CHAPTER 3

Living on the rocks

Figure 66. The view from Mowbray Ridge looking across the Cape Flats to Table Bay and the hills of Tygerberg.

In Cape Town's hundreds of millions of years of geological history presented in Chapter 2, humans don't feature. Our earliest human ancestors appear only on New Year's Eve in our calendar year of Earth history (around 5 to 7 million years ago), and humans similar to us have been around only in the last 20 minutes (200 000 years). And yet modern humans, particularly over the last 10 000 years (the last minute of Earth history as one calendar year), have had an alarming and accelerating impact on Earth's surface environments. Our success at using natural resources to survive and multiply has resulted in alterations of the local as well as the global environment (Figs. 66 & 67). It is as if, having arrived late to the party, we are hell-bent on making up for lost time. Humans have so altered the landscape and atmosphere, particularly since the Industrial Revolution, that our activities are now considered a geological force in their own right and a new geological period has been proposed: the Anthropocene (the human period).

Human activities have a large and visible impact on Cape Town's landscape. Buildings, roads and agricultural fields dominate the lowland areas; the air is filled with the background hum of activity; and, on still winter days, a brown blanket of smog hangs over the city and Cape Flats (Fig. 68). Cape Town is blessed by the close proximity of rugged mountains that provide a natural green space to these developed lowlands, but even the surrounding mountain areas have not entirely escaped human influence, with their large reservoirs, pine plantations and hiking trails. In this chapter we explore the impacts of human activities on the environments and landscapes of Cape Town.

Figure 68. A layer of brown haze (smog) hangs over the Cape Flats, partially obscuring the mountains to the east, as viewed on a winter's morning from the University of Cape Town campus.

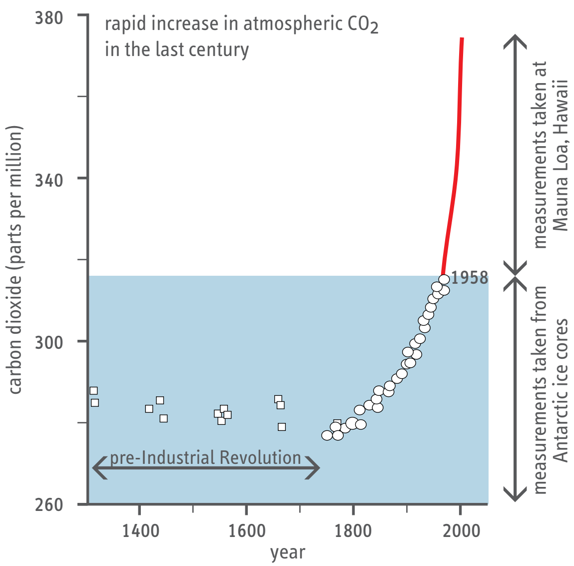


Figure 67. The record of increasing carbon dioxide gas in the atmosphere.

Greenhouse gases

Perhaps one of the most alarming human impacts is the rapid increase in the amount of carbon dioxide (CO_2) and methane gas in the atmosphere, in part because, although it is undetected by our senses, we are immersed in it globally (Fig. 67). Carbon dioxide and methane gases are present in relatively minor quantities but they play an important role in retaining heat in Earth's atmosphere. Along with water vapour, these gases capture some of the energy that Earth continuously radiates out to cold space. By capturing and transferring this energy to the atmosphere, these gases maintain a temperature significantly higher than would be the case if they were not present. They are referred to as greenhouse gases by analogy to the window panes of a greenhouse.

The increase in greenhouse gases can be attributed to the burning of fossil fuels (coal, oil, natural gas) and land use changes (destruction of forest; increase in rice paddies, cattle, concrete, etc.). The increase in these gases is accompanied by an increase in their removal by Earth processes in the oceans and on land. These reactions provide 'negative feedbacks' to the increase in CO_2 and will eventually take out much of the CO_2 we are currently adding to the atmosphere. The problem is that the rate of removal is slow compared to the rate at which we are adding CO_2. It will take tens of thousands to hundreds of thousands of years before the excess CO_2 currently being pumped into the atmosphere is removed. Not much comfort to worries of significant global climate change in the coming century.

If you look carefully while walking along coastal areas of the Western Cape, you are likely to find evidence of earlier human occupation. Old rubbish heaps, or middens, are the most common evidence of human activities and contain mostly discarded mussel and limpet shells piled into mounds or scattered over the surface (Fig. 69). These shellfish were collected from their rocky coastal habitats and carried up to several kilometres away to be consumed by people episodically living in the area. Most of these middens, like the rock paintings in the Cederberg Mountains, are less than 2 000 years old.

Stone tools found scattered on weathered, wind-deflated surfaces indicate that our human ancestors have been in the Western Cape region for at least the last 500 000 and perhaps the last million years. There is as yet no bone or stone tool evidence of our earlier human ancestors, like the 3- to 5-million-year-old fossils from Taung in the

Figure 69. A typical accumulation of discarded shellfish (midden) in coastal dunes next to Langebaan Lagoon at Kraalbaai. The midden is located above the calcrete layer of Figure 64. Radiocarbon analysis (Fig. 34) of limpet shells from the bottom of this layer reveals that it has been a popular picnic site for the last 1 600 years.

Figure 70. The opening to Peers Cave in the TMG sandstones above the town of Fish Hoek. The cave contains evidence of Cape Town's early human habitants, such as rock paintings (right) and tools made from sandstone and silcrete, a finely crystalline quartz rock (below).

Northern Cape and from the Sterkfontein caves at the Cradle of Humankind World Heritage Site near Johannesburg.

Stone tools and other artefacts from Peers Cave, located in the Table Mountain Group sandstones above the Fish Hoek Valley (Fig. 70), indicate that Cape Town's early human inhabitants used the shelter on and off for the last 200 000 years. Unfortunately, the record of human occupation at Peers Cave was largely destroyed by the crude methods used during its initial excavation – methods that included the use of dynamite! More recently, human footprints approximately 100 000 years old were found remarkably preserved in old dune sand deposits at Langebaan Lagoon (Fig. 63). Similarly aged stone artefacts were recovered from open-air sites exposed in the Geelbek dunefield adjacent to Langebaan Lagoon (Fig. 58), excavated from cave sites along the West Coast at Yzerfontein, and found along the South Coast at Blombos Cave. These late Middle Stone Age sites, spanning from roughly 100 000 to 20 000 years ago, are of particular interest because it was during this time that the first evidence has been found to suggest abstract thought expressed as symbols or art.

These early human inhabitants of the Cape Peninsula were probably largely similar to the San (Bushmen), living by hunting and gathering and roaming the countryside in search of fresh water and game. They made use of marine resources such as intertidal shellfish, made stone tools from locally derived rocks and used emptied ostrich eggs to carry water. Their impact was probably small because of their small numbers, and the extent to which they manipulated the environment was probably limited to the use of fire.

Pastoralists – people who herd sheep and cattle – migrated from the northeast into the Western Cape around 2 000 to 1 600 years ago. The pastoralists interacted with the hunter-gathers through trade in pottery and ostrich eggshell beads. The human population as well as the number of grazing herds increased during this time. The environmental impact of these early inhabitants included the partial conversion of renosterveld to grassland, perhaps by use of fire, and the displacement of wild by domesticated herds. These changes were relatively small compared to those that would occur later upon arrival and expansion of industrial populations from Europe. Many of these changes have been touched upon already. Here we examine in greater depth how in the pursuit of controlling our environment and obtaining natural resources, we have significantly and often adversely altered environments in the Cape Town area.

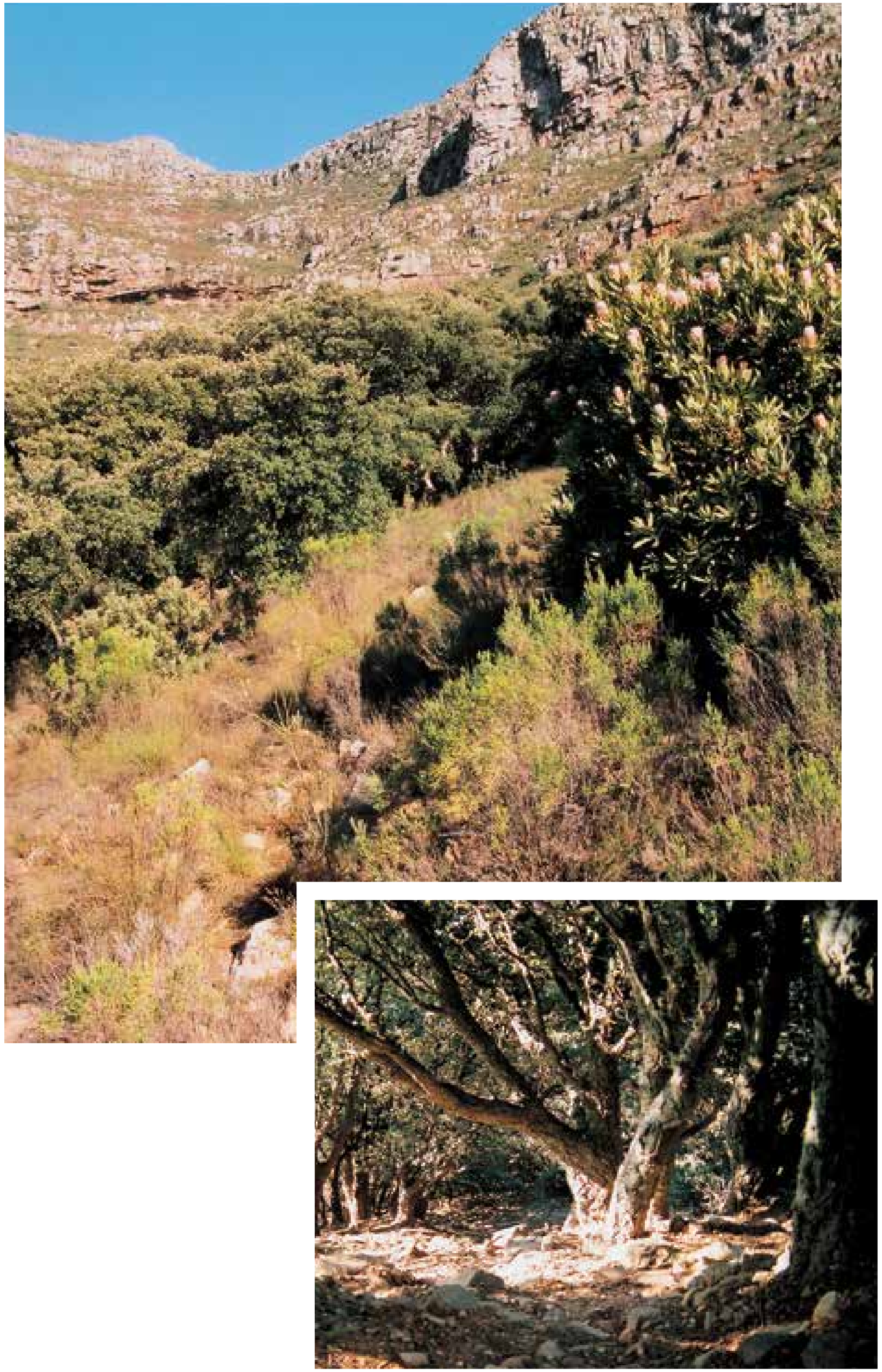
Alien invasion and the loss of soil, water and biodiversity

A far more visible impact of human activities than the increase in greenhouse gases is alteration of the landscape. The burning of natural vegetation to grow crops, and the building of fences, dams, roads and cities, all result in the destruction of what were the habitats of plants and animals prior to the arrival of humans. The fragmentation and destruction of natural habitats has resulted in the rapid loss of species both locally and globally. It is estimated that the rate of species loss is greater now than during Earth's past mass extinction events, in which more than half of the species on Earth were lost as a result of environmental changes brought about by large-scale volcanic activity and extraterrestrial (asteroid) impacts.

In addition to habitat destruction, the introduction of alien vegetation by European settlers has had a major impact on Cape Town's environments. The low-lying Cape Flats have suffered the greatest impact from the displacement of vegetation by farming, buildings and roads. Human activity has been so widespread and so effective in altering the low-lying areas that incomplete relics of the original Cape Flats lowland fynbos survive in only a few small areas, such as the inside oval of the century-old Kenilworth Racecourse and Rondebosch Common.

Alien plants were considered desirable and necessary at the time to make the area hospitable and profitable. Much of the indigenous renosterveld vegetation on the low-lying and fertile soils of the Malmesbury rocks has been replaced by wheat as well as vineyards to support a large agricultural industry. Most of the once-mobile dune sands on the Cape Flats are now stable because of the planting of Australian acacias such as Port Jackson. The residents of the Cape Flats are spared the nuisance of wind-blown sand and the large alien bushes provide shade and wind breaks as well as wood for fire and building not obtainable from the smaller indigenous plants. Many of the mountain slopes are covered by pine forests, which once provided an important source of wood for fuel and building. Hiking through the pines of Cecilia Plantation (which are now being felled in order to reinstate the indigenous vegetation) has always been a distinct experience from walking on the more exposed, windy and sunny trails on the fynbos slopes of Table Mountain; the smell of pine sap is reminiscent of home to Northern Hemisphere visitors. And some might argue that the tall, flat-topped stone pines indigenous to the Mediterranean give the hills around Rhodes Memorial and the Cableway end of Tafelberg Road a more interesting, majestic look. Why then the concern over alien plants if they have proved so useful and have added new dimensions to the landscape?

Today we have a very different perspective from that of the early European settlers because of a greater understanding of ecosystems and because we are now witness



to some of the negative as well as positive consequences of introducing alien species to the Cape. Many of the aliens planted for the purpose of stabilising the dune sand (primarily the Australian acacias Port Jackson, rooikrans and black wattle) have spread rapidly into other environments where, rather than providing economic or practical benefits, they are having large detrimental impacts on the ecosystem. It is the unpredicted and rapid spread of these alien plants that is of greatest concern. From both a practical and an ecological point of view, the largest negative impacts of alien plants have been an accelerating loss of water, topsoil and biodiversity.

Loss of biodiversity refers to a reduction in the total number of species of plants and animals. The Cape Floral Region is remarkable for its large number of different plant species that live in a relatively small area. For example, it contains over 500 species of heather (ericas), even though the differences between these species may be subtle. Furthermore, many fynbos species are restricted to specific mountain environments on the Cape Peninsula. But, you might wonder, wouldn't the introduction of new and additional species to an ecosystem increase biodiversity? Initially, yes, but where alien species so effectively out-compete indigenous plants, the diverse indigenous plants of an area are rapidly replaced by one or two successful alien species over time. The ability to proliferate varies hugely among alien plants. Eucalyptus trees grow relatively slowly and are not particularly invasive, whereas the Australian acacias are extremely aggressive.

The loss of species is alarming and readily apparent. If you walk through a grove of eucalyptus, rooikrans or pine, you will notice the almost complete absence of other plants as they are either shaded or crowded out. An area once characterised by several hundred different species now contains only one species. Remember too that not all of those hundreds of replaced fynbos species are widespread. Some will have grown only in that particular area where the alien species has taken over, so that the alien newcomer has effectively caused the extinction of the indigenous species. And once extinct, a species can never be recovered. The side effects of invasion are also visually striking: the soil is often bare or rocky with large alien roots unable to retain the thin fine topsoil,

Figure 71. The stark contrast between a highly diverse fynbos ecosystem (ericas in foreground; large protea bush to the right) and a grove of cork oaks on the slopes of Table Mountain. The heavily shaded interior of the cork oak grove reveals the severe loss of smaller plants and topsoil from underneath the cork oaks (inset).

the number of insects is greatly diminished and the area is less aesthetically pleasing, with far fewer textures and colours (Fig. 71).

If fynbos plants have spent millions of years adapting to the specific environments of the Cape region, why is it that they are being out-competed by alien invaders? The success of the aliens is based on their ability to make a living out of nutrient-poor soils. Indeed, many Australian soils are more impoverished than those of the Cape region. In addition, alien plants have deep-penetrating roots to tap underground sources of water and are no longer hampered by pests and diseases of their homeland. But perhaps most importantly, they, like the fynbos, are adapted to fire, but have the great advantage of producing viable seeds after only one year of growth. Many fynbos plants require on average seven years before their seeds are mature. Alien plants are also larger than fynbos plants and hence fuel hotter, more intense fires that make them a far greater fire hazard to surrounding communities. If fire reoccurs every two rather than ten years, then the Australian acacia seeds, but not the fynbos seeds, are mature and able to sprout. Therefore, the spread of alien plants has benefited from human activities which have greatly increased the frequency of fires on the Cape Peninsula.

In addition to the loss of biodiversity, alien plants greatly increase water loss from the environment. The deep tap roots and large size of alien plants allow them to act like big water pumps: extracting water from below the surface and transpiring it out to the atmosphere through their leaves, where it is blown away by the dry summer wind. This extraction of groundwater by alien plants to the atmosphere, water that was otherwise destined to flow in streams or springs, draws down water levels and endangers the health of the ecosystem. Hence, the primary argument to eradicate alien vegetation is to save precious water. The Department of Water Affairs and Forestry has instituted the Working for Water Programme to increase employment and to remove the deleterious alien plants – a very worthwhile but extremely difficult task given the pervasiveness and resilience of the alien invaders.

Therefore, the widespread invasion of alien plants diminishes the ecosystem by significantly reducing its water, species diversity and beauty. Degradation of the ecosystem renders it less useful in the long run to humans as well. Soils are no longer as fertile, there is less water available, landscapes are less attractive to tourists, and potential medicinal and other uses of extinct indigenous plants are lost forever. But we need to grow food, and relatively fast-growing shade trees are pleasant to have around in summer. The solution may be in a compromise to limit the number and extent of alien species. To try to completely remove these plants and return the environment to its original condition would be impractical, but stopping the unintentional rapid spread of alien plants that have such a large negative impact must be a priority to prevent further degradation of the ecosystem.

Water from the rocks

The need for fresh water is one of the major factors that influenced early and later inhabitants of the Cape. Many ancient sites of human occupation are situated near water courses or seasonal springs, and the early Dutch settlers abandoned Saldanha Bay as an ideal harbour for lack of fresh water. After people settled in Cape Town, their activities were soon limited by the scarcity of sources of fresh water and it became necessary to build dams, first upon Table Mountain and later in the Hottentots Holland Mountains. But as soon as new water resources were established, use would outstrip supply and thus began a never-ending escalation in the quest for fresh water. The emphasis has now shifted to water conservation and to promoting an awareness of just how precious water is because of the economic and ecological costs of supplying it. South Africans are not alone in their concerns about water. The World Health Organisation estimates that nearly one in six people on Earth lacks access to sufficient fresh water.

We are all familiar with how water arrives in Cape Town as rainfall that then soaks into the soil or runs off the surface into streams to return eventually to the ocean. But the pathway of water is more complicated than this because of its long-term interaction with the vegetation, soil and underlying sediments and rocks (Fig. 72).

The rain that falls in Cape Town is nearly pure, with only 20 grams of dissolved salts (mostly sodium chloride or table salt) in every 1 000 litres of water. The salt content of water running off Table Mountain remains low because the rocks are mainly made up of quartz, which is only slightly soluble in water. The water that flows off Table Mountain is acidic (with measured pH values of less than 4) because it picks up CO_2 from the organic-rich fynbos soils through which it seeps and because Table Mountain rocks lack feldspar or carbonate minerals that can react with and neutralise the acidic waters (Fig. 21). These waters also leach soluble organic compounds from the fynbos soil to give mountain streams a distinct yellow to brown colour similar to that of rooibos tea.

The water that resides in the pores and fractures of subsurface sediment and rock is referred to as groundwater. An aquifer is a system of specific subsurface sediment or rock layers that contains substantial and extractable quantities of groundwater. For example, many homes have shallow boreholes that tap the water-saturated sands of the Cape Flats aquifer to water their gardens. The quality of water from the Cape Flats aquifer varies, often smelling of rotten eggs (as a result of hydrogen sulphide gas generated by microorganisms), and it can stain surfaces orange when the iron in the water is oxidised upon exposure to air. Near-surface aquifers are also more prone to contamination from leaking petrol and septic tanks, and over-extraction of water from areas near the coast can destroy the aquifer by intrusion of sea water. In built-up areas such as Cape

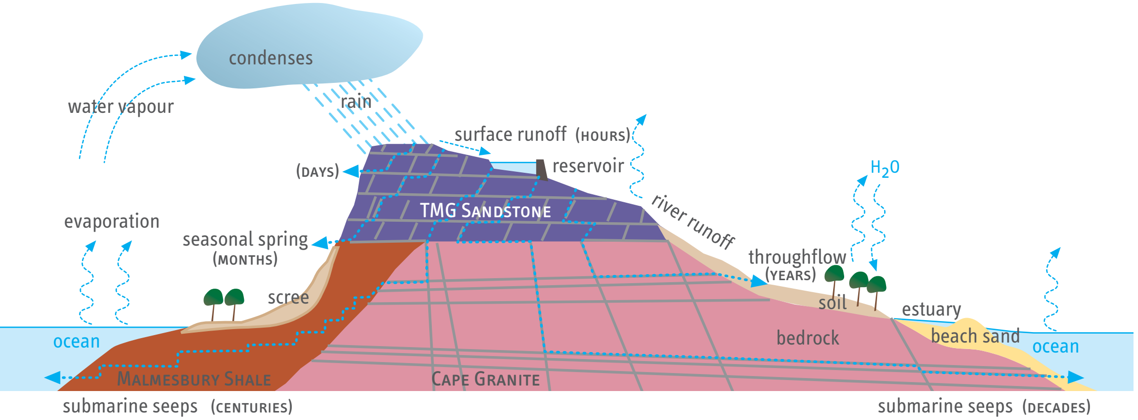


Figure 72. A simplified schematic diagram of Cape Town's hydrologic cycle, showing the pathways that water can follow in its cycling between land and sea.

Hydrologic (water) cycle

Fresh water is obtained by evaporation, mostly as nearly pure water from the salty sea but also from plants and from water on land, such as rivers, reservoirs and lawn sprinklers. Water in the air then condenses to form clouds and rain. Much of the rain that falls on land is evaporated back into the atmosphere, runs off the surfaces and flows into rivers. Alternatively, it soaks into the soil and percolates down into the underlying rocks to be taken up by plants or to continue flowing into the fractured bedrock at depths below the reach of plant roots (Fig. 72). Groundwater flows slowly through sediment or bedrock to emerge later along river courses. Because of the low flow rates, owing to the small size of the connected cracks and pores of the sediment or rock, the time interval between rainwater seeping into the ground and emerging back on the surface as river water can be hundreds to thousands of years. For this reason, rivers with large enough catchments can flow the entire year, even in areas like Cape Town where rainfall is seasonal.

Town, rainwater is quickly lost as runoff from rooftops, tarred and concrete surfaces. Rapid runoff results in more flooding and less seepage of water into soils to replenish groundwater in urban areas.

Groundwater can also occur in rocks to great depths below the surface and in places makes up an important natural long-term reservoir of water. The Table Mountain Group sandstones of the Cape Fold Belt collectively contain vast quantities of groundwater and are actively being explored as an additional source of fresh water to help meet Cape Town's ever-increasing demand. For example, groundwater extraction is currently being tested at several trial boreholes in the Olifants River Valley near Citrusdal (Fig. 73).

The idea of using groundwater is similar to the principle behind a surface dam: to extract groundwater during dry periods of the year or during drought periods and to allow replenishment of groundwater during the rainy season. But the building of dams, canalisation of rivers and extraction of groundwater all contribute to altering the natural flow of water and the sediment it carries through the environment. Groundwater extraction may lower the subsurface water level (water table) and reduce the flow of water in springs and rivers. The reduced flow could then endanger surface ecosystems that depend on water for their sustainability, particularly during dry periods when these ecosystems are already stressed.

Figure 73. A section cut through the deep Table Mountain Group aquifer in the large fold (syncline) of the Olifants River Valley. Cool rainwater enters the elevated rocky exposures of the Cederberg Mountains on the eastern side of the valley and makes its way slowly down through the fractured rock to exit eventually on the western side of the valley. Because the column of water in the eastern flank of rock is higher, the water naturally flows through the rocks to exit in the Olifants River Valley. At the Baths resort near Citrusdal water flows out at natural warm springs at a temperature of 43°C. The water is warmed during its slow, deep journey through the folded rocks.