation of pelagic habitats (nearshore <30 m, neritic 30-200m and oceanic >200m depth)

Kenya: Noise pollution is reported to threaten marine mammals. It disrupts their orientation, feeding and communication ability, causing interference which may lead to strandings and physical damage to the ear of the animals if they are close to the source noise.

Madagascar: Noise pollution is a concern around major ports and specific activities producing underwater noise, particularly industrial shrimp trawling and by seismic and sonar studies undertaken by the oil industry. Sea turtles are sensitive to noise and in Madagascar, during seismic studies turtles were observed to flee 1 to 2 km from the noise source.

Seychelles: There is an increase in the amount of noise pollution in Seychelles associated with the increase in expeditions for oil exploration.

2.5. Increase in the occurrence of harmful or toxic algal blooms (HABs)

Comoros: The MEDA does not report incidents of Harmful or Toxic algal blooms.

Kenya: Coastal waters are increasingly being impacted by land-based pollutants, more specifically wastewater (Kenya MEDA 2012). This creates eutrophic conditions, which could promote HABs development and prolong the duration of their occurrence. A first extensive survey carried in Kenya reported a total of 24 species of potentially harmful microalgae. A bloom mostly comprising of *Gymnodinium sp*. was observed in the Kiunga National Marine Reserve in 2004 (IUCN, 2004). The bloom lasted for 10 days causing extensive marine life mortality due to hypoxic conditions that created dead zones (Kenya MEDA 2012).

Madagascar: There is a problem of intoxication from consumption of marine animals due to the proliferation of micro-organisms such as microalgae, bacteria, cyanobacteria or diatoms, mainly in the warm season (Madagascar MEDA 2012).

Mauritius: In 1990 the coastal waters and ecosystems of Port Louis (Mauritius) suffered from severe eutrophication as a result of nutrient-enriched runoff and sewage effluent, as did seagrass beds in Bain des Dames and Point Moyenne (Ramessur 2002). Domestic sewage released to coastal waters from urban areas and poorly planned housing developments on reclaimed wetlands can cause eutrophication/algal blooms that lead to the smothering of coral reefs. Algal blooms are observed annually at Trou aux Biches and isolated cases have been reported at Bain des Dames near Port Louis. Frequent discharge of pollution and nitrates from agriculture and coastal hotels give rise occasionally to algae bloom and red tides. Mauritius is an endemic region of fish toxicity, especially ciguatera, as a result of the presence of potentially toxic benthic dinoflagellates. Anthropogenic eutrophication and industrial development can trigger toxic algal blooms and this is a genuine concern. Introduction of new toxic species from ballast water is also a potential threat and the effect of global warming and associated effects on climate could cause an increase in coral bleaching and mortality thus contributing to favourable habitats for *G. toxicus.* The tourism industry could suffer in the event of an outbreak of ciguatera fish poisoning (Mauritius MEDA 2012).

Somalia: In January, 2002, a HAB occurred along the East African coast from Mogadishu in Somalia to Lamu in northern Kenya, associated with the strong, upwelling of the Somali current and an unusual strong NE wind (force 5-6) that may have blown it onshore. This bloom lasted for 10 days, with extensive fish mortalities during the first three days, and numerous fish and other marine animals, such as turtles being washed up on the beaches or found floating on the ocean surface (Somalia MEDA 2012)..

Tanzania: Several potentially harmful microalgae have so far been found to exist in Tanzanian coastal waters. They are distributed among three major microalgal groups: the cyanobacteria, mostly dominated by *Trichodesmium* spp; the dinoflagellates, dominated by both *Prorocentrum* spp. and *Gambierdiscus toxicus* and; the diatoms, mostly *Pseudonitzschia* spp. (Tanzania MEDA 2012).

2.6. Introduction of exotic non-native species, invasives and nuisance species

Comoros: Exotics and invasive species are found throughout the Comoros archipelago. There is no official list of invasive plants in the Comoros, although some of the introduced species are known. These include some fruits, spices and some fast growing multipurpose species. Other species were introduced as part of a reforestation and soil erosion control programme in the twentieth century, approximately two thirds of which are trees, the remainder being shrubs (e.g. *L. glutinosa*, *L. leucocephala*, *J. curcas*, *G. sepium*, *L. camara*, *C. hirta*, *Senna* sp.). *Acacia* sp. was introduced in the

1970s to control soil erosion have now become naturalized. New invasive or potentially invasive species have been reported. *Clidemia hirta* is probably a new invasive in Anjouan and Mayotte, with devastating effects widely visible on Grande Comore and Moheli. An estimated 16 tree species are highly invasive in the Comoros archipelago: *Acacia mangium*, *Acacia auriculauformis*, *Albizia lebbeck*, *Cinnamomum verum*, *Clidemia hirta*, *Gliricidia sepium*, *Jatropha curcas*, *Lantana camara*, *Leucaena leucocephala*, *Litsea glutinosa*, *Psidium guajava*, *Psidium cattleianum*, *Senna* sp. *Spathodea campanulata*, *Syzygium aromaticum,* and *Syzygium jambos*. Others are woody species of crops, mainly *S. obtusifolia*, *A. lebbeck*, *S. campanulata*, *P. cattleianum*, *L. glutinosa*, *L. camara* and *C. hirta*. They are typically competitive (e.g. *L. glutinosa* in the rainy season), and deeply rooted (e.g. *P. cattleianum*, *S. obtudsifolia*, *A. lebbeck*). Some herbaceous species are also difficult (e.g. *Hibiscus surratensis*, *Mimosa pudica*) or irritating (*Mucuna pruriens*).

Kenya: A recent study found 36 exotic species in Kenya (ISSG 2009) although only *V. cholera* is an invasive in Kenya. The ballast water handling facility at the Kenya Port Authority is not currently operational, posing a major risk of the introduction of new plankton communities. Some seabirds and coastal shorebirds suffer predation of eggs and chicks by introduced brown rats, *Rattus rattus*. Nuisance species such as COTS have also affected coral reefs in Kenya.

Madagascar: On the southwest reefs of Madagascar, *Turbinaria* became an invasive species following reef degradation due to the combination of overfishing and bleaching events (McClanahan et al. 2009). While the effects of this invasion have not been studied yet, the reduction of light might have negative effects on coral growth. Some seabirds and coastal shorebirds suffer predation of eggs and chicks by introduced brown rats, *Rattus rattus*. Jellyfish blooms also occur in Madagascar and the phenomenon is observed regularly in the region of Toliara during the warm season (P. Vasseur, pers. comm. 1992).

Mauritius: The transfer of alien species of zooplankton in ballast water from one country to another is an on-going problem. There are concerns that *Caulerpa taxifolia* forms dense monoculture beds within the lagoons that prevent the establishment of other seaweeds and excludes almost all marine life.

Mozambique: Exotic seaweeds are farmed in Northern Mozambique (Cabo Delgado and Nampula Provinces) in a system of poles installed in shallow areas close to the shore and this has the potential to cause the introduction of exotic species into the marine environment. During 1995-1996 there was an outbreak of the Crown-of-Thorns starfish (COTS) in Mozambique, which caused extensive reef damage at Bazaruto (80%) and Inhambane (95-98%);

Seychelles: introduced animals such as *Rattus* spp., *Felis catus, Tyto alba* and *Acridotheres tristis*, have caused severe reductions in breeding bird populations through the predation of eggs, chicks and adult birds (Rocamora and Skerrett 2001).

South Africa: 85 alien species have been reported in South Africa (Mead et al. in prep.). The threat from new alien species in the region remains high due to the high volume of shipping processed at Richards Bay and Durban harbours. An assessment of the impacts caused by ballast water in Mozambique has not yet been done, but the country possesses 3 big harbours where large vessels arrive and depart daily.

Tanzania: The Invasive Species Specialist Group (ISSG 2005) of the IUCN Species Survival Commission identified the following invasive species: *Musculista senhousia* (mollusc), *Salmo trutta* (fish), *Tilapia zillii* (fish), *Vibrio cholera* (micro-organism), *Acanthophora spicifera* (algae), *Gracilaria salicornia* (algae), *Tubastraea coccinea* (coral) and *Lutjanus kasmira* (fish). The Indian crow is known to be feeding ferociously on eggs of other bird species thus threatening indigenous populations and their continued existence. COTS outbreaks have also affected coral reefs in Tanzania.

MAC03: Declines in Living Marine Resources

3.1. Decline in populations of focal species

3.1.1. Decline in populations of other marine mammals (excluding whales and dolphins)

Comoros*:* Dugong meat is very popular in Comoros and they are a target species for the artisanal fishery. Mohéli Marine Park used to host a population of several hundred especially during the austral winter months when seagrass beds exhibit the fullest growth. Dugong populations have however declined and sightings are now rarer than before (WWF EAME, 2004; Muir & Kiszka, 2011, Comoros MEDA 2012).

Kenya: Dugong populations in Kenya have declined rapidly from a herd of 500 individuals reported on the south coast in 1967 to 8 in 1975 (Ligon 1976), 10 in 1994 and only 6 in 1996 (WWF EAME 2004; Wamukoya et al. 1996, 1997). The decline in this species was due to hunting and bycatch in gillnets. Currently, dugong are only present in very small numbers, mostly confined to the Tana delta area, the Lamu Archipelago and Kiunga (WWF EAME, 2004).

Mozambique: The largest remaining viable dugong population in eastern Africa is found in Bazaruto Bay, and this population is now considered to be declining (Muir et al. 2004). Recent aerial surveys conducted between April 2006 and December 2007, estimated 247 animals (Cockcroft *et al*., 2008; Findlay *et al* 2011). In other coastal areas of Mozambique, dugongs appear relatively rare (WWF EAME, 2004). Entanglements in gillnets appear to be a major cause of dugong mortality (Mozambique MEDA 2012). Dugong is a desired source of meat in parts of Mozambique and targeting has been reported around Inhaca Island (van der Elst, 2012).

Madagascar: The dugong is known to occur in Madagascar but its status remains unclear (WWF EAME, 2004). A dedicated aerial survey in 2009, recorded seven dugongs in the northwest region (Ridoux *et al.*, 2010), an area now suspected to be important in the WIO, but more quantitative surveys are needed to confirm this observation. Dugongs are rarely hunted by fishermen around Madagascar anymore, but hunting was very important in the early 1980s until 1990, near Vohémar (Rafomanana and Rasolonjatovo 2004) and Cape St. Andre (WCS unpublished data). There are still reports of hunting in more recent years (van der Elst, 2012). Dugong are also caught incidentally by commercial, artisanal and traditional fisheries. Habitat losses (seagrass beds) due to trawling for shrimp and noise pollution associated with trawling are also a concern.

Mauritius: Dugongs, which were once common in the lagoons around Mauritius and Rodrigues, are now extinct and no sightings have been reported in recent years.

Seychelles: Only a few (3) individuals having been recorded at Aldabra atoll (WWF EAME, 2004). Changes in dugong numbers at Aldabra are unknown (Hermans & Pistorius, 2008).

Somalia: One of the last viable populations of dugong on the eastern African Indian Ocean coast is found in Somalian waters, however the remaining populations are threatened by bad fishing practices, particularly the use of shark gill nets (Van der Elst and Salm 1998, Pilcher and Alsuhaibany 2000) and hunting. Hunting of large mammal has been intense, leading to catastrophic declines and the long-term survival of local populations of some species is unlikely.

South Africa: The South African fur seal (*Arctocephalus pusillus*) is found along the south and southwest coasts of South Africa (Best, 2007). Fishing activities have reduced fish stocks on which seals depend; the reduction in prey resources would have a negative impact on their populations. Furthermore, cape fur seals are often trapped and drowned in nets. Fishermen view seals as a pest that compete with them for fish and destroy their fishing gear in the process. Some fishermen retaliate by killing seals at sea by shooting or clubbing them.

Tanzania: Populations of dugong have declined significantly in recent decades and sightings are now very rare. Small resident populations exists in the Rufiji-Kilwa-Mafia area and at Moa in Tanga region, where there are extensive shallow seagrass beds, and sheltered bays and channels (Muir & Kiszka, 2011). The Pemba-Zanzibar channel in northern Tanzania is also recognized as an important dugong habitat. Numbers are estimated to be no more than 100 individuals. They were a target species, but the introduction of nylon filament nets in the late 1960s posed the greatest threat to dugongs (Amir et al. 2002). Dugongs are also threatened by fishing methods that cause seagrass damage (trawling) and seine nets and by the use of dynamite.

3.1.2. Decline in populations of cetaceans

Comoros: There at least 4 species of dolphin and 12 species of whales that have been reported from around the Comoros and Mayotte. Humpback whales are found around the islands between July and November. They are not targeted by local fishers.

Kenya: There are 6 species of whale and 8 species of dolphins found in Kenyan waters. Threats include artisanal gillnets, trawlers and other set nets, industrial pollution, degradation of habitats, as well as tourism and boat traffic due to noise pollution and boat strikes.

Madagascar: Dolphin species are hunted by fishermen, particularly in the south-west region of Anakao, for consumption and sale of meat. The species targeted include the bottlenosed dolphin (*Tursiops truncates*), the Indo-Pacific humpbacked dolphin, (*Souza chinensis*) and the long-nosed dolphin (*Stenella longirostris*) (Andrianarivelo 2001, Razafindrakoto et al. 2004, 2005 & 2007 and Cerichio *et al.,* 2009). The annual catch at Anakao was estimated to be between 100 and 150 spinner dolphins (*Stenella longirostris*), with smaller catches of large dolphin and Risso's dolphin (*Grampus griseus*) (Razafindrakoto et al. 2008, Cout and Cooke 1994). Incidental catches also occur as a result of various fisheries (commercial, artisanal and traditional) but there is little data on the scale of the problem are available and it is thought that the impact is lower than for hunting. Drift nets and longlines take coastal species of dolphins (bottlenosed dolphin, Indo-Pacific humpbacked dolphin, long-nosed dolphin) (Razafindrakoto et al. in prep) and cetaceans are also accidentally caught by jarifa (shark nets). Noise pollution around major ports and activities, particularly industrial shrimp trawling and seismic and sonar studies undertaken by the oil industry, also create a disturbance for these animals. Collisions between ships and cetaceans and harassment, whether intentional or accidental, are increasing. The humpbacked whale is the main attraction for sightseers between June and October. Dolphins are observed during diving, fishing and marine tours. Seawater temperatures may impact on highly migratory species including cetaceans (Madagascar MEDA 2012).

Mauritius: Seventeen marine mammal species have been recorded in Mauritian waters mostly as they migrate to and from Antarctica to warm tropical waters for calving. Dolphins are encountered more frequently than whales, although more recent studies have found resident populations of humpback and sperm whales in the waters around Mauritius. Whale and dolphin watching has become a very popular tourist attraction in Mauritius and the number of boats offering this activity has exploded in recent years as fishers have transitioned out of fisheries into the tourism sector (Mauritius MEDA 2012).

Mozambique: Little is known about the cetacean populations in Mozambique's waters. There are thought to be at least three species of whale and ten species of dolphin. Humpback dolphins are a target species in Mozambique (Guissamulo and Cockcroft 1997). Small coastal cetaceans are also vulnerable to accidental capture, particularly as a result of the use of gillnets. A marked decline in coastal dolphin populations was observed in the early 1990’s (Mozambique MEDA 2012).

Seychelles: Over 40 species of whale and dolphin have been recorded from Seychelles waters. Cetaceans are not a fisheries target species in the Seychelles but there are several incidents of poaching of dolphins every year but the number of occurrences is on the decrease (Seychelles MEDA 2012). The increase in expeditions for oil exploration, are resulting in an increase in the amount of sound pollution which can pose great danger to the cetaceans (Seychelles MEDA 2012).

Somalia: Purse seines yield a high by catch of cetaceans and shark gill nets also catch non-target species including dolphins and whales (Van der Elst and Salm 1998, Pilcher and Alsuhaibany 2000, Somalia MEDA 2012).

South Africa: The waters along the eastern coast support resident and migratory populations of over 34 species of whales and dolphins. Dolphins, whales and seals are trapped in the anti-shark nets in the KwaZulu-Natal region, and various species have been reported as fisheries by-catch in South Africa waters (South Africa MEDA 2012).

Tanzania: Whales, dolphins and porpoises frequently occur in the marine coastal waters of Tanzania. Eight species of dolphins have been observed in various places including the Rufiji delta, Mtwara, Tanga, Saadan, Latham Island, Menai bay, Nungwi and Matemwe. Humpback Whales have also been observed near the coast of Tanga and Mnazi Bay. Cetaceans have been recorded as bycatch in gillnets in various locations, but most notably by the gillnet fishery in the Zanzibar Channel and along the coast of northern Tanzania (Amir *et al.*, 2002). The level of dolphin bycatch in the artisanal gillnet fishery was high enough to likely be impacting upon small local populations (Amir *et al.*, 2002).

3.1.3. Decline in populations of seabirds

Comoros: The Comoros MEDA (2012) did not identify concerns related to birds.

Kenya: Egg collection by fishermen also significantly affects colonial nesting seabirds in Kenya. In Kisite Island, Whale Island and Kiunga Marine Reserve, many years of egg collection by fishermen has predisposed many birds in the *Sterna* genus to breeding failure (Bennun and Njoroge, 1999). Some seabirds and coastal shorebirds suffer predation of eggs and chicks by introduced brown rats, *Rattus rattus*. The Indian crow is suspected to be feeding ferociously on eggs of other bird species thus threatening indigenous populations and their continued existence. The pelagic long-line fishing in Kenya often kills or injures diving seabirds such as petrels, noddies, albatrosses and tropicbirds, which then form part of the by-catch. It is also suggested that to a significant extent, piscivorous birds suffer reduced food supply resulting from overfishing by artisanal fishermen (GOK, 2008). For example, trawl-fishing in Ungwana Bay has reduced fish food available to pelagic fishing seabirds, and created bird-vessel dependency which leads indirectly to unsustainable feeding relationships. Rising sea levels associated with global warming are also expected to depress suitable feeding and roosting habitat for many shorebirds along the East African coast in the coming few years (Kenya MEDA 2012).

Madagascar: Egg collecting takes place on many continental islands accessible to fishermen, and is considered to be a major factor in the decline of seabirds in coastal waters (ZICOMA 1999), although systematic study on this subject has yet been conducted. Some seabirds and coastal shorebirds suffer predation of eggs and chicks by introduced brown rats, *Rattus rattus*. Albatrosses and giant petrels are sometimes accidentally caught by longlines when these birds dive after the bait on the fish hooks (Madagascar MEDA 2012).

Mozambique: Seabirds are used as protein resources by local people, but harvesting of both eggs and adults may be unsustainable. Exploitation of littoral organisms for human consumption also represents a potential threat to the conservation of the shore bird since birds are dependent on these organisms. The accelerated growth of the tourist industry along the coast also poses a serious threat to the conservation of the shore birds due to the loss or damage caused to essential habitats (Mozambique MEDA 2012).

Seychelles: Although the Sooty tern (*Onychoprion fuscatus)* is the most abundant seabird that breeds in Seychelles (Burger and Lawrence 2003), its eggs are also commercially exploited. Despite enforcement efforts to control the amount of eggs harvested, poaching still remains an issue, especially on the outer islands (Feare et al. 1997; Rocamora and Skerrett, 2001); this is largely due to logistical and economical constraints. Introduced animals such as *Rattus* spp., *Felis catus, Tyto alba* and *Acridotheres tristis*, have caused severe reductions in breeding bird populations through the predation of eggs, chicks and adult birds (Rocamora and Skerrett 2001). Other species are threatened by habitat destruction and/or loss from land use changes such as coconut plantations. Albatrosses and giant petrels are sometimes accidentally caught by longlines when these birds dive after the bait on the fish hooks. Mitigation measures used within the IOTC to reduce seabird by-catch include night setting with minimum deck lighting, bird-scaring lines (tori lines) and weighted branch lines (IOTC 2009), (Seychelles MEDA 2012).

South Africa: The incidence of bird mortality on tuna-directed longlines is high (seasonally) on the Agulhas Bank. Seabirds feeding on anchovy and sardine compete with purse-seine fisheries for food and some populations have suffered large decreases in the past 50 years (Crawford 2007), (South Africa MEDA 2012).

Tanzania: Introduced species such as the Indian crow is suspected to be feeding ferociously on eggs of other bird species thus threatening indigenous populations and their continued existence (Tanzania MEDA 2012).

3.1.4. Decline in populations of turtles

Comoros: Four species of sea turtle are found including Green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Loggerhead turtle (*Caretta caretta*), and Leatherback turtle (*Dermochelys coriacea*). Previously all the beaches of the Comoros were sea turtle nesting sites, but now, only the Mohéli Marine Park has sea turtle nesting beaches, and these are some of the most important in the region. The main threats to sea turtles in Comoros include habitat destruction due to sand and stone mining on nesting beaches, discharge of groundwater and runoff on marine turtles habitats (coral reefs, seagrasses, beaches) due to deforestation, and poaching. Despite large public sensitization programs, environmental education in schools and surveillance by coastguards, poaching of Green turtle for its meat and eggs is still prevalent in Comoros. A traditional trade for turtle meat is still active in Anjouan and Moheli. However in some places, such as Itsamia's village, population is well educated on the importance of turtle conservation and the whole community is supporting anti-poaching activities.

Madagascar: Traditional hunting of turtles is performed with harpoon or spearguns. Catches were estimated to be as high as 13,248 turtles per year (*Chelonia mydas* 51%, *Eretmochelys imbricata* 15%, *Caretta caretta* 15% and *Lepidochelys olivacea* 18%) over an 800 km coastline in Southwest (Hughes 1971). Hughes (1973) estimated the national catch of *E. imbricata* at 2,500 individuals and concluded that the species was threatened. So at least *C. mydas* and *E. imbricata*, and probably also *L. olivacea* and *C. caretta* are overexploited which is a major concern. Turtles are also affected by offshore industrial fishing (longline and seine), fishing on the continental shelf, industrial shrimp trawling, fishing nets for shark and traditional fishing with poison. Industrial trawling for shrimp is an important cause of incidental catches of turtles, but has never been scientifically evaluated. In 2000, a trawler captain in Toliara (pers com.) estimated incidental catch at 300 turtles per ship per year. The nesting beaches in Madagascar are also affected by urban development, major construction works such as ports, dams, mining and oil installations and constructions for tourism and development. Light and interference with nesting beaches as a result of increasing tourism also affects turtle populations in Madagascar. Studies confirm that the most important turtle nesting sites are now on small islands in the west of Madagascar (particularly the north west of Madagascar), while nesting is less frequent on mainland beaches, and absent in mainland areas near to coastal towns. Sea turtles are also affected by various forms of pollution, such as marine debris, oil pollution, sedimentation and noise pollution. Noise, especially between 50 and 1000 Hz was found to cause an increase in swimming speed and diving in Madagascar. In the case of seismic campaigns, turtles fled 1 to 2 km from the source. A turtle conservation project in the Maintirano region, found a high incidence of the disease Fibropapillomatosis among sea turtles caught for research purposes around Maroantaly Island, one of Barren Islands. The disease affects approximately 25% of green turtles and can be a significant cause of mortality (Madagascar MEDA 2012).

Mauritius: There are two species of marine turtles which are commonly encountered in coastal waters (Hawksbill *Eretmochelys imbricata* and green *Chelonia mydas*).Population trends of both the species are not known, but believed to be declining (Mauritius MEDA 2012). Both species used to nest on Mauritius and Rodrigues but there is no evidence of nesting in recent times; although there are still nesting beaches on St. Brandon, Agalega and the Mascarene. The hawksbill was traditionally exploited for the carapace and eggs and the green turtle was exploited for meat, eggs, fat and leather (Mauritius MEDA 2012).

Mozambique: Turtle carapaces are still used in the manufacture of tortoiseshell. The artisanal and prawn trawling fisheries of Mozambique have also reported catches of sea turtles with 36 turtles accidentally caught each year between 1932 and 1954 on the Sofala Bank.

Seychelles: There are four species of sea turtles found in Seychelles waters, but only the green turtle (*Chelonia mydas*) and Hawksbill turtle (*Erethmochelys imbticata*) nest on Seychelles beaches. The Seychelles hosts one of the five most significant global populations of Hawksbill turtle, which is particularly significant given that this is a critically endangered species (Mortimer 1985). The numbers of nesting Green turtles appears to have increased significantly during the past 35 years. But there has been a 50 % decline in the number of female nesting Hawksbills in the past 20 years. The most important nesting sites have protected status either as special reserves or as marine national parks. Turtle hunting is also banned, but there are still incidents of poaching, especially of the Greens in the outer islands and the Hawksbill around the inner islands. There have also been instances where marine debris has been swallowed by turtles or entangled the animals. There are concerns that coral reef degradation and seagrass loss could affect the feeding of Hawksbill and Greens, respectively. Coastal development constitutes a significant threat, especially tourism related development, where nesting habitats are either being destroyed or there are increasing activities on previously undisturbed beaches. Also, the nesting turtles are disorientated by lights of hotels. Sea level rise also poses a threat to the nesting habitats. Although turtle bycatch rates may be low, it still occurs in many fisheries and there are issues with entanglements in Fish Aggregation Devices (FADs).

Somalia: Hunting of nesting and foraging turtles and collection of eggs in also a concern in Somalia. Destruction of turtle nesting beaches through coastal development, dredging, mining and erosion threatens turtle populations in Somalia (Okemwa 1998). Gillnets used in the artisanal and subsistence fisheries pose a major threat to all species of turtles (adult and sub-adult) in Somalia.

South Africa: There is large pressure on conservation areas adjacent to nesting beaches to be developed into lucrative tourism areas. This sometimes results in a conflict between the need to add artificial lights in remote areas for security reasons, and the need for dark beaches for turtle nesting and hatching (Jacobson and Lopez 1994; Witherington and Martin 1996; Wilson and Tisdell 2001). Incidental mortality of turtles is problematic in South Africa and vessels deploy Turtle Excluder devices (TEDs).

Tanzania: Turtles and their eggs have been used for domestic consumption and as a source of income for centuries by local coastal communities in Tanzania. Gillnets used in the artisanal and subsistence fisheries pose a major threat. In 2007, and 16 turtles (Green, Hawksbill and Loggerhead) were caught during a by-catch survey conducted in 2007 in the industrial prawn trawl fishery in Tanzania. There are also concerns about human disturbances and light pollution on nesting beaches (by tourists, seasonal fisher camps) in Tanzania.

3.2. Decline in populations of commercial fish stocks

3.2.1. Decline in populations of sharks and rays

Comoros: The Comoros MEDA does not mention any issues of concern relating to sharks or rays.

Kenya: Sharks are targeted by artisanal fishers, using a variety of different gear: multifilament drift gillnets, monofilament drift gillnets, bottom-set gillnets, longlines and handlines (Kiszka 2012). The sharks caught by the artisanal fishers are sold whole (body and fins) (Kiszka 2012). Shark fins are however also exported, with a total of 468 t of shark find exported in 2007 worth over 250,000 US dollars per year. Sharks and rays are also caught accidentally as by-catch, by monofilament and multifilament drift gillnets, bottom-set gillnets, beach seine, longline and handline, although the most impact is due to gillnets (Kiszka 2012).

Madagascar: Approximately 50 species of sharks and rays of neritic and oceanic deep waters of Madagascar are affected by industrial tuna fishing (longline and seine fishing), industrial fish fishing, industrial shrimp fishing, artisanal and traditional fishing. Official statistics on local production and export of meat and fins show an annual mortality of sharks by various forms of fishing from 200,000 to 600,000 individuals. Artisanal and traditional fishermen target sharks using gill nets (100 meters in length, known as jarifa). The prawn trawling fishery and the longline fishery in Madagascar also catch sharks. There is an active export market along the west coast for shark fins, indicating a considerable social and economic importance. In this Toliara region, results from a total of 1,164 catch records, included at least 13 species of elasmobranch, with an estimated total wet weight of over 23 mt. Hammerhead sharks (*Sphyrna* spp.) represent 29 % of sharks caught by number and 24 % of the total wet weight (McVean *et al*., 2006). The scalloped hammerhead shark (*S. lewini*), which is classified as "endangered" on the IUCN Red List, is declining in certain regions including southwest coast of Madagascar (McVean et al., 2006). Sawfish (Pristidae), which are classified as "critically endangered" on the IUCN Red List and on Appendix I of CITES are now very rare in Madagascar probably due to shrimp trawling, use of gill nets across rivers and installation of fish barriers in estuaries (Valakira).

Mauritius: Sharks are both targeted and accidentally caught by sports fishermen and by local artisanal fishermen fishing around FADs. Bottom-set gillnets resulted in a bycatch of both sharks and rays, whereas only sharks were impacted by line (handlining and lining under FADs) and other net fisheries (Kiszka 2012).

Mozambique: Most of the elasmobranchs taken in Mozambique waters are part of a bycatch with shrimp trawlers catching the most significant amount of elasmobranchs, especially over the continental shelf. However, recently, bycatch reduction devices have been tested in prawn trawl fisheries in Mozambique. Over 75% of hauls with grids caught fewer large rays than those without grids while hauls using grids caught no large sharks at all (Mozambique MEDA 2012).

Seychelles: Increased targeting of sharks in recent years has resulted in the stocks of inshore sharks being under threat of overfishing. In 2007, a National Plan of Action (NPOA) for the conservation and management of sharks was produced. The NPOA indicated that the shark fishery is data deficient but that significant historical, anecdotal and fisheries-independent information suggest that inshore populations continue to be severely depleted (Seychelles NPOA Sharks 2007). Stocks of inshore sharks have also been described as being depleted in recent fisheries reports (FAO Fisheries and Aquaculture report No. 899 2009).

Somalia: Elasmobranchs are heavily exploited in both the industrial and artisanal sectors (FAO 2005), and represent 40% of the artisanal catches. The principal groups are hammerheads (Sphyrnidae), grey sharks (Carcharhnidae), mako shark (Lamnidae), houndsharks (Triakidae) and dogfish

(Squalidae). Shark populations are also declining due to the unmanaged harvest of shark fins (Pilcher and Alsuhaibany 2000). Sawfish (Pristidae), which are classified as "critically endangered" on the IUCN Red List and on Appendix I of CITES are also caught as bycatch in shark gill nest in Somalia.

South Africa: Shark populations in RSA waters are declining, in particular blue and mako sharks. Shark and ray bycatch is problematic in several of main commercial fisheries: the large pelagic fishery, which targets 4 or 5 species, results in bycatch of sharks; the midwater trawl fishery, which targets horse mackerel (*Trachurus capensis*) also impacts (as bycatch) large pelagic sharks and occasional marine mammals (dolphins and cape fur seals); the line fishery has a bycatch of elasmobranchs. Sports and recreational fishers also target sharks; the shark-nets along the southern and eastern seaboard to protect bathing beaches also result in mortality. South Africa also offers non-consumptive resource use/tourism sector, in the form of shark cage-diving operations, although this is not thought to be a factor in the decline of shark stocks (South African MEDA 2012).

Tanzania: Fishing for elasmobranchs has occurred for centuries with shark fishing, especially in Zanzibar, being mostly seasonal during austral summer Tanzania MEDA 2012). Sharks are a particularly important fishery in Zanzibar, both as a valuable source of cheap meat when dried, and as a major source of income provided by the fins (Schaeffer, 2004). Long lines and bottom-set gillnets, are used to target sharks and rays, and these vary in length up to 450m, with mesh sizes ranging from 20-40cm (Tanzania MEDA 2012).

3.2.2. Decline in populations of large pelagics

Comoros: Large pelagic fish account for approximately 75% of the fish consumption in the archipelago and nearly 90% between December and June when fishing can take place outside the lagoons because of favourable sea conditions. The lack of storage and processing facilities prevents catch increases per trip, as prices are very sensitive to the volume of landings. The use of deepwater FADs increased the accessibility of large pelagics to the artisanal fishers.

Kenya: The catch of tuna has been declining since 2004 most likely due to overfishing (Kenya MEDA 2012). Large pelagics, tuna and tuna like species are targeted mainly by Distant Water Fishing Nations (DWFN) and a smaller catch is taken by sports fishers. The number of foreign licensed vessels has increased steadily since 2003. Between 2005 and 2007, an average of 37 purse seiners and 30 long liners operated in Kenya waters, all licensed by the Ministry of Fisheries Development, for an annual license fee of US$ 30,000. In 2007, these foreign vessels transhipped a total of 16,564 metric tonnes of Tuna and Tuna like species through Mombasa (equivalent to a total of USD 1.7 million per year). Sports fishing is seasonal with the low season occurring between May and September and peak season in October to March. Targeted species are mainly billfishes especially sailfish, swordfishes, the marlins, sharks and some tunas.

Madagascar: There is limited information available about the state of stocks of tuna, associated fishes, or incidental catches of vulnerable bycatch species. Tuna are subject to industrial seine fishing (under two agreements with Anabac and EU) and longline fishing (under three agreements - the EU, Korea -Dae Young, and Japan- Japan Tuna). Official fisheries statistics indicate that catches are between 10,000 and 11,000 tonnes per year. The development of a semi-industrial fleet in Madagascar since the end of the 1980s boosted production from 5,000 t to 25,000 t today. Only one of the species of Scombridae targeted on Madagascar is 'Critically Endangered', the southern bluefin tuna (*Thunnus maccoyii*). This species may be present in the southern part of the EEZ at 200 miles, where it is targeted by Asian longline fishermen.

Mauritius: In recent years, efforts have been made to encourage the targeting of off lagoon pelagic fishes as a strategy to help alleviate pressure on the lagoon resources. Fish Aggregating Devices (FADs) have been installed for use by artisanal fishermen. Sports fishing is also now an important fishery on Mauritius and has grown in popularity with tourists. The tuna fishery is split into the coastal tuna fishery and the offshore industrial tuna fishery. Tuna and tuna-like species are caught by local fishermen near the coast and mainly around Fish Aggregation Devices (FADs). The total landings from FADs and sport fishermen are estimated at around 650 tonnes annually. Species caught are big eye tuna, skipjack, yellow fin tuna, dorado, wahoo and sharks. Industrial tuna fishing is carried out mainly by long-liners and purse-seiners. These are mostly licensed foreign fishing vessels that catch about 10,000 tonnes yearly in the EEZ of Mauritius. The species caught are mainly the skipjack tuna and yellow fin tunas.

Seychelles: There is major concern about the stock status of yellowfin (*Thunnus albacores*) and big eye (*T. obesus*) tuna. A recent stock assessment conducted by the IOTC working party on Tropical Tuna in 2009, incorporating recently obtained data from the Regional Tuna Tagging Programme-Indian Ocean (RTTP-IO) revealed that the stock of yellowfin tuna has been over-exploited with catches averaging 343,000t (1992-2002 period). It was recommended that catches should not exceed the MSY (250,000 and 300,000t) levels estimated by the current assessment.

Somalia: Stocks of large pelagic fish (yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), longtail tuna (*T. tonggol*), bonito (*Sarda orientalis*), skipjack tuna (*Katsuwonus pelamis*) and Spanish mackerel (*Scomberomorus commerson*) are heavily exploited by the industrial sector and lightly exploited by the artisanal sector (FAO 2005).

South Africa: Large pelagics (and demersal sharks) are targeted by the longline fisheries and a pole fishery for tuna. The longline catch is dominated by five species (yellowfin tuna, bigeye tuna, blue shark, longfin tuna and mako shark) which make up 75% of landings, although up to 61 species may be retained. Other non-directed bycatch recorded from this fishery include sharks, killer whales (depredation) and marine birds (Grantham *et al.* 2008). While this is a relatively small fishing sector, the South African EEZ and surrounding waters are also heavily fished by foreign tuna fleets who access the ports for servicing and fish transhipments. Stocks of Yellowfin tuna are depleted (IOTC assessments), whilst bigeye tuna are considered stable but at risk and the status of swordfish is uncertain.

Tanzania: Large pelagics such as kingfish, tuna, sailfish and marlin, are caught by surface gill nets and trolling lines. Over 95% of the catch is attributed to small-scale artisanal fishing using primitive crafts and gear (Table 11) (Linden and Lundin, 1996). The local supply of tuna, swordfish and marlins has been drastically reduced following the collapse of large pelagics stocks over the last two decades. Catches taken by Tanzania fishermen in Kenya waters are not repatriated, and there are poor transport and conservation facilities.

3.2.3. Decline in populations of small pelagics

Kenya: Small pelagic fish (Stiophoridae, Scombridae) are targeted by the artisanal fishery using bottom-set gill nets. There is limited data available to determine the status of these stocks, although the methods can result in by-catch of turtles, sharks and rays. There has been a noticeably impact of trawl-fishing in Ungwana Bay on the availability of fish food for pelagic fishing seabirds, which has created a bird-vessel dependency that can leads to unsustainable feeding relationships.

Madagascar: There is a significant decline of small pelagic fisheries (Madagascar MEDA 2012). Small pelagic fishes are targeted by shrimp trawlers in all shrimp fishing zones, by artisanal fishing, mainly in the Northwest and by traditional fishing mainly along west coast, in Antongil Bay and in the Southeast. The most common species belonged to Sciaenidae, Leiognathidae, Trichiuridae, and Mullidae families (PNRC 2006). The most affected species by traditional and artisanal fisheries are small Scombridae, often called "small tunas", such as the eastern little tuna, *Euthynnus affinis*, the wahoo, *Acanthocybium solandri*, the narrow-barred Spanish mackerel, *Scomberomorus commerson*, the Indian mackerel, *Rastrelliger kanurgata* and *Auxis* spp., Sphyraeindae, Carangidae, sardines (Clupeidae), anchovies (Engraulidae), Hemirhamphidae, Belonidae and others (Madagascar MEDA 2012).[N.B. This issue was not selected as one of the priority issues by the participants at the national CCA meeting].

Mauritius: Small pelagics are not targeted at present but there is a potential yield of the small pelagic namely horse mackerel estimated in the region of 13,000 to 26,000 tonnes per annum (Mauritius MEDA 2012).

Mozambique: Small pelagics are mainly targeted by the artisanal fishers using beach seine nets. The MEDA did not identify any issues of concern related to this fishery (Mozambique MEDA 2012).

Somalia: The fisheries of the Somali Coastal Current LME are heavily fished and studies show that many stocks are unsustainably overexploited (Kelleher and Everett 1997; Fielding and Mann 1999). Small pelagics including the Indian oil sardine (*Sardinella longiceps*), rainbow sardine (*Dussumieria acuta*), Scads (*Decaptrus* spp.), chub mackerel (*Scomber japonicus*) and horse mackerel (*Trachurus indicus*) are mainly caught off the northeast coast of Somalia by both artisanal and commercial fleets (FAO 2005); anchovies (*Engraulis japonicus, Stolephorus* spp.) also occur but in smaller quantities (Somalia MEDA, 2012).

South Africa: Species mixing between juvenile anchovy (*Engraulis encrasicolus*) and juvenile sardine (*Sardinops sagax*) causes an "early season" fishery problem (before separating into discrete shoals), presenting fishery management issues such as discarding and dumping (South Africa MEDA, 2012). Seabirds which feed on anchovy and sardine must compete with purse-seine fisheries for food and as a result, some have suffered large decreases in the past 50 years (Crawford 2007).

Tanzania: The main commercial marine fish species are small pelagics, including sardine and anchovy, which together form 30-50 % of total fish landings. The small pelagics are caught mainly using purse seine nets or ring nets, and these fisheries may also include small tuna and mackerel (Tanzania MEDA 2012).

3.2.4. Decline in populations of deep demersal fish species

Mauritius: The banks fishery is a mothership-dory fishing operation, which has been operated by a single licensed fishing company since the late 1960s. This fishery targets a single species (*Lethrinus mahsena*) which constitutes 80–90% of the annual catch of 3,000 tonnes. As the fishery only operates to a maximum depth of 50 m, this does not really count as a deepwater fishery, but there is now increased interest in the potential of other deepwater species.

Madagascar: Continental shelf and slope surveys carried out in the 1970s, in the Northwest identified almost 20 species of commercially important deep demersal fish, namely: Lethrinidae (*Lethrinus coerulues*, until 150m), Denticidae (*Cheimerius nufar*, up to 120m; *Polysteganus coeruleopunctatus* up to 150m), Sparidae (2 *Argyrops* at 150m, 2 *Pterogymnus* between 100 and 300m, 1 *Pagellus* species up to 1 250m), Priacanthidae (2 species at 150 and 250m), Branchiostegidae (1 species captured between 100 and 300m), Triglidae (4 species between 100 and 450 m), Sciaenidae (1 unidentified species between 450 and 475m), Brotulidae (1 species between 400 and 500) and Gadidae (1 *Merluccius* sp. between 600 and 720m). In 2007, pilot fishing for alfonsino *Beryx splendens* was launched by a South African company using deep trawling techniques. This fishery caught 7 tonnes with a single vessel in a period of several months. The fishing site consists of seamounts in the south of Madagascar located at approximately 26°S 46°E (Centre de Surveillance des Pêches 2007). The gear used on these trawls are able to deflect rocks weighing several tonnes and destroy large areas of underwater habitat, particularly on seamounts or continental slopes and shelves (CSP 2007).

Mozambique: The line fishery is a multispecies hook and line fishery, comprising more than 200 species, and is conducted over a wide area and mostly at a depth of 30-200 m. It takes place mainly on rocky bottoms that are not suitable for trawling. Some linefish species are also targeted by sportfishers (Torres and Jakobsen 2007). A number of priority species are important components of the linefishery catch.

Seychelles: Demersal fisheries are carried out by both the artisanal and commercial fisheries. Important demersal species include red snappers, groupers, job fish, and emperors (Nageon de Lestang 2011). The two main fishing grounds for the demersal handline fishery are the Mahé Plateau and the Amirantes Plateau at depths from 25 - 70 m. Other fishing areas include the offshore banks and around the southern Group of coralline islands. Experimental drop-line fisheries for certain deepwater species resulted in the rapid removal of stocks (*P. filamentosus)* (Grandcourt 2008).

South Africa: The demersal fishery is the most valuable fishery in South Africa and it targets deep-water and shallow-water hake but also catches many other fish species such as kingklip, horse mackerel, angelfish, snoek and monk as bycatch. The trend in the hake-directed offshore trawl, particularly on the South and East coasts, towards deeper fishing (> 600 m) has resulted in exploitation of a new "deepwater" species regime with a unique set of biodiversity impacts linked to the continental shelf break (500 – 2000 m water depth). In all these fisheries there is a significant problem with bycatch. The demersal longline component is relatively selective compared to the bottom trawl, which catch the full spectrum of size classes of hake (except for the smallest fish generally below 15cm in length). Over-harvesting of deepwater stocks is a particular concern in South Africa, where the deep-water hake stock levels are estimated to be <30% of BMSY (the biomass that can support the Maximum Sustainable Yield, MSY). The impact of heavy deepwater gear on deep water substrates has potential impacts on unknown deepsea biodiversity.

Tanzania: More than 35 captures of Coelacanths have been reported by rural fishers in the fishing villages of Kigombe, Mwarongo and Mwambani, South of Tanga, Mtwara, Lindi and Dar es Salaam using deep-set shark gill nets.

3.2.5. Decline in populations of reef and demersal fish

Comoros*:* The reef fishery produces 3000 tons of reef fish per year in the Comoros. Overexploitation has meant that commercially important food fishes including jacks, groupers and parrot fishes are now very rare (Comoros MEDA, 2012). There has been an increase in the use of destructive fishing methods including the use of dynamite and plant poisons (*Thephrosia candida*), which paralyzes and kills fish and the use of small mesh nets. Other destructive fishing techniques have caused further habitat damage and contributed to the decline in species includes reef walking, the creation of retention ponds for use during low tide, damage due to use of paddles, machetes or pitchforks, bow-nets which requires walking on the reef flat, use stone line or bottom line on the reef flat or on the outer edge of the reef flat.

Kenya: The small-scale fisheries in Kenya are an important sector and an estimated 60,000 coastal residents depend on this sub-sector for their livelihood. Population growth, along with high levels of poverty in the coastal region, has contributed to increases in the number small-scale fishers, with a 34% increase in the period between 2004 and 2008. Over-exploitation has been compounded by an increase in the use of destructive fishing methods which has led to a 50% decrease in demersal coral reef fish yields through the 1990s. Rabbit fish and scavengers, which make up nearly 40% of the small-scale fishers' landings, have declined by 40% in the 1990s (Kenya MEDA 2012).

Madagascar: Reef fish, including large carnivorous families such as Serranidae, Lutjanidae and Lethrinidae, and herbivores, Acanthuridae, Scaridae and Siganidae are exploited by traditional fishing in Madagascar (Madagascar MEDA, 2012). Resources are already overexploited beyond the tolerances of various reef sites (Maharavo, 2009) primarily due to overfishing. Overexploitation of marine resources is likely to continue in the coming decades as human population growth continues. Demand has also increased as an indirect effect of tourism; one study showed that tourists eat five times more by weight of fish than a fisherman villager, increasing local pressure on resources (Tanner 2000).

Mauritius: Reef and demersal fish are exploited by the artisanal and bank fishery. The artisanal fishery provides employment to over 2,000 fishermen on Mauritius (and at least double that on Rodrigues). The main families of fish caught are Lethrinids, Sigganids, mullets, Scarids and groupers. Total production in 2009 was 820 tonnes (Mauritius MEDA, 2012). Reef and demersal fish stocks are over-exploited and no substantial increase in fish production in these areas is expected in future (Madagascar MEDA, 2012). The banks fishery operates on the banks of the Mascarene Plateau, located between 400 and 800 km north of Mauritius. Twelve fishing vessels are in operation and their total catch which comprises mainly Lethrinids (90%) amounts to around 3,000 tonnes annually. This fishery supplies a substantial quantity of fish consumed in Mauritius.

Mozambique: Demersal fish species in Mozambique are threatened by destructive fishing methods which do not discriminate between species and also kill eggs and larvae, as well as they destroying the habitat. An assessment of the stocks of Sparidae, which account for more than 70% of the catch, did not rule out the possibility of local overfishing (Mozambique MEDA, 2012).

Seychelles: The artisanal fishery is an open access fishery and, the lack of management control poses a threat for the sustainability of demersal fish resources. Emperor red snapper (*Lutjanus sebae*) is the most important commercially exploited demersal species in the Seychelles. It is a popular food fish with locals and tourists, has a good local price and an international market, resulting in increased targeting by the artisanal fishery. Recent assessments of the Emperor red snapper (Lutjanus sebae) stocks showed that the stock is overexploited (Seychelles MEDA, 2012). Moreover, the MSY of 380 tonnes is likely to have been overestimated. Recent artisanal catches is around four times higher than the new maximum sustainable yield (MSY) (Grandcourt et al. 2008). The rabbitfish, *Siganus sutor,* have also been overfished (Fisheries and Aquaculture report No. 899, 2009).

Somalia: Around coral reefs, unsustainable exploitation as a result of increased fishing effort and the use of destructive gear (Somalia MEDA, 2012).

Tanzania: Coastal fisheries in Tanzania are dominated by artisanal fisheries, which contribute more than 96% of the total marine fish catches (Tanzania MEDA, 2012). The catches are dominated by reef and demersal fish including bream, grouper, parrotfish, snapper, rabbit fish, emperors, (and sharks and rays), using traps, hooks and lines, nets and harpoons. Fishing effort is concentrated on coral reefs, sea-grass beds and reef flats areas, and as a result of heavy fishing pressure the fishery is showing signs of over-exploitation (Tarbit, 1984). Destructive fishing practices are used, most notably dynamite fishing, which is particularly common in coastal areas near urban centres such as Dar es Salaam, Tanga and Lindi. Dynamite fishing has contributed to the decline in the productivity and catches of artisanal fishery. Seine net fisheries also result in habitat damage, as the fishers encircle the reef with nets and then scare the fish into the net by breaking the coral heads. This is a destructive form of fishing, but it is also indiscriminate.

3.3. Decline in populations of commercial invertebrates

3.3.1. Decline in populations of molluscs (bivalves, gastropods)

Comoros: *Charonia tritonis*, which feeds on the corallivorous Crown-of-Thorn starfish (*Acanthaster plancii)*, is now rare in the Comoros. Many tons of mollusc shells are exported to neighbouring countries (Madagascar, Kenya and Tanzania). Even though there is a ministerial decree, which prohibits the collection of shells, licences are regularly given to exporters without any real control over the quantities or species exported. All the places more or less frequented by tourists offer shellfish for sale and the stocks in the luggage of boarding passengers. The rarity of these molluscs is an indication of over-exploitation (Comoros MEDA 2012).

Kenya: There are fisheries for bivalves, including oyster *Crassostrea cucullata* and oyster pearl *Pinctata imbricata,* barnacle *Balanus amphitrite,* and gastropods including *Cerithidea decollata,* Snails *Nerita plicata, N. undata* and *N. textilis* (Prosobranchia: Neritacea) and *Drupella cornus*. The Kenya MEDA (2012) does not indicate the status of these fisheries.

Madagascar: No national legislation exists concerning the exploitation of gastropods and between 1989 and 1991, one Indian exporter from Toliara annually exported 8,000 kg of ornamental shells and 50 tonnes of industrial shellfish (WWF 1993). In 1997, it was reported that 138 species of gastropods were for sale in shellfish markets at Toliara. Among the rarer and more valuable curio species are the spider conch (*Lambis truncata*), the Mauritius island cowry (*Cypraea mauritiana*), the helmets (*Cassis cornuta, Cypraecassis rufa*), the giant triton (*Charonia tritonis*), the shell tun (*Tonna canaliculata*) and various cone shells (*Conus* spp.) (Romaine 1997). These ornamental species have become rare, particularly near cities such as Toliara (e.g. the queen conch, *Strombus gigas,* triton *Charonia tritonis* and *Trochus niloticus*). The turbo (*Turbo marmorata*) and pearl oysters (*Pinctada* *margaritifera*) are exported for the manufacture of buttons and other pearly objects. Mangroves are also exploited for mangrove gastropods *Terebralia* (= Pyrazus) *palustris*, whose shells are transformed into lime. Bivalves are also exploited as food species such as clams (*Anadara antiquata*), oysters and mussels. Several species of food bivalves are overharvested (Madagascar MEDA 2012).

Mozambique: Exploitation of littoral organisms by the local population is a very common activity along the coast and this represents a potential threat to the conservation of the shore birds (Mozambique MEDA 2012).

Somalia: The mangrove oyster, *Saccostrea cucullata*, targeted by the artisanal fishery is declining. In Tanzania, most of the shells collected for the curio trade are rare and threatened species (Somalia MEDA 2012).

South Africa: High rural population densities, pervasive poverty, a lack of development and very limited control over natural resource use along the coastal sections of the underdeveloped former homeland areas such as Kwa-Zulu, Transkei and Ciskei, have resulted in the stripping of coastal shellfish and other natural resources for subsistence consumption (South Africa MEDA 2012).

Tanzania: Invertebrate stocks are threatened by both the extraction of wild-caught seed for the mariculture industry but also by collection for the curio trade. Intertidal and near shore areas are damaged by shell collectors through trampling (Tanzania MEDA 2012). Shells such as queen snails (*Turbo marmoratus*), helmet snails (*Cypraecassis rufa*), tiger cowrie (*Cypraea tigris*), money cowrie (*C. moneta*) and the most valuable cowrie (*C.mauritiana*) are collected and exported for curio trade. Most of the curio shells are rare and threatened species. A large proportion of ornamental shells intended for the tourist market were exported by the Tanzania Fisheries Corporation and Zanzibar State Trading Corporation.

3.3.2. Decline in populations of cephalopods

Comoros: Octopuses are over-exploited as they are easily accessible without owning a canoe, and a popular food species on the islands especially given their low prices compared to that of fish. Octopus are abundant at Mitsamiouli, Chindini, Malé (Grande Comoro), the Nioumachouoi islets, Wallah, Itsamia (Mohéli), Pomoni, Moya and Ouani (Anjouan). As well as reef walking, another technique used to catch octopus on Mohéli, is to spread lime in the octopuses' habitat; which causes the octopus to exit the den blinded and paralyzed. Many people consider the consumption of octopus as taboo, perhaps due to food allergies associated with their consumption. There are no specific regulations for the protection of octopus in the Comoros.

Kenya: Octopus (*Octopus* spp.), squids and cuttlefish are exploited in Kenya waters. The octopus fishery is a valuable exports estimated to be worth nearly 1.5 million USD.

Madagascar: Three species of octopus were caught around Toliara: the day octopus, *Octopus cyanea*, the marbled octopus *Octopus aegina* and the less common long-armed octopus *Octopus macropus* (FAO 1998). The pelagic deep water or common squid (*Loligo*) is also a exploited in Toliara and Nosy Ve. The species, *Sepiatheulis lessoniana* is the most commercially important. The cuttlefish *Sepia* spp. is a less common fishery product and *Sepia zanzibarica* is more common on sandy bottoms around Nosy Be (Laboute and Maharavo 1998). The octopus fishery (for *O. cyanea*) is very important in southwest Madagascar but it is also heavily over exploited. With only 50 tonnes of production, in 1994, the production in Toliara region reached more than 700 tonnes in 2002. Today, the fishing area for octopus stretches 400 km, between Fanambosy and Morombe reefs, and involves some 60 fishing villages. In 2005, the first decrease of catches was seen, a possible sign of overexploitation. Consequently, the Ministry of Fishery announced a closed season between December 15 and January 31 and imposed a minimum size of 350 g. Meanwhile, an initiative of COPEFFRITO and Blue Ventures Conservation showed the advantage of a longer closure period to maximize the size of octopus, taking advantage of international markets that prefer sizes above 500 g (Humber 2006).

Mauritius: There are fisheries targeting both squid and octopus, both of which are important artisanal fisheries, particularly on Rodrigues. The octopus fishery (*Octopus cyanea*) provides a livelihood to over 2000 people but is heavily overfished. Catches have declined by more than 75 % over the past 20 years, from 800 tons in 1994 to approximately 200 tons in 2006 due to overexploitation, habitat degradations and lack of management control.

Mozambique: There are fisheries for both squid and octopus (Mozambique MEDA 2012), and landings appear to be increasing.

Seychelles: The Seychelles MEDA (2012) does not describe a cephalopod fishery, although the issue was identified by the national participants and being a concern.

Somalia: The Somalia MEDA (2012) does not describe a cephalopod fishery, although the issue was identified by the national participants and being a concern.

South Africa: The squid-jigging fishery targets spawning aggregations of chokka squid (*Loligo vulgaris reynaudi)* in sheltered bays on the south coast. There are no major stock issues although annual catches are somewhat variable and dependent on environmental / oceanographic conditions. There are no bycatch issues associated with this fishery. But the significance of squid in ecosystem / trophic structure and the impact of exploitation are poorly understood. There is also an octopus pot fishery (*Octopus vulgaris*), an octopus gleaning fishery, but there were no concerns expressed about this fishery.

Tanzania: Cephalopods represent a significant fishing resource in Tanzania (octopus, cuttlefish and squids). The common octopus, *Octopus vulgaris* is the cephalopod species with the highest landings in Tanzania particularly among the artisanal fleet. Traditionally, this species has been caught by the artisanal fleet using spears, traps and hand collection during low tides. Regulation has been proposed to include a minimum legal capture of an individual octopus weighing not less than 500 g. Production and export data have revealed that catches of octopus are declining rapidly from 430,000 kg in 2000 to 57,000 kg 2007, representing a 87% decrease in 7 years, which is attributed to overfishing stimulated by high prices of octopus in international markets.

3.3.3. Decline in populations of sea cucumbers

Comoros: Currently, the Comorian sea cucumbers are not subject to any exploitation and there are numerous species found on the reef flats, the outer lagoon and in the mangroves. A Comorian contractor tried to exploit sea cucumbers in 1998, but ceased this following an accident that killed two divers. While there is no formal legislation to protect these species, an awareness raising campaign led to their informal protection by communities. Covert operations are however developing around sea cucumber exploitation through Malagasy and Chinese networks. In a report cited in Conand (2008), the authors expressed "*concern with regards to the present, rather blind, overexploitation of sea cucumbers in the Comoros*" giving a few qualitative observations to support this. The harvesting and processing is controlled by Chinese immigrants

Kenya: There has been a fishery for sea cucumber since the 1990s, and numerous different species are exploited. Overexploitation of sea cucumbers is a concern.

Madagascar: There are about 40 species of sea cucumbers found around Madagascar, and they are an important export product. Sea cucumber fishing is a very common practice (Laroche and Ramananarivo 1995, Rasolofonirina and Conand 1998, McVean et al. 2005) and natural populations are now overexploited (Conand 1998, Conand et al. 1997). The sea cucumbers are not among the species of conservation concern although some species are locally overexploited (Mara *et al.*, 1997).

Mauritius: The exploitation sea cucumber started on a trial basis in late 2005 and was continued by six licensed operators with exports of around 80 tonnes (Kadun, S., Mauritius Government, Mauritius; Laxaminaraya, A., cited in Conand, 2008). Stocks were rapidly depleted, particularly around Rodrigues, and the fishery is now closed.

Mozambique: From recent information, most of the sea cucumber resources in the central and the southern regions of the country are depleted, with the exception of those in the Bazaruto Archipelago National Park (Motta, H., Mozambique, personal communication) (Conand 2008).

Seychelles: Overexploitation of sea cucumbers is a concern in Seychelles. For a long period and until 1999, the fishery was unregulated and thus no catch and effort data were collected. Management regulations to control the fishery and processing were then implemented. Ameruddy and Conand (2008) report an upward trend in the catch of the main targeted species since 1999, while the catch per unit effort (CPUE), expressed in numbers of sea cucumbers collected per diver per day, shows mostly a downward trend (Ameruddy and Conand 2008). There was a particularly high increase in catch between 2004 and 2005, although the number of fishing licenses (25) remained the same. This was most likely due fishers working as a group from a mothership, which meant they could stay longer at sea (Conand 2008).

Tanzania: There has been a rapid expansion of sea cucumber exploitation at some sites of Tanzania (Mgaya, Muruke and Semesi, 1999). Depletion of sea cucumber resources was first reported at Songo Songo by Darwall (1996a, 1996b) as indicated by the harvest of juveniles. Interviews conducted by Mgaya et al. (1999) with sea cucumber collectors in Bagamoyo also indicated that the stocks were declining and the average size of individuals was decreasing. The sea cucumber fishery developed without baseline biological data and without any monitoring. The increase in export of beche-de-mer was observed from 1980s (< 200 tonnes per annum) to 1992 (617 tonnes) while they have continued to decline thereafter (Marshall, Milledge and Afonso, 2001).There has also been a decrease in the number of exporters from 23 to 8 (Conand 2008).

3.3.4. Decline in populations of prawns and shrimp

Comoros: The Comoros MEDA (2012) did not discuss the prawn and shrimp resources.

Kenya: There are small scale and commercial fisheries for Penaeid prawn (*Penaeus indicus, P. semisulcatus, P. monodon, P. japonicas,* and *Metapenaeus monoceros*), and deep water prawns (*Heterocarpus woodmasoni*). Prawn trawlers compete with the small scale fishers who share the same fishing grounds and this leads to conflicts. Trawling methods are destructive to the habitats leading to a reduction in productivity (Kenya MEDA 2012).

Madagascar: Artisanal and traditional fisheries joined the industrial shrimp fishing after a few some years of delay. With fairly stable industrial catches in the early 1990s, a first decline in the industrial catch was observed in 1999 and a significant drop from 2002, which is a major concern (Madagascar MEDA 2012).

Mauritius: Shrimps are a potential high value product in Mauritius which are in particular demand in the tourist industry. There are five species of Penaeid shrimps as well as two species of deepwater shrimps have been identified in Mauritius and are currently being fished. As a first step towards the full exploitation of these resources, research will be carried out to determine shrimp distribution and its potential yield, which was initially estimated as a Mean Sustainable Yield (MSY) of 200 tonnes (Mauritius MEDA 2012).

Mozambique: The shallow water shrimp is the most commercially valuable marine resource and is the second most important species by volume, accounting for 29%, followed by the deep water shrimp at 8%, which were worth 46 million US dollars and 12. 5 million US dollars respectively in 2009 (USAID 2010). Commercial vessels operate mainly on the Southern Sofala Bank, Maputo Bay, Limpopo River, and Angoche. The beach seine fishery in Mozambique harvests adults and juvenile shrimps of both small and large species; generally, catches of small and juvenile shrimp outweighs those of adult shrimps (Mozambique MEDA 2012)

Somalia: Offshore trawling grounds, especially those targeting prawns, are showing signs of overexploitation with excessive bycatch and discards; inshore populations of prawns (*Penaeus* sp.) targeted by the artisanal fishery are also declining (Somalia MEDA 2012).

South Africa: The small crustacean trawl fishery on the Kwa-zulu Natal coast, targets include pink prawn (*Haliporoides triarthus*), langoustine (*Metanephrops andamanicu* and *Nephropsis stewarti)*, and red crab (*Chaceon macphersoni*). The inshore shrimp fishery operates on muddy grounds at depths of 20 to 45 m primarily on the Tugela Bank. The offshore fishery operates at depths of 100 to 600 m from Port Edward to Cape Vidal. The fishery is typical of shrimp trawl fisheries globally with a small target component but a very high fish bycatch as well as incidental catches of turtles (Fennesey and Isaksen 2007). The status of shrimp stocks caught both in the shallow and deep waters on the northern Kwazulu Natal waters is uncertain (South Africa MEDA 2012).

Tanzania: There has been unsustainable harvesting of prawns in Tanzania. The major causes have been pressures in the context of open access harvesting and inadequate management techniques of these species. The commercially important Penaeid prawn species are white prawn *Penaeus indicus* which composes 66% of catches*,* tiger prawn *P. semisulcatus 15 %,* giant prawn *P. monodon 18%,* brown shrimp *Metapenaeus monoceros* 15 % and *M .stebbingi.* The Hippolitydae are represented by *Exhippolysmata ensirostris* and the Palaemonidae represented by *Macrobrachium rude* and *Nematopalaemon tenuipes.* The prawns/shrimps landings from the commercial trawlers was about 500 tonnes in 1970, and then declined to about 200 tonnes when the joint venture company (New

Mwananchi Ocean Products) was disbanded (Bwathondi and Mwaya, 1984) and have remained low or variable since then (Tanzania MEDA 2012)**.**

3.3.5. Decline in populations of lobsters

Comoros: Several species of spiny lobster are found on reefs: *Panulirus japonicus, P. ornatus, P. versicolor* and *P. longipes*. The latter is the most coveted and most exploited species in the Comoros. Lobsters are not currently under threat of overexploitation in the Comoros. However there is potential that future tourism growth will increase fishing pressure (Comoros MEDA 2012).

Kenya: The artisanal fishers will target spiny lobsters (*Panulirus ornatus, P. longipes, P. versicolor, P. homarus, P. dasypus, P. penicillatus*) and a commercial fishery for deep water lobster (*Puerulus angulatus, Thenus orientalis and Metanephrops andamanicus*). The export of lobster is about 47 t worth close to 500,000 USD (Kenya MEDA 2012).

Madagascar: The Malagasy 'littoral crayfish' is an important fishery resource represented by the genus *Palinurus* (*P. homarus*, *P. japonicus* or *P. longipes*, *P. penicillatus*, *P. versicolor*, *P. ornatus* and *P. dasypus*), and are found on rocky and coral reefs all around the island. The lobsters are targeted by traditional fishers using trap fishing, diving and fishing with torches but recently, fishermen have started to use tangle nets. *Panulirus homarus* and *P. japonicas* are the dominant species in the south and south east. A study concluded that the exploitation of *P. homarus* is close to the maximum sustainable yield (MSY), and there is a tendency for fishermen to catch too many juveniles and pregnant females, which threaten the stock recruitment (Rabarison 2000).The slipper lobsters (Scyllaridae) are a frequent catch around Nosy Be, especially *Scyllarides squamosus,* while *Ibacus indicus* was also identified in southern Madagascar in 2008 up to 250m depth (Mara 2009). The mud lobsters (Thalassinidea: Callianasssidae) like *Callichurus* are common on sandy bottoms (Laboute and Maharavo 1998). The area with significant concentrations of *Palinurus delagoae* (Gilchrist) is located in southern Madagascar. On Walter Banks, an unknown species of giant lobster weighting 18 kg was discovered, named *Palinurus barbarae*, this lobster was 50 cm and could be 50 years old (Griffith & Groenveld 2006).

Mauritius: Two species of lobsters are fished around Mauritius and St. Brandon. In Rodrigues, lobsters are caught by reef gleaning by snorkeling.

Mozambique: An industrial trap fishery for *Palinurus delagoae* by licensed Japanese and local vessels operated between 1980 and 1999, and achieved annual landings of up to 400 t/year. As in South Africa, this fisheries also landed slipper lobster *Scyllarides elisabethae* and red crab *Chaceon macphersoni* as a retained bycatch. The fishery was unstable, with declines in catches, and is currently inactive (Mozambique MEDA 2012).

Seychelles: The Seychelles MEDA (2012) does not mention lobster fisheries, although this was identified as an issue of concern by the participants at the national CCA meeting.

Somalia: Spiny lobsters of the genus *Panulirus* are caught along the whole coastline by artisanal fishermen. The commercial sector also exploits two species of deep-sea lobster, *Puerulus swelli*, and *P. carrinatus*, found at depths of 150 to 400m (FAO 2005). The average size of lobsters caught has diminished, with most of the lobsters now caught before they have reached the age of maturity.

Furthermore, berried females are often caught during the breeding season, when the fishery is not strictly managed (Somalia MEDA 2012).

South Africa: The small scale industrial crustacean trawl fishery targets various species but also catches the Natal deepwater spiny rock lobster (*Palinurus delagoae*) and an assortment of other crustacean and fish species. Areas of operation are confined to the province of Kwazulu-Natal. There is also a small fleet of trap boats targeting deepwater rock lobster off the south coast and another off the east coast. The south coast fishery targeted *Palinurus gilchristi*, on the Agulhas Bank, but also landed slipper lobster *Scyllarides elisabethae* and red crab *Chaceon macphersoni* as a retained bycatch. The fishery is active, stable and well-managed since 1974. The second fisheries for *P. delagoae* off the east coast is less stable, and declines in catch rates were reported between 1994 and 1997 and between 2004 and 2007 (South Africa MEDA 2012).

Tanzania: Unsustainable harvesting of lobsters occurs in Tanzania. The open access harvest for commercial artisanal species, as well as that the biology, sustainable off-take and management techniques of these species are inadequately understood and monitored. Shallow water lobsters that are exploited in Tanzania include *Panulirus ornatus, P. longipes,* which contribute more than 80% of landings, as well as *P. versicolor, P. homarus* and *P. penicillatus*. Lobsters are fished using a hand-held net and an octopus, which is used to flush the lobsters out of their hiding areas so that they can be scooped up by the net. Lobsters are also caught by traps and gillnets set and by divers using spear guns. Deep-water lobsters (*Linuparus somniosus* and *Metanephrops andamanicus*) are caught in depths of 250-320 m in the southern end of the Zanzibar Channel (Tanzania MEDA 2012)**.**

3.3.6. Decline in populations of crabs

Comoros: The coconut crab *Birgus latro* is the largest land crab in the world (up to 3 kg). It is captured by fishermen to use as bait for fishing traditional coastal fish (mullet, parrot fish, triggerfish), and it is now rare on the islands. The species is protected under Appendix II of the Nairobi Convention.

Kenya: There is an artisanal fishery for crabs, which targets portunid crab species in mangroves (*Scylla serrata*) and the swimming portunid crabs (*Charybdis spp*.), as well as *Parasesarma catenata* (Brachyura: Sesarmidae), *Epixanthus dentatus* (Decapoda: Oziidae), *Thalamita crenata* (Latreille) and Hermit crabs e.g. *Clibanarius laevimanus.* Populations of the mud crab, *S. serrata*, which are targeted by the artisanal fishery are declining in Kenya, crablets are being harvested from the wild for the mariculture sector with little regard for resource status.

Mauritius: Four species of crabs are currently being fished, but no further information is provided on this fishery (Mauritius MEDA 2012).

Madagascar: The mangrove swamp crab *Scylla serrata* is exploited by traditional and industrial fisheries. Mangrove areas near coastal cities are subject to overharvesting, while more remote areas still support fishable stocks. Bautil et al. (1991) studied the fisheries near Mahajanga and estimated the potential sustainable yield at between 1.66 and 1.8 tonnes/km^2 mangrove/year or 5,500 tonnes/year for the whole of Madagascar. The production of crabs steadily increased from 500 tonnes in 1985 to 1,500 tonnes in 2007. To avoid overfishing, regulations were introduced in 2006 on the exploitation of the mangrove crab, *Scylla serrata*.

Mozambique: The mud crab (*Scylla serrata*) and the blue swimming crab (cf.*Portunus pelagicus*) are important artisanal fisheries. The blue swimming crab are sometimes caught with drag-nets, but the most common method to catch them is by walking in the sand at low tide with a spear. Both the method of netting and spearing of crabs result in a relatively high % of juvenile individuals as well as egg carrying females being caught and killed. Crab production and export values indicate a decline in stocks (Mozambique MEDA 2012).

Somalia: Populations of the mud crab, *Scylla serrata*, which are targeted by the artisanal fishery are also declining in Somalia.

Tanzania: There is a commercial fishery for mangrove crabs *Scylla serrata*. The potential catch of the large mangrove crab was estimated to be 5- 10 tonnes wet wt/month in Pangani and in 1989 the price of the crab was TShs. 75/Kg (Semesi and Mzava 1991). Today the price of the crab is ranges from TShs 2500-6000/kg.

3.4. Excessive bycatch and discards

Comoros: The Comoros MEDA (2012) does not discuss the issue of by-catch or discards.

Kenya: Artisanal fishers often use destructive gears such as beach seines and small-mesh gill nets, which result in the capture of juvenile fish.

Madagascar: Traditional methods of shrimp fishing are diverse in all regions of Madagascar. Five main types of gear are used and it is thought that the low selectivity of traditional gears could have a negative impact on the stock recruitments. The use of mosquito seine fishing for the traditional shrimp fishery led to the capture of juveniles of many invertebrate species, mainly in the West and Northwest coasts and beach seines are common in the region of Toliara.

Mauritius: The Mauritius MEDA (2012) does not discuss the issue of by-catch or discards.

Mozambique: Little is known about the extent of marine mammal bycatch in Mozambique. Entanglements in gillnets appear to be a major cause of dugong mortality along the whole coast. The level of this threat has increased since the early 1990s alongside an increase in gillnet use. Gillnets affects small coastal cetaceans, particularly bottlenose and humpback dolphins. A marked decline in coastal dolphin populations was observed in the early 1990s. The gill net fishery also has a by-catch comprised by *Mugil cephalus, Liza alata, L. duciae, Hemiramphus far* and *Rhabdosargus sarba*. The shrimp fishery by-catch is dominated by Sciaenidae family (Otolithes ruber, Johnius amblicephalus). The most important fish by-catch species in the semi industrial prawn fishery are *Leiognathus equulus, Gazza minuta* (Leiognathidae), *Otolithes rubbe*r (Scianidae), *Mugil cephalus* (Mugillidae), *Pomadasys maculatus, Pomadasys kakaan* (Haemulidae), *Hilsa kelee* and *Pellona ditchela* (Clupeidae).

Seychelles: Pelagic trawling is a very unselective fishing mode with a 5% bycatch which include charismatic species such as dolphins, turtles and sharks.

Somalia: The offshore trawling grounds, especially those targeting prawns, are showing signs of overexploitation with excessive bycatch and discards. A significant fraction of shrimp bycatch is composed of juvenile fish and on average, only 32% of the bycatch is retained, with a discard rate of up to 1.8 tonnes per trawler per day (KMFRI 2003).

South Africa: A number of industrial fisheries in South Africa have problems with excessive bycatch and discards: discarding of non-tuna species such as the oilfish *Rivettus pritiosus* is a growing problem in the tuna longline sector; there is a seasonal bycatch problem on the west coast with juvenile horse mackerel and on the east coast (ASCLME area), high bycatches of horse mackerel can be problematic at times; the prawn trawl fishery (deep and shallow) has a major bycatch concern; and species mixing between juvenile anchovy (*Engraulis encrasicolus*) and juvenile sardine (*Sardinops sagax*) is an "early season" fishery problem resulting in discarding and dumping (South Africa MEDA 2012).

Tanzania: One of the major threats to turtles in Tanzania is shrimp trawls, and 16 turtles (green, hawksbill and loggerhead) were caught during a by-catch survey conducted in 2007 in the industrial prawn trawl fishery (Muir, 2007b). Gillnets also pose a major threat to all species of turtles (adult and subadult) in Tanzania. Most captures are incidental (Muir, 2005, Tanzania MEDA 2012).

3.5. Expansion of mariculture industry (biosecurity, diseases in wildstocks, exotics, habitat implications, water quality)

Comoros: The Comoros MEDA (2012) does not discuss the issue of mariculture.

Kenya: New experimental mariculture activities have been set up along the south coast of Kenya. This a developing sector and there are 8 finfish farms, 6 crab farms and 4 prawn farms, all of which are currently producing for domestic consumption. There has however been inadequate coordination, which has resulted in land-use conflicts, problems of theft, poor water quality and other problems reported from the sector. The destruction of mangroves to make way for prawn farming, as well as the potentially harmful use of wild caught crablets, highlights some of the unsustainable practices currently taking place.

Madagascar: Mariculture is a developing sector in the Malagasy economy with research and pilot projects ongoing in mud crab, sea cucumber, blue-green algae, oyster and eel. Commercial large scale farming of prawn for export and domestic consumption, as well as small-scale production in seaweed is also established. Prawn farming has been very successful in providing employment for rural communities, supplying 4,325 permanent and 30,000 part time jobs in 2003, and export revenues worth an estimated $62 million USD (Madagascar CLA, 2012). The main impact of farms on the environment is the periodic draining of wastewater ponds. The water is rich in phosphates, nitrates and organic matters (and may also contain pathogens, antibiotics and pesticides). During the last five years, diseases emerged in wild populations of shrimp; the link to aquaculture has not yet been confirmed (Madagascar MEDA, 2012).

Mauritius: Only one mariculture farm is active in Mauritius, with cage culture being utilized to produce goldlined sea bream, red drum and cobia in Mahebourg. The farm produces both for domestic consumption and export, employs 65 people and, in 2008, produced an estimated 750 tons. Six mariculture licenses have been granted as of 2009 and the government has identified the sector as having great potential for growth. The problems include user conflicts over marine resources, competition for coastal land with hotel developers and theft and vandalism have also been highlighted as prevalent challenges. Other constraints include the threat of cyclones and poor access to the coast. Research into the potential for the extensive lagoon areas in Rodrigues for pearly oysters, seaweed farming and sea cucumber ranching has been explored.

Mozambique: Mariculture currently employs 2,000 people in commercial seaweed farming, 80% of whom are women, and 1,000 people in commercial prawn farming, and is a strong developing sector in the Mozambican economy. There are also experimental projects underway in finfish and mudcrab, which highlight the opportunities for further development in the sector. The Mozambique MEDA (2012) does not identify negative impacts of aquaculture. There is concern about a lack of monitoring of the existing farms and assessing the potential impacts of the projects before their implementation.

Seychelles: Few mariculture activities are currently operational in Seychelles, with only prawn, giant clam and pearl oysters being produced in small-scale commercial operations. Prawn and clam production has also been decreasing in recent years due to weak demand. Farming of clam and pearl oysters are not labour intensive practices, and offer little employment. While the prawn farm on Coetivy Island employs 350 people, only 18% are native Seychellois. As the demand for marine living resources increases and natural stocks diminish, the Seychelles Government has found it necessary to promote the development of the aquaculture/mariculture industry. In early 2009, a scoping exercise to access the potential for mariculture development was conducted and one of the recommendations from this exercise was the need for the Seychelles to develop a Master plan to drive such initiative. Seychelles is opting for caged mariculture because of the scarcity of land for based aquaculture (Seychelles MEDA, 2012).

South Africa: Medium and large-scale mariculture activity is well established in South Africa, with commercial farming prevalent in abalone, seaweed, mussels and oysters, and pilot commercial projects underway in dusky kob, silver kob and yellowtail finfish. Research is also ongoing for the production of clownfish, white margined sole, west and east coast rock lobster, scallop and blood worm. Although no introductions have occurred along the south and east coasts have been linked to aquaculture, the threat from this industry remains significant. Additionally, parasites, diseases and epifaunal species associated with target species may accidentally be introduced (Minchin et al. 2009).

Tanzania: Mariculture is a vibrant sector in the Tanzanian economy, with finfish, seaweed and mudcrab being farmed in all coastal regions, and pearls and prawns also being farmed in Mafia and Tanga. Potential overexploitation and unsustainable harvesting of juveniles for use in aquaculture is a threat to natural populations. In addition, seaweed farming was identified as a potential cause of the decline in seagrass beds (Tanzania MEDA 2012).