PACE

An education programme by Tusk

Mangroves

THE LAMU MARINE CONSERVATION TRUST

PACE

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THE LAMU MARINE CONSERVATION TRUST

PACE – Pan African Conservation Education was created by Tusk and Siren Conservation Education in 2004.

This booklet on mangroves was devised and created by Penny Fraser, PACE Coordinator, with Teresa Jahangir, Marine Project Manager and her colleagues at Lamu Marine Conservation Trust in Kenya. It is one part of a series of three mangrove education resources we've created for school and community use Africa wide. Many of the photographs, and beautiful paintings are the work of Elke Bertolli, LaMCoT. She retains full copyright to her images.

Additional information on mangroves, and mangrove and sea turtle conservation is available from LaMCot www.lamcot.org and The Story of LaMCoT.

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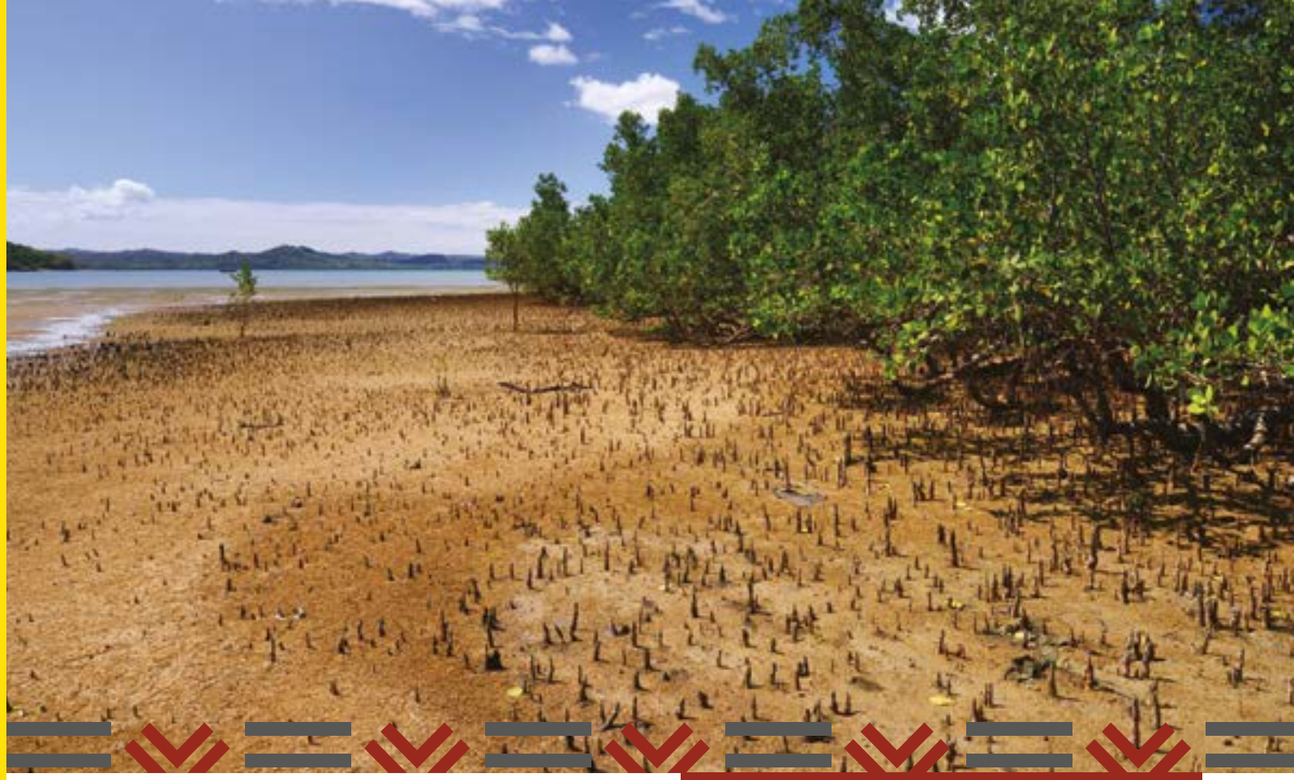

PACE – Pan African Conservation Education

PACE is an education programme of Tusk. PACE is about helping people solve their everyday environmental problems, especially problems that impact on their wellbeing, and on the wildlife and ecosystems we all depend on.

PACE works with conservation and education partners across Africa. Our educational resources are available free of charge. They are arranged in modules: Living with Wildlife, Water, Soil, Trees, Energy, Living by the Ocean, Urban Living, Health and Careers in Conservation.

Lamu Marine Conservation Trust

Lamu Marine Conservation Trust is a Community Based Organisation on the Lamu Archipelago, in Kenya. It was set up by a local hotel owner in 1992, to protect their declining turtle population. LaMCoT has used a grass-roots approach that involves everyone in the local commuities in conservation activities of one form or another. The unsustainable harvesting of turtles and their eggs has ceased and turtles, beaches where they nest and mangroves and reefs where they feed are now monitored and protected. LaMCoT has vibrant education, community development, ecotourism, waste management, and tree planting programmes. They are also taking a lead on establishing and the management of community coral conservancies. Their Bahari Yeta festival is an annual highlight!

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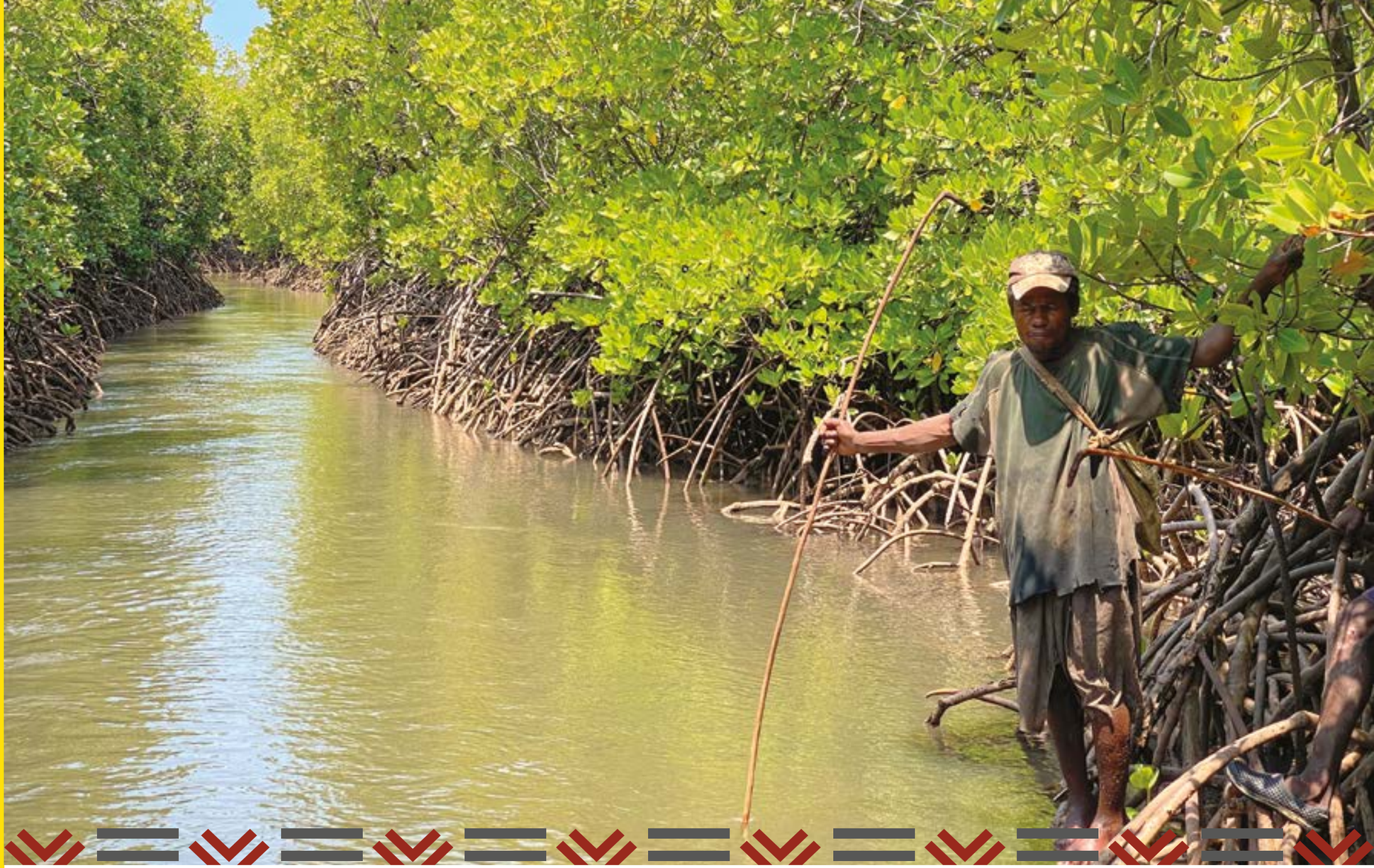


Why Mangroves?

Mangroves are a type of forest, an ecosystem, and also a group of plants.

Mangroves grow on sheltered coast, coastal lagoons, creeks and tidal estuaries around the tropics. Mangrove trees are unique, in their ability to thrive in conditions that will kill most plants. They have an unusual appearance and adaptations, and form a most extraordinary ecosystem. Mangrove forest provides a home, resting place, feeding, breeding and nursery site for a huge range of wildlife, in the air, and above and below the water. Many more marine, bird and land species, as well as coastal communities, depend on the products, regulating role, ecological processes and cultural value of mangroves.

Mangrove grows on nearly 15% of the world's coastline, and in twenty-eight African countries, but it's under threat – clearing for agriculture, industrial and other human development, and in Africa often from simple overharvesting.

Too many people do not know about mangroves, what makes them special and important, why we should take care of them, or how. This booklet is an introduction. It accompanies a short PACE film on Mangrove conservation, and an Action sheet on mangrove planting and sustainability.

Mangroves

Mangroves are woody trees or shrubs that grow on certain sheltered, low-lying coast and tidal shores throughout the tropics, subtropics and warm temperate latitudes, including in Africa.

They grow at or close to sea-level, in places that are protected from strong tides and powerful ocean waves, places like deltas, creeks, bays, estuaries, lagoons, backwaters and the sides of islands away from the open sea. Mangrove species have evolved to survive conditions that would kill most plants. They can tolerate changeable, hot, humid conditions, and salty, often waterlogged and low oxygen soils.
The wood of mangroves is often termite resistant, leaves are thick and fleshy, and roots can have extraordinary shapes. The word Mangrove also refers to the type of forest these plants form.

In 2020 there was 14,735,900 ha of mangrove in the world, 2,139,309 km or 14.9% of the world's coastline!

Mangroves in Africa

Thirty-three African countries have coastline. Twenty-eight of these have mangrove forest. On the West, Atlantic coast of Africa mangroves can be found from Mauritania in the north to Angola in the south. On the Indian ocean coast they grow on suitable sites from north to south.

Mangroves grow on tropical, sub-tropical and warm temperate coasts between 32° N and 38° S.

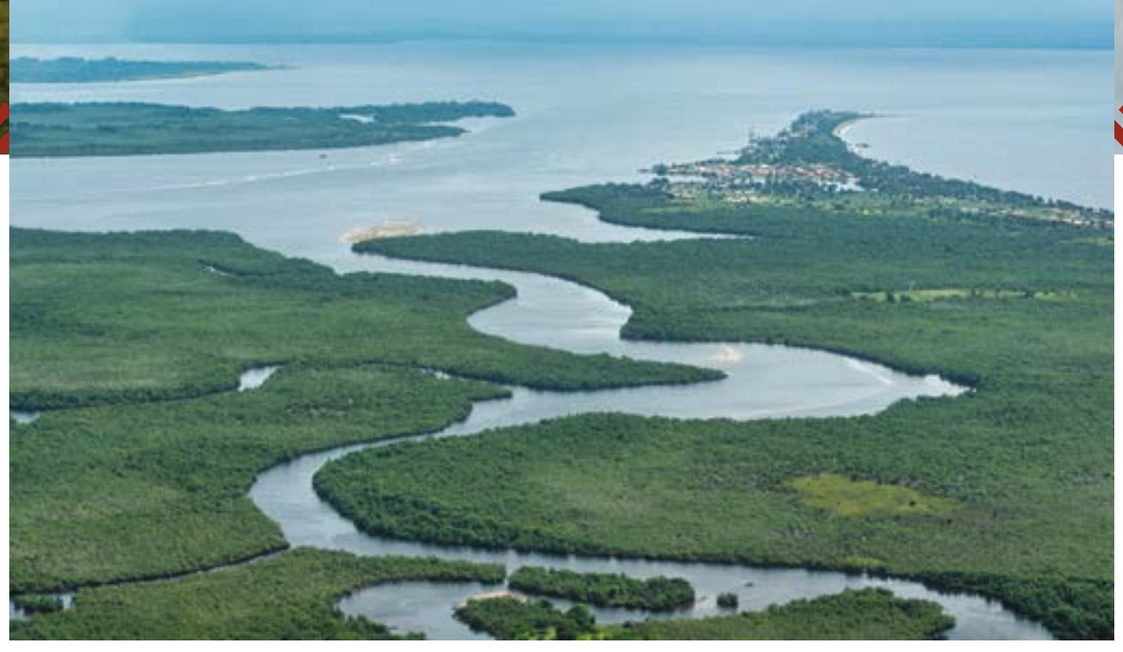
Africa has nearly 20% of all mangrove in the world.

Mangroves like places where the land slopes gently into the sea. This creates a large intertidal zone (the area covered by water at high tide and exposed at low tide), conditions that suit mangroves.

Aerial view of mangroves on Bissagos archipelago, Guinea Bissau. Looking towards the ocean.

The West coast of Africa has

15% **of all the world's mangroves.**



Aerial view of mangrove forest at the mouth of the Congo river in the deepest, and second longest river in Africa. Looking towards the Atlantic Ocean in the background.

Aerial photos of mangrove forest on the Indian Ocean coast of Kenya in East Africa, on the Lamu archipelago.

Tide in

Tide out

In 2022 there were **29,350 km²** of Mangroves in Africa

74%
on the West African coast

26%
on the East African coast

55%
of Mozambique's coastline is mangroves

53%
of Kenya's coastline is mangroves: **544 km²**

The largest areas of mangroves grow where temperatures are above

24°C

89%
of Guinea's coastline is mangroves: **4760 km²**

86%
of Guinea Bissau coastline is mangroves: **2688 km²**

The tallest mangroves grow where there is high rainfall. The most extensive, the largest areas, are in the Niger delta in Nigeria.

Central and West Africa have more large rivers with extensive deltas and tidal estuaries.

82%
of Nigeria's coastline is mangroves: **8440 km²**

81%
of Cameroon's coastline is mangroves: **1970 km²**

Tides and intertidal areas

Mangroves grow on coasts and shores that are tidal, or influenced by tides.

Tides are the twice daily rise and fall of water level in the seas and oceans. Tides follow the daily and monthly cycle of the moon. They are caused by the gravitational pull of the moon and the sun, with local variation due to topography, currents and weather. Every day the ocean moves up and down the sea shore, in and out on a continuous cycle every 12 ½ hours. Around Africa the tidal range, the height difference between lowest and highest point water reaches on the shore varies between about 1 and 5m. Tidal range, and exact timing of high and low tides varies with geography and the weather, but highest tides and lowest tides are always when there is a full and a new moon.

Mangroves grow on coasts and shores that are tidal, or influenced by tides, exposed to the continuous cycle of salty sea water coming in and out.

Sea water is salty, mangroves are amongst the few species that can survive the low tide zone that is covered by sea water most of the time.

A coastal creek at Cacine, Tombali, Guinea-Bissau, at low tide. When the tide is highest the canoes will be floating and water will cover all the mud in this picture.

Mangrove Species in East Africa

On Africa's Indian Ocean coast there are nine mangrove species.

Avicennia marina,
Grey mangrove, Mchu

Heritier litoralis,
Glass mangrove,
Msindikundazi

Rhizophora mucronate,
Red mangrove, Mkoko in Swahili

Brugeria gymnorrhizah,
Black mamngrove, Muia

Sonneratia alba,
Apple mangrove,
Mlilana

Ceriops tagal,
Yellow mangrove, Mkandaa

Lumnitzera racemose,
White-flowered black mangrove, Kikandaa

Xylocapus granantum,
Mahogany mangrove, Mkomafi

Xylocapus molusensis,
Mahaogany mangrove, Mkomafi dume

These same species grow in other parts of the Indian and Pacific oceans, as far away as the Philippines and Malaysia, but they are not found on the western (Atlantic) side of Africa.

Mangrove Species in West Africa

On the Atlantic Ocean coast of Africa there are six native mangrove species

Avicennia germinans,
Black (also called white!) mangrove,
Palétuvier blanc/gris Mang blanc,
Bois de mèche, in French

Conocarpus erectus,
Buttonwood mangrove, Small mangle,
Grey mangrove,
Mangrove à boutons

Laguncularia racemose, also a White mangrove

Rhizophora harrisonii, Rhizophora mangle and Rhizophora racemose,
Rhizophora species are all called red mangrove,
Palétuvier rouge in French

These species are not found in east Africa, but they are found on the other side of the Atlantic in the Americas!

Biogeography is the geography of living things – where they live and geographical reasons for their distribution. Phytogeography is all about the distribution of plant species, and Zoogeography is the study of animal distribution, where species are found and the non-biological causes.

The diversity, the number of species in mangrove forest varies. In Nigeria you can find up to eight species, but in Equatorial Guinea only two! Angola, Mauritania and Togo have three species. Ivory Coast has five. Gabon, Senegal, Gambia and other West and Central African countries have seven species each – but they don't all have the same seven!

There are what scientists call true mangrove species and associate mangrove species. True mangrove species have typical adaptations and are not usually found in other habitats. Associate species don't have all these adaptations, and may grow in other habitats.

A few palm and fern species are also grouped with 'mangroves'. The Nipa or 'mangrove' palm, *Nypa fruticans,* is an example, it prefers the brackish water in mangrove creeks and lagoons to salty sea water. It is invasive and is taking over from naturally occurring mangrove species in West Africa. It is native to the Pacific and Indian oceans. It is very useful for thatching.

Acrostichum aureum, the Golden leather or swamp fern grows in mangroves everywhere. It is the only fern that can grow in mangrove conditions, it is found in West and Central Africa. It has many medicinal uses.

Characteristics of Mangrove species

Mangrove species are adapted to the harsh conditions of a coastal environment – high salinity, high temperatures and extremely anaerobic soils. Their adaptations involve how they function (the physiology), the shape and structure (morphology), their ecology (how they interact with other species and the environment), and how they reproduce.

Adaptation to salty conditions

Some mangrove species prevent salt from entering their tissues. They create a barrier, a membrane on the surface of the root that lets water enter but filters out the salt. Other species absorb salt but then excrete it through special pores in the leaves. Others absorb salty water, but move it to special enclosed compartments in the leaves (vacuoles), where it can't upset the plants functioning, and remains until the leaf dies and falls from the plant. The leaves tend to contain more water than most species, in order to balance the high salt concentrations. This makes the leaves thick and fleshy. They are described as succulent.

Some mangroves also store salt on their bark.

SUCCULENT leaves and stems are thick and fleshy. They don't lose water easily, and have space to store water. Many desert pants are also succulent.

Glands on the leaf surface remove excess salt

Adaptation to high temperature

Like other succulent plants mangrove leaves have thick cuticles and a waxy layer on the surface to prevent water loss. As well as helping to cope with high salinity described above, these are adaptations to the heat and exposure in mangrove environments. They are exposed to wind, salt spray and bright sunshine.

Adaptations to anaerobic soils

Most plants have roots that absorb the oxygen they need from air that is in the soil. Mangroves that grow close to the shore are in soil that is silty, waterlogged and anaerobic (lacking oxygen). When the tide comes in water makes oxygen even more inaccessible.

Mangrove roots don't go deep into the soil. Most have a lot of horizontal roots close to the soil surface where there is more oxygen. The roots take different shapes depending on conditions. *Avicennia* and *Laguncularia* grow specialized vertical roots upwards out of their mesh of underground horizontal ones. As well as anchoring the plant, absorbing nutrients and providing stability in the soft mud 'pneumatophores' absorb oxygen from the atmosphere.

Pneumatophores – air breathing roots

All plant tissue requires oxygen for respiration. Roots normally get their oxygen from spaces between soil particles.

In waterlogged soil, water fills these spaces, meaning there is very little air, so little oxygen. Pneumatophores are specialized root structures. They rise above the mud so that oxygen can be obtained from the atmosphere.

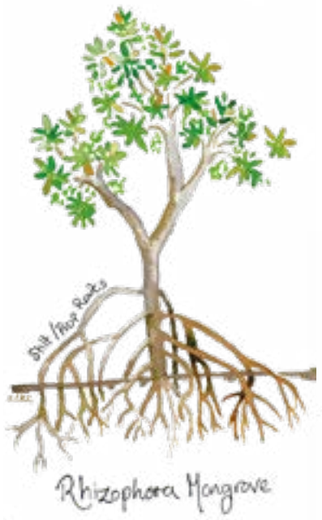
Some mangroves species have other root adaptations, that give support in in the unique wet, muddy and changeable situations where they grow.

Stilt or prop roots arch away from the main stem. They support the stem or trunk of the tree, which may remain above water level. These roots have special lenticels, which allow oxygen but limited water to enter.

Most roots grow with gravity, downwards: pneumatophoes grow upwards, against gravity.

Mangrove tree with vertical pneumatophore peg roots, as the tide comes in, at Nosy Be Island, North West, Madagascar.

Pneumatophores exposed at low tide in Kenya.



Rhizophora species are prop rooted

Bruguiera is an example of a Knee- rooted mangrove species

Sonneratia is a Peg-rooted mangrove species

Heritera is a Buttress-rooted mangrove species

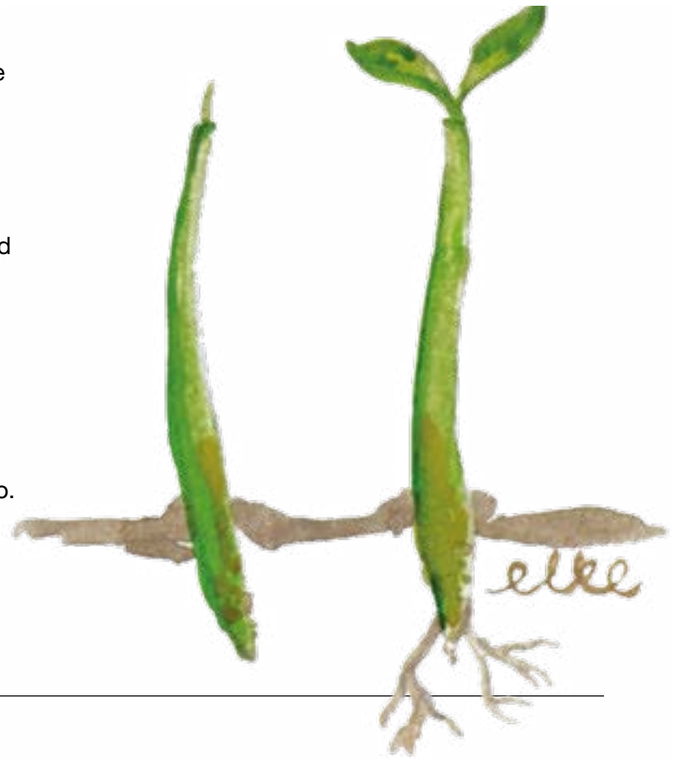
Reproductive adaptations

The fruit of Sonneratia, the mangrove apple have adapted to float on the surface of the water.

The seeds of many mangrove species germinate on the tree and start to develop into a young plant, called a **propagule**, while still attached to the parent. This is called vivipary, the species are **'viviparous'**. It is a way to survive in muddy, salty, waterlogged conditions where seeds would wash away before they could germinate and get established.

These propagules may already have grown the first leaves and roots before falling from the parent plant.

Some are a long thin shape like a dart or torpedo. A shape that helps them penetrate and get a footing in the soft mud, where roots can start growing and quickly anchor the young plant in place.



If they do not anchor immediately Rhizophora propagules can survive up to a year, floating in the water, and still be able to grow when they land somewhere suitable.

Propagules develop some salt tolerance before they drop from the parent tree. Salt will kill most plants. The propagules have lenticels, special oval shaped pores, for gaseous exchange, and can conserve oxygen to enable them to survive during flooding.

Mangroves establish best on places away from wave action. The movement of waves can prevent propagules from anchoring in one place.

Rhizophora propagules can stay viable for as long as a year.

VIVIPARY is when an organism gives birth to live young.

Most mammals are viviparous, but it is unusual for plants.

Some mangrove trees are viviparous. Their seeds germinate and develop into seedlings, called propagules, when still attached to the mother tree.

Rhizophora mangrove propagules on the tree – looking yellow green in colour, above the surface of the water, in the top part of this photo…

and growing in the mud amongst stilt roots, below water, at the bottom of the photo.

Zonation and microhabitats

Mangrove species are all adapted in slightly different ways, and different degrees to the various conditions in a mangrove landscape.

Some can tolerate very salty water most of the time, some can tolerate very salty water for only short periods of time. Some species can only tolerate slightly salty water and need to be in contact with freshwater at all times. Some species can survive if they are exposed to the hot sun and salty wind from the sea, others need to be a little sheltered. Some species can grow on rocky ground or stones, others need some soil or mud (and the nutrients these contain) in order to grow. Each species has its own favoured micro habitat.

Each mangrove species is adapted to slightly different areas and conditions, its favoured microhabitat, in the mangrove ecosystem.

Hydrology strongly influences the species that grow and the kind of forest they form. Hydrology is the quantity and kind of water present at different times, and how it moves – the rivers, springs, streams, over and underground flow.

Elevation, the height above sea level is also important.

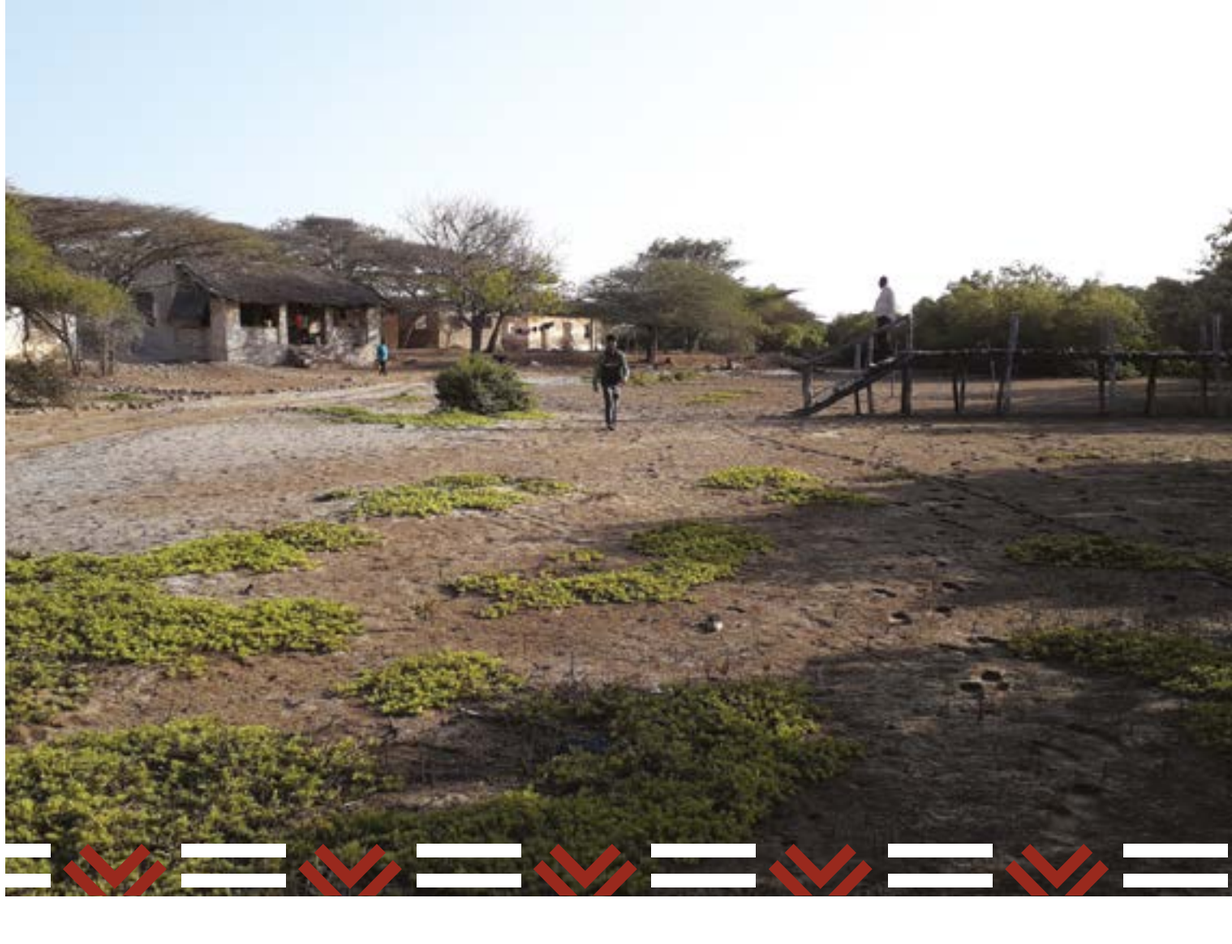
Fresh water. Mangrove forest grows best when there is plenty of freshwater. The tallest and densest is in areas with high rainfall and the shortest most open is in arid places.

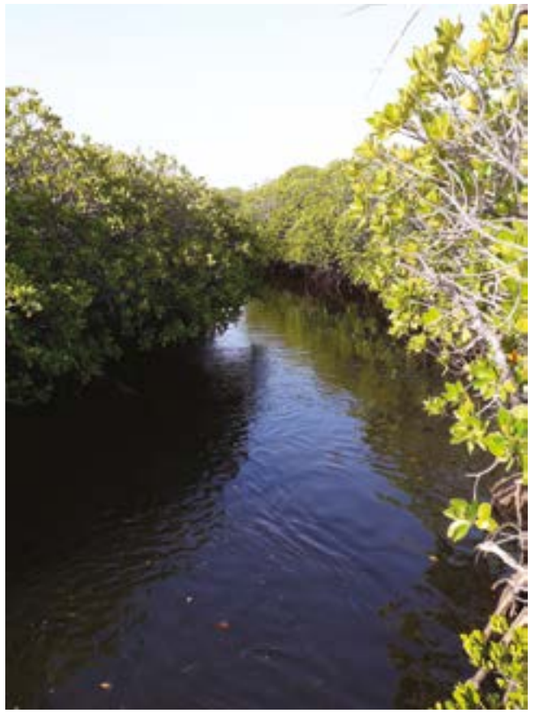
Substrate. Some mangrove species can grow on rocky and sandy soils but the most extensive forests are on silty soils that are common in deltas, lagoons, bays and estuaries.

Topography. A gentle slope on the shore creates a larger area between high and low tide. It also means the tides come in and out more gently than when the shore is steep – less erosion, less force on plants and animals living there.

When there are only gentle slopes on the land behind the seashore, it usually means that the tides extend further inland, carrying salt water up rivers and estuaries. This greater tidal ‘penetration’ allows mangroves to grow far inland, up to 100km inland on some West and Central African rivers.

Mangrove in Senegal





Tiny mangrove plants on the landward side of mangrove woodland on Lamu archipelago, Kenya (above). Water covers the ground here only at highest tide.

On the seaward side (left), trees have their feet in salt water continuously.

The tallest mangroves grow where rainfall is high. In Central Africa mangroves trees reach 40m high.

Types of Mangrove forest

Mangrove species grow in different combinations and form according to the geography of the area. For example Fringe mangrove is found along the coast, and differs from that along creeks, rivers estuaries and basins away from the open sea.

Fringe forest, on the coast, Antsanitia, Madagascar.

Mangroves when the tide is out, Cacine, Tombali, Guinea-Bissau.

Mangrove beside a tidal creek on Unguja Island, Mapopwe Creek, Jozani Chwaka Bay National Park, Zanzibar, Tanzania.

Mangroves are hot and humid, with a lot of insects!

Mangrove forest can be a very inhospitable place – to humans. The dense above-ground roots, often muddy ground make movement difficult. High temperatures and humidity are uncomfortable, and there are usually a lot of insects!

Mangrove ‘swamp’ in the Jozani Forest National Park, Zanzibar, Tanzania.

Mangroves and wildlife

Mangroves provide a wide range of habitats, above and below the water, in the branches of the trees, on and around the root systems, in the water, mud and sand. Mangroves provide homes to birds, mammals, amphibians, reptiles, a wealth of insects and other invertebrates. Mangroves have a very rich meiofauna, very small invertebrates that live at the bottom of the water, and provide food for a wealth of larger species.

Birds

The shallow mangrove mudflats – between high and low tide – are important feeding sites for birds. The Rufiji and Zambezi deltas in east Africa are particularly important for migrating curlew sandpiper, little stint, roseate tern, and Caspian tern. In Ghana, Gabon and Nigeria mangrove deltas are very important feeding grounds for migrating birds. In Madagascar ninety-nine bird species have been recorded in the mangroves. The Malagasy Sacred Ibis is only found in Madagascar (it is endemic), and it is becoming rare because of a loss the mangrove and estuary habitats it needs.

Adult Malagasy sacred ibis (*Threskiornis bernieri bernieri*) in the Betsiboka delta in northern Madagascar.

Hippopotamus (*Hippopotamus amphibius*) emerging from mangroves, Loango National Park, Gabon.

Mammals

Bats live in mangroves, they play an important role pollinating and dispersing seeds of many fruit and timber trees. Depending on the location, various species of monkey live in mangrove forest. The Sclater's guenon is a famous and flagship resident of Central African mangroves and the blue-monkey, black and white colobus elsewhere. Reedbuck and bushbuck live in the mangroves on the Congo river delta in DRC.

Upstream mangroves in parts of the Niger delta, where the water is less salty, are an important habitat for Nile crocodile, hippopotamus, and spot-necked otter.

Dugong migrate all the way from Asia to feed on seagrass growing in the mangrove channels in Madagascar. Four of Madagascar's critically endangered lemur species and 13 endangered lemur species also use mangroves as home.

The Western African Manatee - Trichechus senegalensis – lives along the central and west African coast. They are increasingly rare, and depend on mangroves.

Also called Sea cows, they graze on sea grasses. Adults can reach 4m long, and weigh up to 590 kg! They have a flat, paddle like flipper tail. In the Niger delta they are are considered a totem for Niger goddess Oshimili. Manatees saving drowning people may be the origin of Mami Water mermaid, legends.

Enyi Mmiri, also known as Western African Manatee, T*richechus senegalensis,* photographed in creeks deep in the Niger delta by Ebiojo, 2024.

Fish

Mangroves are important breeding and feeding grounds for a huge number of marine species. They provide shelter and refuge for economic species of fish, crabs, shrimps and molluscs as well as many other fish that are critical parts of our marine ecosystems. Mangroves filter silt and sediments, preventing it from flowing onto coral reefs and seagrass beds. The reefs and seagrass are unique and vital for a huge range of marine wildlife.

Turtles

The Ridley, Hawksbill, and Green turtle all breed and feed in East African mangroves, the Tana River and Rufiji Delta mangroves are especially important for them. In Central and West Africa five species are known to use mangroves – the Leatherback, Loggerhead, Olive Ridley, Hawksbill and Green turtles. The African soft-skinned turtle also lives there.

Crustaceans

Crustaceans like shrimp, prawns, crabs and lobsters live in the mangrove waters. Crabs dig holes in the mud.

Meiofauna

Many very small invertebrates, called meiofauna live in the bottom of these waters. They are the bottom of the food chain, they provide food for the larger species.

Mangroves and people

Many coastal communities depend on mangroves – for products and for ecosystem services.

Products

Mangroves are a source of fish, crabs, shrimps and other shellfish, traditional medicine, fruit, fibre, and mangroves are an important habitat for honey bees.

Mangroves provide wood and charcoal for domestic and commercial use. Mangroves provide poles for construction of houses, fences, furniture. The wood of many mangrove species is termite resistant. Mangrove wood is used to make fishing boats, and fish-traps.

Tannin from mangroves is used in the leather industry.

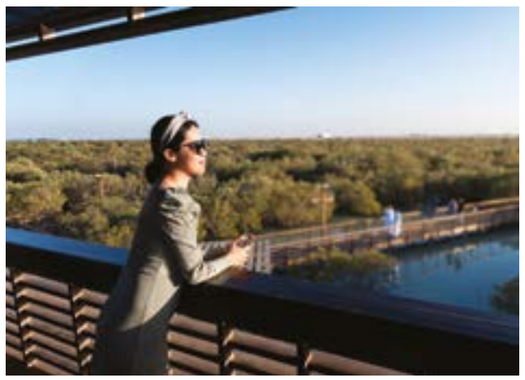
Culture, leisure and well-being

Mangroves are often sacred places. They are also tourist attractions.

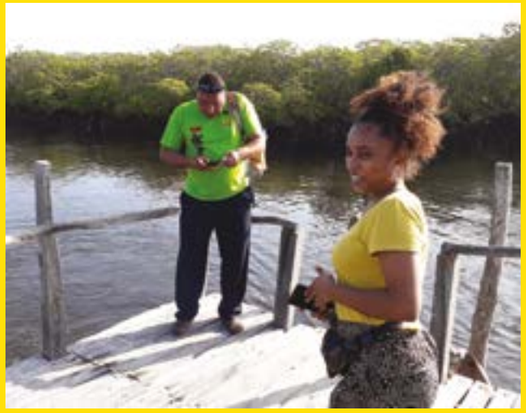
Bird watching and fishing is popular.

Others come to relax, watch nature and enjoy the ambiance.

Boardwalks, sometimes with restaurants are often built to allow paying visitors to easily access and enjoy the mangrove environment, like this one in Kenya.



There are many ways to enjoy and profit from mangroves sustainably. The Jubail Mangrove Park in Abu Dhabi, has a visitor centre with a viewing tower so that people can have an aerial view across the mangrove landscape. They also have kilometers of boardwalks, as well as sailing and kayaking.



Ecosystem services

Ecosystem services are the benefits people derive from the environment or an ecosystem.

Ecosystem services include products like wood, medicines, fish. It also includes the roles of the ecosystem – regulating and protecting, against floods, erosion, climate change; cultural, social and well-being benefits including tourism, recreation, spiritual well-being; processes, like nutrient and water cycling; primary production and biodiversity including birds, bats and insects that pollinate cops and disperse seeds.

Eighty nine percent of fishers in Nigeria fish mostly in and around mangroves.

Mangroves protect and regulate

The dense roots and stems of mangrove forest protect against ocean storms, tsunamis and cyclones. They provide shelter against the force of wind and waves coming in from the ocean.

Mangroves protect coastal land, property and communities from floods, strong winds and erosion.

Mangroves clean and filter water, maintaining and improving the water quality. By filtering silt, detritus and pollutants, mangroves also keep the sea water clean and productive for fisheries and other biodiversity

Mangrove forests are helping us manage climate change. On a local scale they act as a buffer against the rising sea levels caused by climate change. On a global scale they act as a carbon ‘sink’ storing carbon that would contribute to climate change if it were released into the atmosphere. One cause of climate change is the large quantity of carbon dioxide (CO_2) released into the atmosphere by human activities like burning fossil fuels (oil and gas), wood and charcoal. Mangroves, like other forests, absorb very large quantities of CO_2 from the air. They use it in photosynthesis to produce biomass – the wood, leaves and roots. They therefore act as Carbon stores, meaning that less is released into the atmosphere where it will contribute to climate change.

Nearly half the world’s population live within 100 km of the ocean. Our biggest cities are close to the ocean. These populations, and their use of land for housing, agriculture and industry is putting pressure on mangrove forest.

Over the past 50 years mangrove habitats have been lost faster than any other type of forest. The greatest loss has been in Indonesia, then Australia, Mexico, Myanmar and Cuba. We must care for our African mangroves – so they don’t disappear in the same way!

Threats to mangroves

Mangroves are naturally dynamic - they change. Natural events like storms and processes like coastal erosion cut away at mangroves. Equally, sedimentation can create new spaces that mangroves quickly colonise and expand into.

While mangroves do continuously change, human activities exaggerate these natural processes. The biggest losses of mangrove forest and woodland are caused by people. People clear mangroves, and they modify coastline for many different reasons, in ways that increase erosion. Some human activity results in decreased sedimentation, and that can also change where mangroves grow. So, while mangroves do self-repair and regenerate naturally, sometimes we need to help, especially where use by or damage from humans is heavy.

Overharvesting, agriculture, industrialization, coastal development and pollution are causing many mangrove forests to degrade, shrink, and in some places to disappear completely. Mangroves are often used as dumping grounds for agricultural and industrial waste, even sewage. Some people think that pollution will be washed out to sea and disappear, but it causes damage on the way – pollution is destructive, to mangrove plants, wildlife and the ecosystem as a whole.

The Mangroves below have been dug up on the Wouri estuary, opposite the port of Douala in Cameroon.

Photo by Esenge Angeli Robincrusoe.

Planting mangroves

Planting is mainly done in places where mangrove forest has degraded, been lost or altered, either because of human or natural factors. It's usually only done when there are no signs of natural regeneration within 6 to 12 months after changes to the physical conditions: for example, if trees are cut, or died due to drought, storms or flooding.

Reasons to plant mangroves

- Enhance natural regeneration, biodiversity and ecological restoration.
- Sustain yield of wood and non-wood products – poles, timber and charcoal.
- Coastal protection, erosion control and channel stabilization in lagoons and estuaries.
- Support and protect fisheries.
- Establish new mangrove locations.
- Adapt to climate change.
- Coastal landscaping and ecotourism.
- Social enrichment.
- Legislative compliance – your local government need to maintain the mangroves by law and ask for help.

When to plant

The rainy seasons are the best time to plant because most mangrove species grow fastest when there is high rainfall. Planting seedlings or propagules at the start of the wet season, allows them to establish and build enough reserves to survive the dry season.

Which species to grow

Choose species that occur naturally in your area. Mangrove species should be planted in the particular microhabitat, on the substrate and position up the shore, that suits them.

Where to plant.

Many factors need to be taken into consideration for mangrove planting on scale. Be sure to research well, consult experts and all stakeholders.

See PACE Action sheet #89 Mangrove planting and sustainability, it explains how to propagate and grow mangroves, for small scale practical projects.

Inside mangrove 'swamp', Jozani forest in Unguja aka, Zanzibar Island, Tanzania

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