Unit IV:

Africa Physical:

Africa is the second-largest continent after Asia. The continent is bounded by the Mediterranean Sea, the Red Sea, the Indian Ocean and the Atlantic Ocean. It is divided in half almost equally by the equator. Africa has eight major physical regions: the Sahara, the Sahel, the Ethiopian Highlands, the savanna, the Swahili Coast, the rain forest, the African Great Lakes and Southern Africa. Each of these regions has unique animal and plant communities.

Sahara

The Sahara is the world's largest hot desert, covering 3.3 million square miles. That is about the size of the South American country of Brazil. The Sahara is in North Africa and makes up 25 percent of the continent. The Sahara has a number of distinct physical features. These include ergs, regs, hamadas and oases. Ergs cover 20 percent of the Sahara. They are sand dunes that stretch for hundreds of kilometers at heights of more than 1,000 feet. Regs are plains of sand and gravel that make up 70 percent of the Sahara. The gravel can be black, red or white. Regs are the remains of ancient seabeds and riverbeds, but are now nearly waterless. Hamadas are giant shelves of rock and stone that reach heights of 11,000 feet. They include three mountain ranges: the Atlas Mountains, the Tibesti Mountains and the Ahaggar Mountains.

An oasis is a place in the desert with water. Oases are often created by springs, wells or irrigation systems. About 75 percent of the Sahara's population lives in oases. While most of the people in the Sahara live near an oasis, oases make up only 800 square miles of the desert, a tiny portion of the entire Sahara. The Sahara's animal and plant life have adapted to dry conditions. A dromedary camel conserves water by changing its body temperature. That keeps it from sweating as the day gets hotter. Saharan plants survive thanks to root systems that plunge as far as 24 meters (80 feet) underground. In parts of the Sahara, plants cannot take root at all.

Sahel

The Sahel is a narrow band of semi-arid land that forms a transition zone between the Sahara to the north and the savannas to the south. The Sahel is made up of flat, barren plains and stretches roughly 3,300 miles across Africa, from Senegal to Sudan. Unfortunately, the Sahel's

fertile land is rapidly becoming desert. This is happening because of drought, deforestation and agriculture. It is a process called desertification. The Sahel's animals constantly hunt for scarce water and vegetation. The region's green vegetation only emerges during the rainy season, but is often harvested quickly by farmers or eaten by animals.

Ethiopian Highlands

The Ethiopian Highlands began to rise 75 million years ago when magma from Earth's mantle uplifted a broad dome of ancient rock. The Ethiopian Highlands are home to 80 percent of Africa's tallest mountains.

The highland's craggy areas are perfect for nimble animal species. They include native species such as the walia ibex, an endangered wild goat. They also include the gelada baboon. The region's plants include the Ethiopian rose, Africa's only native rose.

Savanna

Savannas, or grasslands, cover almost half of Africa. These grasslands make up most of central

Africa.

Climate

Factors influencing the African climate

A number of factors influence the climate of the African Continent. First, most of the continent—which extends from 35° S to about 37° N latitude—lies within the tropics. Second, the near bisection of the continent by the Equator results in a largely symmetrical arrangement of climatic zones on either side. This symmetry is, however, imperfect because of a third factor—the great east–west extent of the continent north of the Equator, in contrast to its narrow width to the south. In consequence, the influence of the sea extends farther inland in Southern Africa.Moreover, a quasi-permanent subtropical high-pressure cell (the Saharan anticyclone) develops in the heart of northern Africa, while in Southern Africa the belt of high pressure on land weakens during the time of high sun (the season when the Sun is overhead—in December and January in the south). A fourth factor consists of the cool Ocean currents, which chill the

winds that blow over them and thereby influence the climate of the neighbouring shores. Fifth, because of the extensive plateau surfaces of the continent and the absence of high and long mountain ranges comparable to, for example, the Andes in South America or the Himalayas in Asia, climatic zones in Africa tend to shade into one another, rather than change abruptly from place to place. Finally, the high mountains have climatic zones of their own that vary with altitude.

While these factors help to account for the broad climatic patterns of the African continent, there are nevertheless numerous local variations to be found from place to place within the same climatic zone. Urban areas, for example, have climates that often differ in many respects from those of the surrounding countryside. Typically experiencing higher average temperatures, urban areas also frequently have less wind and lower relative humidity; there is too little relevant data from Africa, however, to permit a detailed study of urban climates.

The most important differenciating climatic element is rainfall; this, together with several other climatic elements, depends upon the characteristics of the dominating airmass. The air masses of relevance to the African climate may be broadly classified as maritime tropical, maritime equatorial, continental tropical, maritime polar, and continental polar. Of these, the least important are the continental polar air masses, which may occasionally bring intense cold to northern Egypt in December and January, and the maritime polar air masses, which are associated with rain-bearing depressions over the northern and southern extremities of the continent during the winter. With the exception of these, the continent is affected both by a continental tropical air mass to the north and by maritime tropical and maritime equatorial air masses to the south.

These northern and southern air masses meet at the Intertropical Convergent zone (ITCZ). The hot, dry continental tropical air mass, which is present in the upper levels of the atmosphere, descends to the ground only at the convergence zone. Less hot than the continental tropical are the maritime tropical and maritime equatorial air masses, which originate from the Indian and South Atlantic oceans, respectively; they differ only in that the maritime equatorial air mass is unstable and brings rain while the maritime tropical air mass, when fully developed, is stable and does not normally bring rain unless it is forced to rise by a high mountain.

In July the ITCZ—following the sun—moves northward toward the area of low pressure over the Sahara; there the maritime and continental tropical air masses converge, with the maritime air masses swinging inland from the sea. There is no rainfall on the northern side of the convergence zone, since the region is completely under the dry continental tropical air mass originating over the Sahara. At the ITCZ itself, however, precipitation is prolonged and intense as air converges between the maritime and continental air masses and is forced aloft. Immediately south of the convergence zone, rainfall is heavy because of the unstable nature of maritime tropical air over a heated land surface. South of the Equator, at yet greater distance from the convergence zone, the maritime air masses are less-heated, thick, and stable, and they bring hardly any rainfall, except over some of the East African highlands. Only the southern tip of South Africa receives rainfall at this time, from winter cyclones.

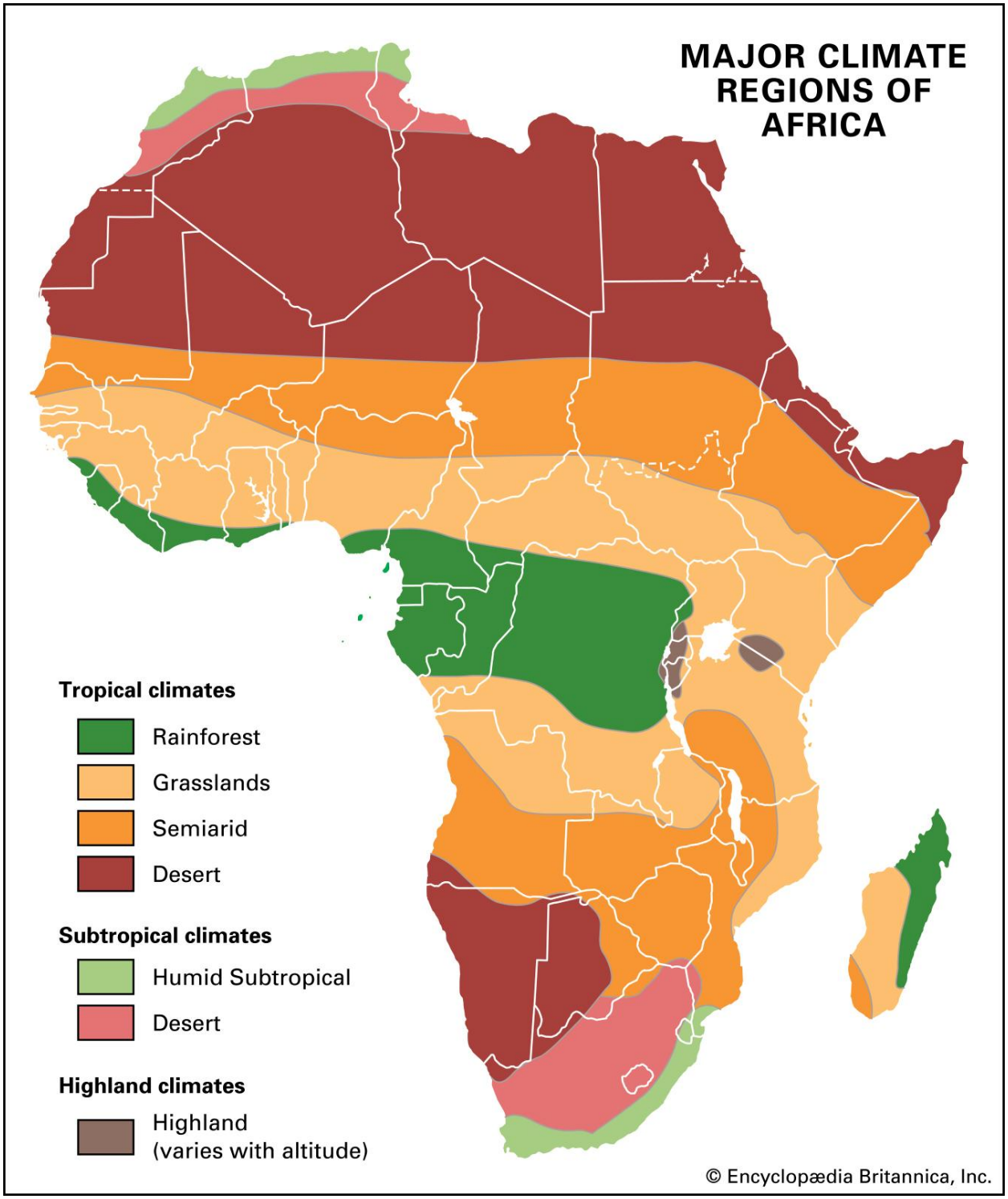
During the period of low sun in the Northern Hemisphere (from December to January, when the sun has moved to its southern limit), the situation described above is reversed. The convergence zone moves southward, dipping into Southern Africa. At this season the whole of northern Africa (except the Atlas Mountains) is under the dry continental tropical air mass, while Southern Africa receives rainfall except in the Cape region and on the southwest coast, where the maritime air mass remains stable offshore over the cool Bengulea current

Climatic regions

When considered in detail, the movement of air masses and their effects provide the basis for a division of the continent into eight climatic regions. These are the hot deserts, semiarid, tropical wet-and-dry, equatorial (tropical wet), Mediterranean, humid subtropical marine, warm temperate upland, and mountain regions

The hot desert region consists of the Sahara and Kalahari deserts, which are always under the influence of dry continental tropical air masses, and the northern Kenya–Somali desert, the aridity of which is principally caused by the stable nature of the maritime air masses that pass over it throughout the year. The stability of these maritime air masses is induced by their passing over the cool body of water offshore. In addition to aridity, the desert climate is characterized by

high mean monthly temperatures; the diurnal (daily) temperature range is, however, greater than the annual range of the mean monthly temperature.



Semiarid climatic regions fringe the desert areas and include the greater part of the land south of the Zambezi River. They differ from true desert regions in being just within reach of the ITCZ in the course of its seasonal movement and therefore receiving more rainfall. Temperatures are about the same as those in the desert regions.

The tropical wet-and-dry region is often called the savanna climatic region; this implies, incorrectly, that all areas with savanna vegetation have this type of climate. This region covers a little less than half of the total surface area of the continent, extending toward the Equator from the semiarid areas. The great distinguishing feature of this climatic region is the seasonal character of its rainfall. During the period of high sun, the maritime air masses produce up to six months of rainfall, the length of the rainy season depending on nearness to the Equator. The rest of the year is dry. In a few places—for example, on the coast of Mauritania and Senegal—there is also a little rainfall in the period of low sun. As in the desert and semiarid climatic zones, mean monthly temperatures show less variation than daily temperatures. In western Africa the period of low sun corresponds to the harmattan season. The harmattan is a warm, dry, northeasterly or easterly wind that blows out of the southern Sahara and is frequently laden with large quantities of sand and dust.

Regions with the equatorial, or tropical wet, type of climate, or variants thereof, are the wettest in Africa. There are two peak periods of rainfall corresponding to the double passage of the ITCZ. Because areas with an equatorial climate are constantly covered by warm maritime air masses, variations in their monthly and daily temperatures are less pronounced than in the tropical wet-and-dry regions.

Marked variations in the rhythm of equatorial climate sometimes occur. For example, the rainfall may be monsoonal and the second rainy season may be all but nonexistent. But the most notable anomaly can be observed on the western African coast from around Cape Three Points, Ghana, eastward to Benin, where, although the bimodal rainfall regime prevails, the total annual precipitation is less than 40 inches (1,000 millimetres). Among the many explanations that have been suggested are that the presence of a cold body of water offshore chills the lower layers of the maritime air mass and makes it stable, that the body of cold air that forms offshore diverts the incoming airstreams to the west and east of the anomalously dry area, that there is a strong

tendency for the winds to blow parallel to the shore during the rainy seasons, that the absence of highlands deprives the region of orographic (mountain) rainfall, that fluctuations in the offshore moisture-bearing winds occur during the rainy season and reduce rainfall, and that local meteorological peculiarities of thunderstorms contribute to the reduction in rainfall.

In the northern and southern extremities of the continent, there is a dry summer subtropical, or Mediterranean type of climate. Rain falls only in winter (December–January in North Africa, June–July in Southern Africa), although in some localities it may fall in autumn (September in North Africa, April in Southern Africa). Mean monthly temperatures are lower than in tropical climates, dropping to about 50 °F (10 °C) in winter, while summer (June–July in North Africa, and December–January in Southern Africa) temperatures may sometimes exceed those of tropical climates. Clear blue skies are characteristic.

The humid subtropical marine climate is restricted to the southeast coast of Africa. This region is characterized by rainfall throughout the year, but it is heaviest in summer. In South Africa, south of KwaZulu-Natal, the winter rainfall is more pronounced, and the temperatures are a little lower than in the north. Thus, at Port Elizabeth there are six months when temperatures are below 62 °F (17 °C), while at Durban mean monthly temperatures do not fall below 64 °F (18 °C).

Soils

Soil types

In general, soil types on the African continent may be divided into five or six broad categories. There are desert soils; chestnut-brown soils, which border the deserts; and chernozem-like soils (dark black soils rich in humus and carbonates), which are found immediately south of the chestnut soils from Sudan westward to just beyond the Niger Bend (the bend in the middle course of the Niger River) and pockets of which are also found in East Africa, Zambia, Zimbabwe, and South Africa. In addition, there are black soils (often grouped with chernozems), and found on the Accra Plains of Ghana; red tropical soils and laterites (leached red iron-bearing soils), which occur in the tropical wet-and-dry and equatorial climatic zones;

and Mediterranean soils, found in the Atlas Mountains of North Africa and the Cape region of South Africa.

The most important factors that affect soil formation are climate, parent material, relief, drainage, vegetation cover, and the passage of time. Where the land has been generally stable and fairly flat for prolonged periods, as in Africa, the climate becomes the major determinant of the soil groups. The different rocks are deeply weathered and are broken down into their common component elements to produce broadly similar soils under the same climatic conditions. Given sufficient time under a tropical climate, the differences in humus content of the great soil groups, which are introduced by vegetation types, are minimized. But within these groups there will naturally be differences in soil types as a function of local differences in physical factors.

Desert soils

These soils are characterized by the general lack of organic content; by the types of rock reflected in them, the chemical weathering of which has been inhibited by the lack of water; and by the crusts or concretions of soluble salts on or just below their surface. While these crusts are in general thought to have been formed as a result of evaporation, it is nevertheless possible that they may have been formed under a wetter climate during the Pleistocene Epoch.

Chestnut-brown soils

In the semiarid areas bordering the desert, increased rainfall makes grass vegetation more plentiful, results in rocks becoming more weathered than in the desert, and produces better developed soils with a higher humus content. It is the humus content that, according to the amount present, gives the chestnut soils their characteristic light or dark brown colour. Chestnut soils also differ from desert soils because they receive enough water to wash out some of the salt accumulations either on the surface or immediately below it.

Chernozem-like and black soils

An unfailing characteristic of the chernozem is the presence of a subsurface zone of calcium carbonate, sometimes accompanied by calcium sulfate, which is left behind after all the soluble salts have been washed out. Grouped with them are the black soils, which should, perhaps, be differently classified, for their black colour is not necessarily due to high humus content but rather to the presence of certain minerals, as in the black soils of the Accra Plains, in Ghana.

Red tropical soils and laterites

The majority of tropical soils have shades of colour varying from yellow and brown to red. The reddish colour reflects the presence of iron oxides that form as a result of chemical weathering. At one time all tropical red earths or soils were indiscriminately referred to as laterites, but it is now clear that the term laterite should be confined to those tropical soils with large concentrations of iron and aluminum sesquioxides (insoluble compounds) that have formed a hard pan at or just below the surface.

At the most advanced state of laterization, bauxite, from which aluminum is extracted, is formed. Most tropical soils are in varying stages of laterization, which is to say they are at various stages of accumulating insoluble compounds as the soluble elements are leached out. The compounds accumulate more readily in areas with a pronounced dry season and where the water table is not too far below the surface. If the top horizons (layers) of the soils should erode, the subsurface concentrations of sesquioxides are then exposed to the atmosphere, whereupon they crystallize irreversibly to form true laterite concretions.

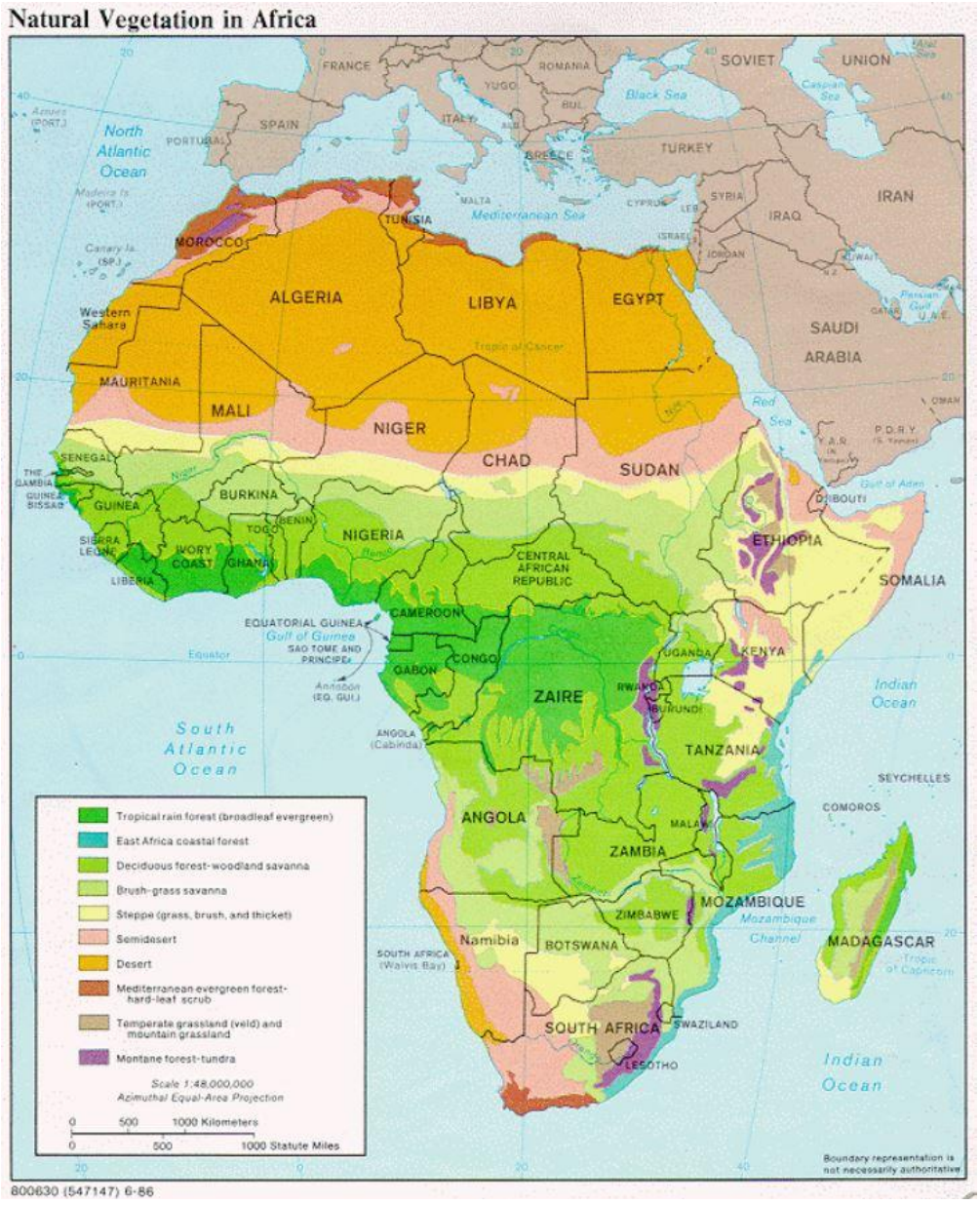
Mediterranean soils

Mediterranean soils are generally deficient in humus, not so much because of sparse vegetation cover as because of the slowness of the chemical processes that convert the vegetable matter to humus. Low rainfall, occurring when temperatures are lowest, retards chemical weathering. The uneven surface relief of the regions where these soils occur also makes it difficult for mature soils to develop, since the land, except in the valley bottoms, is not sufficiently flat over wide enough areas to allow the soil-forming (parent) materials to remain in place and thus to be thoroughly weathered.

Vegetational zones

Lowland rainforest

African lowland rainforests occur along the Guinea Coast of western Africa and in the Congo basin. The full development of this tropical formation requires continuously warm conditions and an annual rainfall exceeding 50 to 60 inches (1,270 to 1,520 millimetres) distributed fairly evenly over the year. The vertical limit is about 3,500 to 4,000 feet. This multistoried, highly diverse, extensive, and potentially self-perpetuating assemblage has been described by some as the source of virtually all tropical floristic diversity. No other part of the world sustains a greater biomass (total weight of organic matter in a given surface area) than lowland tropical rainforests. Even though the speciation (proliferation of distinct types of plant) within the African rainforests is notably poorer than that of its counterparts in Southeast Asia and the Amazon basin of South America, these forests sustain a huge multiplicity of life-forms, occupying different strata (generalized levels of plant height) and niches (separate, small-scale habitats).



Characteristically, tropical rainforest is composed of a ground story, from 6 to 10 feet tall, of shrubs, ferns, and mosses; a middle story of trees and palms 20 to 60 feet in height; and a dominant top canopy consisting of trees up to 150 feet high with straight unbranched trunks, buttressed roots, and spreading crowns of perennial leafage. The large branches of these crowns provide niches for epiphytes, including orchids, ferns, and mosses. Lianas tie trees to one another, parasitic species cling to trunks and branches, and strangler figs (*Ficus pretoriae*) put down aerial taproots. Nevertheless, these are not "impenetrable" jungles. It has been suggested that some early European travelers and pioneer botanists may have exaggerated the difficulties of

human penetration because they journeyed along atypical waterways and along tracks where disturbance of the original vegetation had thickened the regenerating ground layer. In true rainforests, grasses are adventitious (occurring in consequence of fortuitous intrusions). Elephant grass (*Pennisetum purpureum*) can grow abundantly in areas where the vegetation has been disturbed, providing good fodder for grazing animals when young but quickly becoming rank, coarse, and a refuge for insects. Cogon grass (*Imperata cylindrica*) is a troublesome grass on depleted and fire-seared ground.

Eastern African forest and bush

Lowland forests and evergreen bushland form a long belt of land some 125 miles broad along the Indian Ocean. From various causes—notably the monsoonal climate, freely draining soils, and long historical impact of humans—these forests are much more limited in their structure (physical form), speciation, and robustness. On more favoured terrain—such as estuarine fringes, the seaward flanks of the islands of Zanzibar and Pemba, and hill masses athwart the rain-bearing southeast monsoon—forest and a close broad-leaved woodland are still dominant. Where land is in a rain shadow, in areas of unfavourable geology (e.g., raised coral reefs), and near cities and small ports, thorny bush, succulent shrubs, and scrawny grassland prevail. Nevertheless, the region now sustains a number of economically important domesticated trees—both indigenous and exotic—such as the coconut palm, cashew, mango, and (especially on Zanzibar and Pemba) clove

Mangrove swamp

Mangroves include a variety of species of broad-leaved, shrubby trees (10–40 feet high) that fringe muddy creeks and tidal estuaries. They require warm saline water—hence their distribution along tropical coastlines. Often they form nearly impenetrable stands, for which the easiest access is by sea. The trunks and roots are termite-resistant, and they have long been favoured as a building material and for making charcoal.

Broad-leaved woodland and grassland

This classification constitutes one of the most extensive composite categories now recognized and includes much of the land formerly labeled as savanna. Two broad band extend across the continent, one from about 7° to 12° N latitude and the other from about 8° to 22° S latitude. Structure and floristic composition vary greatly with the increase of latitude, both in the north and the south. Annual rainfall averages 35 to 45 inches, with marked seasonality of occurrence and considerable fluctuations from year to year, both in total rainfall and in the onset of rainy periods. The woodlands of western Africa strikingly resemble those south of the Equator. In both areas, undulating wooded interfluves on light soils successively alternate with swampy, clay-based valley grasslands (called *fadama*s in Nigeria and *dambo*s in Zambia and Malawi) in a topographically linked sequence of soils called a catena.

Trees, 30 to 50 feet high, are typically deciduous and often fire-resistant, since much of this land is burned annually. Common western African species include types of *Isoberlinia* (a spreading leguminous tree of the pea family), *Daniellia* (a leguminous tree with white bark), and *Lophira* (a tree with strap-shaped leaves that is said to yield the most durable timber in the region). Other hardwoods, forming distinct communities, are *Combretum* and *Terminalia*, which are better suited to the drier areas. Prevalent southern equivalents include *Brachystegia* (a leguminous hardwood, the bark of which formerly was used to make cloth) and *Julbernardia* (another plant of the pea family resembling *Isoberlinia*). Over much of the interior of Tanzania, in areas of reduced rainfall and poorer soils, a light-canopied, sustained woodland called *Miombo* forest rises above a rather scrawny ground layer. This is an excellent habitat for bees, and honey has long been gathered there.

Because of periodic burning, tall grasses have become dominant over large expanses of plateau land, which sometimes contains few, if any, of its original trees. The tall, coarse red grass *Hyparrhenia* can form prominent stands, but it makes poor grazing land and often harbours insects that spread disease. Much better for the pastoralists are induced swards of *Themeda*.

For centuries humans have selectively retained certain economically important tree species in areas cleared for farming; the effect has been to create what is called “farmed parkland,” in which a few favoured trees rise above the fields. Examples include the shea butter nut tree (*Butyrospermum*), common in Ghana and Côte d’Ivoire; *Acacia albida*, found in Senegal

and Zambia; and the truly domesticated baobab (*Adansonia digitata*), which is perhaps the most widely distributed.

Thorn woodland, grassland, and semidesert vegetation

Toward the margins of the tropics, the vegetation cover becomes lower and thinner as the fluctuating transition to desert vegetation ensues. In the same progression the concept of an annual rainfall (nominally 5 to 20 inches) yields to the reality of extreme unreliability in both incidence and expectation. Under such restraints a definitive "boundary" with the desert becomes meaningless. Moreover, there appears to have been a trend toward declining precipitation in the last half of the 20th century, and human impact certainly has enhanced the natural deprivation of plant life in the marginal regions.

The southern margin of the Sahara—roughly between the latitudes of 15° and 20°—is called the Sahel (Arabic: Sāḥil; meaning "shore" or "edge"), the word being extended by implication to comprehend the fluctuating margins of the great sand seas of the Sahara to the north. The southern equivalent covers much of the Kalahari, which is often called a desert but is more properly a thirstland.

Thorn woodland displays a predominance of xerophytic, sometimes succulent or semisucculent trees, such as acacia, *Commiphora* (the myrrh tree), or *Boscia* (an evergreen hard-leaved tree). The occurrence of the bunched and thorny desert date (*Balanites*) seems to accompany land impoverishment. A relatively luxuriant shrub layer, often forming dense thickets, is found in conjunction with succulents, such as aloes, *Sansevieria* (a fibrous species), and *Adenium*, or desert rose (a succulent shrub with smooth gray bark, a huge water-storing base, and beautiful red or pink flowers), and smaller euphorbias.

Farther toward the desert, tree growth and perennial grass—surviving in narrow strips along watercourses—separate much larger areas of sparse annual grasses (*Cenchrus* in western Africa, *Eragrostis* south of the Equator, and *Chrysopogon* on the margins) and scattered low shrubs, often mainly acacias. Shrubs may often be salt-tolerant. While shrubs may die from inadequate moisture, they are little affected by the rare fires that occur.

Afromontane vegetation

All high mountains exhibit azonality; i.e., their vegetation differs from that found in the climatic zones from which they rise. The differences manifest themselves as progressive modifications, which are usually well stratified and reflect altitude-dependent climatic changes. Generally, as elevation increases, temperature decreases (to the point where frost and even glaciation can occur) and precipitation increases (although above a certain level precipitation decreases markedly). Mountainous terrain can retain ancient climatic conditions—making possible, for example, the survival of relict species—and the relative inaccessibility of the higher elevations to humans has helped preserve more of the vegetal patterns of the past.

Vegetation strata typically are skewed with regard to slope orientation (aspect). This is mainly due to a contrast between exposure to rain-bearing winds and shadowing from them but may also reflect long-term history. If lower slopes rise abruptly from the base, as they often do in Africa, then a distinct boundary between vegetation formations may be clearly distinguished; if the rise is gentle, vegetations merge (as in the western Kenyan highlands). (All the circumstances mentioned above are represented in the African mountain systems, but for purposes of illustration the vegetational map identifies only areas of altitudinal modification. Thus, some areas that are included are not tropical, such as parts of the Red Sea Hills and the mountains of South Africa and Lesotho.)

Altitudinal modifications of vegetation are clearly discernible on the high East African peaks near the Equator (e.g., Kilimanjaro and Mounts Kenya and Elgon), and a rich forest belt—much reduced upslope by human activities, except where the land has been reserved—clothes the zone that receives the maximum rainfall and is free of frosts (up to about 5,000 to 6,000 feet). Such mountains have great human importance as watersheds and as repositories of native plants.

Desert vegetation

The Sahara has one of the lowest species densities in the world, and a sustained vegetation cover (which can include trees and bushes) occurs only in the massifs and oases. Elsewhere the vegetation is discontinuous and consists of two main types: perennials with huge root systems and sparse aerial parts, often protected by waxy cuticles, thorns, and hairs; and

ephemerals with slight root systems and little foliage but with the ability to flower profusely immediately after occasional storms and then to seed quickly and abundantly. The stony and rocky expanses give more hold for plants than do the vast areas of shifting sands. In some areas with slightly more rainfall, grass tufts may grow 50 yards apart. *Aristida* is the dominant grass, and for brief periods it can yield a nutritious forage called *ashab.*

Drainage

The uplifting and warping of the surface of the African continent that occurred during the Pliocene and Pleistocene epochs produced a number of structural basins; these are now either individually occupied by, or are linked up with, drainage systems. With the exception of the Chad basin, all the major drainage basins have outlets to the sea. In addition, minor drainage basins, similar to that of Lake Chad, are situated in the East African Rift Valley. Some, again like Lake Chad, constitute the focus of centripetal drainage (drainage directed toward the centre), while others are linked to river systems. Although the East African lakes are climatically and economically important, relatively little is known of their hydrological characteristics.

. Climate, geology, and the history of tectonic activity have imparted certain common characteristics to African rivers. Spatial variations in the incidence and amount of rainfall are reflected in their hydrological regimes. In areas that have one rainfall season, for example, and have pronounced drought throughout the rest of the year, the rivers flood in the rainy season and shrink in the dry season.

Whatever their hydrological regimes, all the important African rivers are interrupted by rapids, cataracts, and waterfalls. This is explained by several factors, the most important of which is the past tectonic activity, or regional land movements, that caused ridges to be formed across the courses of the major rivers. Waterfalls are often found where the rivers are still engaged in cutting downward as they flow across these ridges; Cahora Bassa (falls) on the Zambezi and the Augrabies Falls on the Orange River are examples. Another factor that contributes to the creation of rapids or falls is the incidence of rock strata that have proved resistant to the erosive effect of the rivers' flow. (Tropical rivers do not generally carry large

quantities of stone or rock; instead, they have a tendency to carry loads of fine silt, produced by chemical weathering.)

Although the Nile, the Zambezi, and the Niger rivers have large deltas, their size does not compare with, for example, the enormous delta region of the Ganges and Brahmaputra rivers. In Africa the generally poor development of deltas is mainly because of the restricted extent of the coastal plain, together with the relatively narrow continental shelf, which provides neither sufficient room nor shallow enough water for the deposition of delta-forming material. The great speed with which most of the rivers flow into the sea is another factor inhibiting delta formation.

The major drainage basins of Africa are those of the Nile, the Niger, the Congo, the Zambezi, and the Orange rivers and of Lake Chad.

Nile basin

There are two theories concerning the development of the Nile, which, it appears, originally consisted of two sections. The first theory is that the lower Nile had its source at about latitude 20° N, whence it flowed directly into the sea, while the upper Nile, issuing from Lake Victoria flowed into an inland lake that covered the Al-Sudd region in what is now South Sudan. The lake became filled with water, which then spilled over at its northern end and flowed into what is now the lower Nile. According to the second theory, the upper section originally flowed into a vast lake between Mount Al-Silsilah (near Luxor, Egypt) and what is now Aswān; this was tapped by the lower section of the Nile after the so-called Sebile erosion (which takes its name from the fact that the breakthrough by the lower Nile was identified at Sebile).

The Nile, which is about 4,132 miles long, is the longest river in the world. From Lake Victoria it flows, as the Victoria Nile, into Lake Albert, from which it emerges as the Albert Nile. Farther north it is known as the Al-Jabal River. Thereafter, having received several tributaries, it becomes the White Nile and finally the Nile, emptying at last into the Mediterranean Sea. Its major left-bank tributary is the Al-Ghazāl, and the largest right-bank tributaries are the Sobat, Blue Nile, and Atbara. Because of the numerous rapids and waterfalls, the Nile descends fairly rapidly from source to mouth, as do its major right-bank tributaries. This is especially true of the Blue Nile, which, after issuing from Lake Tana on the Ethiopian Plateau

at a height of approximately 6,000 feet, flows for most of its length through a steep gorge. Swamps also interrupt the river's course. Of these the largest is Al-Sudd, a vast area of floating swamp reeds, mostly papyrus.

The river's regime is now controlled by a series of dams situated on the Nile itself or on one of its various tributaries; of these, the largest is the Aswan High Dam on the main Nile.

Niger basin

The Niger basin is the largest river basin of western Africa. The Niger River, which rises in the mountains of Guinea and enters the sea through its delta in southern Nigeria, is about 2,600 miles in length. Rapids interrupt its course at several points, although some of these (such as below Bamako, Mali) have been submerged in waters impounded by dams.

The Niger receives its largest tributary, the Benue, which flows in from its left bank, in Nigeria. The valleys of both the Niger downstream from Taoussa and the Benue appear to be faulted troughs dating from the early Cretaceous Period. Originally, the middle Niger was separate from the upper Niger, which flowed into an inland lake, the remnants of which now form the inland Niger delta. The middle Niger flowed southeastward to the sea; its valley eroded toward its headwaters, eventually tapping the inland lake and linking the middle with the upper Niger.

Congo basin

With a total area of about 1,335,000 square miles, the Congo basin consists of a vast shallow depression that rises by a series of giant steps to an almost circular rim of highlands through which the river has cut a narrow exit into the Atlantic Ocean. The present exit is geologically relatively recent; the previous exit was to the north of the present one.

The Congo River is some 2,900 miles in length. Its many waterfalls and rapids cause its valley, like that of the Nile, to lose elevation quickly. The river's course is often constricted by gorges. The best-known are the Boyoma (Stanley) Falls at Kisangani, where the river swings through an arc to flow westward; in fact, the Boyoma Falls are no more than a series of unevenly

spaced rapids at no great height, extending along a 60-mile stretch of the river. Downstream from Kisangani, the Congo is joined first by the Ubangi from the right and then by the Kasai—which rivals the Ubangi in the size of its drainage basin—from the left. Below its confluence with the Kasai, the main river cuts through the Cristal Mountains in a deep gorge, which at one point expands into Malebo (Stanley) Pool, a shallow lake measuring 22 miles in length and 14 miles in width. The Congo enters the sea through a swampy estuary that is about 6 miles wide at its mouth.

Zambezi basin

The Zambezi River is about 2,200 miles in length and occupies a basin with an approximate area of 463,000 square miles. Originally, there were two rivers, corresponding to the upper and lower courses of the present river; the valley of the lower section eroded toward the headwaters until it captured the waters of the upper section. Although there are stretches of the river where the gradient is very gentle—a drop of only about three inches to the mile—the valley as a whole has a fairly steep gradient. There are numerous waterfalls, the most spectacular of which is the Victoria Falls.

After these falls, the river winds through a number of deep gorges cut out of basalt and, after flowing through a broad valley, enters Kariba Gorge, which is more than 16 miles in length and is cut through paragneiss (a gneiss, or coarse-grained rock, in which bands rich in granular minerals alternate with bands containing schistose minerals, formed out of sedimentary rock). The Kafue and the Luangwa, the two main tributaries, which both flow through gorges, join the Zambezi on its left bank downstream from Kariba. At the mouth of the main river is a delta about 37 miles wide.

Orange basin

The Orange River is the longest in South Africa. Flowing across almost the entire width of the country, it makes its way from the highlands in the east through the Kalahari depression in the west to empty into the South Atlantic Ocean. Its major tributary, the Vaal River, is one of its northern headwaters; the two rivers together have a combined length of about 1,300 miles. Together with other major rivers on the continent, the Orange–Vaal river system shares the

characteristic of flowing over steep gradients for numerous stretches of its course. The largest drop (about 400 feet) occurs at the Augrabies Falls.

Chad basin

The Chad basin constitutes the largest inland drainage area in Africa. Lake Chad, a large sheet of fresh water with a mean depth between 3.5 and 4 feet, lies at the centre of the basin but not in its lowest part. Lake Chad is fed by three major streams, the Komadugu Yobe, Logone, and Chari, but these are in danger of having their waters captured by the drainage systems of rivers that flow in opposite directions. Lake Chad itself, with an area of only some 5,000 square miles, was formerly much more extensive.