In general, the African continent may be divided into seven broad geographical regions. Each region is defined by distinct geological, climatic and/or ecological characteristics and landscapes which, in turn, determine the soil properties. Specific soil types are not necessarily exclusive to a region (i.e. Cambisols may occur in all regions while Gypsisols are only found in arid locations). However, broadly speaking each region can be characterised by a typical assemblage of soil types (e.g. wetlands and river valleys will contain more gleyed, organic-rich and fluvial soils than other regions). In summary, the soil regions of Africa can be described as:

- **Mediterranean** – found on the northern and southern margins of the continent. The climate is characterised by a dry, hot summer (>35°C) and cooler winters (10°C), with rain fall only in the winter months. Vegetation tends to be shrubby but agriculture can be productive if water is readily available. Soil organic matter levels are generally low. Soil parent material tends to be rich in lime or gypsum.

- **Deserts** – consisting of the Sahara, the Kalahari and the northern Kenya–Somalia region. In addition to high aridity, the desert region is characterised by high mean monthly temperatures and large daily temperature range (often greater than the annual range of the mean monthly temperature). As a consequence, vegetation cover is low or non-existent and soils are coarse-textured, shallow, rocky or gravelly. Finer particles can be blown away leaving heavier fragments behind.

- **Sahel and Savannah** – covering almost half of the total surface area of the continent, the savannah is a mixed grassland/woodland ecosystem that is adjacent to the forest region. The soils are generally well drained and possess a thin layer of organic matter, which can be thicker in wetter conditions. They can support limited cultivation but can quickly become impoverished. Savannah regions often receive large quantities of sand and dust from adjacent drier regions.

- **Forests** – tropical forests are characterised by high levels of vegetation and the lack of seasonality (temperature is constant and conditions are either rainy or dry). Soils are generally nutrient-poor and acidic. Decomposition of organic matter is rapid and soils are subject to heavy leaching. Variations in climatic conditions cause a variation in the species composition and structure of the forest and consequently affect soil characteristics.

- **Mountains** – the mountains of Africa fall into two broad types. The Atlas Mountains of North Africa, together with the highlands of the Sahara and South Africa, are hot and dry with limited soil development. In the rift region of eastern Africa and the highlands of Ethiopia, bio-climatic zones are defined by altitude. Soils can be varied and reflect the underlying geology. On the highest peaks, such as Kilimanjaro or the Ruwenzori Range, permanent snow can be found on the summits.

- **River valleys and wetlands** – the soils on the floodplains of the major river valleys are characterised by stratified fluvial deposits, good drainage and high nutrient levels. Swamps are forested wetlands, similar to marshes, often found near rivers or lakes consisting of mineral soils that drain very slowly. Waterlogged conditions can result in the formation of peat. Mangrove soils occur in recent marine or river-borne sediments. Soils have high clay and silt content and contain high levels of organic matter.

- **Southern Africa** – while not a specific biome as the others, the southernmost region of the African continent is characterised by a very old geology and a warm and dry climate which gives rise to some unique soil types. Overall, soils are generally thin and moderately fertile.
Soil of Mediterranean Africa

So-called Mediterranean conditions occur on the northern (from Morocco to Egypt) and southern (from West Coast Peninsula to Port Elizabeth) coasts of the continent. The northern region falls into two distinct areas: one from Morocco to Tunisia, where the Atlas and Rif mountains dominate the landscape, and one comprising the Libyan and Egyptian coastline, where the Sahara almost reaches the sea. The southern region lies between the coast and the high plateau lands of South Africa. This region is characterised by mild, moist winters and hot, dry summers. Annual rainfall decreases along the Mediterranean coast from west to east, from about 950 mm in Tangiers to about 100-200 mm along the Egyptian coast. In the southern hemisphere, both Cape Town and Port Elizabeth receive around 650 mm but rainfall becomes more evenly distributed throughout the year to the east. Wind storms occur frequently in both regions. The naming of the Cape of Good Hope reflects this condition while the sirocco sweeps Saharan dust deep into Europe.

Historical events have left their imprint on the environment and soils of North Africa. Native vegetation has almost disappeared as a result of large-scale deforestation during Roman times (which led to wide-spread soil erosion) and the introduction of sheep and goats by the Arabs. In addition, over-exploitation of the water resources has resulted in salinisation of soils in many locations. Large areas have been converted to cropland with some replanted forests along the coast. Where crops cannot be grown due to climate or topography, sparse grassland can be found which is used for extensive grazing. Morocco and Tunisia are amongst the largest producers of phosphate in the world – a key component of inorganic fertiliser. The famous Fynbos biome of shrubland and thicket can be found in the southern hemisphere, which also contains much of South Africa’s wine production.

In summary, the soils of this region are varied but generally low in organic matter and the presence of salts is common. They range from very sandy Arenosols in dune complexes to clay-rich Luvisols and Vertisols in level terrain. Where higher levels of rainfall occur, increased vegetation can give rise to Kastanozems in Morocco and leached Podzols in South Africa. Saline groundwater is responsible for Solonchaks while calcium carbonate is common along the Mediterranean coast.
Soil of the deserts

Africa has two main desert regions: the Sahara in the north, stretching from the Atlantic Ocean to the Red Sea and the Horn of Africa; and the Namib and Kalahari deserts in the south, occupying a zone along the coast of Namibia and South Africa.

The Sahara is the largest hot desert in the world, covering about 9.5 million km². About 70% of the area consists of rock plateaus and rock-covered plains (hamadas or regs) while 30% is occupied by sand or dunes (called ergs). Rainfall is erratic and daytime temperature during the summer can reach over 50°C, while at night it can freeze.

The Sahara has not always been as dry and barren as it is today. Rock paintings showing giraffes, elephants, crocodiles and other animals indicate that a more lush vegetation and abundant water must have been present in the past.

The Namib is regarded as the oldest desert on Earth (with an estimated age of 55 million years) and covers an area of about 81,000 km². It is also one of the driest places on Earth, with less than 10 mm rainfall annually. The few plants that can survive, amongst them Namibia’s famous Welwitschia, draw moisture from the frequent fogs that drift inland from the sea. The southern part is mainly a sand desert with spectacular dune formations, the northern part is rocky and flat.

A variety of soils have been recognised in desert regions. Rock outcrops, gravelly deposits and sands constitute the largest part of soils in the deserts; these are Leptosols (referred to as Nudilithic when bare, Lithic when covered with a thin soil or deposit, and Hyperskeletic when consisting of thick rock debris). Sands are classified as Arenosols (Protic if non-stabilised, Haplic when stabilised, Rubic when reddish coloured). Many soils have notable secondary accumulations of salts (e.g. Calcisols, Gypsisols and Solonchaks) while abundant Regosols reflect the limited horizon development. In oases, Anthrosols may occur as a result of sedimentation through irrigation, whereas the dry river beds or wadis have Fluvisols.
The Sahel and Savannah regions of Africa are bordered on one side by the deserts, by deciduous forest and tropical rainforest region on another and by the mountains and highlands on a third side. Characteristically they have one or two pronounced dry seasons of several months. Rainfall varies from 300 - 1000 mm per year. Their vegetation is open, ranging from sparse grassland to open-wooded grassland.

The Sahel and Savannah region is the most populated part of Africa. Most people live in small villages and their main source of income is agriculture. Depending on the amount of rain, food crops such as sorghum, maize, sweet potato, cassava, yam and a range of vegetables are grown. In many places the traditional slash-and-burn technique is practised. Cotton and tobacco are the most important cash crops. Attempts to grow wheat have failed, mostly because of the adverse soil conditions and diseases. Cattle and poultry farming are important. Drought is a major factor in agricultural production in this region.

Soil of the Sahel and Savannah

The soils in this region are characterised by moderate leaching and, when adjacent to desert regions, by the addition of airborne dust. Most soils are old and deep, with a low nutrient-retention capacity because they are dominated by a kaolinitic clay mineralogy. Exceptions are the large level areas where shrink-swell clays are found; here the dominant mineralogy is montmorillonitic, resulting in a high nutrient-retention capacity. In general, the soils are poor in organic matter. The low leaching also results in the accumulation of carbonates if a source of calcium is present. Carbonates are also deposited as wind-blown dust (e.g. in the Harmattan regions). Many soils are red in colour due of the accumulation of hematite (iron oxide). The dominant soil types are Arenosols, Cambisols, Lixisols, Planosols, Pinthinolos, Regosols, Solonezts and Vertisols.
Soil of the forests

Dense tropical rain forests cover the coastal zone of West Africa from Guinea to Nigeria (with a short break in East Ghana and Benin), the southern parts of Cameroon, Chad and Central African Republic, and large parts of Gabon, Congo and DR Congo. In East Africa they are found in northern Mozambique and southern Tanzania, and along the east coast of Madagascar.

The climate is characterised by high temperature, high humidity and high rainfall all year round, although short dry spells do occur. Average temperature ranges from about 20 to 30°C with little fluctuation over the year and between day and night. Relative humidity is usually 90% or higher. Annual rainfall varies from 1 500 mm in the drier parts of the forest zone to about 10 000 mm along the western slopes of Mount Cameroon, the wettest part of Africa.

As in other parts of the world, the tropical rain forest in Africa is under pressure. Logging, expansion of cities and infrastructure, industrial activities and mining, development of large plantations (e.g. cacao, oil palm and rubber), and shorter fallow periods after cultivation are the main reasons for the disappearance of virgin forest. Only in the Democratic Republic of Congo do large tracts of original rain forest remain.

The soils of the upland forests in Africa are highly weathered, often deep and generally infertile. Due to the high rainfall and high temperature, the chemical alteration of primary rock constituents is rapid, leaving behind insoluble residues such as silica, iron and aluminium compounds. The resulting soil is often a mixture of quartz, the clay mineral kaolinite, goethite (iron-hydroxide) and sometimes gibbsite (aluminium-hydroxide). Most nutrients that are essential for plant growth (e.g. potassium, phosphorus) have disappeared. Large trees in the forest usually have a tap-root extending deep into the soil to take up nutrients from the weathering rock. Other plants live from the litter layer on the forest floor and the thin humus-rich topsoil.

Ferralsols and Acrisols are common in well-drained positions with Plinthosols and Gleysols where drainage is poorer. Outcrops of basic rocks rich in iron may give rise to the formation of Nitisols.

Dense tropical forest rises up on the banks of the Rodrigue River in the Mbaéré-Rodrigue National Park in the Central African Republic. (HG/IRD)

Ferralsol with a dark, humus-enriched topsoil over a uniform, yellowish subsoil from Gabon. The yellowish colour indicates the presence of goethite. (ISRIC)

Tropical rain storm over central Congo. (DS)

Moist evergreen Afromontane forest in the Belaer-Cera National Forest Priority Area, Oromia, Ethiopia. Farmers manage plots as ‘coffee forests’, a traditional, low-impact coffee production system where arabica coffee beans are collected from wild coffee shrubs. (RA)

Ferralsol from Gabon with a thick, black, humus-rich topsoil over a greyish, clay-enriched subsoil which becomes more red towards the sandstone rock from which the soil is derived. (ISRIC)

Acrisol from Gabon with a thick, black, humus-rich topsoil over a greyish, clay-enriched subsoil which becomes more red towards the sandstone rock from which the soil is derived. (ISRIC)

Gleysol from a forested valley in the Taï National Park of Côte d’Ivoire. (ISRIC)

Plinthosol from Ghana; a greyish layer abruptly overlies a layer rich in iron, which hardens irreversibly to “ironstone” when exposed to air and sunlight. When left this material is called “plinthite”. (ISRIC)
Soils of mountains and highlands

The mountains and highlands of Africa occur in the extreme north-west (Atlas and Rif mountains), in its eastern part (Ethiopian highlands, the Ruwenzori range in Uganda and the Democratic Republic of Congo and the mountains of Kenya, Rwanda and Burundi), in central Africa (Cameroon and Angola), in the south-east (Drakensberg mountains in South Africa and the eastern highlands of Madagascar) and in isolated positions such as the Tibesti plateau in the central Sahara. The eastern highlands and mountains are related to the uplift action around the Rift Valley, which traverses Africa from Ethiopia to central Zambia. The Rif and Atlas mountains form part of the Alpine mountain building process. The others are remnants of earlier tectonic activity or are related to volcanism (e.g. Mount Cameroon). Some of the mountain peaks reach so high that permanent snow covers the top (e.g. Kilimanjaro, Ruwenzori), although much has disappeared during the past decades due to climate change.

The highlands, particularly in east Africa, are densely populated areas. For example, the average size of land per household in Rwanda is about 0.2 ha. People are attracted to the highlands because of the mild climate, fertile soil and the wide range of crops that can be grown there (including cash crops such as tea and coffee).

The mountains of Africa are dominated by shallow and weakly developed soils. Where mountains are steep, or where the climate is dry, such as in the Atlas and Rif mountains in the north-west and the Tibesti plateau in the Sahara, Leptosols and Regosols prevail. Under more humid climatic conditions or in less steep parts Cambisols develop, locally even Alisols or Acrisols. Due to more undulating topography, the soils of the highlands are generally much deeper than in the mountainous regions. The most common soils are Acrisols, Andosols, Ferralsols, Lixisols, Luvisols, Nitisols and Phaeozems. Vertisols occur on valley floors with Cambisols and Regosols on the steeper slopes.

Young tephra deposits in volcanic ranges give rise to Regosols, or Andosols in more weathered volcanic ash. Over time, these soils can develop into Luvic and Aquic Nitosols and Andosols, and, ultimately, into Ferralsols. The profile shows a young Andosol in the highlands of Kenya. The soil is built-up from several volcanic eruptions, which are recognizable from the different colours of the various volcanic ash layers. (EM)

The summit of snow-capped Kilimanjaro on the border between Kenya and Tanzania in the late 1980s. (OS)

The highlands are shaped by rivers of African soil: a geographical perspective | Soil Atlas of Africa

Deep Nitisol profile from Tanzania showing a lack of strong horizon development due to a homogenization of the upper part of the soil by biological activity. Nitosols show a characteristic blocky aggregate or ‘nutty’ structure. Nitosols are possibly the most inherently fertile of tropical soils due to their high nutrient content and deep, permeable structure. They are widely exploited for plantation agriculture. (EM)

The summit of snow-capped Kilimanjaro on the border between Kenya and Tanzania in the late 1980s. (OS)

Intensive land use in central Rwanda where many tea and coffee plantations can be found. (OS)

Cultivation systems on Andosols in the volcanic highlands of Madagascar. (MB/IRD)

Vertisols occur on valley floors with Cambisols and Regosols on the steeper slopes.
Soils of wetlands and river valleys

Wetlands in Africa are found along the coast in estuaries and deltas, as well as in inland areas. Well-known coastal wetlands are the Casamance Region in Senegal, the Niger Delta in Nigeria, the tidal flats near Douala, Cameroon, and the Nile Delta in Egypt. Famous inland wetlands are the inner delta of the Niger River in Niger and the Okavango Delta in Botswana, the Etosha Pan in Namibia, the Zambezi floodplain and the Kafue Flats of Zambia, the Sudd along the Mountain Nile in South Sudan and the confluence of the Upper and Lower Congo Rivers in the Democratic Republic of Congo. Wetlands also occur on low-lying watersheds such as between the Zambezi and Kafue Rivers in Zambia.

Wetlands play an important role in Africa. Many of them have a large variety of wildlife, which is attractive to tourists; hence, a number of wetlands are declared national parks. Some wetlands feature unique species, not to be found elsewhere in Africa, such as several Lechwes in Zambia, or the small wetland forest elephant in the Democratic Republic of Congo.

Some wetlands, such as in the inner delta of the Niger River and in the Nile Delta, provide sufficient water for irrigation, turning these regions into large agricultural areas. Other wetlands are used by local communities for fishing, which provides a major source for protein. Wetland vegetation varies from the submerged forests of the Congo Basin to salty grasslands in the Okavango Delta and the Etosha pan to mangrove forests in the Casamance. Seasonal floods in wetlands sometimes force people to move temporarily to higher grounds.

The soils of the wetlands and river valleys are all strongly influenced by water. The periodic or permanent wetness manifests itself as pale colours, strong mottling, sometimes giving rise to plinthite and, in the presence of saline water, salt accumulation. The most common soils are Fluvisols, Gleysols, Histosols, Planosols, Plinthosols, Solonchaks and Vertisols, and gleyic or histic variants of other types of soil.
Soils of southern Africa

Although not a bio-climatic region as those described in the preceding pages, the soils of southern Africa deserve a special mention. This region, which includes roughly South Africa, Lesotho, Swaziland, a large part of Mozambique, Zimbabwe, Namibia, and the southern parts of Angola and Zambia, is underlain by a variety of the oldest rocks on Earth - varying in age from 1 billion to 3.4 billion years. Granite, gneiss, migmatite, greenstone belts, volcanic intrusions and sedimentary rocks such as turbidites, greywackes, shales, sandstones and conglomerates form the main lithological constituents. The whole complex is of great economic importance; containing gold, diamonds, iron, platinum, chromium, titanium, uranium and tin ores. An important geological formation in the region is the Upper Pleistocene Kalahari Sand, with an area of 3.5 million ha it is the largest terrestrial sand body on Earth. It occurs in Botswana, western Zimbabwe, and the south of Angola and Zambia; outliers even reach the southern part of the Democratic Republic of Congo.

The climate is typically subtropical bi-modal with a rainy season starting around October/November and lasting until March/April. Temperatures are between 20°C and 25°C during daytime, dropping to around 15°C during the night; at higher elevations it may freeze during the nights in June and July. Humidity is relatively low apart from at the onsets of the rainy season. The extreme south-west of South Africa experiences a Mediterranean climate with winter rains and summer dryness.

Topography is generally smooth to undulating, except for some isolated mountain ranges such as the Drakensberg Mountains in South Africa, hill ranges comprising volcanic dykes (e.g. in Zimbabwe) and deep valleys such as the Zambezi Gorge on the border between Zambia and Zimbabwe. Quite typical is the occurrence of many kopjes (exfoliated large granite boulders) scattered over the landscape.

Native vegetation is mainly Mopane woodland, with grassland in the shallow valleys (known locally as dambos or vleis). Much of it has disappeared at the expense of large agricultural enterprises, cities and opencast mines.

Tourists are drawn to the large game parks in the region, of which the Kruger National Park in South Africa on the border with Mozambique is the most well-known.

The large variety of parent material, the long period of soil formation under relatively stable tectonic conditions, and historical climatic variations (e.g. a long dry period during the Upper Pleistocene) causing considerable changes in vegetation have resulted in a vast array of soils; almost any soil type imaginable can be found. Due to their weakly developed subsoil, such soils are often filled with cracking clays, whereas non- to weakly-developed soils prevail on slopes.

The main soil types of this region are Acrisol, Arenosols, Cambisols, Leprosols, Livisols, Luvisols, Nitisols, Phaeozems, Regosols and Vertisols. Sub lithological soils are Alisols, Calisols, Gleysols, Ferralsols, Fluvisols, Planosols and Solonetz, while rarer soils include Chernozems, Histosols, Kastanozems, Podzols and Umbriols.

In areas with a lot of human activity, such as around mines, Technosols can be found.

A comprehensive review the soils of South Africa can be found in [74a].

[74a]