



An introduction to the first ever Soil Atlas of Africa

Raising awareness of the value of soil across Africa

Arwyn Jones

**European Commission
DG Joint Research Centre
Soil Action, Land Resource Management Unit**

The natural resources of Africa!



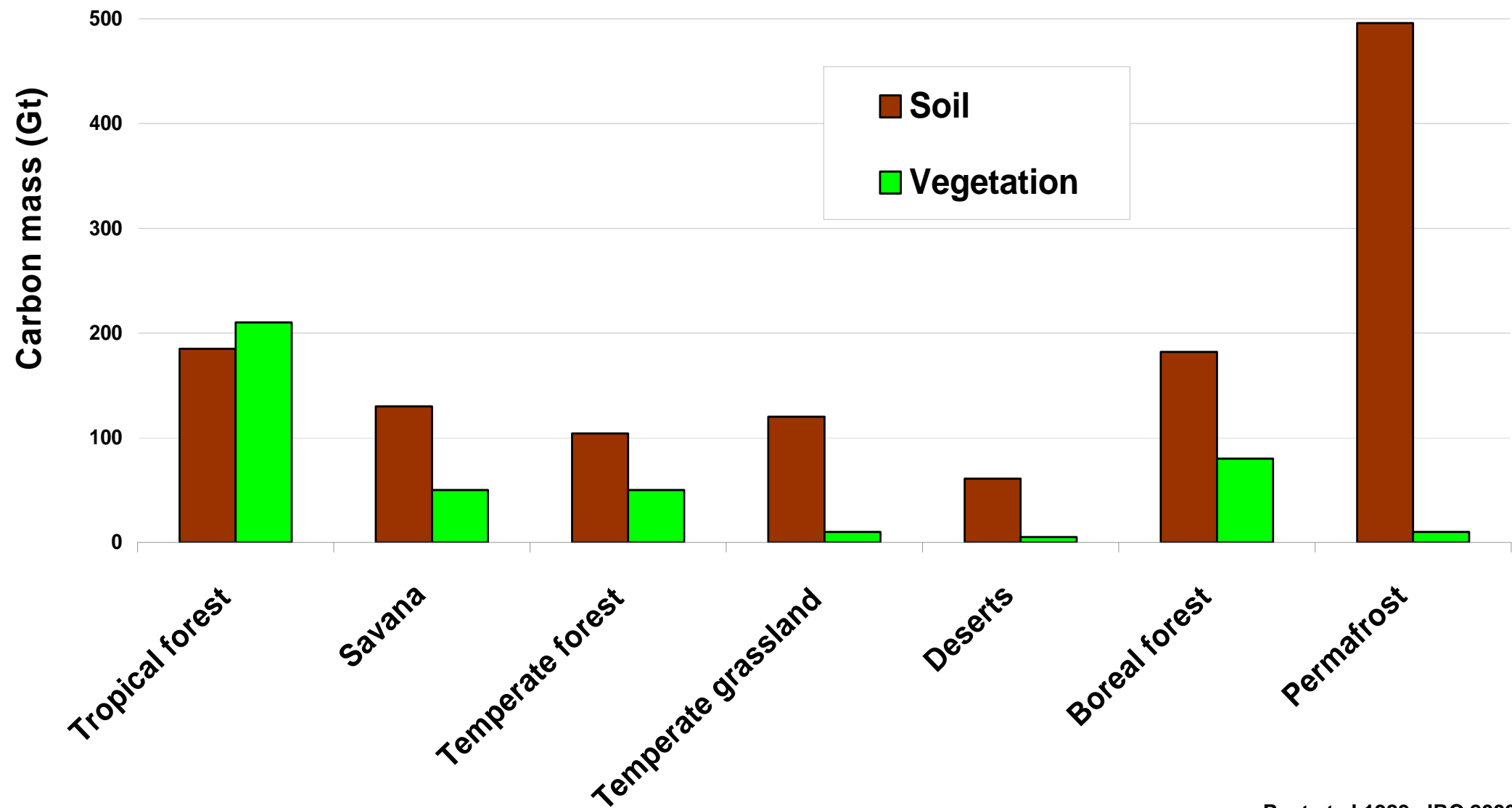


Do we take soils for granted?





Global Carbon Stocks



What is Soil?

Soil is a complex mixture of weathered minerals, organic and inorganic compounds, living organisms, air and water.

Soil is a product of their interactions.

Soil forming processes are dependent on these interactions.

Processes are generally significant upto 1-2 m below the ground surface.

Material below this depth is referred to as the soil parent material.

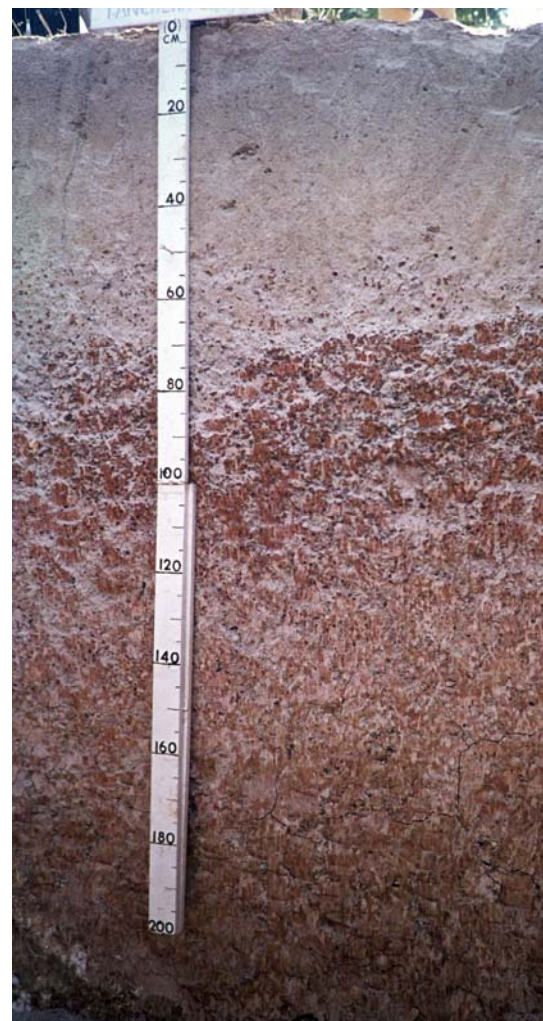
Hidden resource but vulnerable!





Soils vary

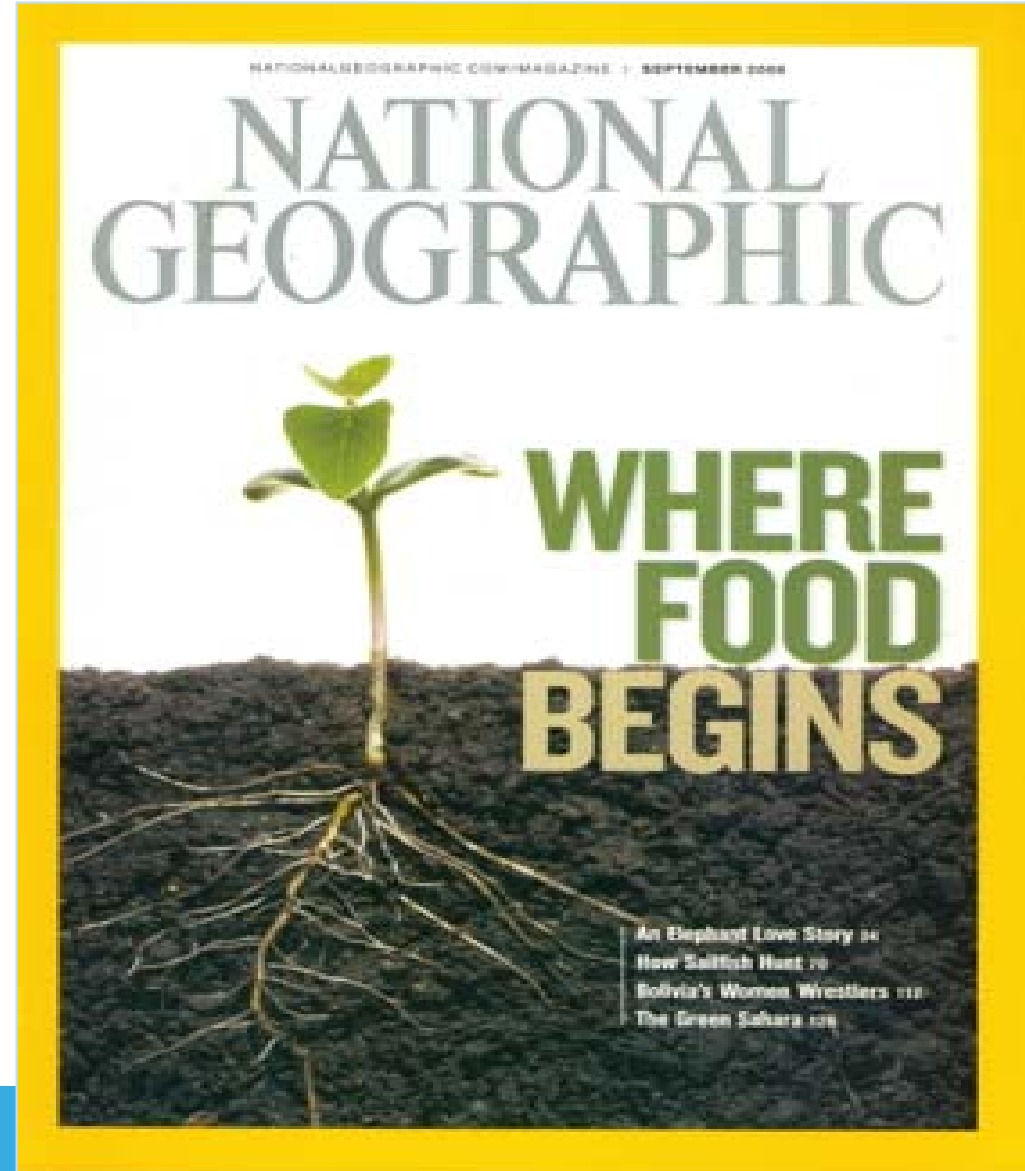
geographically

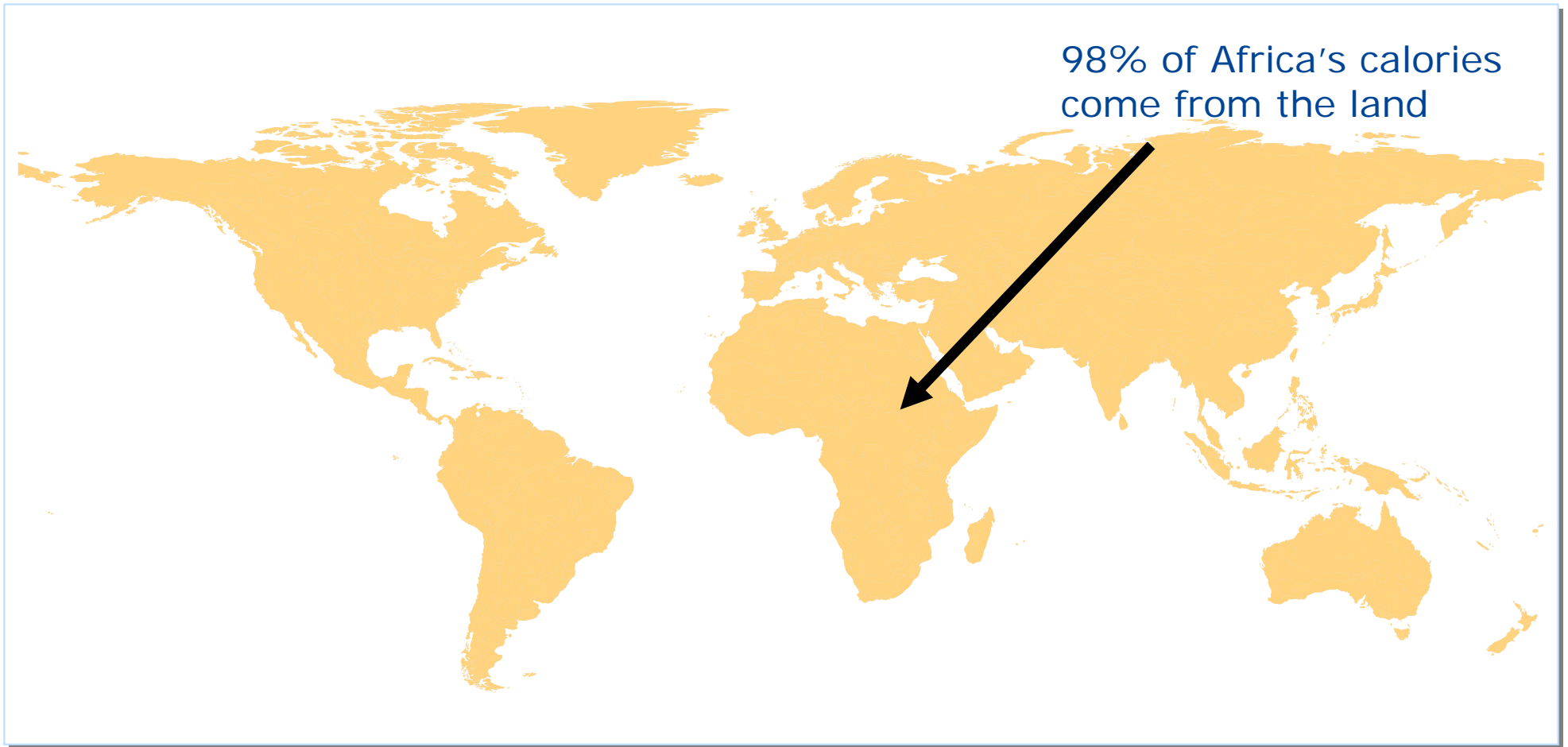


Savanna

Tropical Forest

Soil in an African context



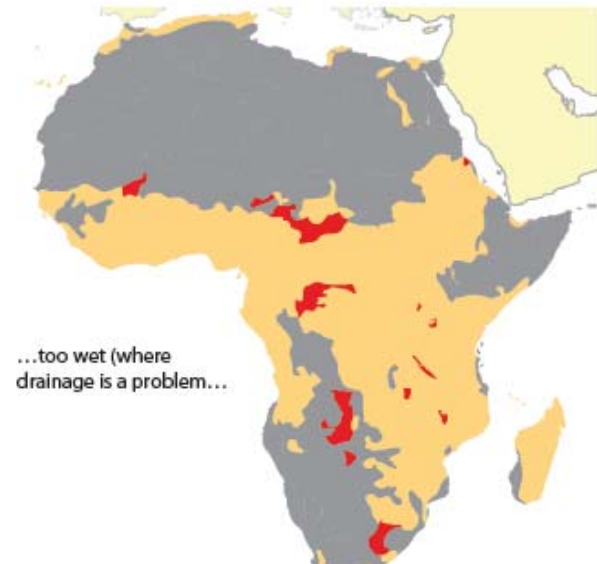
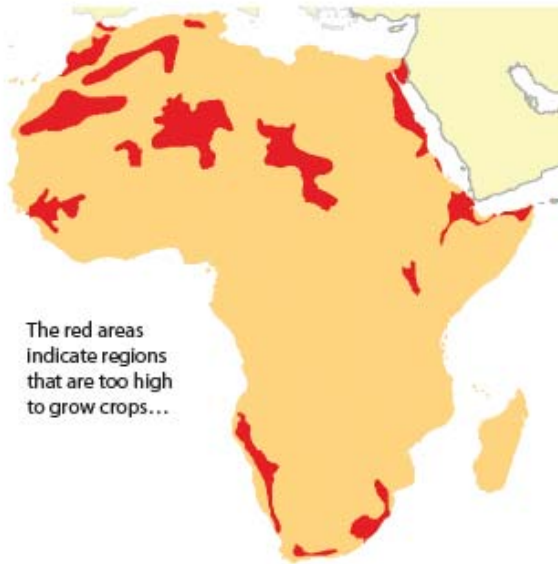


**Two-thirds of the planet's surface is water –
only 1% of global calories come from the
sea (FAO figures)**

**How much of the land can be used for food
production?**



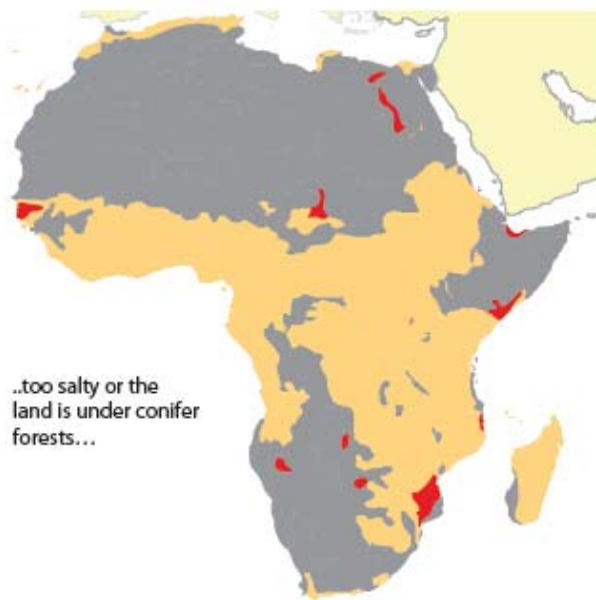
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Too high.

Too dry.

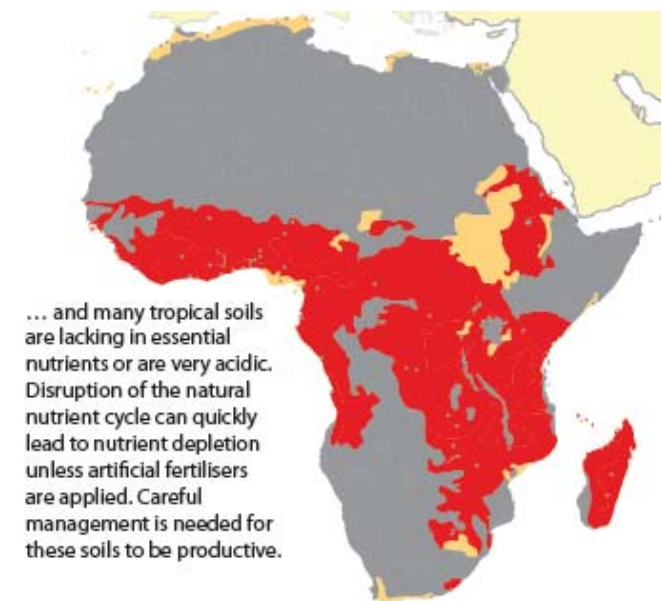
Too wet.



Too salty.



No soil.



'No' nutrients.



Vertisols

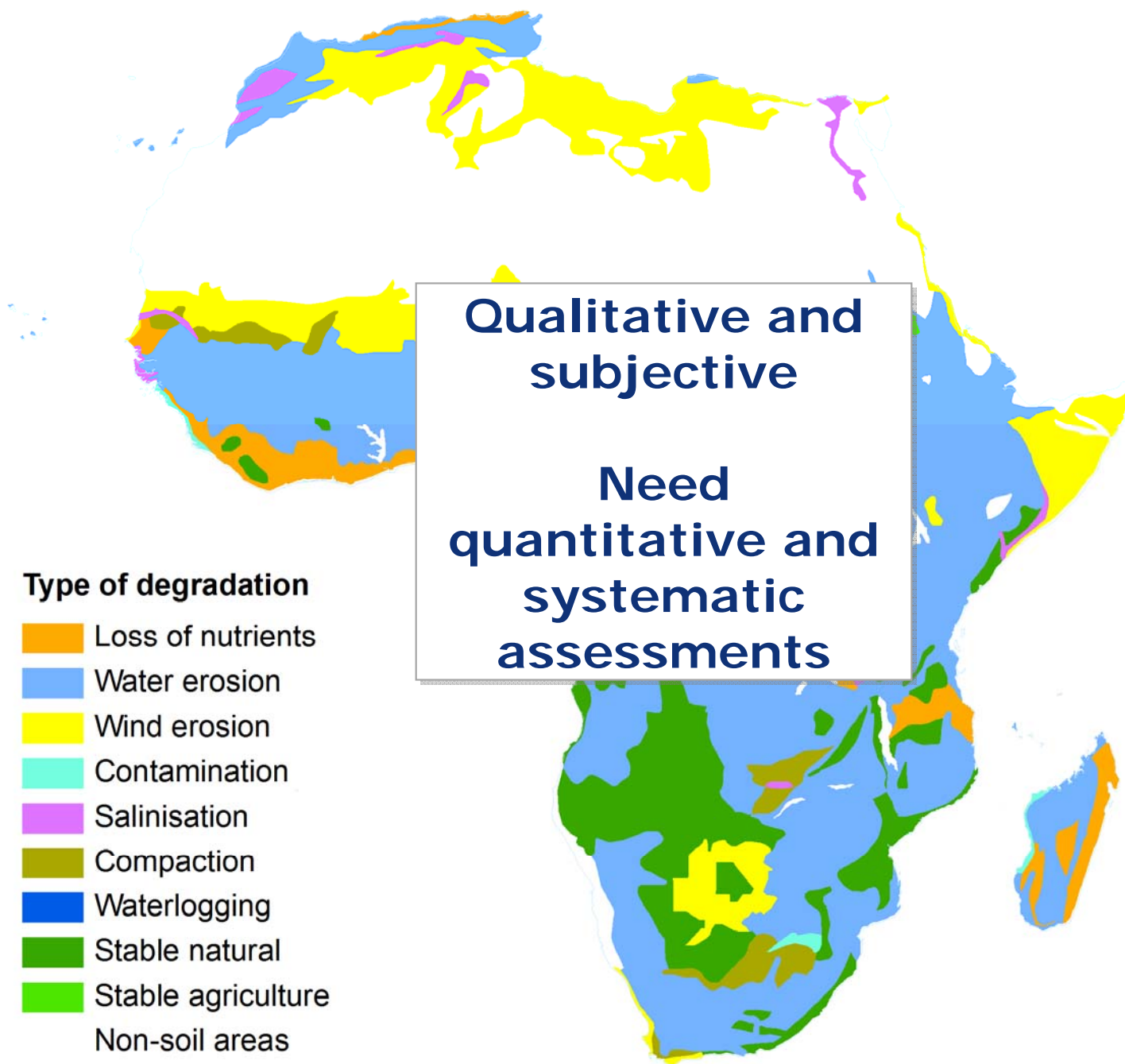
Conducive to intensive agriculture?

More than this thanks to farmers.



Change in land cover or use





A conserva
land area, a
Discount no
Overgrazing
Africa, follo
In sub-Saha
Key factors
population

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What happens when soil is mis-managed?

Shallot cultivation in Ghana coastal strip

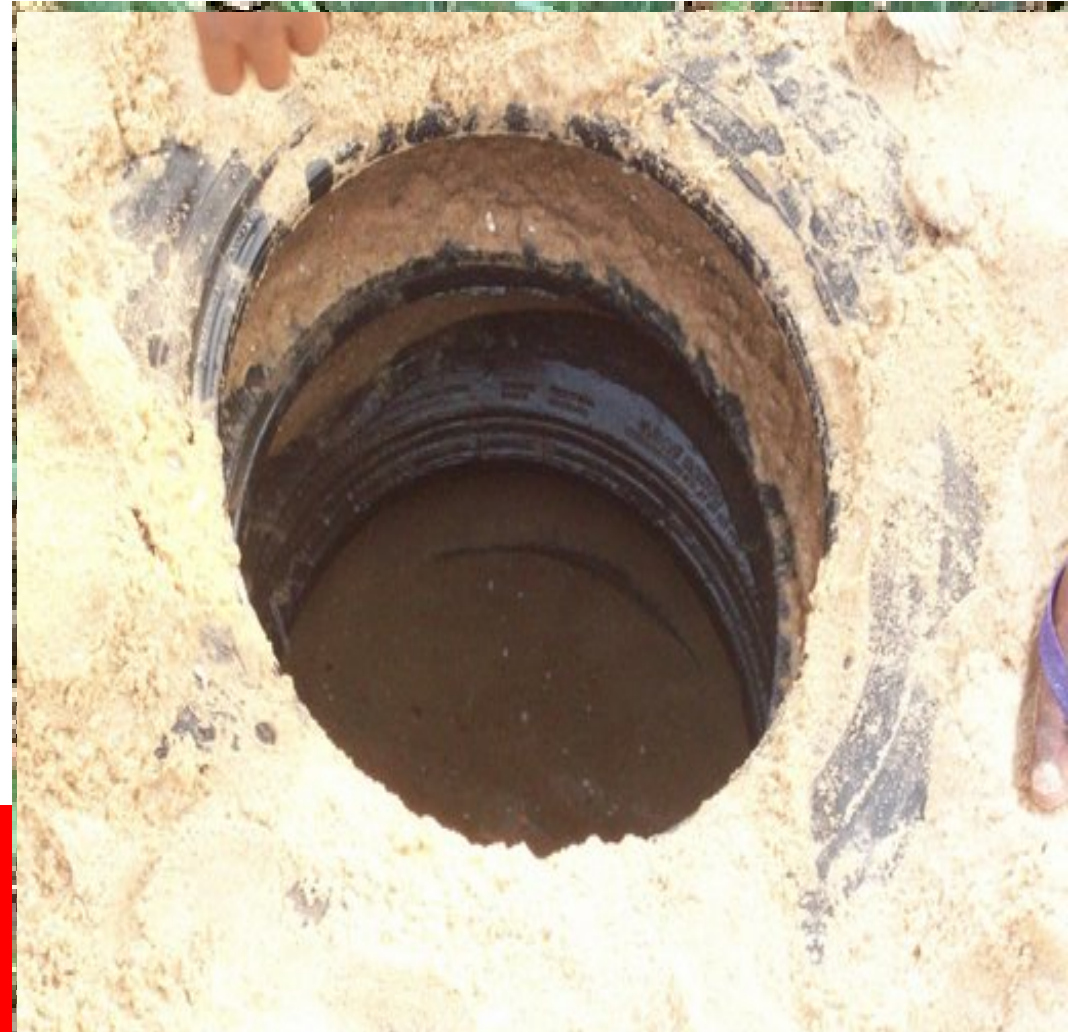
Marginal environment

Successful long-term cultivation system

- Labour intensive
- Low technology
- Low-yield

Donor provides electric pump & transport to bring in cow manure

**Aquifer failure, invasive weeds,
water contamination, land
abandonment**



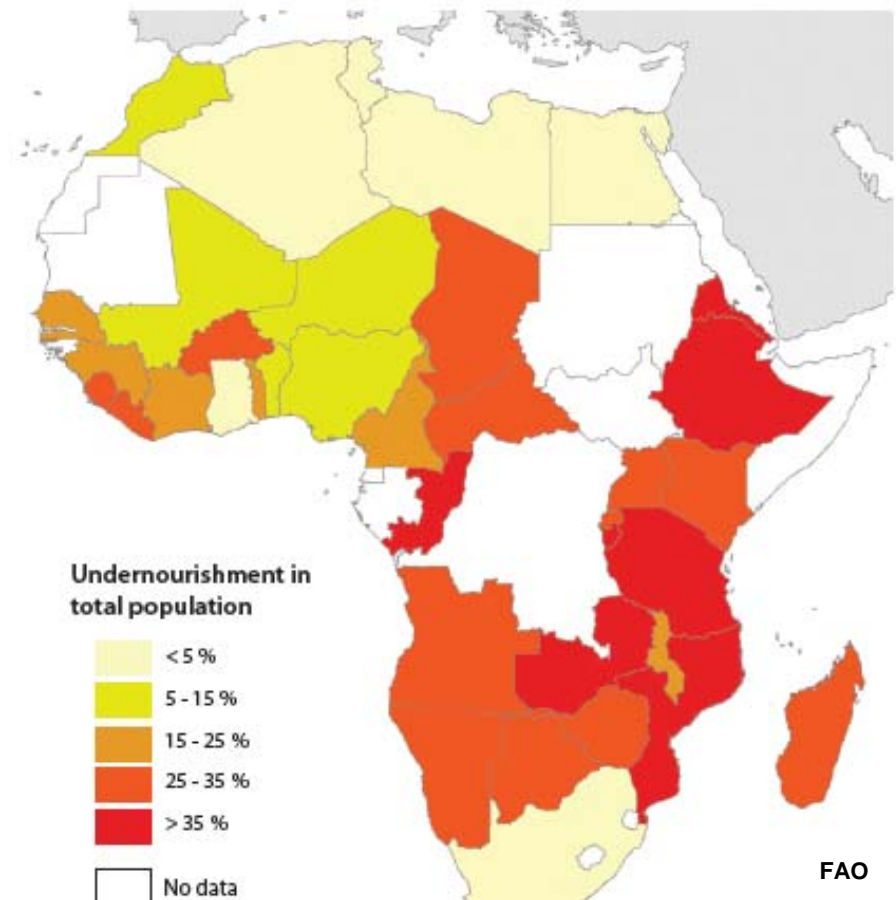
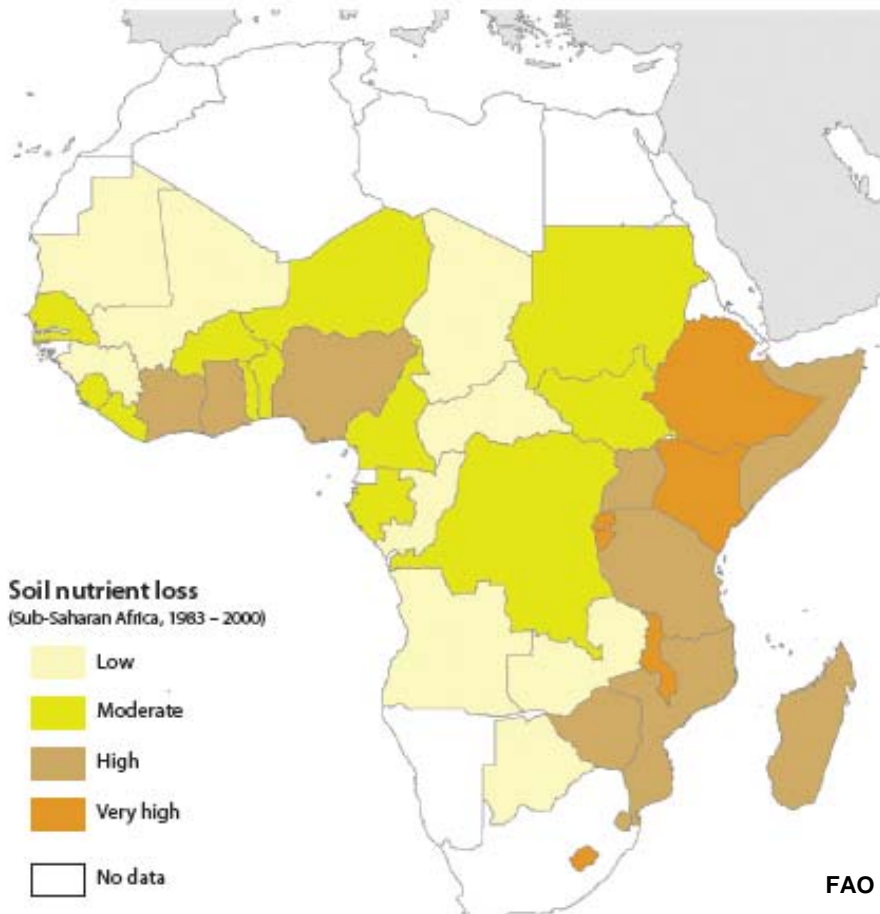
Soil nutrient 'mining' in Africa

Several studies have indicated that on average 660 kg N ha⁻¹ have been lost during the past 30 years from about 200 million ha of cultivated land in 37 African countries (excluding South Africa).

TheFAO estimates that Africa is losing 4.4 million t N every year from cultivated land,

Africa's annual fertiliser consumption is 0.8 million t N.

Poor soil = Poor people = Hungry people?



Poor society = no money for fertiliser = low yields, continued soil degradation = more poverty, food insecurity...



Soil in Africa is generally undervalued –by policy makers and many land managers.

Lack of knowledge and limited scientific data on soil in many countries.

Collapse of soil survey in last 40 years.

Need to invest in education.

Develop capacity for soil survey, soil science and soil use.

Soil Atlas of Africa - Goals

- To raise the awareness of the general public, policymakers, land users and scientists of other disciplines of the importance of soil in Africa.
- A source of educational material to schools and universities.
- To support EU policies and instruments for Development and Aid Assistance and Land Management strategies of the AUC.
- Support to the Global Soil Partnership.



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SOIL ATLAS OF AFRICA



What is soil? Where does soil come from? What is special about soil in Africa? What does soil provide to society and the environment? How do our activities affect soil?

The first ever SOIL ATLAS OF AFRICA uses striking maps, informative texts and stunning photographs to answer and explain these and other questions.

Leading soil scientists from Europe and Africa have collaborated to produce this unique document. Using state of the art computer mapping techniques, the SOIL ATLAS OF AFRICA shows the changing nature of soil across the continent.

The SOIL ATLAS OF AFRICA explains the origin and functions of soil, describes the different soil types that can be found in Africa and their relevance to both local and global issues. The atlas also discusses the principal threats to soil and the steps being taken to protect soil resources.

The SOIL ATLAS OF AFRICA is more than just a normal atlas. Rather, this volume presents an interpretation of an often neglected natural resource that surrounds and affects us all.

The SOIL ATLAS OF AFRICA is an essential reference to a non-renewable resource that is fundamental for life on this planet.



Green strips being grown in a field of sorghum to minimise soil erosion. Soil degradation is a major issue across large parts of Africa which in affects food security, economic development and social cohesi... (12)

Plants are dependent on soil for the supply of water, nutrients and as a medium for growing. Soil stores, filters, buffers and transforms substances that are introduced into the environment. This capability is crucial in producing and protecting water supplies and for regulating greenhouse gases. Soil is a provider of raw materials. Soil is also an incredible habitat and gene pool. Soil is a fundamental component of our landscape and cultural heritage.



Half-moon shaped pits in Burkina Faso are dug in traditionally-poor soil and filled with organic material to support the growth of crops. The hard surface crust is used to keep irrigation water within the soil. This is a good example of how local knowledge can be used to improve and successfully utilise the soil. (12)

The properties of soil vary tremendously from region to region. Soils under tropical rainforests are vulnerable to erosion and nutrient depletion if the vegetation cover is removed. Oasis regions in deserts and the Sahel show how seemingly infertile soils can be cultivated in the presence of water. The wetlands of Congo and other major African systems are stores of soil organic carbon and important wildlife habitats. The black, clay-rich soils of the Nile Valley in Sudan are rich in nutrients but difficult to cultivate when very wet or very dry. Soils with high salt levels are not suitable for the cultivation of crops but may support a limited range of plants...



Soils are a reflection of their parent material, climate, topography, vegetation, time and the influence of human activity. Their properties or characteristics are derived from the inter-play between these factors. The above photograph shows a Parosol from Ethiopia, a soil with a marked change in texture in the subsoil (the clay-rich underlying darker subsoil). As a consequence waterlogging of the topsoil can be avoided. The ICRAC is a joint initiative of the European Commission and the International Centre for Tropical Agriculture (CIAT). (12)

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Publications Office

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The African Carbon Cycle



Precipitation

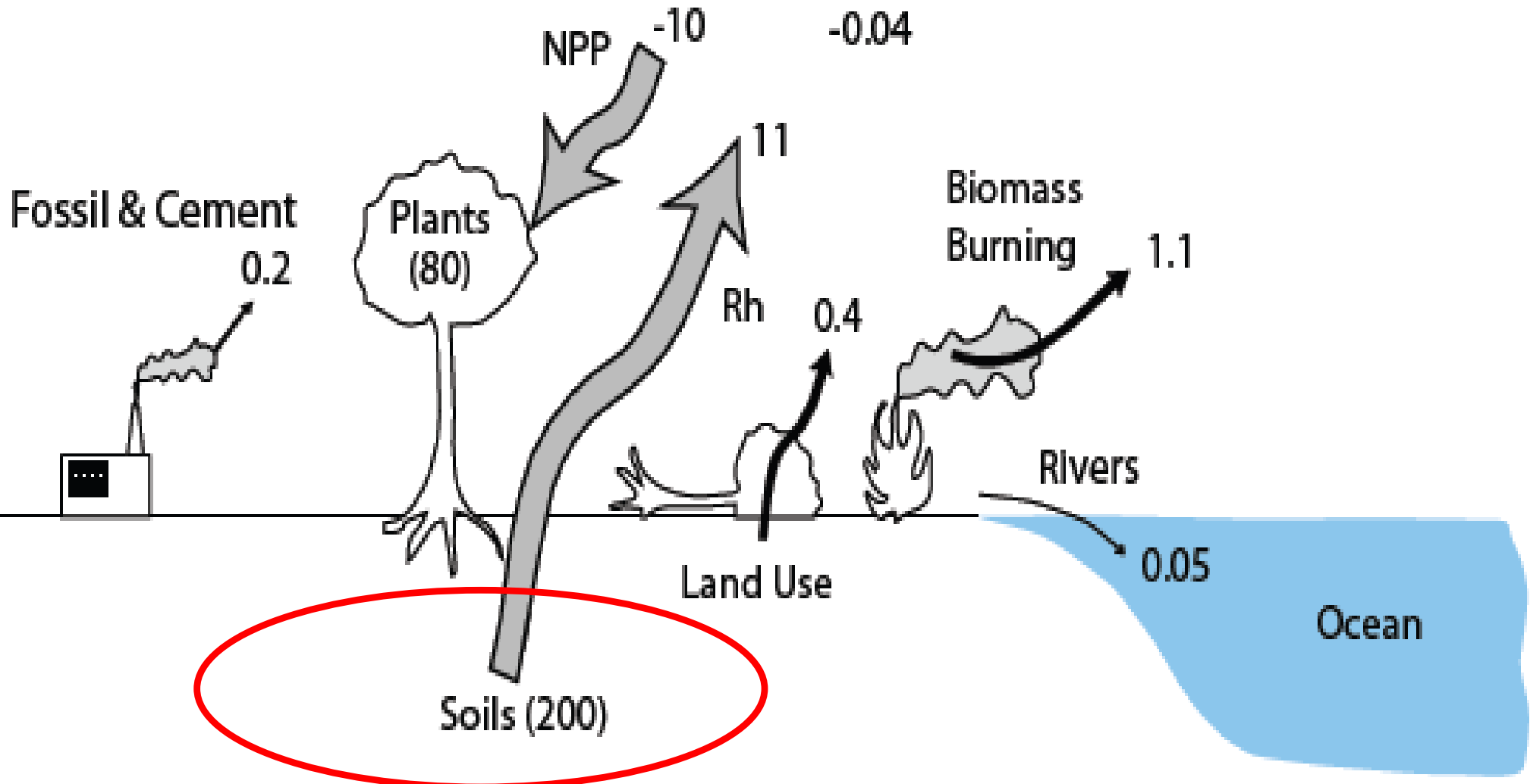




Plate 18 | Angola, Democratic Republic of the Congo, NW Zambia

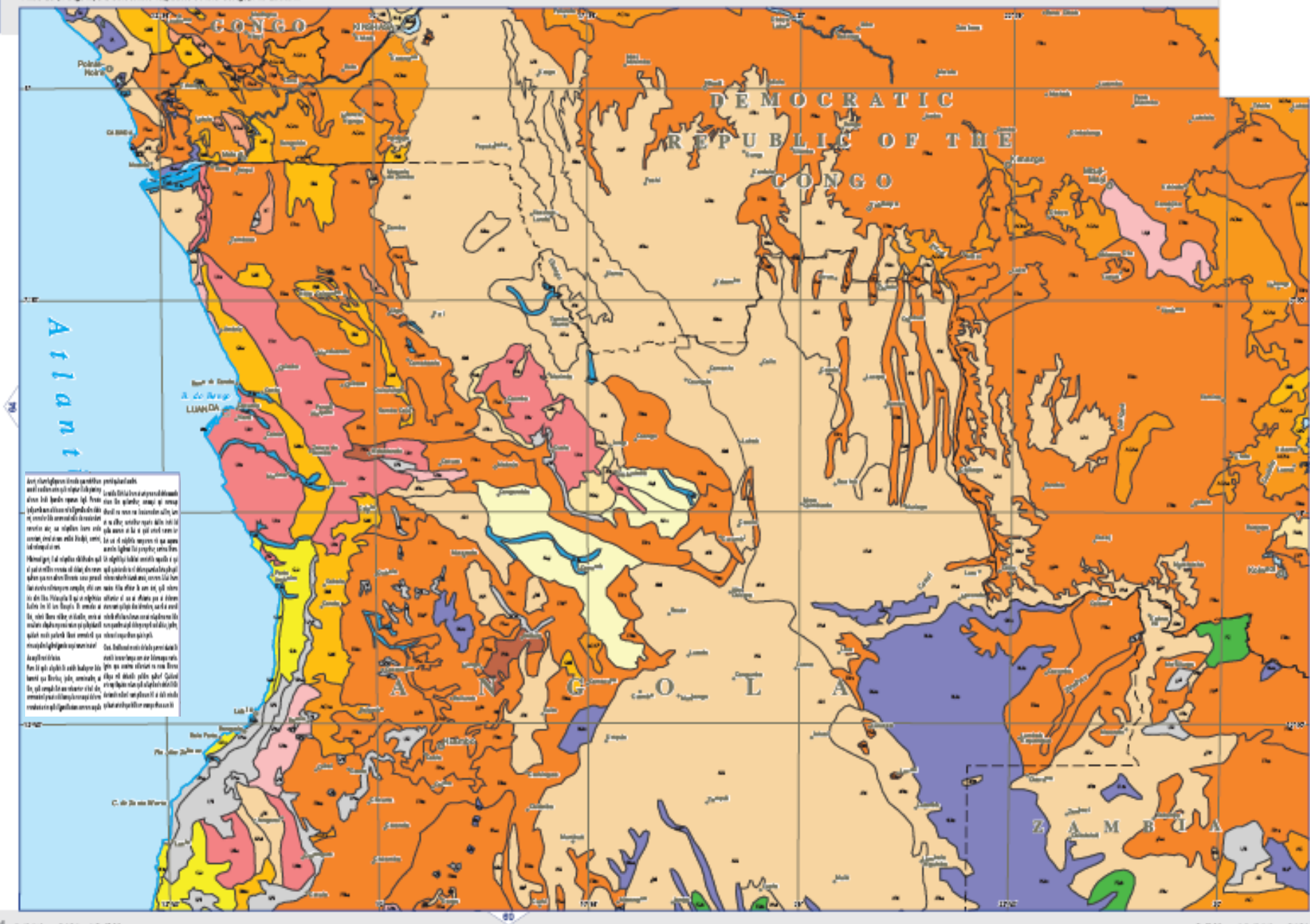
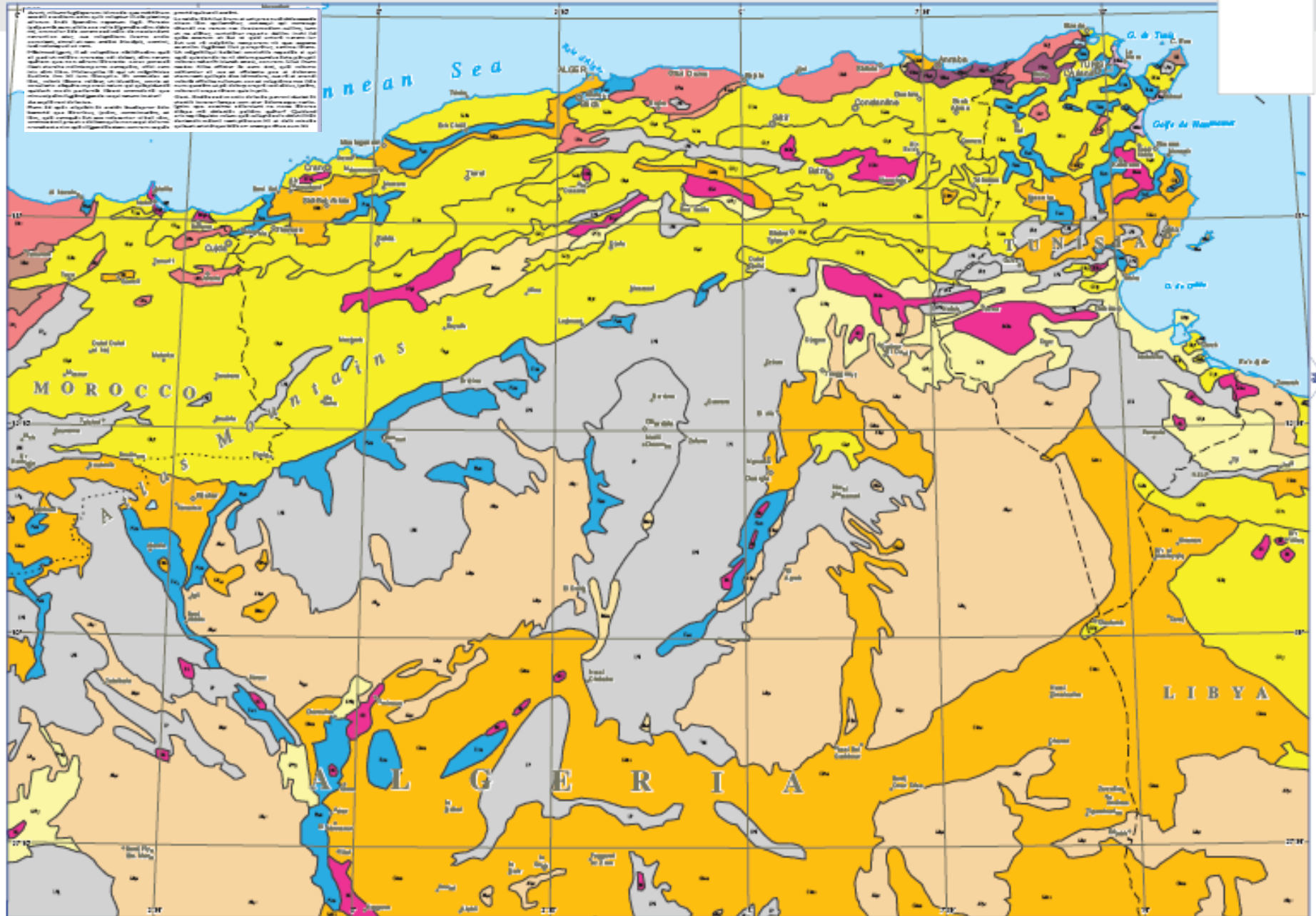




Plate 2 | E Morocco, N Algeria, Tunisia, W Libya





The role and importance of soil

Soil is essential because it is the repository for the world's largest store of carbon. It is also the source of the world's largest store of phosphorus and potassium. It is also the source of the world's largest store of nitrogen.

Soil is the medium that enables us to grow our food, natural fibre, timber and support wildlife

One of the most widely used soil indicators of soil's inherent fertility is the amount of nitrogen in the soil. In most soils, the amount of nitrogen is low. This is because nitrogen is a mobile nutrient and is easily lost from the soil. However, the amount of nitrogen in the soil is a good indicator of the soil's ability to support plant growth. This is because plants need nitrogen to grow. The amount of nitrogen in the soil is also a good indicator of the soil's ability to support wildlife. This is because many animals, including birds, insects and small mammals, need nitrogen to survive.

Soil is the medium that enables us to grow our food, natural fibre, timber and support wildlife

Soil is the medium that enables us to grow our food, natural fibre, timber and support wildlife. It is the source of the world's largest store of carbon, phosphorus and potassium. It is also the source of the world's largest store of nitrogen. Soil is the medium that enables us to grow our food, natural fibre, timber and support wildlife. It is the source of the world's largest store of carbon, phosphorus and potassium. It is also the source of the world's largest store of nitrogen.

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Soil and water
Water is the principal process involving the movement of water through the soil surface, especially the soil air, between the atmosphere and the ground. The ability of water to enter the soil is related to its **permeability** (the ability of water to flow through the soil). This is determined by the texture and structure of the soil. The soil's moisture content, soil compaction and the presence of clay particles can cause changes in the soil's permeability. This is why some soils are better at holding water than others.

Soil permeability is the movement of water through the soil by gravity and capillary forces. Water that is in contact with air in the soil is called soil water. Water that is in contact with air in the soil is called soil water. Water that is in contact with air in the soil is called soil water. Water that is in contact with air in the soil is called soil water.

Water table
The level at which the water table is located is determined by the amount of water in the soil. The water table is the level at which the water table is located. The water table is the level at which the water table is located. The water table is the level at which the water table is located.

Spring
A spring is a natural source of water that flows from the ground to the surface. Springs are formed when water from the ground flows to the surface. Springs are formed when water from the ground flows to the surface. Springs are formed when water from the ground flows to the surface.



Diagram illustrating soil layers and their characteristics.

Soil texture
Soil texture is the relative proportion of sand, silt and clay particles in a soil. It is a key factor in determining soil permeability and water-holding capacity. Soils with a high proportion of sand are well-drained, while soils with a high proportion of clay are poorly drained.

Soil structure
Soil structure is the arrangement of soil particles into aggregates. It is determined by the soil's texture, organic matter content and the action of soil organisms. Good soil structure allows water to infiltrate the soil and air to circulate, which is essential for plant growth.

Diagram illustrating soil structure and its importance for plant growth.

Soil compaction
Soil compaction is the process of soil particles being pushed together, which reduces the soil's permeability and water-holding capacity. It is caused by heavy machinery, livestock trampling and other factors. Compacted soil is difficult for plants to grow in.

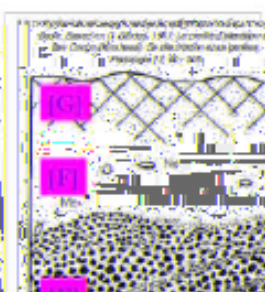


Diagram illustrating soil layers and their characteristics.

Soil horizons
Soil horizons are the distinct layers of soil that form in a soil profile. They are labeled A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. Each horizon has specific characteristics, such as color, texture and structure.

Soil erosion
Soil erosion is the process of soil being removed from the ground by water or wind. It is a major problem in many parts of the world, especially in areas with steep slopes and little vegetation. Erosion can lead to soil loss, reduced fertility and increased sedimentation in water bodies.

Diagram illustrating soil erosion and its impact on the environment.

Soil conservation
Soil conservation is the practice of using techniques to prevent soil erosion and maintain soil fertility. This includes planting cover crops, using mulch, and avoiding heavy machinery on the soil. Soil conservation is essential for sustainable agriculture.



Photograph of a soil profile with a vertical measuring rod.

Soil sampling
Soil sampling is the process of taking a sample of soil from a specific location. This is done to determine the soil's properties, such as its texture, structure and nutrient content. Soil sampling is essential for soil testing and fertilization.

Diagram illustrating soil sampling techniques.



Photograph of a desert landscape with palm trees and a body of water.

Soil fertility
Soil fertility is the ability of soil to provide plants with the nutrients they need to grow. It is determined by the soil's texture, structure and nutrient content. Soil fertility is essential for sustainable agriculture.

Soil pH
Soil pH is a measure of the soil's acidity or alkalinity. It is determined by the concentration of hydrogen ions in the soil. Soil pH is important for plant growth because it affects the availability of nutrients in the soil.



Photograph of a soil profile with a vertical measuring rod.



Photograph of a soil profile with a vertical measuring rod.

3. Climate

Soil formation depends enormously on the climate as temperature and moisture levels affect weathering processes and biological activity.

With the equator runs through to the poles, Africa has the largest tropical area of any continent and about 90% of its land area lies within the tropics. In countries south of the equator, the seasons are opposite to those of countries that lie to the north of the equator. The broad climatic pattern of Africa is defined by its position around the equator, the impact of east-west currents and the absence of mountain chains acting as climatic barriers. Diverse soil climate zones can be distinguished.

A hot, humid zone around the equator where annual rainfall exceeds 1,500 mm – covers 14% of Africa. To the north and the south is a sub-humid zone where annual rainfall is between 600 mm and 1,200 mm, covering 37% of the land area. The rainfall is increasingly seasonal in relation to distance from the equator.

A hot, semi-arid zone with an average annual rainfall of less than 600 mm which falls in only a few months, covers 17% of the total land area. A dry desert zone occupying nearly half of the African land area (71%). Annual rainfall is scarce with less than 100 mm precipitation in areas across the zone. Daily and seasonal extremes of temperature are great with the average summer temperature greater than 30°C.

A Mediterranean climate in the extreme north and south with high temperatures in the summer and mild winters with moderate rainfall is widely distributed. In the highlands of eastern Africa, particularly in Kenya and Uganda, rainfall is well distributed throughout the year and temperatures are equable.

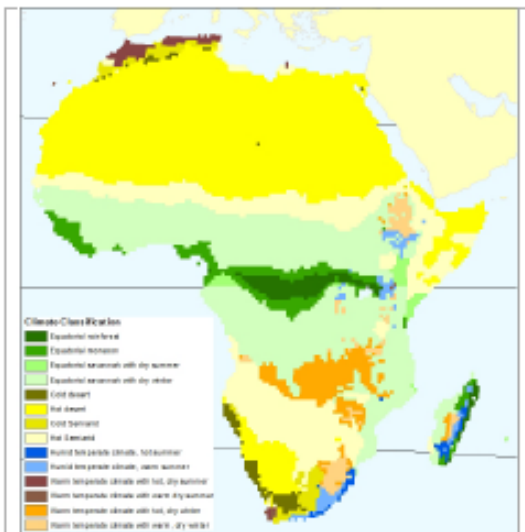
The high plateaus of eastern Africa have a temperate climate. On a few high mountain peaks, a sub-arctic climate can be found, even in the equator.

Annual Temperature Range
Temperature and fluctuations in temperature have important bearings on soil forming processes. The map on the right shows the annual temperature amplitude or range for Africa based on the difference between the monthly mean temperature of the warmest and coldest months. This change depends on the annual cycle of heating solar radiation, which is determined by the latitude, altitude and proximity of the ocean.

What is clear is that the continent of Africa exhibits tremendous variations in annual temperature range. The map clearly shows a clear seasonal cycle of annual precipitation and aridity of the equator. The differences in the extent of the forest is controlled by the shape of the continent based on the north-south axis.

The region with the least variation is the equatorial zone. Africa is a significant area to display a marked fluctuation of between 11 - 10°C. The range for the coastal fringe of the Gulf of Guinea and western DR Congo is only around 3 - 6°C. Travelling away from the equator, the more temperate climate of the Mediterranean regions, the Sahel, the highlands and large parts of southern Africa are clearly evident. What may surprise many people is that the hot and semi-arid regions display high temperature ranges with parts of the Sahara registering variations in excess of 40°C. This is caused by a set of constant high pressure cells over the depths of the continent which give rise to cold winters (0 - 10°C) and hot summers (7 - 45°C). Drifted in winter is compensated by parts of the High Atlas Mountains of Morocco.

The Tropics
The tropics denote the areas on the Earth where the Sun is directly overhead at least once during the solar year. It is defined by the Tropic of Cancer at approximately 23° 26' 36" N, and similarly by the Tropic of Capricorn at 23° 26' 36" S.



Most of Africa has a semi-arid to arid climate. The highlands and mountains of eastern Africa are classified from semi-arid to arid. The highlands and mountains of eastern Africa are classified from semi-arid to arid. The highlands and mountains of eastern Africa are classified from semi-arid to arid.



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Intertropical Convergence Zone
One of the main drivers of climate in Africa is a feature known as the Intertropical Convergence Zone (ITCZ). While migrating from high pressure cells in the northern and southern hemispheres come together over the equator, where they heat by the sun and drives upward. This rising movement cools the air, forcing the moisture out, which falls as precipitation. The more dry air sinks back toward the surface where it descends, producing arid climates at approximately 20 degrees north and south of the equator. In Africa, the ITCZ is located just north of the Sahel at about 10°N. Variations in its position can result in drought conditions.



The rocky, arid landscape of Mali gives rise to a semi-arid climate. The rocky, arid landscape of Mali gives rise to a semi-arid climate. The rocky, arid landscape of Mali gives rise to a semi-arid climate.



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Soil provides the foundation upon which we construct our buildings, roads and other infrastructures.

In addition to providing the support for the vast majority of human infrastructures, soil provides a range of raw materials such as clay, sand, minerals and peat. Clay is used for earthen bricks for construction, pottery bases (e.g. earthenware) and as the first writing medium (clay tablets).

Clay is a building material that has been used for at least 5,000 years for making the walls of buildings. A woven lattice of wooden strips is coated with a sticky material usually made from wet soil, clay, sand, animal dung and water. It is still an important construction material in many parts of Africa and the technology is becoming popular again as a low-cost sustainable building technique.

Mud bricks, made of a mixture of clay, silt, sand and water mixed with a binding material such as the husks or straw, are a common building material in rural areas such as Niger and Mali. Dried in the sun for 25 days, they have a lifetime of some 30 years.

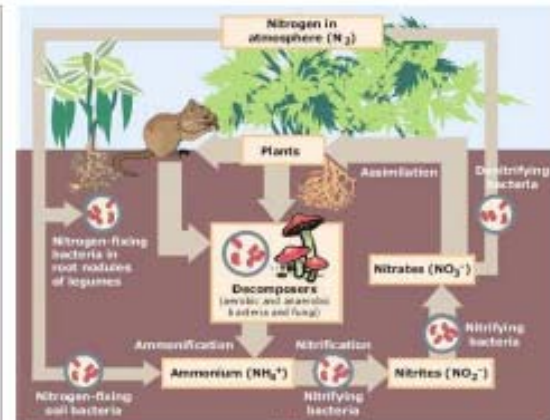
Due to its impermeable properties, clay is used as a barrier to stop water seeping away which is why many ponds, canals and terraces are lined with clay. Sand and gravel deposits, laid down by rivers, are heavily used in the construction industry as aggregates in concrete making, while sand is the principal ingredient in glass making and used in sand blasting. Like sand, gravel has countless uses. For example, in Africa, stone roads have gravel surfaces that prevent rutting.

While peat can be added to soil by gardeners to improve structure and enhance soil moisture retention, in some parts of Africa, peat is a source of fuel. Unfortunately, people are becoming aware of the environmental impact of peat extraction and are looking for 'greener' alternatives.



Below: The Great Mosque of Djenné, Mali, is the largest mud-brick structure in the world (UNESCO).

Below: Many buildings in Mali and other West African countries, their construction can be built using any clayey soil with a particularly high content of kaolinite.



The role of soil in the global nitrogen cycle. Soil plays a crucial role in a number of the existing natural biological and chemical cycles. Carbon, nitrogen and a range of essential nutrients are continuously recycled between the soil and plants, the global nitrogen cycle, groundwater and the atmosphere.

The intensity of these biological and chemical cycles varies from place to place and is regulated by soil characteristics, land use and climate.

What is pH?
Soils are often classified as being acid or alkaline or having a certain pH value. The pH index is a number which indicates the degree of acidity based on the concentration of hydrogen ions in a solution. The pH of soil is usually measured by mixing a sample of soil with distilled water, KCl or CaCl₂. While the pH scale is from 0 to 14, soils typically fall between pH 4 to 10, with a neutral soil having a pH of 7. Alkaline soils will range from pH 7 to 14, although not all soils strongly acid soils will have a pH below 4.



Below: Many buildings in Mali and other West African countries, their construction can be built using any clayey soil with a particularly high content of kaolinite.



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Soil and Food Security/Carbon

Soil assessment/land evaluation

Identifying and naming soils

Major soil types of Africa

Soil maps

African soil in a global context

Sources of information

Soil of the region: Mediterranean, deserts, Sahel, rainforest, highlands and mountains, south, wetlands and valleys

Strengths, Weaknesses, Opportunities, Threats

National perspectives

Additional information

The hope....



More of this!

Less of this



Thank you for your attention.



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