Sandy Beaches 1A

About 70% of South Africa's 3000 km-long coastline is made up of sandy beaches and dunes. These are extremely dynamic systems, constantly reshaped by wind, waves and currents.

Physical processes

Sandy beach ecosystems can be divided into three zones:

- The surf zone, where waves break
- The beach, which includes the intertidal and backshore zones
- The dunes, made up of small, recently formed foredunes and large, established backdunes.

In the sea, waves and currents continually move sediment along the shore, as well as on- and offshore, in a process known as littoral transport. On land, wind blows sand from the beach into the dunes, called aeolian transport. When sand blown up the beach by onshore winds is trapped by plants growing near the driftline, it forms mounds called hummocks, which initiate the development of foredunes. Sandy beach systems therefore comprise a marine wave-driven ecosystem and a terrestrial wind-driven ecosystem that together make up the littoral active zone – the area in which sand exchange occurs.

While sand exchange is an ongoing process, some seasonal effects linked to weather conditions are noticeable. During stormy weather, rough seas erode sand away from the beach and foredunes and deposit it as a sandbar offshore. When calm conditions return, gentle waves carry the sand back to rebuild the beach. In this way, the beach undergoes seasonal cycles of erosion and accretion.

Flora and fauna

At first glance sandy beaches may seem devoid of life, but they support a diversity of animals and plants interacting in a complex food web. Many of these organisms are hidden below the sand.

Life between the sand grains In the moist sands of the surf and intertidal zones, as well as in the slacks between dunes where the water table is close to the surface, an entire community lives between the sand grains. Microscopic diatoms are the primary producers of this food web, and together with fungi and bacteria that obtain nutrients from organic matter, they provide food for protozoans such as flagellates and ciliates. Meiofauna, which are no larger than 2 mm and include nematodes, copepods and ostracods, have a range of feeding forms. They consume bacteria, diatoms, protozoans, other meiofauna and detritus, and are found in particularly dense concentrations beneath decomposing seaweeds stranded on the shore. This so-called interstitial food web therefore plays an important role in sandy beach ecosystems by breaking down organic matter and recycling nutrients.

Life in the surf zone In the surf zone of high-energy and nutrient-rich beaches, dense blooms of phytoplankton (microscopic algae) provide a source of food for zooplankton, such as small shrimps and prawns. A variety of fish are also found in the surf zone of sandy beaches, including pompano, baardman, mullet, steenbras, galjoen, elf and sandsharks. While some are plankton-feeders, others eat molluscs, crabs and worms from the sandy bottom, or prey on fish.

Life in the intertidal zone No rooted plants or attached seaweeds can survive the harsh environment of the intertidal zone (the area between the high and low water mark), but some animals are able to burrow into the sand to escape the pounding waves, and rely on food imported from the sea. For example, sand mussels and mole crabs filter phytoplankton from the water, as well as the detritus of seaweeds broken down into small particles by the pounding surf. The plough snail emerges from the sand to scavenge on stranded jellyfish and bluebottles, and is preyed upon by the three spot swimming crab. However, birds are the top predators of the sandy beach food web. Kelp gulls and oystercatchers are

able to crack open the shells of sand mussels to reach the succulent flesh inside, while plovers and Sanderlings pick shrimps and worms from the sand and may even nip off the protruding siphons of sand mussels and clams.

Life in the backshore zone In the backshore zone (that part of the beach above the high tide mark), stranded animals and seaweeds that accumulate along the driftline are food for ghost crabs, insects, amphipods and isopods. They in turn are consumed by predatory beetles and birds. In addition, African Black Oystercatchers, White-fronted Plovers and Damara Terns nest in this zone, while in Kwazulu-Natal leatherback and loggerhead turtles lay their eggs at this level.

Tidal and lunar rhythms

Many of the animals that live on the sandy shore have tidal or lunar rhythms to help them survive. The plough snail migrates up and down the beach with the tides to feed on stranded animals, while the mole crab and some types of sand mussel migrate with the tides to ensure that they remain in the surf zone – the best place for filter-feeding. Isopods and ghost crabs are most active at night, when the moon is not full, thereby reducing the risk of predation and desiccation, and only emerge at low tide to avoid being swept away by waves. Sandhoppers emerge from the sand at dusk and migrate down the beach to feed on debris such as decomposing kelp, and then return at dawn to bury themselves in the sand near the driftline. They use the light of the moon for orientation.

Life in the dunes

Behind the driftline, vegetation encourages the development of dunes by trapping mobile sand. Strong wind, high salt loads and rapid sand movement restrict the vegetation in this area to a few 'pioneer' species, mostly grasses and creeping plants such as sea pumpkin, dune gazania and pipe grass. These hardy plants are adapted to grow ahead of accumulating sand, stabilising it so that other plant types can follow as the dune matures, in a process known as succession. Pioneer species give way to a community of shrubs such as waxberry, taaibos, hottentot's fig and blombos, which may be replaced on older and more stable dunes further inland by scrub-thicket comprising milkwoods, sea guarri and bietou. On the oldest dunes, and where rainfall is sufficiently high, a climax community of dune forest may develop, as in Kwazulu-Natal.

The most abundant invertebrates in dunes are insects such as ants, bees, wasps, beetles, earwigs and flies, although spiders are also common. A total of 932 vertebrates (amphibians, reptiles, birds and mammals) have also been recorded from our dunes, the number increasing from the dry semi-desert west coast through to the high rainfall dune forest of the east coast. The west coast, however, supports higher numbers of the 31 species that are endemic to dunes. Of these, 13 are listed in the Red Data Book as in need of conservation.

Threats to sandy beach ecosystems

Sandy beaches and dunes are sensitive systems that can be damaged or disrupted in a number of ways.

- Development in the littoral active zone, including breakwaters, groynes or buildings, impedes the natural movement of sediment along the shore, as well as between the dune, beach and surf zone. This may result in erosion of beaches or sand inundation of buildings. Artificially stabilising dunes with vegetation (often through unchecked infestation by alien species), or removing the foredunes for development or mining, removes the reservoir that supplies sand to the beach.
- Off-road vehicles (ORVs), and trampling by people and livestock, may destroy dune vegetation. As a result, dunes may gradually move inland, devaluing and threatening adjacent property. ORVs may also crush animals buried in the sand, as well as the eggs and young of birds nesting above the driftline. Furthermore, their tracks can impede the movement of small animals, such as turtle hatchlings and ghost crabs.
- Pollution also impacts sandy beaches, especially oil spills, which can have devastating consequences. Oil is toxic to most animals, and can smother them or affect their swimming ability. Plastic and other forms of litter are not only unsightly, but can cause painful death for animals if they are mistaken for food.

Author: Sue Matthews September 2000

FURTHER INFORMATION:

• Branch, G. & Branch, M. 1981. *The Living Shores of Southern Africa.* Struik Publishers, Cape Town.

RELATED FACTSHEETS:

• Off-road Vehicle Use • Dune Vegetation • Ecosystems in the Sea • Erosion and Siltation • Tides

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Sea Sand 1A

Sea sand is formed when rocks and the hard shells of marine organism are broken down into small particles by wind, waves and weathering. Technically speaking, sand grains are between 0.2 and 2 mm in size. Smaller particles form silts and clays and larger particles are known as gravels. Many different coloured sands clothe the coast of southern Africa. The east coast sands are often brown because of a high soil content washed down by the rivers. They also contain black heavy metals. The white sands of the Eastern and Western Cape have a high shell content and originate from pale sandstone. Miniature red garnets sprinkle the water line near Rooi Klippies in Namaqualand. In Namibia the towering red dunes and wind scoured valleys were once scattered with diamonds. Some of the most beautiful sand is found at Agate Beach near Luderitz, where the agates sands are sorted by the waves into rows of tiny glistening gemstones, each worn into a little round pebble one or two mm in diameter.

Sands formed from rocks

Although most of the rock-making minerals are present in sand, quartz is by far the most common; because it is abundant in rocks, is comparatively hard and it has practically no cleavage planes so it is not readily worn down to a fine state. Moreover, it is nearly insoluble in water and does not decompose. Quartz consists of silicon dioxide or silica (SiO^2). Lime or calcium carbonate and feldspar are often common in sea sand. All sands contain small quantities of "heavy" rock-forming minerals such as garnets, tourmaline, zircon, tutile, topaz, pyroxenes, amphiboles and iron ores. In desert areas such as Namibia the high iron content gives the dunes their characteristic orange glow. In certain areas these heavy metals become concentrated by the removal of the lighter particles by currents or wind. Economically valuable deposits of heavy metals are being mined in Namaqualand and around Richards Bay and further deposits have been identified in the Transkei. Dune mining is an ecologically sensitive operation as dune vegetation is often destroyed. Dune reclamation is a compulsory part of dune mining but unfortunately it is almost impossible to replace climax dune forests that have taken aeons to develop.

Sands from sea shells

The hard shells from marine organisms are so plentiful in some areas that they form a major part of the sand particles. On the west coast huge banks of shells are cast up on the shore after winter storms. These are gradually worn down by the elements to become sand grains. In coral seas and on the east coast of S. Africa, the hard skeletons of the coral comprise part of the sand. Sea urchins, with sturdy spines, break down to form coarse calcareous sands and are common in the Galapagos and Mozambique. Some sands when examined under the microscope are seen to contain millions of beautifully sculptured shells of tine marine organisms that occur in plankton, these are foraminferans, diatoms and radiolarians.

Abrasive action of sand

A walk along a windy beach with the sand blasting against one's legs, makes one realise the abrasive force of sand. The movement of sand by the wind is an important geological process, especially in desert regions. It produces a highly distinctive landscape with wind sculptured balancing rocks, and wind swept valleys with polished rocks. The early diamond finds in the Spergebied of southern Namibia were largely due to the sifting and sorting of the sand by the winds. For hundreds of miles from the Karoo to the Kalahari there are rows of reddish dunes, urged north westwards by the prevailing south-easterly winds. The older dunes are covered by vegetation but the newer dunes march relentlessly forward. The Quiseb River forms a barrier and each rainy season the floods wash away the sand that has accumulated. At the river mouth however the dunes

PHOTO G. BRANCH

Sand – rippled by wind and wave

PHOTO G. BRANCH

Polished agate sand (magnified)

have won the battle and the river flows under the towering dune barrier only to emerge again at the coast at Sandwich Harbour.

Don't build on dunes!

There are also dramatic examples of sand movement where people have built houses in dune fields. A classic example is at Rooiels in the Cape where houses were built in the dunes so that their owners could enjoy prime views and access to the beach. Owners discovered that their homes formed a barrier to the wind blown sands, which soon reached window height and threatened to engulf them. As a solution vegetation was planted on the small dunes in front to trap the sands and protect the houses. But ten years down the line another problem emerged. The frontal dunes had reached such a height that the houses no longer had their stunning views. So the owners wanted to removed the vegetation and let the sand blow away – but where to! Dune fields are some of the most dynamic environments and should not be built on or interfered with.

Waves and sand

Waves also drive the sand grains creating a powerful abrasive force, grinding away cliffs, rocks and promontories. The sand is continually moved and sorted by the waves and then as the waves dissipate, the sand is dropped to contribute to sandy beaches. It is very important to use models of harbours and breakwater barriers to test the effects of waves and sand movement before building such structures.

Uses of sand

The abrasive properties of quartz sand have been put to many uses as sandpaper, grindstones and for sand blasting. Garnet sand is used in fine quality abrasive polishes for jewellery. In 1994 the Chinese ship the Apollo Sea sank off the Cape coast causing a devastating oil spill that coated the Cape Peninsular beaches. The sand beaches had to be laboriously sieved to remove the oil – which resurfaced again the following year when the winter storms turned over the sand. The oil that coated the high level boulders was removed by blasting sand in a high-pressure jet of water to loosen the oil. In these conditions, another option would be to use steam cleaning techniques.

Very pure quartz sand is used as a source of silica in pottery, porcelain, glass making and silicate (water glass) industries. Quartz is a non-conductor of electricity and is not acted on by acids (except hydrofluoric acid used for etching). It will fuse in an oxyhydrogen flame to form a clear colourless glass. This is used to line the hearths of acid steel furnaces and for making moulds in which metals are cast.

Quartz comes in many beautiful colours and textures, creating popular gemstones such as agate, purple amethyst, aventurine, carnelian, rose quartz and garnets. Tiger's eye is a silica replacement of asbestos, which maintains the fibrous texture of the asbestos.

Sand in building

Sand is an important component of cement and concrete, which is used to stick together bricks and to build structures. Cement used in building is made by grinding clay and limestone together. The mixture is then burnt in a large kiln at such high temperatures that it starts to melt. The small lumps, clinkers, formed on cooling are ground into a fine grey powder. When mixed with water, this powder sets as hard as stone within a few hours. The cement can be strengthened by the addition of gravel or stone or by reinforcing it with steel rods. This reinforced concrete is used to build skyscrapers. Sand used for building is usually obtained from rivers or older dunes from which the salt has been leached away. Builders must have a permit to collect sand. Sand mining can have a detrimental effect on the dune vegetation and must be carefully controlled. Children on the Cape Flats have been smothered and killed by collapsing sand banks while playing in mined areas that were not properly fenced off.

Sandstone

Sand stone is formed from sand and sediment that settles in layers over a long period. Under the weight and pressure of many layers, sometimes several kilometres thick, the sand becomes cemented into solid rock by silica or calcium carbonate. Sedimentary coastal rocks such as Table Mountain Sandstone and Malmesbury Shales are made up of layers of sand and mudstone and these often contain the remains of living organisms preserved as fossils.

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FURTHER INFORMATION:

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• Erosion and Siltation • Sandy Beaches • Dune Vegetation • Sensitive Coastal Areas • Orange River Mouth • Dune Mining • Mining the Sea • Marine Fossils

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