that travels along the beach and surf zone while the ebb-tide bar forms an accretion wave that moves along the shore in deeper water. Their relative on/offshore positions depend on the inlet tidal velocities that are functions of the size of the inlet and the volume of tidal flow through it (Inman and Dolan 1989; Jenkins and Inman 1999).

Accretion/erosion waves associated with river deltas and migrating inlets are common site-specific cases that induce net changes in the littoral budget of sediment. However, it appears that accretion/erosion waves in some form are common along all beaches subject to longshore transport of sediment. This is because coastline curvature and bathymetric variability (e.g., shelf geometry and offshore bars) introduce local variability in the longshore transport rate.

Mechanics of Migration

An accretion/erosion wave is a wave- and current-generated movement of the shoreline in response to changing sources and sinks in the local balance of sediment flux along a beach. The downdrift propagation of the wave form is driven by advective and diffusive fluxes of sedimenb mass (Fig. 3a). For convenience, these processes are usually expressed in terms of the longshore flux of sediment volume Q_ℓ into and out of a control cell (Q_{in}, Q_{out}; Fig. 3b). By convention, fluxes of sediment into the cell are positive and fluxes out are negative. The net change of the volume fluxes between the updrift and downdrift boundaries of the control cell (Qin $-$ Qout $=$ divergence of drift) will result in a net rate of change in the position of the shoreline $\partial x/\partial t$. Shifts in shoreline position will in turn cause the beach profile within the control cell to adjust to new equilibrium positions (Fig. 3b). The new profile positions alter local wave refraction causing adjustments in the flux of sediment leaving the control cell (Q_{out}). The variation in Q_{out} will alternately accrete and erode the beach downdrift of the control cell. As a consequence, propagation of the accretion/erosion wave involves a chain reaction in the local sediment flux balances. The reaction is set off by a disturbance on the updrift side of the control cell that yields a shoreline response on the downdrift side.

At a tidal inlet, these dynamics are impacted by additional fluxes of sediment into or out of a control cell centered at the inlet. When the tidal transport of sediment is ebb-dominated ($\Delta Q_t > 0$), the sediment flux into the control cell builds the ebb-tide bar and increases the rate of sediment that passes over the bar to the downdrift side of the inlet (Fig. 2). This stabilizes the inlet position by decreasing deposition on the updrift side and erosion on the downdrift side. Flood-dominated tidal transport ($\Delta Q_t < 0$) has the opposite effect and will cause the inlet to migrate faster (Jenkins and Inman 1999).

Cross-References

- ▶ Beach Features
- ▶ Beach Processes
- ▶ Coasts, Coastlines, Shores, and Shorelines
- ▶ Energy and Sediment Budgets of the Global Coastal Zone
- ▶ Littoral Cells
- ▶ Longshore Sediment Transport
- ▶ Scour and Burial of Objects in Shallow Water
- ▶ Sediment Budget

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Africa, Coastal Ecology

Anton McLachlan
College of Science, Sultan Qaboos University, Muscat, Oman

Introduction

The continent of Africa straddles the equator and extends to about 35° latitude both north and south. It is, therefore, dominated by warm water regions and its coastline includes environments such as coral reefs and mangroves, except at the northwest and southwestern extremes, where temperate environments occur. The African coastline, excluding Madagascar (4,000 km), totals 35,000 km. A review of the literature dealing with sandy beaches in Africa (Bally 1986) found the earliest paper to have been published in the 1880s and, of more than 1,000 papers published over 100 years, 19% concerned north Africa, 16% west Africa, 15% east Africa and Madagascar, and 55% southern Africa, particularly South Africa. Early papers were primarily taxonomic but later publications were mainly ecological. English was the language of 59% of the papers, followed by French (29%), German (7%), and Italian (3%). This sketch for literature on sandy beaches is probably representative of all papers dealing with coastal ecology in Africa. If so, it can be concluded that coverage of coastal ecology in Africa is patchy and, whereas the coastal ecology of South Africa has been extensively researched, most other regions are less well known.

The Physical Environment

Precipitation along the African coast is mostly low, with the exception of Madagascar, central east Africa, and west Africa, where rainfall is high (Fig. 1). It is in central to northwest Africa that the largest rivers enter the sea, whereas greatest evaporation occurs in northwest Africa and in the Red Sea. Lowest salinity in coastal waters is therefore in the Gulf of Guinea and highest values are in the Red Sea. The coasts of Africa experience semi-diurnal tides, with the exception of the east coast of Madagascar, the horn and the Mediterranean coast of Egypt, where tides are mixed. Spring tide range mostly approximates 2 m, except in the Mozambique Channel where it is larger and can exceed 4 m, and along the Red Sea and Mediterranean coasts where tides are small (Davies 1972). The entire east coast experiences temperatures permanently above 20 °C, as does the central west coast. Upwelling in the southwest and northwest lowers temperatures regionally. Major currents are the Somali and Mozambique/Agulhas in the east and the Benguella, Guinea, and Canary currents in the west. Wind and wave energy is greatest in the south and lowest in the equatorial regions, the Mediterranean and the Red Sea.

Regional Descriptions

West Africa

The northwest coast, from Morocco to Senegal, is sandy and relatively unindented, but from Dakar southeast to Monrovia it becomes very indented and there are numerous offshore islands. Moving further south, the coast becomes low lying and sandy and more deltaic in nature, with large lagoons further east. The eastern area is dominated by the delta of the Niger River. Further south, the Congo River has a major influence and freshwater can extend far offshore. High precipitation and numerous rivers in central west Africa result in warm, low salinity water, known as Guinean waters, circulating in the Gulf of Guinea.

The most notable feature of this coast is the extent of mangrove forests, estimated at 28,000 km^2 or 15% of the world's mangroves. Coastal lagoons range from tidal swamps and seasonal marshlands, associated with the river deltas and estuaries, to extensive coastal lagoons, which are typical of the Guinea coast. Sea grass beds are not well developed and there are no true coral reefs due to the cool waters of the Benguela and the Canary currents. Sandy beaches occur throughout the coast, particularly along the coast of Mauritania and northern Senegal. There are permanent areas of upwelling off Senegal, Zaire, and Namibia, coupled to the Canary and Benguela currents.

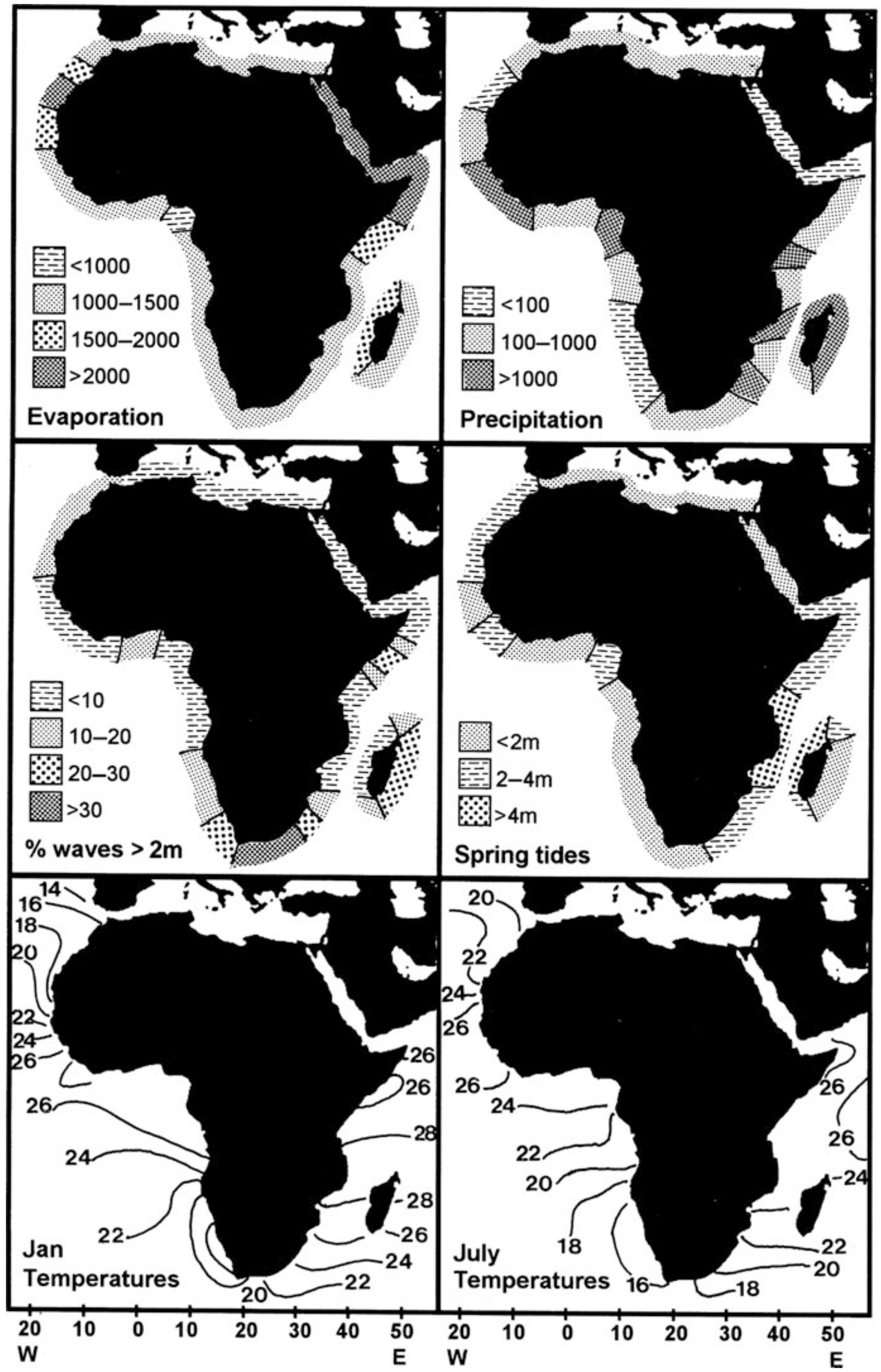
The marine resources of the west African region are important in the local and regional economies. Although seaweeds are not diverse, invertebrates (lobsters and shrimps) are exploited and there is a rich icthyofauna with about 250 species and high levels of endemism. Five species of marine turtles nest along the coast and on the islands and there are three species of crocodiles. Millions of migratory birds, especially waders, visit the coast seasonally. The northwest African manatee occurs in suitable habitats from Senegal to Angola.

The coastal human population in west Africa exceeds 50 million and the rate of industrialization and urban population growth is accelerating along the coastal zone. Oil production has increased markedly in Nigeria, Angola, and Gabon. Tourism is an important earner of foreign exchange in the economies of several countries including Gambia and Guinea Bissau. Increased fishing effort and the introduction of more efficient technologies has led to over exploitation of fisheries resources.

East Africa

Oceanic current patterns and monsoon seasons have a major influence on the biogeography and biodiversity of east Africa. The main oceanic currents are the Somali, Madagascar, and Mozambique/Agulhas currents. The continental shelf is mostly narrow, varying from a few kilometers off Pemba to nearly 145 km in the Bight of Sofala, Mozambique. The shelves and banks are areas of intensive biological activity and productivity; in general, the narrower the shelf, the less productive the sea area. The western Indian Ocean is fairly poor in fisheries compared with other regions. The mainland coast is relatively unindented due to the absence of large rivers and coastal waters are moved by coast parallel currents. Much of the Mozambican coastline consists of low coastal plains forming long stretches of sand beaches and dunes interspersed with muddy rivers. North of the Zambezi estuary, many small coral islands fringe the shore. To the south, the islands of the Bazaruto group and Inhaca are mainly sand.

Africa, Coastal Ecology, Fig. 1 Physical features of African coasts



The total area of mangrove coverage in east Africa is about 10,000 km^2 or 5% of the world mangrove. Diversity of mangrove communities in east Africa is higher than in the west, with 10 species compared with only 7. Sea grass beds are found in all countries where there are low energy environments. The east African coast features fringing and patch reefs along the coastline from Somalia to Mozambique. Sandy beaches are well developed throughout. Small-scale local upwelling occurs seasonally, particularly in the waters off Somalia.

The coast of east Africa supports an enormous diversity of life. More than 350 marine algal species and more than 135 species of coral are known and there are more than 900 fish species, mostly associated with coral reefs. The five marine turtles are abundant. The region has a varied assemblage of seabirds, including frigate birds, tropic birds, boobies, shear-waters, terns, noddies, and gulls. The dugong is present, but its distribution and migration along the mainland coasts is not known. At least 15 species of cetaceans occur along this coast.

The coastal human population in east Africa is about 80 million. Shipping/port development and tourism are the fastest growing industries in the east African coastal zone. These industries are becoming incompatible with conservation in areas where pollution threatens to destroy the scenic beauty of beaches and coral reefs.

Red Sea

The Red Sea, over 2,000 km long and up to 360 km wide, is an important repository of marine biodiversity on a global scale. It features a range of coastal habitats including coral reefs, mangroves, salt marshes/sabkhas, rocky and sandy beaches, dune systems, and sea grass beds. These habitats accommodate more than 500 species of seaweeds, 1,000 fish species, 200 species of stony coral, 130 species of soft corals, more than 200 species of echinoderms, and 200 species of birds. There is a considerable variety of coral reef types with great structural complexity. The diversity and the number of endemic species of corals are extremely high.

The coastal human population is about five million. Urbanization, oil and other industries are developing rapidly in the Red Sea and tourism plays a major role in the economy of several countries. Pressures from recreation and tourism are high in the northern part and in the Gulf of Aqaba. Much of the oil produced in the Middle East is transported through the Red Sea and land-based activities (e.g., power and desalination plants, sewage treatment plants, industrial facilities, solid, wastes, and others) are adversely affecting the coastal and marine environment.

North Africa

The north African part of the Mediterranean is warm and arid. While it exhibits a low level of biological productivity, the Mediterranean Sea, as well as the surrounding land, is characterized by a moderate degree of biological diversity. Among the ecosystems that occupy coastal marine areas, the rocky intertidal, estuaries, and sea grass meadows (*Posidonia* beds, especially in Libya and Tunisia) are of significant ecological value. The Nile delta is a major feature of this area. Endangered species include the Mediterranean monk seal, marine turtles, and marine birds. It has been estimated that 500 species from the Red Sea have entered the Mediterranean through Suez, since damming the Nile has reduced the freshwater barrier (Por 1968). The coastal population is about 40 million and human impacts are considerable. Tourism is of great importance in several areas.

Southern Africa

This region, including South Africa and Namibia, is subtropical to temperate, with cool upwelling waters in the west. It mostly consists of open high-energy coast receiving swell from the Southern Ocean. There are numerous large zetaform bays on the exposed south coast and few sheltered waters. The west is arid and the east is moist. Sandy beaches and rocky shores dominate and there are many small estuaries. Large volumes of sand transport characterize the south, with extensive, coupled dune and beach systems. Rocky shores are notable for their diversity of large limpets. Productive kelp beds occur on the west coast, and salt marshes are typical of estuaries and lagoons in the south and west. Biodiversity is highest in the east and decreases towards the west coast. Fur seals and penguins occur around the islands and two species of turtles breed on the east coast of South Africa.

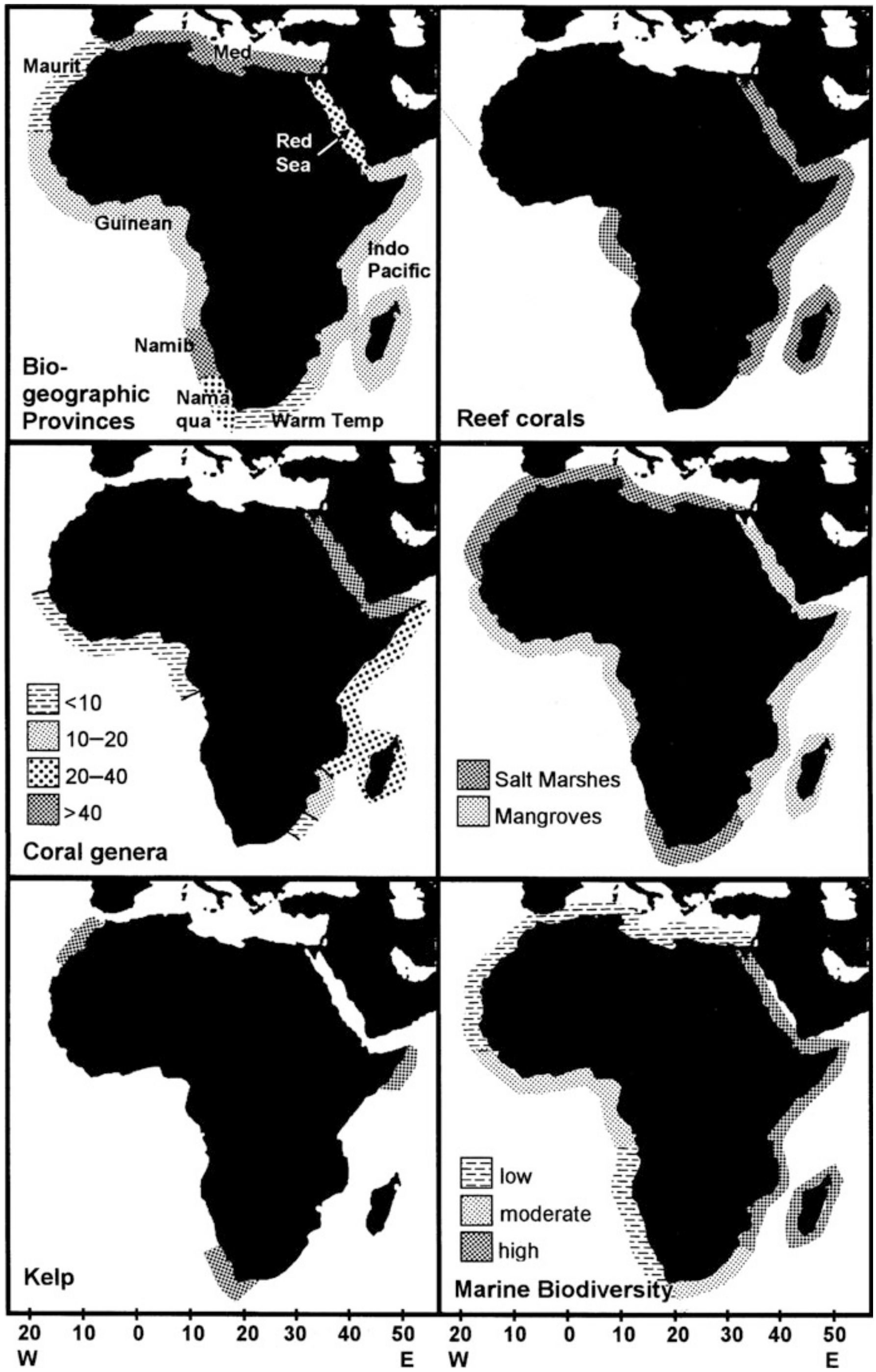
There are a number of invertebrate fisheries: in addition to abalone in the southwest and subsistence fishing on the east coast, lobsters are exploited in the south and west, and penaeid prawns on the east coast. Demersal and seine fisheries are well developed, especially on the west coast. The coastal population is about 15 million and there are five major harbors. A wide range of activities impinges on the coast: besides recreation, tourism and industry, these include dune mining for heavy minerals, beach mining for diamonds, and damming of rivers.

Biogeography

The "shallow water" or coastal marine biogeography of Africa is dominated by warm water regions (Fig. 2), the Indo-Pacific component on the east coast and the Atlantic component on the west coast. The Red Sea and Mediterranean coasts have distinctive, warm water faunas, which may be considered tropical and subtropical, respectively. Their marine boundaries are at Gibraltar and at the entrance to the Red Sea. Southern Africa harbors three provinces in addition to the Indo-Pacific component to the east: a warm temperate region on the extreme south coast and two temperate regions, the Namaqua and Namib provinces on the southwest. The eastern boundary between the southern warm temperate region and the Indo-Pacific is a broad transition region spanning the Eastern Cape and Natal coasts of South Africa. The junction between the Namaqua and Namib provinces, both influenced by upwelling, lies in southern Namibia near Luderitz and the boundary between the Namib and the Guinean is in southern Angola. The boundary between the tropical Guinean province and the north African.

Mauritanian province lies around 15°N. Biodiversity is greatest in the Indo-Pacific province and in the Red Sea

Africa, Coastal Ecology, Fig. 2 Biogeographic features of African coasts



on the east coast and lowest in the temperate provinces in the southwest and northwest (Namaqua. Namib, and Mauritanian) and the Mediterranean.

Environments

The warm water provinces are characterized by corals, mangroves and. in some cases, sea grass beds, whereas the temperate provinces harbor kelps, where there is upwelling, and salt marshes. Sandy beaches and associated dunes, rocky shores and estuaries occur throughout.

Coral Reefs

True coral reefs occur around Madagascar and along the African east coast from the Red Sea to Mozambique with some reef forming (hermatypic) corals extending further south into South Africa. On the west coast, the influence of upwelling restricts corals to a more limited region around the equator and islands off the northwest, but these are not true coral reefs. Those on the east coast are much richer in genera, being a part of the Indo-Pacific region (Fig. 2). Coral reefs are mostly of the fringing type and occur predominantly in two provinces, the Red Sea and East Africa/Madagascar (Sheppard et al. 1992). Reef development in between, around the horn and Gulf of Aden, is limited by upwelling. In the northern Red Sea reefs are well developed and drop into deep, clear water, whereas in the south they occur in shallower, more turbid water and are less well developed. Besides fringing reefs, barrier reefs, patch reefs, and even atolls can occur. Coral diversity in the Red Sea is high and there is a clear north/south zonation into 13 communities. Coral reefs also display a depth zonation with maximum coral diversity at 5–30 m depths, depending on exposure and water clarity. Coral cover is mostly less than 50% on slopes but in sheltered areas *Porites* can attain 80% cover. Coral reefs support a diverse associated fauna of cryptic invertebrates and fishes, which play a variety of roles in these complex communities. The Red Sea harbors more than 1,000 species of fishes, many associated with coral reefs. Greatest fish abundance occurs near the reef top, whereas greatest species richness tends to occur at depths of 10–15 m.

Sandy Beaches

Sandy beaches, backed by dunes, are the dominant coastal form, comprising as much as 70% of the coastline, and have been well studied in South Africa. Beach form is controlled by the interaction between sediment particle size and wave and tide energy. Conditions of high wave energy, large tide ranges, and fine sand give rise to wide flat beaches referred to as dissipative; whereas, narrow steep beaches, called reflective beaches, develop under conditions of low wave and tide energy and coarse sand. African beaches range from high-energy dissipative systems on the southwest tip of the continent, through intermediate types to microtidal reflective beaches in the Mediterranean and Red Sea. Macrotidal beaches and sand flats occur in the Mozambique Channel. High-energy dissipative systems have been shown to be richest in terms of productivity, with large populations of filter feeders (Brown and McLachlan 1990). Such beaches, together with macrotidal flats, support diverse benthic faunas. Reflective systems, which are typical of tropical regions with modest tide ranges, generally support lower diversity and lack surf zones. Temperate high-energy beaches with extensive surf zones often develop blooms of surf zone diatoms, which fuel rich food chains. Besides meiofauna and microfauna, beaches support a macrofauna of scavenger/predators, filter feeders and deposit feeders. Among the macrofauna, donacid clams, gastropods of the genus *Bullia,* ghost crabs *(Ocypode),* cirolanid isopods, mysid shrimps, and polychaete worms are typical. The species richness per beach ranges from less than 10 species on reflective beaches to more than 30 on tropical dissipative beaches and tidal flats. Zonation on sandy beaches is less marked than on rocky shores and throughout most of Africa consists of three zones: ghost crabs at the top of the shore, cirolanid isopods on the mid-shore, and a variety of species lower down. In the temperate areas, sandhoppers (talitrid amphipods) and/or oniscid isopods occur at the top of the shore. Beach fauna is, therefore, controlled primarily by physical factors and beach type, with biogeography and climate playing a lesser role.

Sea Grass Beds

In the Mediterranean, the Red Sea and throughout the western Indian Ocean, sea grass beds are common in intertidal areas, coastal lagoons, shallow sandy bottoms with good light penetration and sandy areas adjacent to shallow reefs. At least 10 species are common and include members of the genera *Possidonia, Thalassia, Halodule, Syringodium, Halophila, Cymodocea,* and *Thalassodendron.* Sea grasses are not true grasses but are closer to pondweeds. They are aquatic plants with leaves above the surface and rhizomes and stems buried in the sand. Sea grass beds create habitats distinguished by high primary productivity, enhanced by encrusting algae epiphytes. However, there is limited direct herbivory, probably due to distasteful compounds and indigestibility of seagrasses. Instead, seagrasses are consumed via detritus food chains after processing by microorganisms. Sea grasses stabilize the sediment, create habitat, and serve as nursery areas and support a high diversity of associated species, especially molluscs, polychaets, crustaceans, and fishes. Many commercial fishes utilize them as nursery areas. Ten species occur in the Red Sea, *Halodule* and *Halophila,* being the commonest.

Dunes

Dune forms depend on rainfall (vegetation growth) and sediment transport (supply X wind) and are closely coupled to beach type. Simple vegetated foredune ridges and hummocks are the most widespread type. Such dunes typically occur behind low energy and reflective beaches and are characteristic of the moist tropics. Transgressive dune sheets occur in windy areas with large volumes of sand transport, for example, the south coast of South Africa, and parabolic dunes occur in places with predominantly unidirectional winds. Coastal dunes are rapidly colonized by plants, *Ipomoea* and *Scaevola* being typical foredune pioneers. These may be followed by scrub and thicket until climax forest is reached. In the arid southwest and north of Africa coastal dunes are highly mobile and support limited vegetation. Climax dune vegetation may be scrub in arid areas, or even pioneers in hyperarid situations. In the moist tropics, forest may extend right down to the beach. Coupled to landward succession in dune vegetation is a change in animal communities: bird diversity increases as vegetation structure becomes more vertical; insects and small mammals also respond to this gradient. In general, therefore, coastal dune ecology is a function of dune forms and vegetation succession, which in turn are controlled by sand supply and climate.

Rocky Shores

Rocky shores form about 30% of the coastline of Africa. Intertidal rocky-shore organisms are exposed to a wide range of physical conditions. Unlike the situation on sandy beaches, organisms on rocky shores cannot burrow to escape adverse conditions: they must simply be tough enough to tolerate the fluctuations. Tides establish a gradient of physical stress, with the high-shore being sun-baked and desiccated, and the low-shore more mild. This gradient leads to a distinctive vertical zonation of organisms, with the top of the shore characterized by a small number of species, low biomass and productivity, and progressive increases in all these variables as one moves down the shore. Physical stress tends to limit the extent to which species can advance up the shore, but biological interactions between species often set limits to how far they extend down the shore. For example, competition from mussels ousts barnacles; grazers, such as limpets and chitons, control the growth of algae; predators, such as whelks, crabs, fish, and birds, limit the zonation of their prey. Moving horizontally along rocky shores, different gradients come into play. The first of these is wave action, which operates on a scale of meters to kilometers. Mobile predators and grazers tend to be inhibited by waves, whereas algae benefit from a reduction in grazing and from an increase in the turnover of nutrients. Filter feeders, such as mussels, are enhanced because waves import the organic particles that comprise their food. The overall effect is that biomass and productivity are highest on wave-beaten shores, such as those occurring on the south coast of Africa (Branch and Griffiths 1988).

At larger scales of 100s to 1,000s of kilometers, there are gradients of productivity. High nutrient levels associated with upwelling accelerate algal growth, supporting high biomass of grazers and predators but a low diversity of species. On a similarly large scale, there are climatic gradients from temperate to tropical conditions. High temperatures in the tropics lead to greater physical stresses, so that rocky shores there tend to be sparsely occupied, with low biomass and productivity, but high levels of species diversity. Tough coralline turfs become a dominant element among the seaweeds. Grazers and sedentary predators are often confined to shelters during low tide to avoid potentially lethal conditions. On the other hand, mobile predators, such as crabs and fish, are more abundant in the tropics than on temperate shores. In sum, vertical changes in community structure on rocky shores are dictated by gradients of physical stress overlain by biological interactions. Moving horizontally along rocky shores, community patterns and processes controlling them change radically in response to wave action, productivity, and climate.

Kelp Beds

Kelps are large and complex in structure, with a root-like holdfast, a long stipe and frond-like blades. Kelps are fast growing plants and are restricted to coastal areas where sunlight is readily available and nutrient levels are high. In Africa, they are confined to zones of upwelling, where cool and nutrient-rich water is brought to the surface by winds that drive surface waters offshore. Upwelling is concentrated on the west coast of southern Africa, off west Africa and in the region of the Somalian horn of Africa, where the world's only tropical upwelling areas can be found. Kelp forests thus occur in the southwest in the Namaqua and Namib provinces *(Ecklonia, Laminaria, Macrocystis)* and in the northwest in the Mauritanian province *(Laminaria)* and off Somalia. Kelp plants are of direct economic significance because they produce alginic acid, widely used in food and other products.

Kelps form dense underwater forests, which break the force of wave action. They are themselves, however, powerfully influenced by waves, which tangle and tear out swathes during storms. Whole kelp plants wash ashore on sandy beaches where they contribute substantially to energy flow. Sandy shores "supplemented" in this way have high levels of biomass and productivity, and their life is concentrated at the top of the shore where the kelp deposits. Surprisingly little kelp is directly eaten by herbivores; most is abraded from the growing plants and contributes to a pool of organic matter that fuels particle-feeders and filter feeders, such as sea cucumbers, mussels, ascidians, and sponges that dominate much of the floor of kelp beds. Large fragments of kelp also break off and support urchins and abalone. Intertidal grazers also benefit: the highest biomasses of grazers ever recorded in the world occur on rocky shores on the west coast of South Africa. Their existence depends on the vital "subsidy" they receive in the form of drift from adjacent subtidal kelp beds. Clearly, kelp beds play significant ecological roles that extend well beyond their confines. They are commercially valuable in their own right, but also sustain other species of commercial importance, such as abalone.

Estuaries

Estuaries, lagoons, and river mouths are highly variable around the coasts of Africa, depending on climate. Other than for the Zambesi in the east, all the major rivers (Kunene, Orange, Congo, Niger, Volta) drain to the west and the Nile empties into the Mediterranean. The Nile (20,000 km^2), Zambesi (700 km^2), Volta (9,000 km^2), Senegal (8,000 km^2), Oueme (1,000 km^2), and Niger (36,000 km^2) have extensive delta systems. Large coastal lagoons occur in west and in southeastern Africa and many wetlands are of considerable conservation value. In the arid areas of southern and southwest Africa, the Red Sea and the Mediterranean coast, most estuaries are ephemeral and close during the dry season. Many estuaries have been impacted by damming of rivers, in some cases the reduction in freshwater supply eliminating normal salinity gradients and/or reducing floodplains (e.g., Niger). Mangroves, salt marshes, and phytoplankton contribute to primary production and support benthic fauna of high abundance but low diversity. Estuaries are important nursery areas for penaeid prawns and a variety of fishes.

The regulation and impoundment of freshwater in river systems is probably the single most important threat to natural functioning of estuarine systems in many parts of Africa. Most of these estuaries are classified as temporary open/closed. Floods, in particular, are important in maintaining functional links between the estuaries and the sea, but because of impoundment schemes, changes in the frequency and intensity of flood events is becoming evident. Many estuaries close more frequently and for longer periods since the removal of accumulated sediment in marsh channels by floods is not as effective as before. Thus, many estuaries are beginning to function differently compared with the natural state. Not only do freshwater abstraction schemes lead to negative downstream impacts, but they also have the capacity to influence the marine nearshore. Major regulations along the Zambesi river (Kariba and Cahora Bassa dams) are having a negative influence in coastal waters, with die back of mangroves and a collapse of the coastal prawn fisheries (Davies et al. 1993).

Salt Marshes

Salt marshes are temperate habitats, mostly associated with estuaries. African salt marshes occur in the Mediterranean, on the northwest and on the south and southwest coasts. Most African salt marshes are of limited extent; for example, total salt marsh area in South Africa is 1,700 ha, most of which is confined to five systems. There is clear zonation of the marsh flora from the subtidal to the top of the intertidal zone, *Spartina, Zostera, Sarcocornia,* and *Limonium* are the most typical genera. These African salt marshes are distinguished from those elsewhere by their warm temperate character and limited size. Associated fauna includes a variety of marsh crabs and shrimps, wading birds and, at high tide, fishes.

Mangroves

Total world mangrove area is 181,000 km^2 and 20% of this is in Africa, 15% on the west and 5% on the east coasts (Spalding et al. 1997). On the east coast, in the Red Sea and Madagascar, they form part of the Indo-Pacific province; there are 10 species and the most widespread are *Avicennia marina, Rhizophora mucronata,* and *Sonneratia alba.* On the west coast of Africa their affinities are with New World tropical regions and, of the seven indigenous species, *Avicennia germinans, Rhizophora racemosa,* and *Laguncularia racemosa* are widespread. Distribution may be as much limited by aridity as temperature. Estuaries may harbor large mangroves systems but they can also occur as narrow strips along the coastline where rivers are absent. Associated fauna includes mudskippers *Periopthalmus,* mangrove snails *Cerithidea,* fiddler crabs, *Uca,* and oysters. Fishes and penaied prawns utilize mangroves as nursery areas. Mangroves are important sources of detritus for estuarine food chains. Wood collection threatens mangroves in several areas (e.g., Mozambique).

Islands

Coastal islands form important rookeries for seals and nesting sites for seabirds. Colonies of Cape fur seals, Jackass penguins, Cape gannets, cormorants and other seabirds occur on numerous coastal islands, especially off South Africa and Namibia. Socotra is also an important breeding area for boobys and terns and also harbors six endemic species of birds and eight endemic reptiles. Red Sea islands support colonies of gulls and terns. Islands off Mauritania are important for migratory birds and support large breeding colonies of gulls and terns.

Utilization

Coastal resources are extensively utilized throughout Africa. These activities range from subsistence gathering of shellfish and mangrove wood to commercial exploitation of abalone, kelp, lobsters, and inshore fishes. Subsistence utilization can cause degradation and damage to coastal habitats. Dynamite fishing also threatens Africa's coastal ecosystems in some localities as it disturbs coral reefs and lagoon systems. Nonliving resources that are exploited include oil (Angola, Nigeria), diamonds in beach and nearshore sediments (Namibia), heavy minerals in dune sands (South Africa), sand, rock, and groundwater. The coast is also a focal point for recreational activities including swimming, surfing, angling, and diving. Indeed, the African coastline is becoming as important as its game reserves and ancient civilizations in attracting tourism. For most recreational activity, sandy beaches are focal points. One third of the coastline is considered to be under threat from developments and other human activities.

Conservation and Management

Marine and coastal resources contribute significantly to African economies, especially through fisheries (e.g., Namibia) and tourism (e.g., Mauritius). Current development trends and pressures from increasing urbanization and industrialization are steadily degrading fragile ecosystems. Pollution, mining, and oil exploration are also threatening coastal ecosystems. Oil spills due to well blowouts have caused serious problems in the Niger delta, decimating "black water" biodiversity. In addition, toxic wastes from developed nations have been illegally dumped along the coasts of poor African nations. Many industries dispose of untreated wastes directly into rivers running into the sea. In the Red Sea and in north Africa there is an increasing risk of pollution as over 10^9 t of oil are transported through the area annually and there are limited maritime traffic regulations. The coastal countries of Africa are also susceptible to the problem of accelerated coastal erosion. This is driven by natural processes that are exacerbated by sealevel rise, upstream construction of dams, other coastal infrastructure, and clearing of mangrove systems.

In recent years, Africa has seen major political, economic, and social changes and has transformed from a rural society to a complex modern region whose ties to natural capital remain strong despite economic development. Population growth (2.8%) is almost twice the global average (1.5%), far in excess of the average rate of economic growth. In many African countries, national parks and conservation areas include parts of the coast as increasing human impact necessitates protection and management. Coastal reserves, which have been established in a number of areas to afford protection or control utilization, need to be expanded, to involve the local populations and to be better managed. Important resources/habitats requiring protection are dunes, mangroves, coral reef, and islands. Integrated coastal zone management, in its infancy or absent in most of Africa, is essential for the future wellbeing of these spectacular coasts.

Cross-References

▶ Africa, Coastal Geomorphology
▶ Beach Processes
▶ Coral Reefs
▶ Demography of Coastal Populations
▶ Dune Ridges
▶ Estuaries
▶ Human Impact on Coasts
▶ Mangroves, Ecology
▶ Rock Coast Processes
▶ Salt Marsh
▶ Wetlands

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Africa, Coastal Geomorphology

Antony R. Orme
Department of Geography, University of California,
Los Angeles, CA, USA

The African continent measures 30×10^6 km^2 and its relatively unbroken coastline is 30,000 km long, compared with the 70,000 km coast of Asia, which is only 1.5 times larger than Africa, and the 76,000 km coast of smaller North America (24×10^6 km^2) with its numerous Arctic islands. Over long distances, the African coast is unbroken by sizable inlets, and its major river mouths, except the Congo, are either deltaic or blocked by sand barriers. Excepting Madagascar (587,000 km^2), no large islands lie off the African coast.

Offshore, Africa's continental shelf covers only 1.28×10^6 km^2 compared with 9.39×10^6 km^2 for Asia and 6.74×10^6 km^2 for North America. The shelf averages only 25 km in width, wider off southern Tunisia, Guinea, and major deltas, and reaching 240 km wide across the Agulhas Bank, but narrowing to 5 km off Somalia, northern Mozambique, and Kwa-Zulu. This narrow shelf and paucity of sheltering islands allow deep-water waves and surface ocean currents to approach unmodified close to the mainland shore where they are unusually influential in moving sediment (Orme 1996).

Explanations for Africa's relatively smooth coastline and narrow continental shelf are to be found in the tectonic processes that triggered the rupture of Gondwana in Mesozoic time and in the geomorphic processes that have shaped the coast more precisely during later Cenozoic time.

Coastal Origins

The broad outlines of Africa's coastal margins may be explained in terms of plate-tectonic events over the past

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