GEOGRAPHY

Student Textbook
Grade 11

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FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

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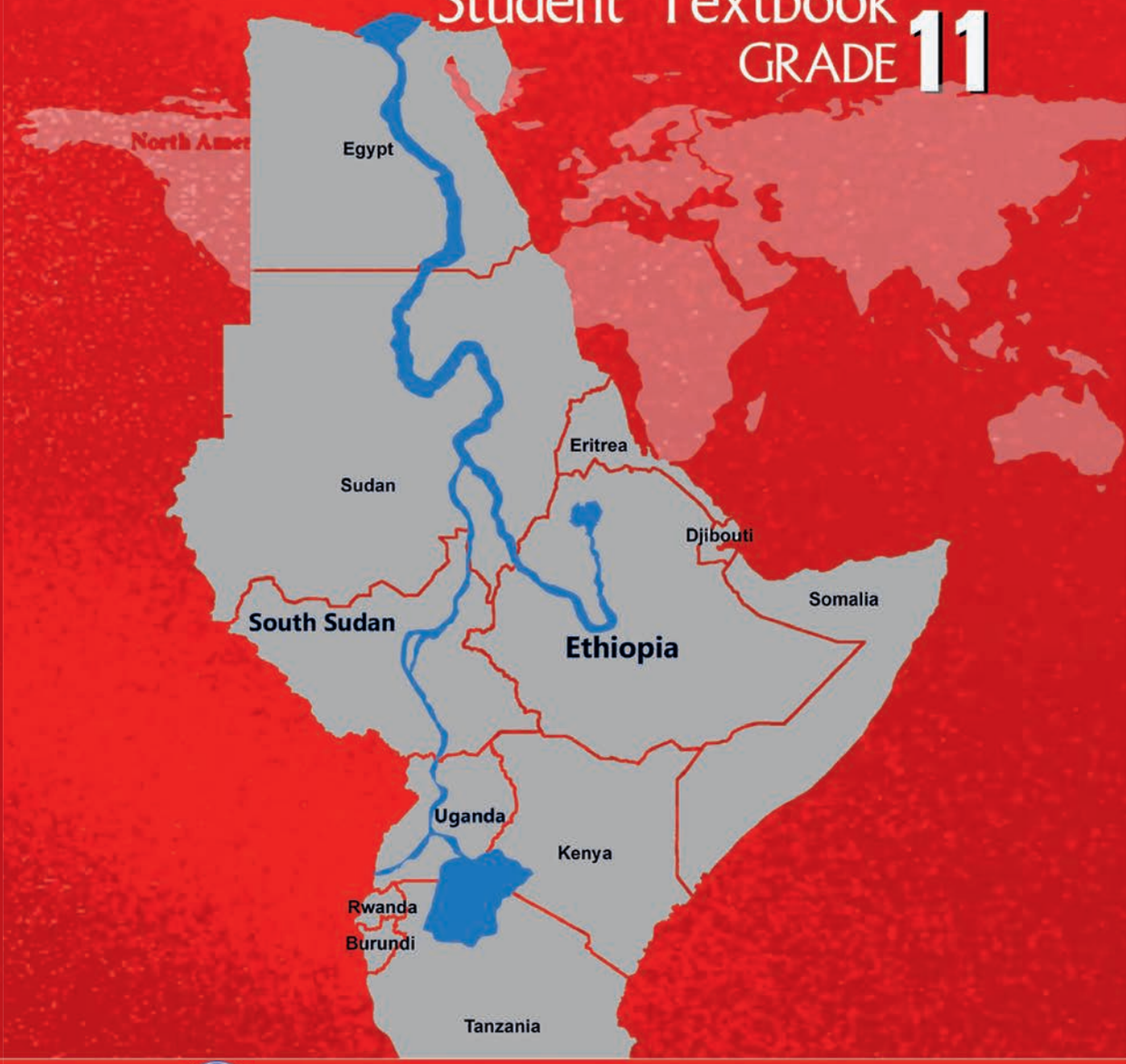

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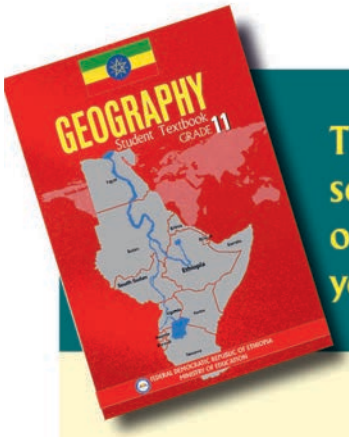

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GRADE 11

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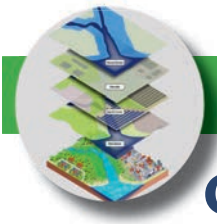


UNIT EIGHT

GEO-SPATIAL INFORMATION AND DATA PROCESSING

UNIT ONE
FORMATION OF CONTINENTS

Learning Outcomes:
At the end of this unit, you will be able to:

- recognize the Earth's geological history;
- describe the formation of the Earth's Continents;
- explain the relative distribution of Continents and Oceans overthe Globe; and
- appreciate the changing positions of the Earth's Continents and
- Oceans over geological times.

Main Contents :

Introduction
Students, do you remember the lessons on 'Geological History of Ethiopia' and 'Landforms of Africa' in your Grade Nine and Ten Geography, respectively? If yes, can you tell us what geological history is and how the landforms of Africa have been developing? In unit one of Grade 11 Geography you are going to learn about the timescale of the Earth's geological processes; the development stages of the earth's continents; and the relative position (distribution) of the Earth's oceans and continental landmasses. With these basic contents you are; therefore, expected to be aware of and appreciate the Earth's geologic timescales, formation of the continents, and relative position/distribution of the Earth's oceans and continental landmasses.

1.1. FORMATION OF CONTINENTS

This section presents how the Earth and continents evolved. The topic takes you to the wider scientific wisdom of the origin of the Earth and its Continents.

At the end of this section, you will be able to:

- examine how the Earth was created; and
- describe how the Earth's continents evolved.

Keywords:

- **Big bang**
- **Continents**
- **Continental drift**
- **mid-oceanic**
- **Pangaea**
- **Rodinia**
- **Sea-floor spreading**
- **Solar system**

Brainstorming Activity 1.1

Please attempt the following questions first individually and then in groups:

1. Do you know how the Earth was formed or created?
2. What do you imagine about the formation of the Earth and Continents?

The Earth, together with other planets and their moons, form the planetary system. The Sun and the planets together again form the Solar System (Sun System; see Figure 1.1). The formation of the Earth is thus attributed similar to the creation of other companion planets and the entire development of the Solar System. Therefore, it is necessary to comprehend the origin of the Solar System to understand the foundation of the Earth.

As can be learned from Earth Science literature, there are different views and theories on the formation of the Earth and that of the Solar System. However, most of the theories depend on speculation and ambiguous assumptions. None of them are capable of acceptably demonstrating all the ultimate features of the Earth and the Solar System.

Among the various assumptions and theories proposed about the formation of the Universe and Earth, the "Big Bang" is most widely supported by scientists. According to this theory, the Universe originated sometime 10–20 billion years ago by an abrupt cosmic explosion initiated by the expansion of a small volume of matter at an exceedingly high density and temperature. This space explosion was then followed by the formation of numerous space objects like the Sun, planets (Figure 1.1), stars, meteors, asteroids, and comets through material collision, cooling, and gravitational attraction. Our Earth was thus created from the mixture of gas and dust particles moving in space around the Sun about 4.5 billion years ago.

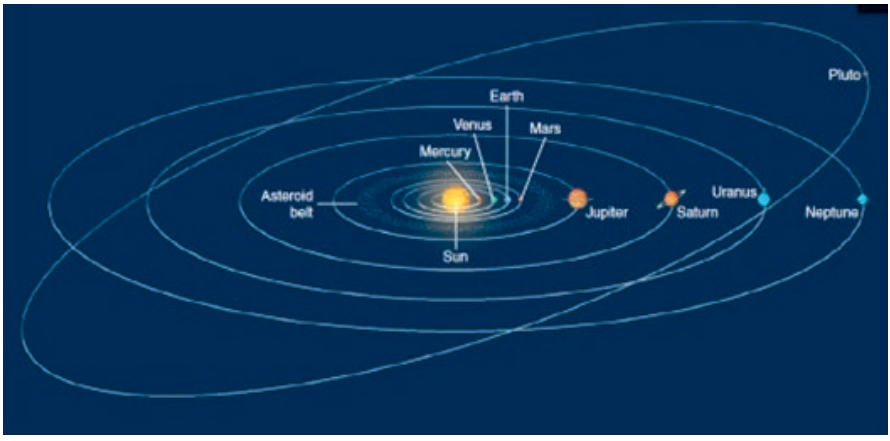


Figure 1.1 The Solar System (Sun & Planets) [Wicander & Monroe, 2010]

Brainstorming Activity 1.2

Discuss the questions below with your classmates and teacher:

1. How were the continents formed/created?
2. How did the present-day continents come into being?
3. How were they separated from the Pangaea?
4. What is continental drift? How does it happen?

The first cosmic rocks solidified and created the first Earth at about 4600 to 3900 Ma. Following that, initial land masses gathered to form the early continent called 'Rodinia' (Figure 1.2).

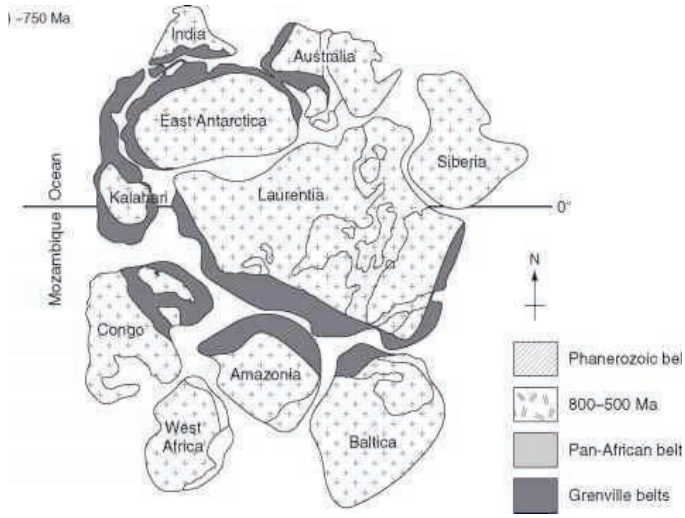


Figure 1.2 Neoproterozoic Supercontinent; Rodinia at about 750 Ma (Wicander & Monroe, 2010)

During the late Cambrian period (514 Ma) the Gondwana Supercontinent had evolved around the South Pole. Next to this four major continents (Gondwana, Baltica, Siberia & Laurasia) came into being during 458 Ma (in the mid-Ordovician Period). Then the Laurasia continent collided with the Baltica and closed the Iapetus Sea during the mid-Silurian (425 Ma).

The continual collision had then produced the pre-Pangaea continent during the early Devonian period, at about 390 Ma. At about 306 Ma (in the late Carboniferous period) the North American continent started to develop from the assemblage of rocks. By then, the Supercontinent (Pangaea) had come into being at about 255 -210 Ma. From 210 -180 Ma (in the Triassic period) this Supercontinent started to break apart. The break-up had continued until the late Cretaceous. In the meantime, North America had moved away from the African continent. During the late Cretaceous, the breaking-apart of Pangaea widened and bigger water masses (Oceans) were created along the continental cracks. Finally, continental break-up progressively continued during the Tertiary period; the Earth's continents have then retained their present position during the Quaternary (Figure 1.3).

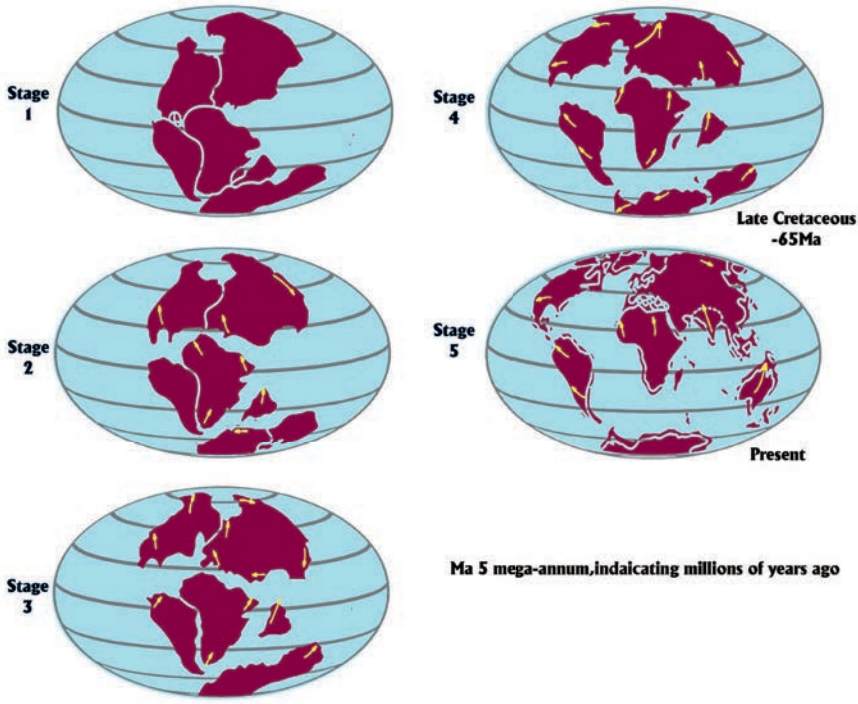


Figure 1.3 Continents at different Geological times (Gabler et al., 2007)

Tip: An additional information is available online for you at: https://www.youtube.com/watch?v=6-vHe4599NE

From the preceding section, it is possible to note that the present-day continents were joined together by forming Pangaea until about 200 Ma. At about 160 Ma, Pangaea divided into two bigger landmasses called Gondwanaland and Laurasia by the process of continental drift. The landmass that developed into sub-continent India moved northwards and separated from the Gondwana continent at about 140 Ma. This occasion caused the collision of the Indian sub-continent with Eurasia and initiated the formation of the Himalayas ranges. Some 100 Ma, Australia had separated from Antarctica and this has pronounced the break-up of the Gondwana continent. The two giant continents (Gondwanaland & Laurasia), then moved-apart east and west thereby resulting in the opening of the Atlantic Ocean.

NOTE

Continental drift refers to the moving apart of continents initiated by Sea-floor Spreading at mid-Ocean-ridge locations. The event makes the Pacific Ocean narrower, the Atlantic Ocean wider, the Mediterranean Sea narrower, and the Himalayan Mountains higher. The drift makes Australia reach the equator in 60 million years.

Reflective Activity 1.1

Please answer the following questions:

1. Explain how the Earth's continents were created?
2. Name the two Supercontinents that evolved at about 200 Ma.
3. What is Pangaea?

1.2. THE GEOLOGICAL TIMESCALE

This topic focuses on the geological history of the Earth as condensed in the geological time-cale, mainly on the major Earth forming processes, resultant landforms, and the successions of interrelated life-forms.

At the end of this unit, you will be able to:

- use the geological timescale for the explanation of the geological processes, resultant features, and associated life-forms;
- describe the difference between relative and absolute ages of the Earth's rocks;
- examine the geological eras of the earth.
- Examine the Geological Eras of the Earth.

Keywords:

- Absolute age
- Epoch
- Geological era
- Geological timescale
- Isotope
- Half-life
- Period
- Radioactive decay
- Relative age

Brainstorming Activity 1.3

Please organize yourself into groups and attempt the following questions:

1. Have you ever heard about the geological history of the Earth?
2. What is the geological timescale?
3. How was the age of the Earth established?
4. How do scientists determine the age of the Earth and its products?

1.2.1 Meaning of Geologic Timescale

Geological timescale is the time-frame (timetable) showing the possible age of the Earth and its associated life-forms. It provides a review of Earth's history and the major changes that occurred over time. It is developed by Earth scientists through the study of Earth's rocks. Through

the study of rocks, scientists determine the Relative and Absolute ages of rocks.

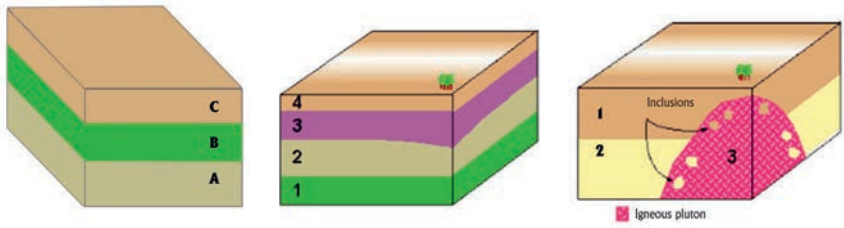
1.2.2. Relative and Absolute Age of Rocks

❖ Relative Age

Relative age mainly depends on the analysis of the sequence of geological occurrences without giving due regard to the exact time of origin. It focuses only on determining the sequence of formation of events (whether the event had occurred before or later than the other related one). This method principally depends on the study of sedimentary rocks and often applies to local conditions interpretations. Geologists employ three basic principles (rules) during the study of the relative age of rocks:

- **Principle of Original Horizontality,**
- **Law of Superposition, and**
- **Principle of Cross-Cutting Relationships.**

The principle of original horizontality indicates that layers of sediments are originally placed horizontally under the action of gravity. This means that except for the disturbed sequences, sedimentary rocks are always deposited in nearly horizontal beds. In the hypothetical Figure 1.4a,
the rock-layers A, B & C must have been developed in horizontal beds because they have the same orientation. If the beds are no longer horizontal, they must have undergone deformation after formation. The principle of superposition asserts that in an undisturbed sequence of sedimentary rock layers (beds) or lava flows, the overlying bed is younger than the underlying rock. For instance, in Figure 1.4b, the rock layers are placed from earliest (1) to latest (4).



Source: www.kean.

A) Original Horizontality B) Superposition C) Cross-Cutting

Figure 1.4: Sample sedimentary rock-layers

The principle of cross-cutting relationships indicates that a rock-layer that cross-cuts another rock-layer is said to be younger than the rocks it cross-cuts. This is a condition where older rocks are cut by younger geologic features or igneous intrusions. In Figure 1.4c, layer 3 is an igneous intrusion created after the formation of the sedimentary layers 1 and 2.

❖ Absolute Age

Absolute age refers to the actual age of rocks given in numerical values through the analysis of the spontaneous decay of radioactive isotopes. The term isotope refers to the presence of an element in different forms.

Radioactive decay stands for the conversion of unstable (Parent) elements into daughter (Stable) elements through the gaining or losing of particles in their nucleus. For instance, Potassium-40 (^{40}K) decays into Argon-40 (^{40}Ar). Similarly, Carbon-14 (^{14}C) changes to Nitrogen (^{14}N). Rubidium-87 (^{87}Rb) converts also to Strontium-87 (^{87}St). Likewise, Uranium-235 (^{235}U) change to and Lead-207(^{207}Pb) (Table 1.1).

Table 1.1 Parent and Daughter isotopes and time-taken (half-life) for conversion

No	Parent isotope	Daughter isotope	Half-life
1	Uranium - 238 ($^{23}8U$)	Lead – 206 (^{206}Pb)	4.5 billion years
2	Rubidium – 87 (^{87}Rb)	Strontium – 87 (^{87}Sr)	48.8 billion years
3	Potassium-40 (^{40}K)	Argon – 40 (^{40}Ar)	1.25 billion years
4	Uranium - 235 (^{235}U)	Lead – 207 (^{207}Pb)	704 million years
5	Carbon-14 (^{14}C)	Nitrogen – 14 (^{14}N)	5,730 years

The time taken to convert from parent element to Daughter element is commonly measured in half-lives. The half-life of an isotope is the time taken for half of the parent isotope to change to its product atoms. The relative proportions of the Parent and Daughter isotopes are used to determine the number of half-lives. Before conversion, 100% of the Parent prevails and no daughter product is formed. After one half-life, 50% of the Parent remains while 50% of the atoms are changed to Daughter atoms. After two half-lives, the number of Parent isotopes is again halved (25%) whilst the number of Daughter atoms increases by the same amount (to 75%). For more clarity please see Table 1.2.

Table 1.2 Proportion of Parent and Daughter isotopes during radioactive decay

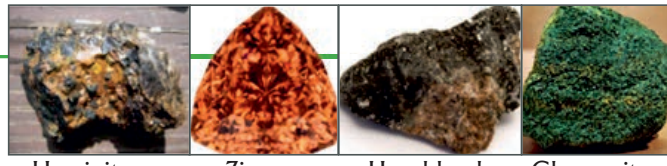
No	No of half-lives	Proportion (% of total isotopes)	
		Parent isotope	Daughter isotope
1	0	100	0
2	1	50	50
3	2	25	75
4	3	12.5	87.5

NOTE:

Radioactive decay occurs when elements recombine to form new minerals during the processes of metamorphism or when magma cools. Radioactive elements found in igneous and metamorphic rocks are commonly used in rock-dating studies. For instance, see some of the rocks used for dating purposes in Figures 1.5 & 1.6.

As mentioned earlier, the geological timescale forms a division of geological processes and life-forms based on standard time units through the study of fossil remains imprinted in rock layers. The scale divides the age of the Earth into Eons, Eras, Periods, and Epochs (Table 1.3).

When the geological timescale was initially developed, the earliest fossils were found not exceeding 600 million years (Ma) from the present (the Cambrian Period) in age. Based on that, the part of the geological history of the earth before the Cambrian Period (the time from 600-4500 Ma) is classified as Precambrian. Precambrian, thus, means the time before Cambrian.



Uraninite Zircon Hornblende Glauconite

a) Sample rocks used in radiometric

Trilobite fossil (Cambrian) Ammonite fossil (Jurassic) Crinoid fossil (Carboniferous)

b) Some index fossils used in geological

Figure 1.5 Sample rocks and index fossils used for geological dating purposes (a,b)

Figure 1.6 Radiocarbon

Table 1.3 Geological timescale

EON		PERIOD		EPOCH	AGE (Ma)*	MAJOR EVENTS
PHANEROZOIC	CENOZOIC	QUATERNARY		Holocene	Present – 0.01	Modern Humans
				Pleisto-cene	0.01 – 1.6	Ice Age
		TERTIARY	NEOGENE	Pliocene	1.6 – 5.3	Early Whominids
				Miocene	5.3 – 23.7	
			PALEOGENE	Oligo-cene	23.7 – 36.6	
				Eocene	36.6 – 57.8	Extinction of Dinosaurs
				Paleo-cene	57.8 – 70	
	MESOZOIC	CRETACEOUS			70 - 144	First birds
		JURASSIC			144 - 208	
		TRIASSIC			208 - 250	Start of Pangaea break-up; First mammals; First Dinosaurs
	PALEOZOIC	PERMIAN			250 - 286	
		Carbon-iferous	PENNSYLVA-NIAN		286 - 320	Coal deposits, First Reptiles
			MISSISSIPPIAN		320 -360	
		DEVONIAN			360 - 408	First Amphibians
		SILURIAN			408 - 438	First land animals; First land plants; First Fish
		ORDOVICIAN			438 - 505	
		CAMBRIAN			505 - 600	First shelled animals
PROTERO-ZOIC	PRECAMBRIAN				600 - 2500	Formation of the oldest known rocks and solid-ification of the earth
ARCHEAN					2500 - 3900	
HADEAN					3900 - 4500	

*Ma: Million years

Crawford (1998); Wicander & Monroe (2010); www.kean.edu

Based on the geological timescale, the history of the formation of the Earth is classified into four longer geological periods named Eons. Hadean, Archean, Proterozoic, and Phanerozoic are four major sub-divisions of the known Eons. The Hadean, Archean and Proterozoic Eons are often called Precambrian by scientists to refer to the geological time before the emergence of life on Earth. The Phanerozoic is the most recent Eon. It is further sub-broken into three Geological Eras named Paleozoic, Mesozoic, and Cenozoic (see Table 1.3).

1.2. 3.Geologic Eras

As can be learned from Table 1.3, four known Geological eras are identified in the history of the Earth. They are the Precambrian, Paleozoic, Mesozoic, and Cenozoic. The Precambrian is the oldest of all the geological eras. It covers the time from 600 million to 4.5 billion years (about 85% of the geological time of the Earth). It was the time of solidification of the Earth and the formation of the oldest rocks. Rocks created during that time are rich in base metallic minerals and are often called crystalline basement complex rocks. Figure 1.7 indcate that they are often found along with the continental Shields or Cratons (landscapes resisted long period of erosion) The Hadean Eon of the Precambrian covers the time 4600 – 3900 Ma and not much is known about it. Archean is the other Eon covering some 1400 (3900 – 2500 Ma). The latest of the three Eons is the Proterozoic lasting from 2500–570 Ma.

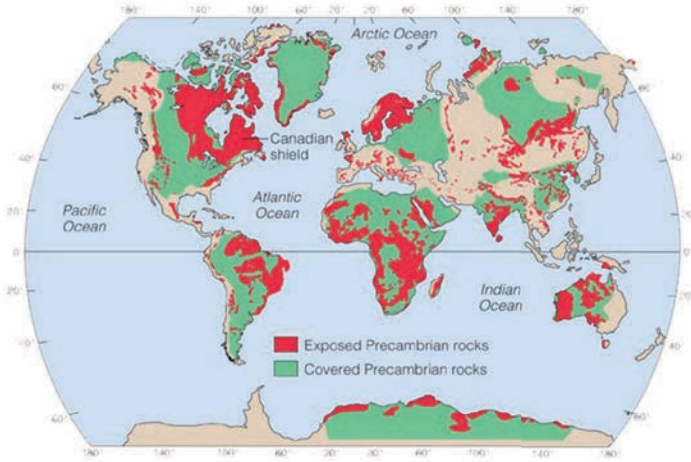


Figure 1.7 Distribution of Precambrian rocks (shields) [Wicander & Mon-

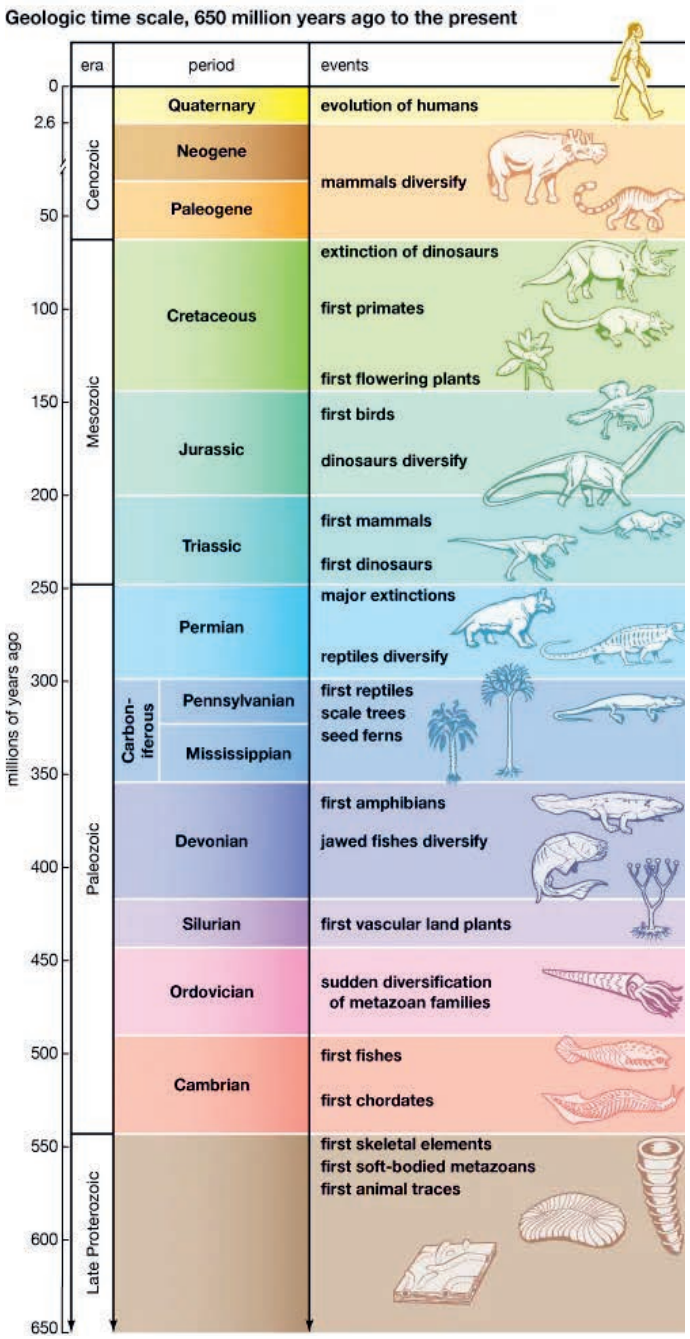


Figure 1.8: Life forms evolved during the different geological eras (Crawford, 1998)

The Paleozoic era covered the time from 600 to 250 Ma from the present. It is believed that it marked the beginning of life and is commonly referred to as the age of ancient life. Trilobites and shelled animals (see Figure 1.8) were the common species of the time. The Devonian, the fourth period of the Paleozoic, was rich in fish species and referred to as the age of fish. By the end of the Paleozoic, all continents of the Earth had joined together and created the Supercontinent named Pangaea (Figure 1.9). The creation of Pangaea led to extreme seasonal weather changes that caused the great extinction of Earth species. Due to that, around 75% of the Amphibian species have perished.

Figure 1.9 The Supercontinent (Pangaea) (Gabler et al., 2007)

The Mesozoic era marked the time from 250-70 Ma. It is often referred to as the era of middle life and the age of Dinosaurs owing to their relative dominance. Turtles, snakes, crocodiles, and lizards were among the life forms of the time. Low-lying areas were occasionally flooded by shallow marine transgressions followed by depositions of red sandstones and mudstones. Tropical areas were dominated by extensive swamps which later became rich coal deposits. The mid-Mesozoic era was experiencing the splitting of Pangaea into Laurasia and Gondwanaland (Figure 1.9). Igneous activities had initiated also the development of volcanic mountain ranges in western North America. The end of the Mesozoic era saw the emergence of land mammals but marked the mass extinction of Dinosaurs (see Figure 1.8).

The Cenozoic era is the recent one covering the time since 70 Ma. As it forms the recent geologic time, it is well known compared to the other Geological eras. Birds, mammals, and flowering plants dominante succeeded on Earth. It is commonly named an era of recent life and the age of mammals.

During the beginning of the Cenozoic era the the rifting of Pangaea has been fully achieved and the continents retained their present form. Great volcanism and orogenic folding caused the formation of numerous volcanic, fault-block, and fold mountains in the different parts of the Earth's continents. Glaciations were experienced in some high-latitude areas while heavy rainfall occurred in other localities. Extinction of some mammals happened in some localities.

NOTE:

Orogenic is the formation of mountains, especially through the folding of the earth's crust

Reflective Activity 1.2

Please organize yourself into groups and answer the following questions:

1. How is the geological timescale established?
2. What are geological eras?
3. Could you please name some of the life forms that evolved in the different geological eras?
4. Prepare a geologic timescale chart using graph paper.

1.3. DISTRIBUTION OF THE CONTINENTS AND OCEANS

This topic of unit one is about the relative size and distribution of the Continental landmasses and Oceanic basins over the Globe.

At the end of this section, you will be able to:

- compare the sizes of landmasses and oceanic basins over the globe; and
- locate the current positions of Continents and Oceanic basins.

Brainstorming Activity 1.4

1. How do you explain the distribution of Continents and Oceans over the Globe?
2. Show the location of the world's Continents and Oceans using sketch maps? Please study the maps from your textbook and tell the answer to your teacher.

The surface area of the Earth is estimated to be 510,072,000 km^2 and the area of the Oceans is about 363, 000,000 km^2. All water (hydrosphere) in total covers greater than 71% of Earth's surface. The largest of these are the Oceans, which account for over 97% of all the water on Earth. Glaciers and polar ice caps contain just greater than 2% of the Earth's water in the form of solid ice. Only about 0.6% is found under the surface as groundwater. Nevertheless, groundwater is 36 times more plentiful than water found in lakes, inland Seas, rivers, and in the atmosphere as water vapor.

The distribution of Ocean basins and Continents is unevenly arranged over the Earth's surface (see Figure 1.10). In the Northern Hemisphere, the ratio of land to ocean is about 1:1.5. But it is 1:4 in the Southern Hemisphere. The greater abundance of water in the Southern Hemisphere has some interesting effects on the environment of that area. For example, the climate tends to be more moderate in the Southern Hemisphere because of the ocean's ability to release large amounts of stored heat energy.

The Continents

A continent is a huge area of land mostly separate by a water body. There are seven known continents on the earth today. They are: Africa, Antarctica, Asia, Australia, Europe, North America, and South America. A brief description of the continents is presented as follows:

Africa

Africa is the second largest continent in the world next to Asia. The equator divides Africa into two parts. But the largest part of the continent is found north of the equator. Africa is the only continent in the world crossed by the equator, Tropic of Cancer, and Tropic of Capricorn. The world's largest hot desert (Sahara), and the world's longest river (River Nile),are found in Africa. Africa has 54 countries.

Antarctica

Antarctica is a permanently ice covered continent located around the South-Pole. The climate is very cold and there are no permanent human settlements in Antarctica. But, many countries have research stations in Antarctica. It is the third smallest continent on the earth.

Asia

Asia is the largest continent in the world. It lies in the eastern hemisphere covering one-third of the total land area of the earth. It is crossed by the Tropic of Cancer and separated by the Ural Mountains from Europe. It is part of the Eurasia and crossed by the Arctic Circle at its northern margin. It is bounded by water bodies on three sides and by the Pacific Ocean in the east and southern part. Asia has 48 countries and accommodates two-third of the world population. It has the highest mountains (Himalayas), the deepest depressions (Dead Sea), the driest desert (Lut desert), highest precipitation (Assam) and long tradition of civilization (Mesopotamia).

Australia

Australia is the smallest continent in the world. It is surrounded by water in all of its sides and often called an Island continent or Oceania; and has the largest area of ocean jurisdiction of any country on Earth. It is the driest inhabited continent in the world with 70 percent of it either arid or semi-arid. The vast majority of its population is concentrated along the eastern and south-eastern coasts. Australia entirely lies in the southern hemisphere.

Europe

Europe is the second smallest continent in the world, and home of the industrial revolution. It has 44 countries. It lies to the west of Asia and north of Africa. Europe is crossed by the Arctic Circle. It is bounded by the Atlantic and Arctic oceans and by the Mediterranean Sea in the south.

North America

North America is located to the west of the Atlantic Ocean and linked to South America by the narrow strip of land called the Isthmus of Panama. It is the third largest continent of the earth. It lies north of the equator in the western hemisphere and surrounded by the Atlantic, Pacific and Arctic Oceans. The main countries are three (USA, Canada & Mexico).

South America

South America is also located in the western hemisphere, but most of its area lies south of the equator. It is bounded in the east by the Atlantic Ocean and in the west by the Pacific Ocean. The world's largest River (Amazon River), largest and most bio-diverse rainforest, tallest uninterrupted waterfall (Angel Falls) and the north-south extending longest mountain (Andes Mt.) are found in South America. South America has 12 countries.

Geographers have divided and named the interconnected Oceans of the world into five groups. They are:

- The Arctic Ocean,
- The Atlantic Ocean,
- The Indian Ocean,
- The Pacific Ocean, and
- The Southern Ocean.

Arctic Ocean

The Arctic Ocean is the world's smallest Ocean with an area of 14,056,000 km^2. It lies in the area between Europe, Asia, and North America. Most of its waters are north of the Arctic Circle. Its average depth is 1,205 m. The deepest point lies at the Nansen Basin or Central Basin and it is −4,665 m deep. Throughout most of the year, much of the Arctic Ocean is covered by a drifting polar icepack that is an average of 3 m thick. However, as the Earth's climate changes, the Polar Regions are warming and much of the icepack melts during the summer months. The Northwest Passage and the Northern Sea route have historically been important areas of trade and exploration.

Atlantic Ocean

The Atlantic Ocean is the world's second-largest Ocean with an area of 76,762,000 km^2. It is located between Africa, Europe, and the Southern Ocean in the Western Hemisphere. It contains the majority of the Earth's shallow Seas, but relatively few islands.

The shallow Seas found in the Atlantic Ocean basin are the: Baltic Sea, Black Sea, Caribbean Sea, Gulf of Mexico, North Sea, and the Mediterranean Sea. The average depth of the Atlantic Ocean is 3,926 m. Its deepest point is the **Puerto Rico Trench** which is some 8,605 m deep (Figure 1.11).

Many streams and rivers discharge their water into the Atlantic Ocean. This basin also drains some of the world's largest rivers including the Amazon, Mississippi, St. Lawrence, and Congo. It receives more freshwater from continental runoff than any other Ocean basin. The Atlantic Ocean is important to the world's weather (as are all oceans) because strong Atlantic hurricanes often develop off the coast of Cape Verde, Africa, and move toward the Caribbean Sea from August to November.

Figure 1.10 Continents and Oceans of the World

Indian Ocean

The Indian Ocean is the world's third-largest ocean and it has an area of 68,566,000 Km^2. It is located in the area between Africa, the Southern Ocean, Asia, and Australia. The Indian Ocean has an average depth of 3,963 m. Its deepest point is at the **Java Trench** or **Sunda Double Trench** (Figure 1.11). The maximum depth reaches some 7,258 m. The waters of the Indian Ocean also include parts of the adjacent water bodies such as the Andaman, Arabian, Flores, Java, and the Red Sea as well as the Bay of Bengal, Great Australian Bight, Gulf of Aden, Gulf of Oman, Mozambique Channel and the Persian Gulf.

The Indian Ocean is known for causing the monsoon weather patterns that dominate much of Southeast Asia and for having waters that have been historical checkpoints (narrow international waterways). Because of its proximity to the equator, this basin has the warmest surface Ocean temperatures.

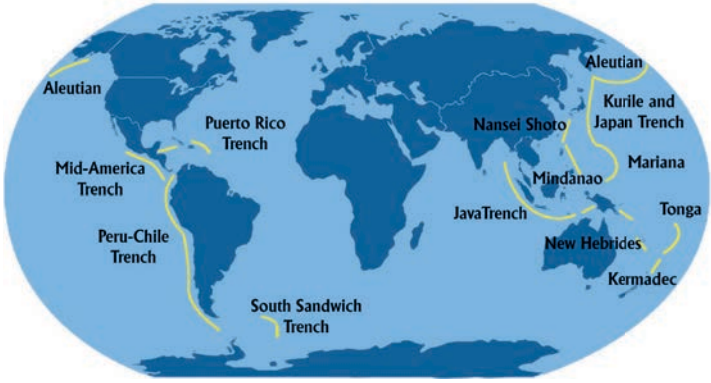


Figure 1.11: Trenches (deepest parts of the Oceans)

Source: www.trenchesandtrenches.weebly.com

Pacific Ocean

The Pacific Ocean is by far the world's largest ocean basin with about 155,557,000 km^2. It covers 28% of the Earth and is equal in size to nearly all of the land area on the Earth combined. It is located between the Southern Ocean, Asia, and Australia in the Western Hemisphere. It has an average depth of 4,028 meters, but its deepest point is the Challenger Deep within the Mariana Trench (Figure 1.11), about 10,924 m deep. This area is also the deepest point in the world. The Pacific Ocean has few marginal Seas but many islands. It is an important Ocean basin from the geographers' perspective not only because of its size but also because it has been a major historical route of exploration and migration.

Southern Ocean

The Southern Ocean is the world's newest and fourth-largest Ocean. In the spring of 2000, the International Hydrographic Organization decided to delimit it as the fifth Ocean.

In doing so, boundaries were taken from the Pacific, Atlantic, and Indian Oceans. The Southern Ocean extends from the coast of Antarctica to 60 degrees south latitude. It has a total area of 20,327,000 km^2 and an average depth ranging from 4,000 to 5,000 m. The deepest point in the Southern Ocean is unnamed, but it is in the south end of the South Sandwich Trench (Figure 1.11) and has a depth of 7,235m.

Reflective Activity 1.3

Please answer the following question:

1. Locate the present-day Oceans and Continents on a sketch map and then show it to your teacher?

1.4. CHANGING POSITION OF CONTINENTS AND OCEANS OVER GEOLOGICAL TIMES

This specific section acquaints you with the changing positions of Continents and the Ocean basins over the geologic times.

At the end of this section, you will be able to:

- appreciate the changing positions of the Continents and Oceanic basins over the geologic time; and
- produce sketch maps showing the changing location of the Oceans and Continents

Keywords

- **Continental drift**
- **Continents**
- **Oceans**
- **Plate tectonics**
- **Rodinia**

Brainstorming Activity 1.5

What do you know about the changing positions of Continents and Ocean basins? Please think individually and then discuss with your classmates.

As can be observed from Figure 1.3 (on page 5), the location of the continents and oceans was not fixed. Due to plate movement (tectonics) the position of continents and oceans has been changing several times. For instance, during the Triassic period of the Mesozoic era (≈210 Ma), the earth's continents were joined together forming one big continent called Pangaea (meaning the whole of the earth). Pangaea during this time was surrounded by on big water body named Panthalasu. During this time, Laurasia was located around the equator whereas Gondawana was located around the South-Pole.

During the second stage, in the late Triassic period (≈180Ma), Pangaea started cracking because of continental drift. Following the rifting of Pangaea, Laurasia moved to the north. Africa, South America, India and Arabia started moving to the north too. Antarctica and Australia positioned around the South-Pole. Following the cracking of Pangaea, the oceans flooded the rifted area between the continents (see Figure 1.3).

During the late cretaceous (65 Ma), the separation between Eurasia and North America increased. These two big continents positioned almost north of the tropic of cancer. Africa, South America, Arabia and India separated and positioned around the equator. Antarctica still placed at the South-Pole. Since the cracks between the separating continents widened, all the free areas were occupied by the Pacific, Atlantic, Arctic and southern oceans.

After the separation of the Pangaea (see Figures 1.9 &1.12), North America and Eurasia are positioned in the northern hemisphere while India and Arabia joined Eurasia. Africa, South-America, and Australia are positioned around the equator; but Antarctica is still placed at the South-Pole. The Atlantic Ocean covered the area between Africa, Eurasia and the two America's. The Pacific Ocean occupied the area between the America's, Eurasia and Australia. The Arctic Ocean covers areas north of the Arctic Circle and areas between North America, Europe and Asia.

The Indian Ocean covers the area between Africa, the Southern Ocean, Asia, and Australia. The Southern Ocean covered areas south of the Pacific, Atlantic and Indian Oceans and the coastal lands of Antarctica (see Figure 1.10).

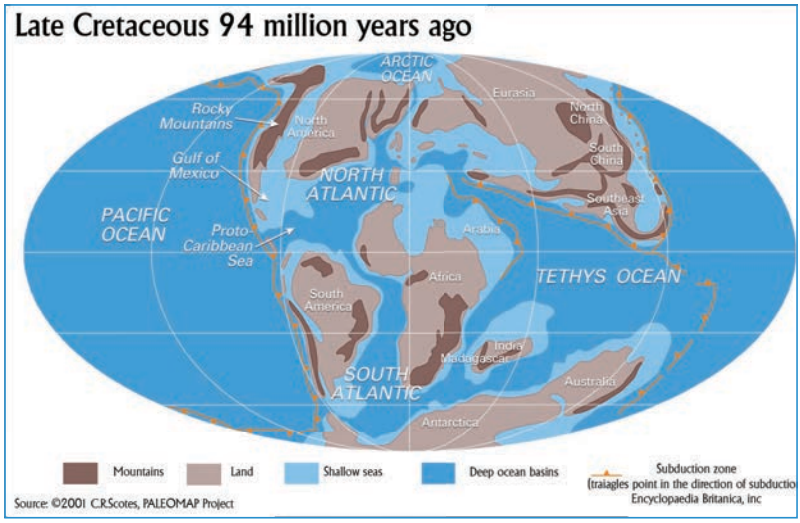


Figure 1.12: Location of continents and Oceans during the late Cretaceous

Today, seven continents and five Oceans makes-up the Earth. Most Continents occupy areas north of the equator while oceans dominate the southern hemisphere. The Pacific Ocean is located between Eurasia and the Americas while the Atlantic divides Africa and Eurasia from the Americas. The Indian Ocean also covered the area between Africa, Asia and Australia. The Arctic and Southern Oceans are centered at the North and South-Poles, respectively.

Reflective Activity 1.4

Please answer the following question:

1. Describe how Continents and Oceanic basins had been changing their positions over the geological times?
2. Please support your descriptions with sketch maps?

UNIT SUMMARY

The geological timescale is the timeframe showing the estimated age of the Earth and its associated life-forms. It is established by Earth scientists through observation and analysis of rock layers. Two types of rock dating methods (Relative and Absolute dating) are used during rock dating activities. In relative dating, three principles (Original horizontality, Superposition, and Cross-cutting relationships) are in use. Radiometric isotopic dating methods are used for determining the absolute ages of rocks.

The Earth is estimated to be 4.5 billion years old. The earliest life-forms assessed from fossilized bacteria are detected to be only about 3.5 billion years old. Scientists guess that early Earth was very hot and hostile to life. Its history is classified into Eons, Eras, Periods, and Epochs. Eons cover longer time units (billions of years) in the geological timescale. They are the Hadean, Archean, Proterozoic and Phanerozoic. The Phanerozoic Eon is the latest and divided into four Eras. Eras cover larger time units (hundreds of Ma). They include the Precambrian, Paleozoic, Mesozoic, and Cenozoic eras. The eras are further classified into periods that cover millions of years. They are 13 in number and each divided into relatively shorter periods named epochs. Of the eras, the longest and oldest is the Precambrian. It is the time when the earliest rocks solidified and were created. The Paleozoic is known to be the age of ancient life. The Mesozoic marks the age of middle life in the geological history of the Earth. The Cenozoic is the latest and is an era of developed mammals, birds, and modern humans.

The formation of the Earth is attributed similar to the creation of other companion planets and the entire Solar System. The present-day continents are assumed to be developed by continental drift. At the beginning (during the Paleozoic and Mesozoic eras) all current continents were joined together forming a big landmass (Pangaea) embraced by a big water body named Panthalasu. In the mid of the Mesozoic, Pangaea started to break apart to form two major continents named Gondwanaland and Laurasia. These two supercontinents later split into several smaller landmasses.

Due to continental drift, the Earth and its continents as well as the ocean basins have been continuously changing their shape, size, and position since the time of their creation. Their distribution has also been changing since time immemorial. For instance, the Supercontinent Pangaea was situated around the South Pole during the late Permian. Eurasia was also centered around the equator during that time. The present-day Oceans were not known by then. Today a large part of the continental landmass is located north of the equator. On the other hand, Oceanic environments are much more in the southern hemisphere. The proportion of land and water is not also equal over the planet Earth. Large areas (›71% of the Earth) are covered by water. Generally, the Earth's continents and Oceans are not permanent and static. Their shapes, sizes, and locations are continuously changing with changes in time and earth processes.

REVIEW EXERCISES

Instruction: Attempt the following questions accordingly.

I) True/False: For questions 1-5, write 'True' if the statement is correct and 'False' if wrong.

1. Radioactive dating methods are applied to place rock layers in their relative ages.
2. The Cenozoic era is well known and divided into a number of periods and epochs.
3. The initial creation of the Earth is inseparable from the creation of the entire Solar System.
4. The Earth's continents are immovable and static.
5. In continental formation, Pangaea evolved ahead of Rodinia.

II) Matching: Match items listed in Column 'A' with the geological eras under Column 'B'

Column 'A'	**Column 'B'**
1. Modern humans	A) Precambrian era
2. Not accurately known	B) Paleozoic era
3. Formation of continental shields	C) Mesozoic era
4. Rifting of Pangaea	D) Cenozoic era
5. Trilobites	
6. Ice age	
7. Formation of Pangaea	
8. Age of Dinosaurs	

III) Multiple choice: For questions, 1-5 choose the best answer from the given alternatives.

1. Which relative dating principle applies for conditions where younger rocks cut across older rocks?

A) Original horizontality
B) Cross-cutting relationship
C) Radioactive decay
D) Superposition

2. How were the present-day Continents and Oceans created?

A) By the will of God C) By the art of cartographers

B) Through space explosion D) Through continental drift

3. One of the following is correct about the formation of the Earth's continents

A. The current continents and oceans have been shaped by the process of plate tectonics

B. The present-day continents evolved 4.6 billion years ago

C. Earth's continents were formed by rapid chemical precipitation from the world's oceans

D. All of the Earth's surface features had evolved in less than 6,000 years

4. Mariana trench (challenger deep) forms the lowest part of the Earth in the:

A) Atlantic Ocean B) Arctic Ocean C) Pacific Ocean D) the Indian Ocean

5. Which is correct about the distribution of Continents and Ocean basins?

A) Continents and Oceans account for equal size on Earth

B) Continents occupy more area in the southern hemisphere

C) There is wider Ocean coverage in the northern hemisphere

D) More continental coverage north of the equator compared to the south

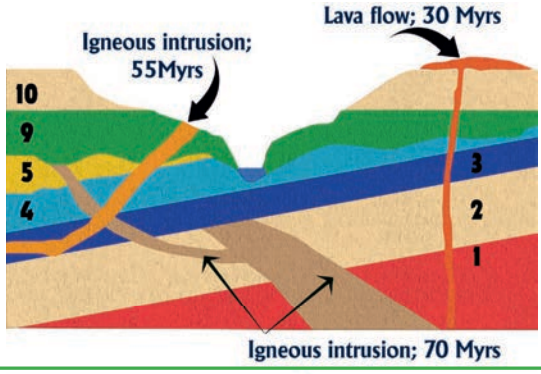
IV) Short answer writing:

Give short answers to questions provided below.

1. How do scientists assign absolute ages to Earth's rocks and ancient fossils?

2. What is the difference between relative and absolute ages of geological events?

3. Study the sketch (figure 1.13) below and then determine the age estimates (in Ma) for the sedimentary beds 1-5; 9 and 10?



UNIT TWO

CLIMATE CLASSIFICATION AND REGIONS OF OUR WORLD

Learning Outcomes:

At the end of this unit, you will be able to:

- list the criteria commonly used to classify climates of an area;
- classify climates of an area based on Köppen's classification methods;
- identify the factors influencing world climatic regions;
- describe climate zones in Ethiopia;
- compare and contrast the local and Köppen's methods of climate classification; and
- locate world climatic regions on a map.

MAIN CONTENTS

INTRODUCTION

This section will guide you about the climatic classification methods and global climatic areas. The unit also includes approaches, climatic region classification criteria, and elements that influence global climatic regions. As a result, you should make an effort to understand the offered contents both independently and jointly. Climate is a multifaceted and abstract notion that contains data on all aspects of the global environment. The climate in two or more locations on our planet may not be the same. Climates vary within a narrow range throughout a limited area of the planet, yet there is some uniformity in the patterns of climatic elements within the climatic zone. Understanding Earth's climates require climate classification to recognize, clarify, and simplify climatic similarities and variations between geographic regions.

Climate classification is useful for determining expected weather patterns for a certain region, comparing exceptional and regular daily meteorological variables, and indicating climate variability and change through time. Different environmental elements and criteria are used in the classification schemes. Many climate factors have only been collected for brief periods and are not available for significant portions of the globe. Data on soil, vegetation, temperature, and precipitation is widely available and has been collected over long periods. Most classification schemes (such as Köppen's and Trewartha's) are intended for global or continental scale use and identify climatic zones based on the criteria.

2.1. CRITERIA FOR CLIMATE CLASSIFICATION

At the end of this section, you will be able to:

- identify the criteria used to classify the climates in different classification schemes;
- differentiate between the criteria used to classify climates in different classification schemes

Keywords

- **Climate classification**
- **Criteria**

Brainstorming Activity 2.1

Note the following questions and try to think independently and share them with your classmate in a group of 5.

1. How do you understand climate from your courses in grades 9 and 10?
2. What exactly do you mean when you say "climate classification criteria"?
3. How did the ancient Greeks categorize the world's climates?
4. How do you distinguish between genetic and empirical classification methods?

There are criteria used for different types of climate classification, including ancient Greeks, genetic, and empirical (including Köppen's and Trewartha's). The ancient Greeks divided the earth into latitudinal zones based on their perceptions of habitability in particular zones, such as the Frigid Zone, Temperate Zone, and Torrid Zone. They did so by considering temperature and the distribution of sunlight around the earth. The planet's Polar Regions, including the Arctic and Antarctic circles, are represented by the Frigid Zone, which has extremely frigid temperatures. The Temperate Zone, which lies between the Torrid and Frigid Zones, is thought to offer the best climate and habitat.

The tropics, or warmer areas south of the Mediterranean Sea, are represented by the Torrid Zone. The Earth-Sun relationship served as the foundation for ancient Greek climate classification. According to the data utilized for classification, climate classification methods can be divided into two types: genetic and empiric. Climates are classified using a genetic classification method based only on the major forcing processes that shape climate. Climate is classified using the genetic method based on the activity and features of air masses, circulation systems, fronts, jet streams, solar radiation, topographic effects, and other factors that contribute to the spatial and temporal patterns of climatic data. Genetic systems, while more scientifically desirable, are more complex to implement and less successful overall since they do not rely on simple observation. The most widely utilized genetic systems are air mass ideas.

The empirical classification system is a classification system that uses data input to calculate the climatic type based on specified class boundaries. Köppen and Trewartha's systems, for example, have the advantage of being simple to deploy in regions with high-quality and abundant climatic data. They also make certain that two places with similar climatic characteristics for the variables in question are grouped.

The classical period of climatic analysis began in 1970 with the mathematics and distribution of natural vegetation based on the botanist Vladimir Köppen's climatic classification system. For world climate classification, the Köppen method typically includes yearly and monthly temperature and precipitation, as well as the seasonality of those variables. Winds, temperature extremes, precipitation intensity, sunshine quantity, cloud cover, and net radiation are not considered in Köppen's climatic classification system.

Trewartha's classification incorporates the fundamentals of both empirical and genetic classification schemes. The classification structure is based on the most important and basic weather parameters, such as temperature and precipitation. The impacts of water surfaces on a region's climate are also taken into account.

Reflective Activity 2.1

Please answer the following question:

1. Compare and contrast the Köppen and Trewartha's climatic classification systems' criteria.

2.2. KÖPPEN'S CLIMATE CLASSIFICATION

At the end of this section, students will be able to:

- classify a region's climates using Köppen's climate classification method;
- assess the pros and drawbacks of Köppen's climate classification; and
- use a map to show the distribution of Köppen's climatic zones.

Keywords:

- **Climate classification**
- **Modified Köppen**
- **Simplified Köppen**

2.2.1. The Simplified Köppen's Climate Classification System

Brainstorming Activity 2.2

1. Why Köppen climatic classification method is commonly used?
2. Using Figure 2.1, identify the climate types of Ethiopia using the simplified Köppen's climate classification?
3. Which climate types are determined by temperature, and which are determined by precipitation? In a group of 3-5 people, discuss and share your thoughts on these topics.

Because of its simplicity and strong alignment with climatic areas, natural vegetation, and soil types, the Köppen climate classification system is commonly used for classifying world climate. The Köppen method recognizes that most vegetation types respond immediately to climate inputs, particularly temperature and moisture fluctuations, and is based on dominant vegetation types. Köppen observed and mapped the ecotone (the zone where two biomes meet), then utilized temperature and precipitation data to construct equations that defined the climatic boundary between the two biomes. Köppen published his initial climate classification scheme in 1900 and revised it in 1940.

Based on the aforementioned criteria, the Köppen system distinguishes between five major terrestrial climatic types:

1. Tropical climate (A): All months have an average temperature above 18° C (64°F). There is no real winter season because every month of the year remains warm.

2. Dry Climate (B): It has deficient precipitation most of the year.

3. Meso-thermal or Mid-latitude Mild (C): Average temperature of the coldest month is below 18^{0}C (64^0 F) and above -3^{0}C (27^{0}F).

4. Micro-thermal or Mid-latitude Cold (D): The average temperature of the warmest month exceeds 10^{0}C (50^{0}F), and the coldest monthly average drops below -3^{0}C (27^{0}F).

5. **Polar Climate (E):** It has extremely cold winters and summers. The average temperature of the warmest month is below 10^0 C (50^{0}F). Given that all months are cold, there is no real summer season.

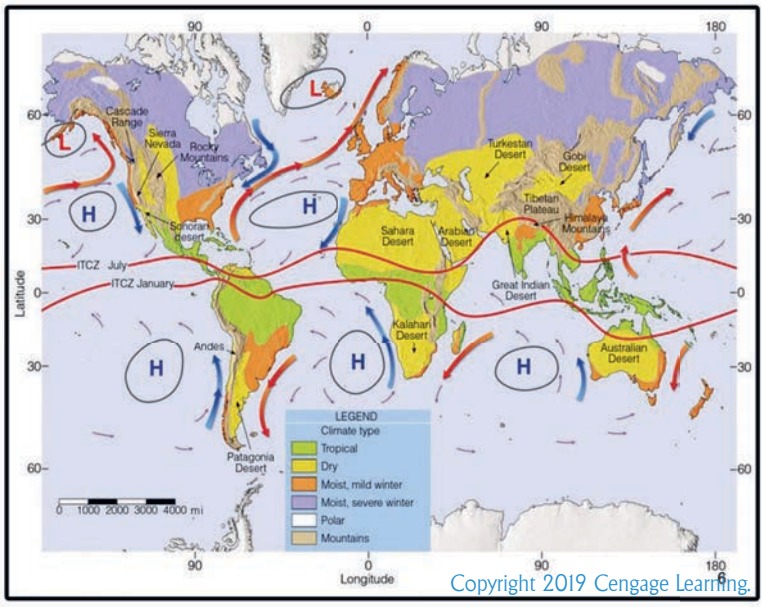


Figure 2.1:A simplified overview of the major climate types, according to Köppen

The climates A, C, and D stimulate tree growth, whereas the climates B and E are too dry and too cold, respectively, generally do not. The four primary climatic kinds, A, C, D, and E, are characterized by temperature, although type "B" denotes a climate in which dryness, rather than coldness, is the governing element of vegetation. A new group, highlands (H), was later created to account for the significant climate changes in mountainous areas over short distances.

2.2.2. Modified Köppen climatic classification systems

Brainstorming Activity 2.3

1. How can you tell the difference between a basic Köppen system and one that has been modified?
2. Which climate types are found in Ethiopia, according to modified Köppen's climatic classification schemes?

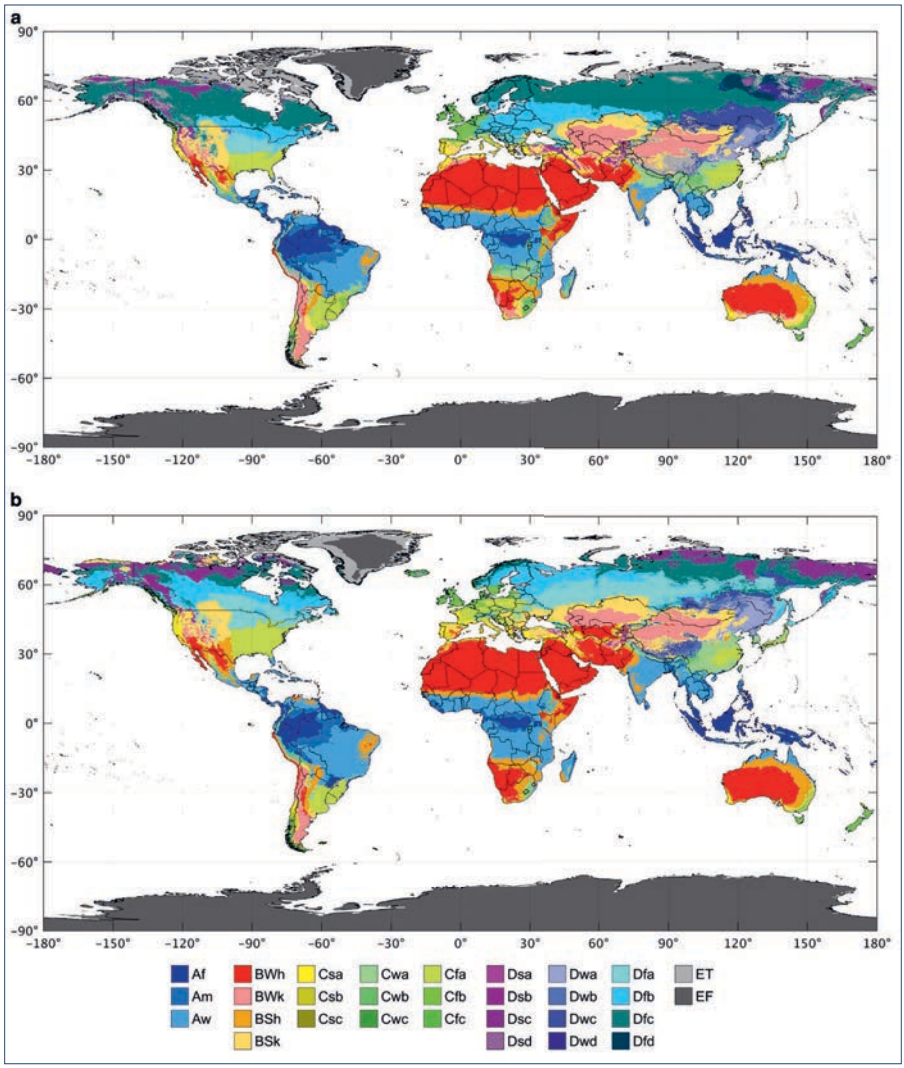
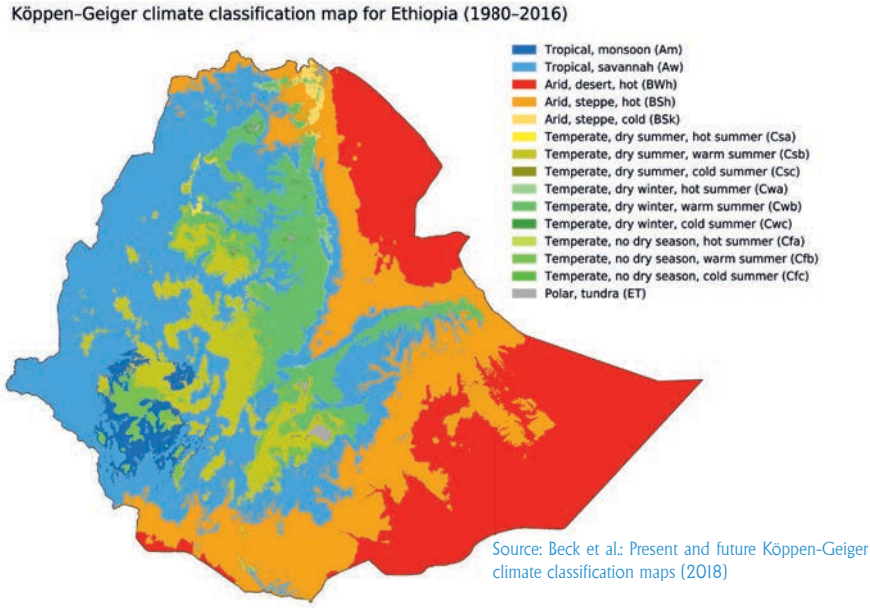


Figure-2.2. Improved Köppen-Geiger classifications of our world:
Part (a) shows the present-day map (1980–2016) and (b) the future map (2071–2100).

Source - Present and future Köppen-Geiger climate classification maps at 1-km resolution @www.gloh2Org/ Köppen

Using air temperature (^{0}C) and precipitation (mm y^{-1}) criteria from high-resolution climatic datasets, the present Köppen-Geiger map (Figure 2.2a) was developed. The current Köppen-Geiger classification didn't consider the rising levels of greenhouse gases in the atmosphere, which may alter how vegetation relates to various climate classes. Consider the future Köppen-Geiger classification (Figure 2.2b) as providing information on possible spatial changes in regional climatic zones under climate change, which caused by the rising levels of greenhouse gases in the atmosphere.



"Figure 2.3. Köppen-Geiger climate classification map for Ethiopia (1980-2016)"

Rudolf Geiger, a climatologist, altered the Köppen classification system in 1961 to improve the alignment of climate zones and biomes. By merging appropriate first, second, and third-order subdivisions, modified Köppen–Geiger climatic types are produced. To classify regional climates more precisely, those primary (first) climatic types were subsequently classified into second and third-order subdivisions.

The average monthly and total annual precipitation for **A, C,** and **D** climates is denoted by the second-order subdivision (with "f" denoting a climate that is wet all year, "m" denoting tropical monsoon conditions, "s" denoting dry summer climates, "w" denoting dry winter climates and "m" representing tropical monsoon conditions).
The second-order subdivision in the case of **B climate** is "W" if the dry climate is a true desert, and "S" if the dry climate is only semi-arid. Second-order subdivisions for "E" climate include "T" for Tundra climate, a milder arctic sub-type, and "F" (frozen) for Ice Cap climate.

The third order subdivisions in **the Mesothermal and Microthermal climates** specify the features of summer temperatures, with "a" indicating hot summers, "b" indicating warm summers, "c" indicating mild summers, and the rare "d" indicating cool summers. The third-order subdivision of arid climates is "h" for hot and "k" for cold.

From the equator to 15° to 25° north and south latitudes, **the tropical wet climate** (A) exists. The average temperature in all monthly records exceeds 18° C (64.4°F). More than 60 inches (›1500mm)of rain falls each year.

The climate in this category is divided into three minor Köppen climatic types, each of which is named after the seasonal distribution of rainfall.

1.Tropical wet or equatorial rainforest climate (Af):

Af refers to a tropical environment with year-round precipitation. In this environment, monthly temperature differences are fewer than 3°C. Cumulus and cumulonimbus clouds occur practically every day early in the afternoon due to severe surface heating and high humidity. The average daily high temperature is 32°C, while the average nighttime temperature is 22°C. This climate is found in areas such as Amazon rain forest and Congo basin.

2.Tropical monsoon climate (Am)

Am denotes a climate with yearly rainfall similar to or greater than **Af,** but with the majority of precipitation falling during the 7 to 9 hottest months to support the rainforest. There is extremely little rain throughout the dry season. This type of climate found in regions such as parts of India and South east Asia.

3.Tropical wet and dry or savanna (Aw)

The third group, tropical wet and dry or savanna (Aw), is characterized by a prolonged dry season in the winter. During the rainy or summer season, precipitation is frequently less than 40 inches. examples inculed the african savanna and the tropical regions of south america.The difference between **Aw** and **Am** climates is determined by annual precipitation and the driest month's precipitation, using the formula below:

a=3.94-r/25 , where a= precipitation of driest month, and r = annual precipitation. If the precipitation of the driest month of a place is less than the value of **"a"**, it will be Aw climate, whereas if it is more than the value of **"a"**, it will be Am climate.

CASE EXAMPLE: 2.1

If the average annual precipitation of a place is 80 inches, then Am/Aw boundary would be = 3.94-80/25=3.94-3.2=0.74 inches. If the precipitation of the driest month of that place is 2 inches, the climate type would be Am. On the contrary, it would be considered Aw climate if the area's driest month had precipitation of less than 0.74 inches.

Dry climate (B)

Dry climates are generated by their location:

- In trade wind belts,
- On the leeward side of high mountains, and
- In the interior of continents along cool ocean currents.

During most months, mean evapotranspiration tends to exceed mean precipitation in a dry environment. Type B climates are characterized by a lack of precipitation for the majority of the year, which limits vegetation growth and spread. Aridity is defined by the interaction between precipitation input to the soil where plants grow and evaporative losses. Aridity is defined by Köppen in terms of the temperature-precipitation index, with evaporation thought to be controlled by temperature. The horn of the Africa is an exception to the rule that aridity is typically linked to subsidence. For instance, Somali's extreme driness can be attributed to the contininet of Africa's orientation concerning atmospheric circulation. Based on yearly temperature and the wettest month of the year, the dry climate is classified into two minor classes.

NOTE:

Evapotranspiration is the term for the combination of two distinict processes of water loss, one by evaporation from the soil surface and onother by transpiration form a plant.

Desert (BW): A true arid climate dominated by xerophytes vegetation that covers 12% of the earth's land surface. It is found between 15 and 30^0 North and South, where warm, dry air sinks because of subtropical highzones. Vast deserts such as the Sahara or Gobi are included.

Dry Semiarid or Steppe (BS): A grassland climate that encompasses 14% of the planet's land area. The climate gets more precipitation than the BW from the inter-tropical convergence zone or mid-latitude cyclones. The boundary between BW and BS is established using the formula: r=0.44t-8.5/2, where ***r*** represents annual precipitation (inches) and ***t*** represents temperature (0^0 F). If the annual precipitation of a certain location exceeds the value of "***r***," the climate is BS, but if it is less than "***r***," the climate is BW. In the United States, the great plains, portions of the Southern California cost and the great basin are semi-arid deserts.

CASE EXAMPLE: 2.2

If the temperature of a place is 90°F, the annual value of precipitation for dividing boundary between BS and BW climates will be: r=0.44x90-8.5/2=15.5 inches

Dry (B) climates are further classified based on annual temperature. The climate is represented by the letter "h" when the mean annual temperature is greater than 18^{0}C (64.4^{0}F) and by the letter "k when the mean annual temperature is less than 18^{0}C (64.4^{0}F). Desert climates are further divided into hot/tropical/desert (BWh) climates, which have an average annual temperature greater than 18^{0}C (64.4^{0}F), and middle latitude cold desert climates (BWk), which have an average annual temperature less than 18^{0}C. Hot dry semiarid or tropical steppe (BSh) climate, with a mean annual temperature above 18^{0}C, and cold dry semiarid or middle-latitude latitude cold steppe climate (BSk), with mean annual temperature below 18^{0}C, are two third-order divisions of steppe climates. The BWh climate is found in areas such as the sahara desert while BWk climate is found in colder desert regions, such as the Gobi desert.

Cloud cover is unusual in most low-latitude deserts (fewer than 30 days per year have clouds in some areas). Although the unreliability of precipitation is more relevant than the modest totals, precipitation quantities are generally in the range of 0–10 inches. These places, on the other hand, have high temperatures, with monthly averages in the range of 21–32^{0}C (70–90 ^{0}F). Furthermore, daily temperature swings are considerable.

Mid-latitude Mild or Mesothermal (C)

Warm and humid summers alternate with mild winters in this region, which is located between 25 and 40^0 latitudes, primarily on the eastern and western borders of most continents. It is frequently dominated by convective thunderstorms during the summer months. During the winter season, the dominant meteorological feature is the mid-latitude cyclone. The seasonal distribution of precipitation further divides mid-latitude climate into four distinct climatic subgroups.

(I) Cf climate: This climate is characterized by precipitation throughout the year, with more than 1.2 inches of precipitation in the driest month of the summer season. This is the most common climate in Western Europe. There are two third-order sub-divisions within this climatic type:

A. **Humid subtropical (Cfa)**, Is found along east costs of continents are characterized by warm humid summers with frequent thunderstorms; and precipitation coming from mid-latitude cyclones during the mild winter season); and

B. **Marine west coast (Cfb)**, is found in the western sides of continents are characterized by humidity, short dry summer, and persistent mid-latitude cyclones (causing heavy precipitation during mild winters).

(II) Cw Climate: Characterized by dry winters, and has 10 times more prcipitation in the wettest month of summer season than the driest month of winter season. It is the dominant climatic type in China.

(III) Cs (Mediterranean): The primary rainfalls from mid-latitude cyclones during the winter season. Extreme summer aridity is caused by the sinking airs of the subtropical highs. The wettest winter month receives at least three times the amount of rain as the driest summer month.

Mid-latitude Cold or Microthermal (D) Climate

This climate type also called continental climate is found on the poleward side of the moderate (C) mid-latitude climate. Warm to cool summers and cold winters are the most prominent features. Snowstorms, high winds, and brutal cold from polar or arctic air masses characterize the harsh winters. Df climate (humid cold climate with no dry season), Dw climate (humid cold climate with dry winters), and DS climate (humid cold climate with wet winters) are the three sub-classes of this climate type (dry winters and dry summers).

Polar Climate (E)

This climate is characterized by cold temperatures year-round, with the warmest month having a temperature of about than 10^0C. Geographically, it is found on the landmasses of Greenland and Antarctica, as well as the northern coastal portions of North America, Europe, and Asia. The two minor types of polar climate are polar tundra (ET) and polar ice caps (EF). Polar tundra (ET) is defined by permafrost, which is soil that is permanently frozen to depths of hundreds of meters. The warmest month's average temperature is greater than 0^0C (32^0F) but less than 10^0C. (50^0F). Mosses, lichens, dwarf trees, and scattered woody shrubs can be found scattered throughout the polar tundra. A polar ice cap (EF) is characterized by a land surface permanently covered with snow and ice. The average temperature of the warmest month is 0^0 C (32^0F) or below.

Highland Climate

Why are the tundra and polar conditions observed sometimes in the low latitude or tropical regions?

Due to the effects of height, tundra and polar conditions could be seen in low latitude places. In high latitudes, climate change experienced while climbing 300 meters (1000 feet) in elevation is equivalent to horizontal changes encountered while moving 300 kilometers (186 miles) northward (this distance is equal to about 3^0 latitude). Over a relatively little vertical shift in elevation, highland climates often show a tremendous lot of diversity in temperature, precipitation, and flora. The presence of glaciers in tropical mountains demonstrates that altitude has a cooling impact.

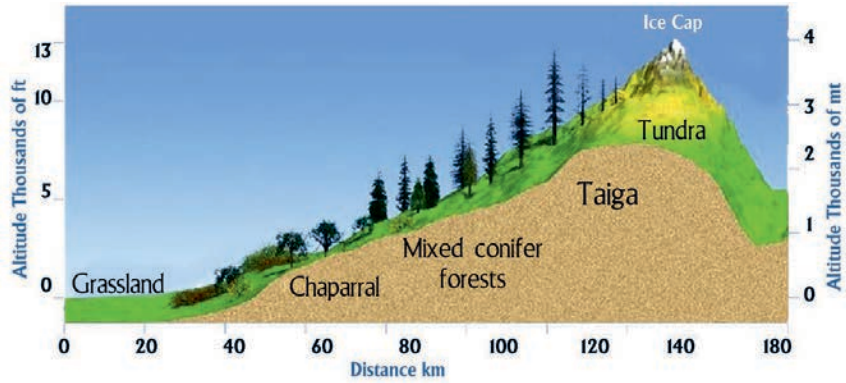


Figure 2.4: Altitudinal zone of highland climate

The afro-alpine zones on the highest parts of the Ethiopian plateaus, for example, have a highland climate. The Senate Plateau (Bale Zone), Simien Mountains (north Gonder), Mount Guna (south Gonder), Amara Saint (South Wollo), and the Choke Mountains (Gojam) are examples of small isolated high places where it can be found (Figure 2.4).

The Merits and Demerits of Köppen's System

Despite many critics, the Köppen system is still the most widely used climatic classification system today. The Köppen system has been criticized by several people, including for reasons.

- Extreme events, such as a periodic drought or a common cold for, are as reasons important in controlling vegetation distribution as the mean conditions on which Köppen's scheme is based;
- In addition to precipitation and temperature, sunlight and wind are important to vegetation;
- Natural vegetation can only respond slowly to environmental change (as a result, the vegetation zones visible today are in part adjusted to past climates);
- It is inconsistent since it based A, C, D, and E zones on mean temperature, whereas zone B is based on a precipitation-evaporation ratio;
- It is insufficiently thorough since it ignores the climate of mountainous regions and fog-affected regions, and
- The boundaries of Köppen's climatic classifications are too empirical.

The strength of Köppen's system is its ability to provide a clear, quantifiable, and straightforward method for assigning a given location to a certain climate sub-group based on temperature and precipitation. Furthermore, geographers are drawn to the Köppen method because it acknowledges the link between vegetation kinds and climate.

Reflective Activity 2.2

Take sometime to answer the questions below and discuss your answers with your classmates for a better understanding.

1. Recognize and describe the modified Köppen climatic classification that characterizes the world's regions.
2. Discuss the advantages and disadvantages of using the Köppen climate classification system.
3. Using the modified Köppen climatic classification system, describe and show Ethiopia's climatic division on a themed map.

2.4. WORLD CLIMATIC REGIONS

At the end of this section, students will be able to:

- describe the major world climate regions; and
- compare and contrast the elements of weather in different regions

Keywords:

- **Climatic regions**
- **Highlands**
- **High-latitude**
- **Low-latitude**
- **Mid-latitude**

Brainstorming Activity 2.4

Please attempt the two questions provided below, think individually about each, then discuss in a group of 5 and share the outcome with other groups

1. What do you think about the major classification schemes used for the identification of the world climate region?
2. What do you think is the importance of the classification of our world into the different climatic regions?

The world's climatic zones have been divided into three broad climate groups based on the Köppen classification and seasonal dominance of air masses. Low-latitude climate, mid-latitude climate, and high-latitude climate are the three types.

2.4.1. Low-latitude Climatic Regions

I. Tropical wet region

This region is found along the equator between 6^{0}N and 6^{0}S. Throughout the year, maritime tropical air masses dominate the region indicated by the Köppen classification "Af." The intertropical convergence zone and the equatorial westerlies have an impact on the region all year. It has high daily temperatures ranging from 20 to 30^{0}C, and monthly temperatures ranging from 24 to 28^{0}C, with consistent precipitation throughout the year (over 80 inches of total rainfall). The region's vegetation is dominated by rainforests, which are dense, tall, broad-leafed, and evergreen trees. In the afternoons of practically every day, high surface heat, marine humidity, and convergence result in cumulus or cumulonimbus cloud forms and thunderstorms. The sun warms the ground and the air above it. Warm air rises in convection currents as it becomes lighter. The elevated air expands, cools, and condenses into white cumulus or cumulonimbus storm clouds, which ultimately produce conventional rainfall.

NOTE:

A cloud is a dense concentration of very fine invisible water droplets or ice crystals, formed by the condensation of water vapor below the dew point in the atmosphere. Clouds can be categorized based on their height, appearance, and shape.

The Amazon basin, Congo basin of equatorial Africa, East Indies, and the area from Sumatra to New Guinea fall under this region (Figure. 2.5).

II. Tropical wet and dry region

The region can be found between 6^0 and 15^0 N and S latitude. The tropical wet and dry climatic zone lies halfway between the wet tropics and the subtropical deserts. Maritime tropical air masses, high sun season, continental tropical air masses, and low sun season describe it. The seasonal pattern of moisture is influenced by the migration of the inter-tropical convergence zone. The rainy season is produced from the high sun and the existence of the convergence zone, whereas the dry season is formed from the subsidence associated with the presence of the subtropical high zone during the low sun season, resulting in more stable air.

During the rainy season, the climate is comparable to that of a tropical wet climate, with frequent thunderstorms, whereas during the dry season, semi-desert conditions prevail. It is dominated by savanna biomass in terms of vegetation cover. This climatic type can be found in India, Indochina, West Africa, southern Africa, South America, and Australia's north coast (Figure. 2.5).

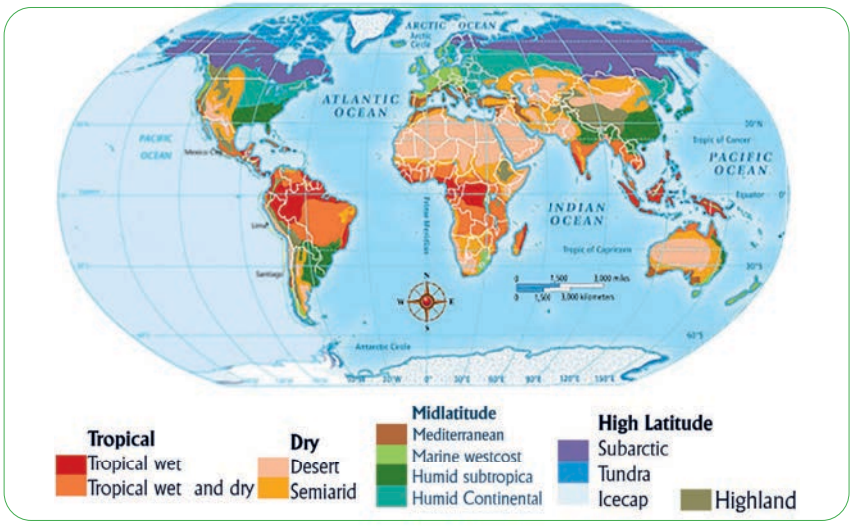


Figure 2.5: World climate region

Source:https: sites.google.com

III. Dry desert (BWh) and steppe (BSh) region

The region lies between 15^0 and 25^0 North and South latitude. Throughout the year, continental tropical air masses dominate. The largest region of tropical desert climate is located near the tropics of Cancer and Capricorn, usually on the western side of the continents. Low relative humidity and cloud cover, low frequency and amount of precipitation, high mean annual temperature, high monthly and daily temperatures, and strong wind velocity describe the region in general.

Because of the presence of the subtropical high-pressure zone, the climate of this region is mostly controlled by upper air stability and subsidence. The region's vegetation is characterized by the desert biome and steppe plains. The arid climatic zone encompasses the southwestern United States, Northern Mexico, Argentina, North Africa, South Africa, and the central section of Australia (Figure. 2.5).

2.4.2. Mid-latitude Climatic Region

The climate of this region is principally influenced by the continual fight between tropical air masses moving towards the poles and polar air masses moving towards the equator.

I. Mid-latitude desert (BWK) and Steppe (BSk)

The climatic zone is located between 30^0 and 55^0 N and S latitude. Summer is dominated by continental tropical air masses, whereas winter is dominated by continental polar air masses. Low relative humidity and cloud cover, low frequency and volume of precipitation, and moderate to high average monthly temperature characterize the climate of the region. The main source of precipitation is moisture from maritime sources. Because of the rain shadow effect, the presence of mountains upwind of these climates might further restrict moisture availability. Mountain ranges to the west and south restrict ocean air masses, allowing polar air masses to prevail throughout the winter months.

The east of the Caspian Sea, the north of the Himalayas, the western United States, and the east of the Andes are the key areas influenced by mid-latitude deserts. When compared to subtropical deserts, summer temperatures in mid-latitude deserts are not as high. There are exceptions, such as Death Valley, California, which is one of the world's hottest locations. The winter months are usually fairly cold. Mid-latitude temperatures have a wider range of daily annual temperatures than their subtropical counterparts. The climate of the mid-latitude steppe receives somewhat more precipitation than that of the mid-latitude deserts and has similar temperature characteristics. In the desert and steppe zones, the grasses biome and steppe plains, respectively, are prominent vegetation types. This climatic regime covers significant parts of western North America and central Asia (Figure. 2.5).

II. Mid-latitude wet region

The influence of marine tropical air masses on summer weather in this region causes thunderstorms due to rising temperatures. In the winter, the polar climate is dominated by frontal weather linked with a mid-latitude cyclone. Abundant precipitation is evenly spread throughout the year, and total annual precipitation is very variable, depending on the affected localities' latitude and continental position. During the summer, the equatorial borders experience convectional rainfall. Monthly average temperatures in the region range from 21 to 26^0C, slightly warmer than in the tropics. The deciduous forest biome is the most common in terms of vegetation. The climatic areas of northern America run from Canada's Pacific coast at latitudes above 55^0 eastward to the Atlantic coast, where they dominate the continent's eastern half. The climate extends to the southeastern tip of South America, New Zealand, and Australia's southeast coast.

III. Mid-latitude winter dry (Cw and Dw)

The temperature and precipitation patterns in this region have distinct seasonal patterns. Maritime tropical air masses with conditional tropical air masses from nearby deserts arrive in the summer. Summers are hot and humid, with plenty of traditional summer storms, showers, and thunderstorms. In the winter, continental polar air masses associated with dry and cold weather conditions predominate, with maritime polar air emerging on occasion. During the season, a little amount of precipitation was produced by the mid-latitude cyclone's activities. The major vegetation type is grassland. The arid climate zone is geographically limited to the interiors of North America and Eurasia (Figure 2.5).

IV. Mid-latitude summer dry (Cs)

Between 30^0 and 50^0 latitude, the region is located on the western borders of the continents. The climate is commonly referred to as a Mediterranean climate, with precipitation falling primarily in the winter due to a mid-latitude cyclone. The subtropical highs' sinking air generates exceptionally dry and heated weather in the region during the summer. The chaparral biome, Sclerophyll plants that range in formation from forests to woodland and brush, dominates the region. Central and Southern California, coastal zones bordering the Mediterranean Sea, coastal Western Australia and South Australia, the Chilean coast, and the Cape Town region of South Africa all have Mediterranean climates (Figure. 2.5).

2.4.3. High-latitude Climate

Brainstorming Activity 2.5

How do you distinguish polar tundra from Polar Icecap

I. Polar Tundra (ET)

Cold winters, cool summers, and a summer rainfall regime characterize the climate region. The Arctic coasts of North America, Iceland, coastal Greenland, Europe, Asia's Arctic coasts, and the Southern Hemisphere islands of Macquarie, Kerguelen, and South Georgia all experience this climate type (Figure. 2.5). During the summer, most places receive less than 10 inches of yearly precipitation.

II. Polar Ice Cap (EF)

This climatic region encompasses a large portion of the globe, particularly the high latitudes and continental territories like Greenland and Antarctica. The primary climate types are continental arctic and continental air masses.

The location receives no sun energy for half of the year. Because of the long days and relatively transparent atmosphere, available insolation is rather high throughout the summer months. The albedo of a snow-covered surface, on the other hand, reflects up to 90% of the insolation back to space. As a result, monthly average temperatures are typically below 0 degrees Celsius. High-velocity, persistent winds occur in the region most of the time, resulting in blizzard conditions.

NOTE:

Albedo is the amount of energy or the fraction of incoming sunlight reflected by a surface.

2.4.4. Highlands Climate

Highland climates have a wide range of climatic variables spread out over a short area. Lower temperatures are the most well-known climatic effect of increased altitude, but heavier precipitation owing to orographic lifting is also typical. Mountainous regions have a nearly limitless variety of local climatic variables due to variations in atmospheric conditions with height and exposure to the sun's rays. This type of climate is mostly found in mountains and high plateaus. Because the climate is prevalent throughout the world, the latitude range is not limited.

Reflective Activity 2.4

Please attempt all questions provided below, think individually about each, and discuss in a group of six.

1. Distinguish the temperature and precipitation character between subtropical dry desert and steppe region from mid-latitude desert and steppe.
2. How do you differentiate the climatic character of tropical climate regions from mid-latitude or temperate climate regions?
3. Explain the relationship between elevation, precipitation, and temperature in the highland climate.

2.5. FACTORS INFLUENCING THE WORLD CLIMATIC REGIONS

At the end of this section, you will be able to:

- identify the factors responsible for the formation of world climatic regions, and
- visualize the impact of several factors on the formation of global climate zones.

Keywords:

- **Atmospheric Circulation**
- **Continentality**
- **Centrifugal**
- **Elevation**
- **Latitude**
- **Ocean Circulation**
- **Subtropical High Pressure**

The global climate distribution looks to be jumbled, with comparable climatic conditions occurring in widely dispersed locations of the globe. Climate controls are the elements that influence the climate in any given location. The amount of sunlight and its variation with latitude, the distribution of land and water, ocean currents, prevailing winds, the position of high and low-pressure zones, mountain barriers, and height are all factors that influence a region's climate.

2.5.1. Latitude (Seasonality)

Brainstorming Activity 2.6

Why does latitude have anything to do with climate?

On any given day, solar energy insolation strikes the earth at a decreasing angle from 90^0 (direct overhead) to 0^0 (where the sun is on the horizon). Above the horizon, when the sun's angle is lower, there is less intense insolation (i.e. closer to 0^0). This is because when solar rays reach a high latitude region, low angle earth, they are attenuated and depleted more efficiently by colliding with more air particles. Solar rays flow through the atmosphere most efficiently when the sun is directly overhead (i.e., at a 90^0 sun angle) at equatorial locations because they reach the surface perpendicular to it and have fewer opportunities to be attenuated.

Every day, 12 hours of bright sunlight will be experienced in the low latitude zone (equatorial locales), providing more time for the surface to heat up and resulting in little seasonal change. On the other side, high latitude regions (arctic/polar locations) have highly distinct seasons, with cool summers and relatively long days. Winters are bitterly cold, and the nights are long. The change in solar declination and day duration is explained by the shifting relationships between the earth's surface and the sun over the year. Seasonal variations in the sun's angle and the amount of daylight can thus be considered the most fundamental elements influencing global temperature dispersion.

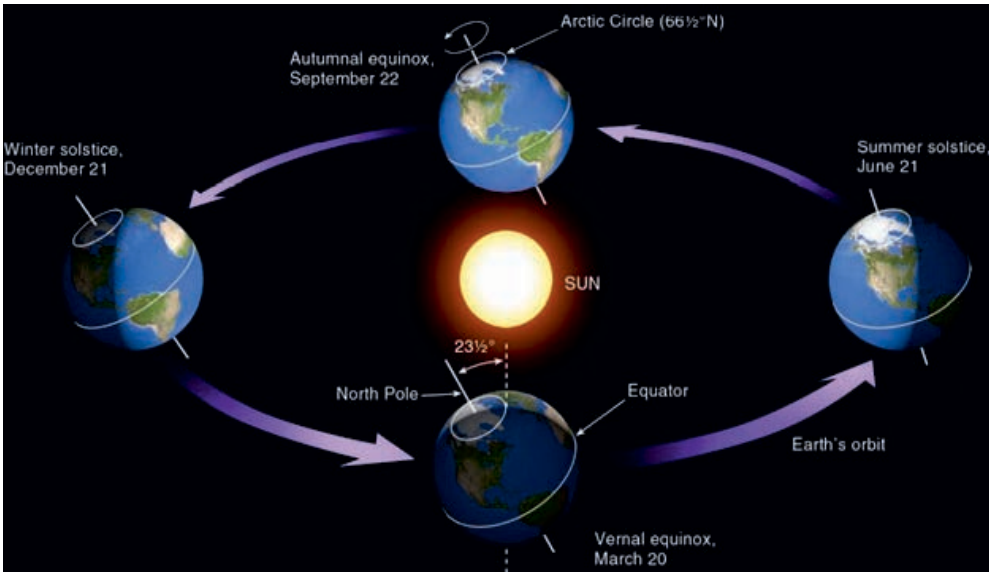
2.5.2. Combined Effects of Revolution, Rotation and Tilt of the Earth

Brainstorming Activity 2.7

How do you explain the combined effects of revolution, rotation, and tilt in the area closer to the equator and areas closer to the pole by looking at figure 2.7?

The difference in day length from December to June is smaller the closer an area is to the equator, whereas the difference in day length from December to June is bigger the closer it is to the pole or high latitude. In June, for example, the daylight covers more than half of any parallel latitude in the northern hemisphere, whereas darkness covers more than half of any parallel latitude in the southern hemisphere. In December, however, more than half of any latitude in the northern hemisphere is in darkness, while more than half in the southern hemisphere is in the sunshine (Figure 2.6).

a



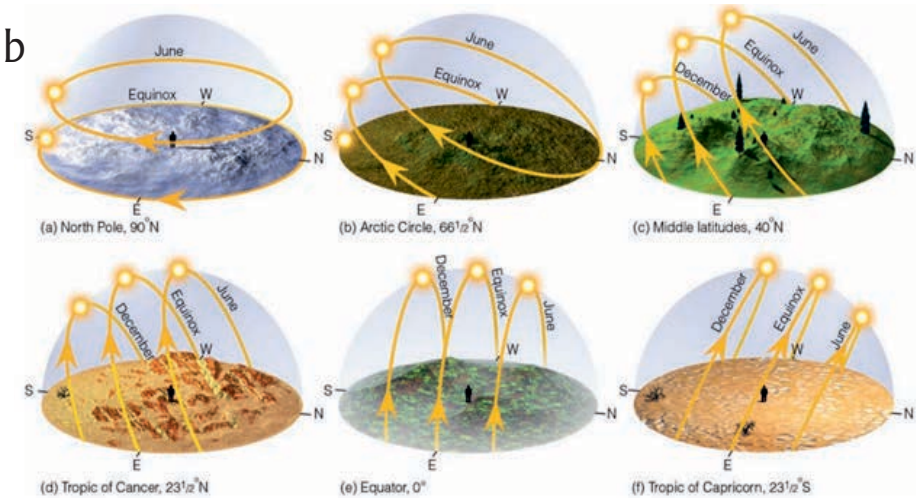


Figure 2.6 Relationships between Earth's axis and the circle of illumination during the course of the year (a,b)

On June 21, the day length in the northern hemisphere increases from 12 hours at the equator to 24 hours at the Arctic Circle. Nights are longer than days in the southern hemisphere from March 21 to September 22 (centered on June 21), since the South Pole is tilted away from the Sun during this time (Figure 2.6).

2.5.3. Continentality (distance to large water bodies)

Brainstorming Activity 2.8

What do you think are the effects of continentality and maritime conditions on climate variation in the local area?

Large bodies of water are capable of storing massive amounts of energy during high-energy times (i.e. hotter in the summer) and slowly releasing this energy to the atmosphere during low-energy times (i.e. colder in winter). These energy flows can have a major impact on the climate of places with negligible continentality along an ocean shoreline and places in the interior of a landmass regarded to be very continental. Inland areas (extremely continental) heat up and cool down more quickly than areas near huge bodies of water. Inland locations have a wider temperature range than coastal locations.

Seasonal extremes are greatest over the world's largest landmass (i.e., Asia, the greatest continentality on earth). Coastal places that confront prevailing winds (trade or westerlies) that are heavy with moisture evaporated from the ocean can get more rain.

Lakes, swamps, and marshes, for example, can generate significant temperature variations. Windward (upwind) locations of the lake see more dramatic temperature changes than leeward locations (downwind).

Insolation at the water or land surface also adds to temperature variation. Some insolation is required on the lake surface to evaporate water rather than to heat surfaces. Evaporation converts radiant energy into latent energy, which cannot be used to heat air at the same time (sensible energy). During the summer months, water in the form of clouds also plays a considerable influence in daily temperature changes, particularly in most tropical and mid-latitude locales. These clouds are typically formed by convection and are most visible in the late afternoon when warm, humid air near the surface rises and its water vapor condenses into liquid water.

2.5.4. Atmospheric Circulation

Brainstorming Activity 2.09

How do atmospheric circulations affect climate distribution across the world?

Two locations may not have the same climate despite they have the same latitude, the same distance to the ocean, and being located in the same hemisphere. This is because the climate of a place is also affected by the location relative to atmospheric circulation. This means one location may be affected by atmospheric circulation from a certain direction more often than another.

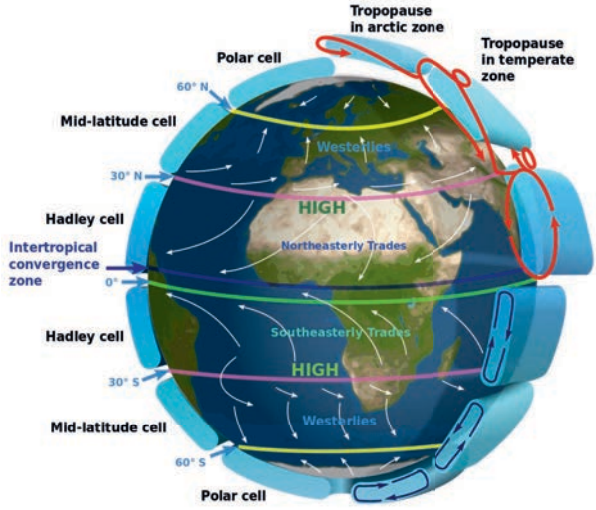


Figure 2.7: Global atmospheric circulation

According to the second law of thermodynamics, the job of atmospheric circulation is to balance energy inequities across latitudes. Horizontal inequalities in atmospheric pressure produce the circulations that result in climate differences throughout space. "High pressure" refers to pressure above mean sea level, whereas "low pressure" refers to a pressure below mean sea level. In either the vertical or horizontal directions, atmospheric mass or air travels from additional air, i.e. high-pressure regions, to lower pressure locations.

2.5.5. Seasonal Movement of Subtropical High Pressure

Brainstorming Activity 2.10

How does climate varies in response to the seasonal movement of subtropical high pressure ?
Think individually and share with your classmates.

Because the Subtropical High Pressure (STH) is the source of surface westerlies, the seasonal migration of the STH has climatic implications. The STH about 30^0 latitude, according to the general circulation model, pulls surface air toward the pole and equator. The intertropical convergence zone (ITCZ) is located in low-pressure zones that receive the most heat from the sun. Rising motions of trigger clouds and precipitation-forming processes connected with thunderstorm weather are triggered by the convergence of winds into a low-pressure center or cyclone.

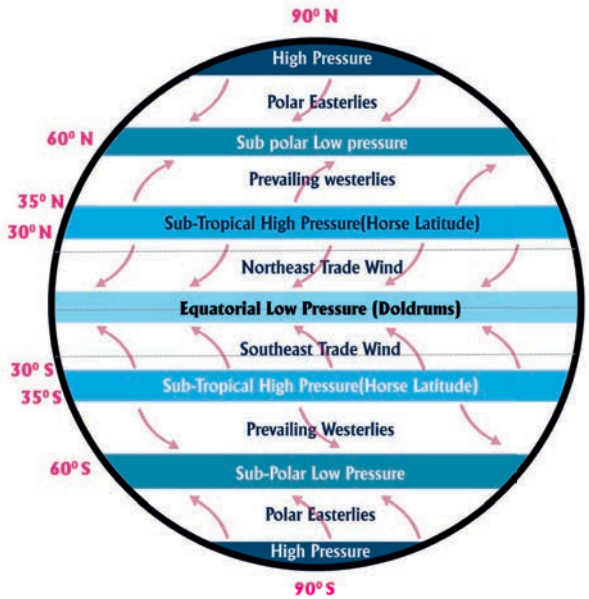


Figure 2.8 Subtropical high belts

2.5.6. Coriolis Effect, Centrifugal Acceleration, and Friction

The Coriolis Effect (CE) is when other factors cause air to shift its trajectory and speed. The apparent outward-directed force on an item traveling along a curved trajectory is known as centrifugal acceleration (CA). It is an example of inertia in action. The other force that influences wind direction and velocity is friction. It is greatest at the surface and diminishes with increasing height until it is negligible in the free atmosphere (friction-free zone). The degree of friction provided to the flowing air is determined by the type of the surface; for example, mountains have a lot of friction, while ocean bodies have less or no friction.

2.5.7. Ocean Circulation

Brainstorming Activity 2.11

How do ocean circulations affect climate distribution?

Ocean circulation, like air circulation, is a process for balancing energy on the surface. The most significant oceanic circulation influences on climate are surface currents, which often follow the winds produced by semi-permanent pressure zones in the atmosphere.

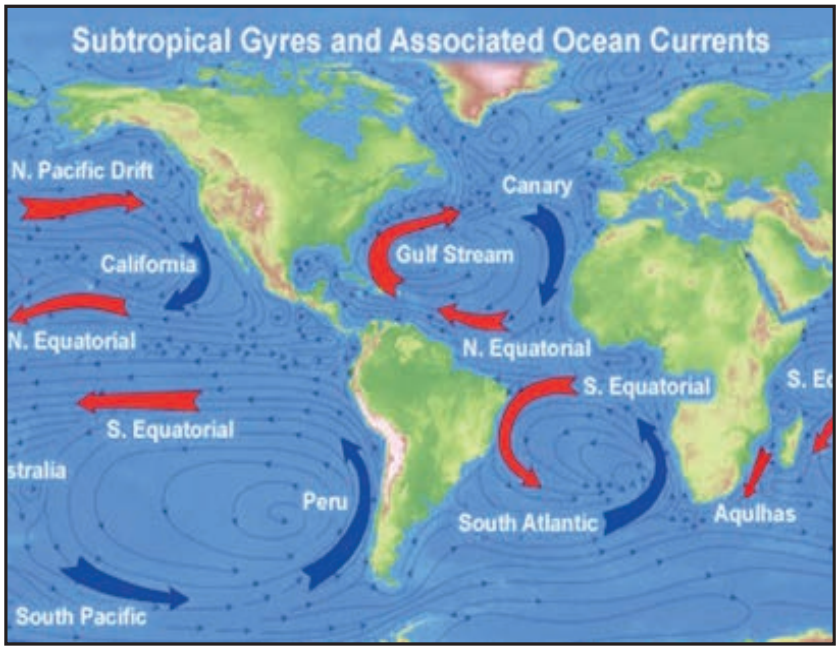


Figure 2.9: Ocean circulation

2.5.8. Topography or elevation

Because of fast fluctuations in height and hence temperature, as well as the quantity of solar exposure throughout the year, the climate in mountainous areas fluctuates greatly over short distances. High diurnal temperature ranges are prevalent at high elevations due to a decrease in mass and density compared to other areas that are lower in elevation but along the same latitude parallel.

How does temperature decrease as height rises?

In the lower atmosphere or troposphere, the normal temperature decrease with height is 6.4^{0}C per kilometer. Radiation, convection, and condensation all affect the normal or ambient lapse rate, which is highly changeable.

EXAMPLE:

If the altitude of Ras Dejene mountain is 4620 m above sea level and assuming that the temperature at sea level is 30^0 C.

What will be the expected temperature at the top of the mountain?

1000 m=6.4^{0}C

4620 m=?

Temperature at sea level-([Elevation x normal laps rate or 6.4^{0}C]/1000)) =temperature at the top of the mountain. (4620m x 6.4^{0}C)/(1000 m)=29.57^{0}C .

Therefore, the temperature at the top of the mountain= 30^{0}C -29.57^0 C=0.43^{0}C.

Moreover, the orientation of mountain slopes has a major impact on solar radiation receipt and temperature and also governs exposure to wind. Mountains ranges create barriers that alter wind and precipitation patterns. The orographic rainfall falls on the windward side of the mountains (Figure 2.10).

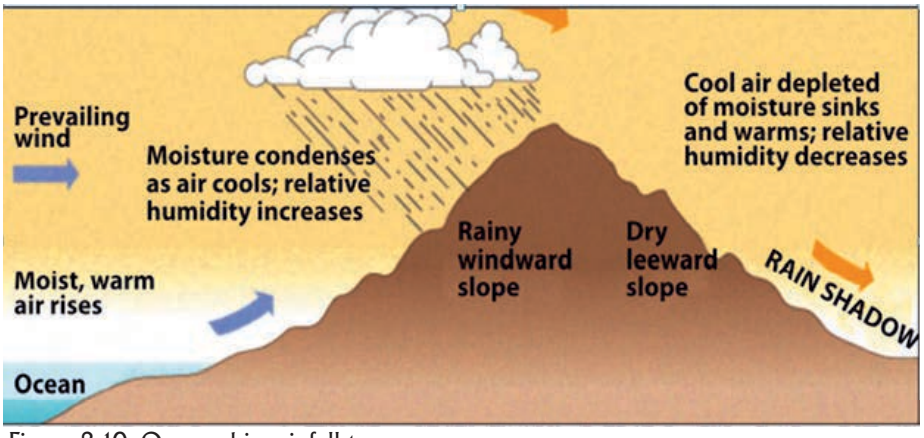


Figure 2.10: Orographic rainfall type

Reflective Activities 2.5

Please attempt all questions provided below, think individually about each, and discuss in a group of six.

1. Explain the effects of small water bodies, such as lakes, swamps, and marshes on temperature variation in the local environment.
2. How do you explain the greater difference in day length from December to June as you move from the equator to poleward?
3. What is the task of atmospheric circulation?
4. How do you relate the seasonal movement of subtropical high pressure and overhead of the sun?

2.6. LOCAL CLIMATE CLASSIFICATION OF ETHIOPIA

At the end of this section, you will be able to:

- describe the local climate types of Ethiopia; and
- compare the methods used in climate classification locally against Köppen.

Keywords:

- **Local**
- **Climate classification**
- **Ethiopia**

Brainstorming Activity 2.12

What do you know about the local climate classification of Ethiopia?

Ethiopia's local climate classification is based on height, temperature, and growing season length. The country can be divided into five primary climatic zones: Bereha, Kolla, Woina-Dega, Dega, and Wurch, according to the traditional climatic classification system.

1. Bereha: The hot lowlands are referred to as Bereha. It's the climate of the desert-like lowlands, which are found below 500 meters above sea level and have an average annual rainfall of fewer than 16 inches and a temperature of more than 30^{0}C. Because of the harsh environment it is mainly inhabited by pasoralists. Strong winds, high temperatures, low relative humidity, and limited cloud cover characterize the climatic zone. Examples of such climate are found in Afar lowlands, Somali lowlands, etc.

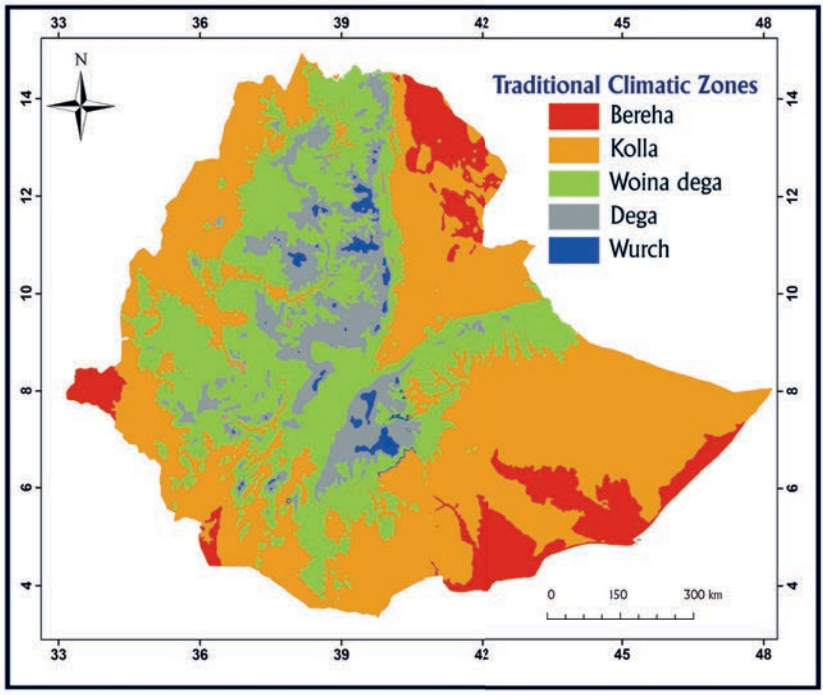


Figure-2.12: Traditional climate zone of Ethiopia

2.Kolla: describes a semi-arid environment that is warm to hot. It is the climate that defines the hot lowlands, which are located between 500 and 1500 meters above sea level. The average annual temperature is between 20 and 30^{0}C, while the average annual rainfall is between 16.4 and 32.8 inches. In the rainy western lowlands of Gambella, though, rainfall can reach 64 inches. Furthermore, rainfall varies greatly from year to year. This area has a climate that is both hot and humid. Common crops include sorghum, finger millet, groundnuts, cowpeas, and sesame.

3. Woina-Dega: It encompasses the temperate highlands, which are located between 1500 and 2300 meters above sea level. The average annual temperature is 15^{0}C to 20^{0}C, with an average annual rainfall of 48 inches. Wheat, teff, barley, maize, sorghum, chickpeas, and haricot beans are often grown in this climatic zone.

4. Dega is a term used to describe the climate of cold temperate highlands located between 2300 and 3300 meters above sea level. The coldest month sees temperatures below 10^{0}C and rainfall ranging from 40 to 80 inches. Wheat, highland pulses, and highland oil seeds are the most common crops.

5.Wurch refers to an Alpine climate found at elevations greater than 3,300 meters above sea level. This climatic zone includes Afro-alpine plateaus (Senate plateaus), Simien Mountain (Ras Dejen mountains), Guna Mountains, Choke Mountains in Gojjam, and Amare Saint in south Wollo. The yearly average temperature is below 10^0C, and annual rainfall is between 35.2 and 80 inches. In the climatic area, barley is commonly produced.

Reflective Activities 2.6

Please attempt all questions provided below, think individually about each, and discuss in a group of six.

1. Identify different agroecological zones distributed in local Kebele and Woreda.
2. What are the major crops grown in different traditional agroecological zones?
3. Why do you think that different crops grow in different agroecological zones?
4. Why are crops rarely growing in desert and Kur (›3700 meters above mean sea level) agroecological zones?

UNIT SUMMARY

Climatologists divide climatic regions to simplify and summarize the concept of a diverse range of climates. The ancient Greeks categorized our world into three zones based on habitability: Frigid Zone, Temperate Zone, and Torrid Zone. Because of its strong alignment to vegetation and soil domains, Köppen's classification system has become the most extensively utilized system in modern times. The primary parameters for classifying the global climate are natural vegetation, temperature, and precipitation. Most vegetation types respond immediately to climate inputs, particularly temperature and moisture, according to the Köppen system, which is based on dominating vegetation types. The link between flower types and their properties is used to classify climates. The Köppen system classifies five primary terrestrial climate types based on these criteria: A (tropical or megatherms), B (xerophytes or Arid), C (mesothermal or mid-latitude mild), D (micro-thermal or mid-latitude cold), and E (micro-thermal or mid-latitude cold) (hekistotherms, polar).

Combining the required first, second and third-order subdivisions yields the modified Köppen–Geiger climatic categories. To describe regional climate more precisely, those primary (first) climatic types are further categorized into second and third-order subcategories. The Köppen approach is more appealing to geographers since it identifies the relationship between vegetation types and climatic types. Some of the scheme's flaws include its failure to account for essential meteorological elements like precipitation intensity, cloudiness, and the number of rainy days, as well as daily temperature extremes, air masses, and winds.

Trewartha developed a simple climatic categorization technique that included empirical and genetic classification schemes. It determines the climatic type of a location just based on precipitation and temperature, avoiding complex statistical and mathematical calculations. Because of its simplicity, Trewartha's scheme grew more popular among geographers. Trewartha established six broad first-order climatic types at the global level and labeled them A, B, C, D, E, and F climates.

The key elements that govern the distribution of world climate include latitude (seasonality); the combined effect of revolution, rotation, and tilt; continentally; atmospheric circulation; seasonal movement of subtropical high pressure; coriolis effect; ocean circulation; and elevation. Ethiopia's local climate classification is based on height, temperature, and growing season length. The country is divided into five primary climatic zones: Bereha, Kola, Woina Dega, Dega, and Wurch, according to the climatic system.

REVIEW EXERCISES

True/False Item

Instruction : Say True if the Sentence is "Correct" and Say False if the Sentence is "Incorrect"

1. The recognition of the association between the types of vegetation and climate is one of the merits of the Köppen scheme
2. Low pressure" indicates pressure above the mean sea level.
3. Humid Subtropical (Cfa) is a type of climate affected by westerlies throughout the year

Multiple Choice Item

Instruction: Choose The Best Answer from the given alternatives of the following questions

1. Which one of the following criteria is not used by an empirical classification system

A. Perception of habitability in the zones C. Temperature
B. Precipitation D. Air masses

2. Which classification system combines the fundamentals of the empirical and genetic classification schemes?

A. Simplified Köppen C. Trewartha's
B. Modified Köppen D. All

3. Which one denotes hot summer and the third order subdivisions in Mesothermal climates

A, a B. b C. c D. d

4. The region's climate is categorized as savanna, with equatorial westerlies and inter-tropical convergence dominating in the summer and dry trade winds or subtropical anticyclones dominating in the winter.

A. Tropical Wet and Dry Climate (Aw)
B. Monsoon climate (Am)
C. Tropical Wet Climate (Af)
D. None

III. Write the Short Answers to the Following Questions

1. Why are genetic schemes more difficult to implement and less successful overall even though they are scientifically more desirable?
2. Why is Köppen's scheme commonly used for classifying world climate although it has some major limitations?
3. What are the climatic factors not considered by Köppen's climatic classification system?
4. Explain the characteristic features of the dry climate.
5. Which of the climatic regions are influenced most by the migration of the inter-tropical convergence zone?
6. Which of the climatic regions is most influenced by upper air stability and subsidence?
7. Why does solar energy insolation on a given day strike the surface at a decreasing angle from 90^0 to 0^0?
8. How does the Earth-Sun relationship affect the spatial and temporal distribution of energy?
9. How does insolation at the water's surface or the land's surface affect temperature variation?
10. Compare and contrast the maritime effect and continentality by examining the climate of selected cities that are at the same latitude.

UNIT THREE

NATURAL RESOURCES AND CONFLICTS OVER RESOURCES

Learning Outcomes

At the end this unit, you will be able to:

- describe the importance of land as a natural resource;
- specify the functions of land;
- evaluate the intricate relations between land and people and management strategies for sustainability;
- assess the effects of population pressure on land;
- explain why renewable or non-renewable resources are under immense pressure;
- analyze the relationships between resource overuse, environmental degradation, and population growth;
- compare annual water uses of Ethiopia, Sudan, and Egypt; and
- explain how unfair water use could lead to regional conflict.

MAIN CONTENTS

INTRODUCTION

This unit presents the importance of land as a natural resource, its functions, and use as well as management strategies. It appreciates the classification of resources as renewable and non-renewable. Common pool resources under immense human pressure will be identified; their depletion and consequences will be described.

Transboundary Rivers shared by two or more countries and regional cooperation on the sustainable use of the waters of the mentioned rivers will receive due focus. This unit likewise appreciates the water resource potential and use of Ethiopia in comparison to neighboring countries like Egypt and Sudan. This unit finally winds up by giving a brief explanation of conflicts arising over the use of natural resources.

3.1 THE FUNCTIONS AND MANAGEMENT OF LAND

This topic presents a wide-range of definitions, functions and management of land and its resources. At the end of this section, you will be able to:

- explain the importance of land as a natural resource,
- identify the functions of land,
- describe the relations between land and people, and
- elaborate the importance of land management.

Keywords:

- **Land,**
- **Land management**
- **Natural resources**
- **Non-renewable resources**
- **Renewable resources**

3.1.1. The importance of land as a natural resource

The land is a very broad concept and has a wider range of meanings. It may be examined from many different viewpoints or perspectives. For instance, it can be viewed as a resource, an environment, a legal object, an economic asset, and/or cultural wealth.

The land is the ultimate resource and foundation of all forms of human activity for without it, life on Earth cannot be sustained. It is the source of all wealth; both a physical commodity and an abstract concept that the rights to own or use it are as much a part of the land as the object rooted in the soil. From the land, we obtain food, shelter, space to work, and room to relax. Land again represents fundamental components of the ecosystem. Land as a resource, therefore, incorporates the natural resources (often referred to as land resources) and is viewed also as an environment.

Brainstorming Activity 3.1

1. How do you explain the importance of land as a resource?
2. What do you know about the types or categories of natural resources?
3. Why do we study natural resources?

Please form groups and exchange ideas on the given questions.

Land resources are useable materials that are often occurring naturally in the environment. They are derived from the Earth: from Lithosphere, Biosphere, Atmosphere, or Hydrosphere. They are classified into different groups based on different parameters. For instance, based on:

- Regeneration: renewable and non-renewable resources,
- Origin: biotic and abiotic resources,
- Current use and future availability: stock and flow resources,
- Distribution and volume: ubiquitous, unique, common, and rare resources,
- Stage of development: potential, actual and conditional resources.

Renewable resources such as plants and animals are often regenerative and replaceable after use. These resources go on replacing themselves as far as the rate of use is less than the rate of regeneration and as long as their environments are well kept. Renewable resources can be replenished or reproduced easily. They are resources that grow again and again or come back again after use. The rate of regeneration differs from resource to resource. For instance, crops take a short time to regenerate. Resources like soil on the other hand may take a relatively long time to renew. Forest resources can take a longer time compared to others. Nevertheless, many renewable resources can be depleted through excessive use. Being classified as a renewable resource does always mean not depleting at all. If excessively used, they can be easily depleted (exhausted). Sustainable (wise) use of such resources is thus the basic requirement for preserving land resources for the benefit of humankind. Some of the renewable resources are inexhaustible–exist as flow chattels (e.g. sunlight, oxygen in the atmosphere, wind, etc.).

Non-renewable resources exist in a finite supply and do not replace themselves after use. They diminish in size and quality with excessive use. These resources do not come back after use or would take a very long time to regenerate. Minerals and fossil fuels are the best examples of these resource groups. The rate of formation of these resources is very slow; hence, they cannot be replenished soon once they get depleted. As it is difficult to get back these resources, recycling and reusing are among the recommended management options. Reuse involves using a resource over and over again in the same form or after recycling it. Nonetheless, resources like coal and petroleum cannot be recycled like metallic minerals. Therefore, it is essential to carefully manage the use of non-renewable resources because their unmanaged use may lead to rapid exhaustion which finally restricts the benefit of coming generations.

NOTE:

By referring to geography books from your school library or by using internet sources please read about biotic and abiotic resources; stock and flow resources; ubiquitous; unique, common, and rare resources; potential, actual and conditional resources.

Land as an environment refers to the ecological aspects of the Earth such as soil quality or biodiversity and its functions within the ecosystem. From an ecological perspective, land plays a vital role in the breeding and survival of living organisms. Land as an environmental resource again serves as a sink for waste.

The land comprises both biophysical and socioeconomic resources. Due to this, it can be defined differently by different people. But land as an environment can never have one single definition. Land as an environment is considered as an area of the Earth's surface embracing all aspects of the biotic and abiotic components existing on, above, and below the surface of the Earth. Plants and animals of the biosphere, gases of the atmosphere, the underlying geology and soils as well as the hydrology, plus the results of past and present activities of human beings are attributes of land or considered to be part of the land.

3.1.2 The functions of land

Land as a useable material serves several purposes and tends to provide many functions, including:

- Production function: serve as means of production,
- Waste disposal function: serve as a sink of wastes,
- Economic asset: can be converted into a capital resource,
- Cultural asset: serve as host of traditional and religious sacred amenities.

NOTE:

Read about the other functions and perspectives of land from books or internet sources. Focus on reading about the legal, economic, and cultural perspectives of land to widen your knowledge.

3.1.3 Land management

Land management refers to the proper use and protection of land resources to provide optimal benefit to growing populations and uphold sustained ecosystem services. For that land should be managed to provide a wide range of services including the making of food and fiber. It has to deliver distinctive landscape opportunities for outdoor public recreation as well as pivotal ecological functions. The management of land has essentially to encompass the protection of wider landscapes and resources (mountains, hills, rivers, depressions, water, air, vegetation, wildlife, etc.) to retain sustained public benefits and ecosystem services. It thus has to reflect the principles of sustainable resource use and development. For that, it has to build upon national, regional, and local needs and aspirations. The prime objective of land management is to control land degradation to balance resource exploitation and regeneration.

As land management is materialized through the protection of its resources, it has to base itself on the management of soil, water, natural vegetation, and air. For instance, proper farming practices, tree planting (afforestation and reforestation), controlled grazing, terracing, and check-damming can be used to protect soils, water, and forests. Adaptation of fuel-saving technologies in vehicles; use of renewable power sources (e.g. hydropower) for industrial and home energy requirements help to reduce environmental pollution. Besides these, land management should consider cultural, economic, and political settings. It has better rely on the indigenous culture, and local knowledge, and on awaking and educating the immediate beneficiaries of the area under consideration.

Reflective Activity 3.1

Please answer the following question:

1. How do you characterize land as a resource?
2. What are the functions of land as a resource and as an environment? Explain?

3.2 RESOURCES UNDER PRESSURE

This section refers to the identification of resources that are seriously affected by human use and those fall under intense pressure.

At the end of this section, you will be able to:

- identify renewable or non-renewable resources under immense pressure
- describe the consequences of resource depletion

Keywords:

- **Afforestation**
- **Soil degradation**
- **Water stress**
- **Watershed management**

Brainstorming Activity 3.2

Please think about the following questions independently and then discuss them with your classmates:

1. Which land resources are under immense human pressure?
2. Could you please identify the renewable and non-renewable resources found under immense human pressure?
3. How do you describe the extent and consequences of resource degradation/depletion?
4. How do people control the degradation/depletion of resources?

There are several resources provided by the environment for human use and ecosystem services. All are of course affected by excessive human use. But from all renewable resources, soils, water, and forests are the most influenced by humans and placed under increased pressure. Large parts of these resources are available as common-pool wealth in many areas and face greater pressure (the tragedy of the commons). They are repeatedly misused, mismanaged, and degraded (see e.g. Figure 3.1) through unwise and careless uses. They face the prime impact of rapid population growth and increased rural-urban migration. This topic thus focuses on the discussion of the pressure exerted over these resources.

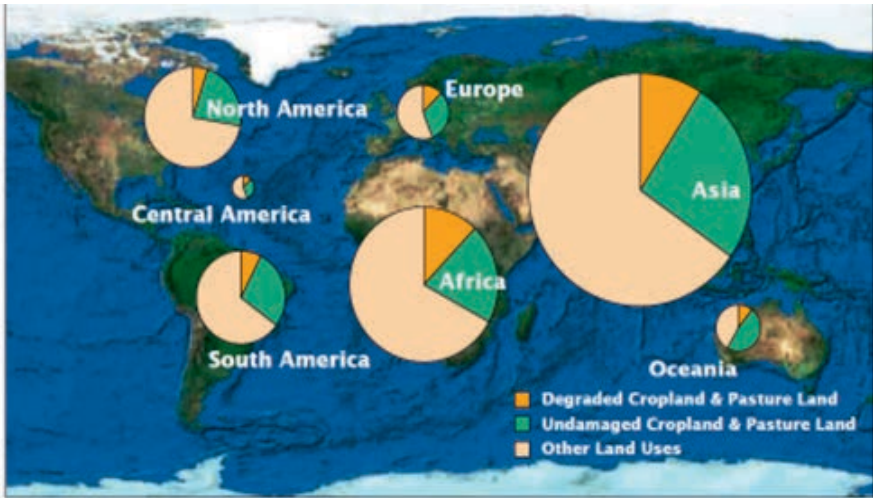


Figure 3.1 Degradation of land resources at global scales (pasture, crop, and other land uses) Global Assessment of Human-induced Soil Degradation (GLASOD, 1990 in Haile et al. 2006)

3.2.1 Soil resources

Soils are essential agricultural resources. But they are frequently losing their intrinsic quality due to erosion or excessive utilization. Nearly 33% of the world's arable land and soils have been destroyed by soil erosion (e.g. see Figure 3.2). The main causes of the depletion are the loss of essential soil nutrients; reduction of the biological components; removal of the top soil; crusting and compaction; plus pollution and soil salinity. The main forms of soil degradation (depletion) are

- Physical (crusting, compaction, depth reduction),
- Chemical(salinization, alkalinisation, acidification), and
- Biological (loss of soil biota, decline of soil organic carbon).

Yet, the depletion of soils reduces their productive capacity and environmental quality. Soil depletion likewise annihilates the essential ecosystem functions in the soil system. But still, the mentioned problems have solutions. They can be managed through proper utilization; by the adoption of erosion control structures; and through the addition of manure and natural fertilizers.

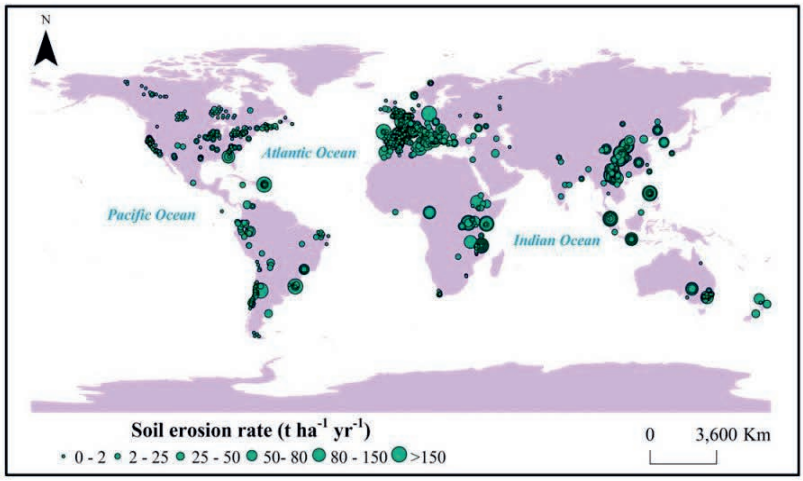


Figure 3.2 Soil erosion at global scales (Li & Fang, 2016; in IPCC, 2019)

3.2.2. Water resources

Water is one of the basic life necessities for the survival of human beings as well as animals. It is essential for the generation and growth of plants. It forms also the major components of soil formation, rock weathering, organic matter decomposition, and rainfall formation. Water (mainly freshwater) forms the essential portion of the environment and serves as a habitat for diverse life forms. In addition, its service for the production of power is so great. Nonetheless, it is enclosed by a far greater number of constraints than ever before. With the commencement of the 21st century, the world's freshwater resources fall under great pressure from more different directions than ever before in the Earth's history.

Freshwater stands by now among the land resources that suffer a lot from excessive human pressure. Rivers and lakes are among those extremely threatened by domestic and industrial wastes. Particularly those found closer to urban areas are polluted by plastic bags, and exotic water plants like the water hyacinth. Oil spills (leakages) from steamships/boats plus chemicals released from industries entering the lakes, seas, and rivers cause excessive accumulation of nutrients and toxicity over the animals inhabiting those hydrologic ecosystems.

Due to the spectacular rising populations, water scarcities and effluence of the sources are resulting in turbulence. The scarcity of water is currently distressing in many arid and semiarid areas of the world where population pressure is somewhat extensive including parts of the Middle East, Africa, and Asia.

This is a shortage pronounced by a demand for water which is intensifying faster nowadays than at any time in the Earth's history. This fact is a shortage that looks probably to occur and perhaps would heighten in the future. The outcome would likely be a worldwide water crisis that might transpire in the middle of this century (see Figure 3.3) as far as demand surpasses the existing supply over wider areas of the world.

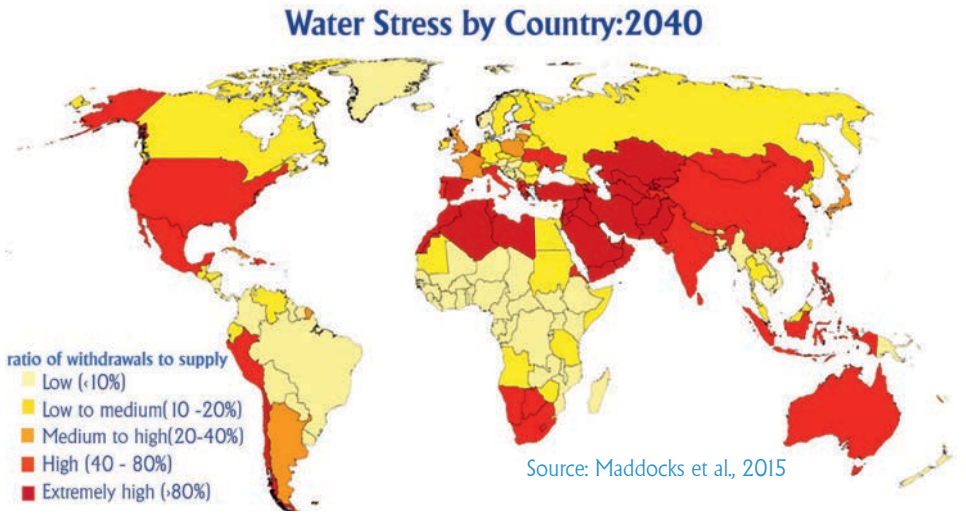


Figure 3.3 Water stress feared to take place in the middle of the 21st Century

The world population is likely to approach 10 billion by 2050 which might cause more demand for water to satisfy the expanded needs of agriculture and industry. The amplified population again may pose natural disasters like flooding, droughts, and pollution of surface and ground waters. The pollution would probably reduce the available quality of freshwater. Climate change may likely upset the features of the hydrological cycle in many delicate areas. With that water would likely emerge as a source of contention and skirmish between nations sharing river basins (international rivers) coupled with the diminishing base of resources. The risks posed by water may impact also human health, livelihoods, socio-economy, political stability, culture, and society, for water arrives essentially into all human activity. Water is equally imperative at spatial, personal to global scales and from seconds to hundred-year time scales and far beyond.

Owing to the widespread hunger and mounting overall food demands across the globe, sustainable use of water and land ecosystems is imperative. Nevertheless, freshwater appears to deplete by competing and unwise uses. Managing water resources has thus now become mandatory.

The following measures can be taken to address the competing uses and sustain the health of freshwater resources:

- developing safe waste disposal sewerage systems, particularly in urban areas to avoid contamination of stream and lake waters from domestic effluents,
- adopting laws restricting withdrawal of wastes to river and lake systems,
- locating industries far from rivers and lakes,
- desalination of sea water to minimize stress on streams and lakes,
- recycling of waste water through careful treatment,
- using porous pavements to avoid the drain of wastewater into watercourses from impervious surfaces in urban areas, and
- watershed management.

3.2.3 Forest resources

Forests are making up significant portions of the land area of the world. Throughout the history of humankind, forests have been essential for the well-being of people and presently donate much to the livelihoods of billions of populations worldwide. They particularly provide subsistence items, income, and agricultural inputs to the livelihoods of many households. Forest ecosystems in addition donate a wide range of services like climate stabilization, flood control, waste filtration, and soil erosion control at local, regional, and global scales. They also uptake and store the world's carbon stocks and serve as heat and waste sequestration. Forest resources again serve as a habitat for the Earth's known terrestrial species. Nevertheless, deforestation (excessive tree cutting), encroachment of farming into the communal forest areas, and mismanagement largely reduce their services despite the enormous benefits that they provide.

About 13 million ha of forested lands have been annually converted into other land uses due to natural causes at the global level over the past few decades. Forest clearance for large-scale plantation agriculture and livestock ranching in the tropics (e.g. in the Amazon basin) resulted in the loss of rainforest ecosystems. Increasing demand for biofuels, mining, rapid urbanization, climate change, changes in consumption patterns, and human values and ethics due to the rapid increase of world population and world trade (globalization) have been creating additional pressure on the status of world forests.

NOTE:

Please read about the current and future influence of high population growth on resource use and management from books or intent sources and share the information you get with your classmates. This will widen your knowledge about land resource use and management.

Brainstorming Activity 3.3

It is hoped that you learned that the world's forest resources are under the intense pressure of degradation induced by increased populations, as well as additional food, fiber, and fuel demands. Hence, what remedial measures have to be taken to minimize the pressure on the world's forest resources? Please discuss in groups and tell your answer to your teacher.

As you might recall, forests constitute the largest terrestrial ecosystems on the Earth and provide a wide range of ecosystem services. Nevertheless, their provision is threatened by excessive human use and over exploitation. If this continues, the security of wildlife and livelihood of the people of the world; primarily those of the poor developing countries will be endangered soon. Remedial measures are mandatory to conserve these endangered resources. The following measures could be taken to safeguard the security of forest resources at any place in addition to other measures adopted by residents:

- initiating afforestation and reforestation programs like the 'Green Legacy' practiced in Ethiopia,
- integrating forest management with Soil and Water Conservation (SWC) programs,
- looking for alternative energy sources from other renewable resources (hydropower, solar power, wind power, etc.),
- adopting restrictive laws on unwise use of common-pool forests (e.g. using bylaws),
- encouraging participatory forest management (e.g. engaging users in decision making),
- education and awareness creation (educating and awaking forest users), and
- watershed management (protecting the watersheds).

NOTE:

From the non-renewable resources, Fossil fuels (natural oil & coal); precious minerals (Gold & Diamonds) are among those facing intense pressure. The exploitation of these resources has been frequently causing conflict among ethnic groups and even between countries. Examples are the Middle East, Central Africa, and West Africa.

Reflective Activity 3.2

Please discuss this in detail and enumerate the possible remedial measures

1. Could you please outline the resources under intense human pressure?
2. What factors impose pressure on such resources and what would be the consequences?

3.3 LAND RESOURCE DEPLETION AND DEGRADATION

After studying this topic you will be able to appreciate the concepts, causes, and impacts of resource depletion and the management measures. You will first define what land degradation means and continue discussing the causes, impacts, and management measures.

At the end of this section, you will be able to:

- describe the concept of resource degradation/depletion,
- identify the causes of resource degradation and depletion,
- evaluate the impacts (consequences) of resource depletion, and
- explain the resource conservation measures.

Keywords:

- **Proximate cause**
- **Resource degradation**
- **Resource management**
- **Underlying causes**

Brainstorming Activity 3.4

What are the causes and consequences of land resource degradation? Please form a group and sort out the causes and consequences and then share your findings with your teacher.

3.3.1 Concepts of resource degradation and their causes

Resource degradation is the overall loss (decline) of the quality and quantity of land resources such as soils, water, and biological mass (e.g. see Figure 3.4). It is often initiated by human activity and sometimes by natural hazards such as earthquakes, volcanic eruptions, land-sliding, and flooding.

Degraded land in the Atsbi-Womberta area, Tigray, Ethiopia. (Gebremedhin et al., 2010)

b) Eroded wasteland in Rajasthan, India https://archive.unu.edu/env/plec/l-degrade/D-Ch_2.pdf

c) Erosion on cotton plantation farm in Ghana

d) Eroded 'badlands' over sodic soils in Bolivia

Figure: 3.4 Examples of land resource degradation in the different parts of the world

The degradation of land resources happens at a wider scale all over the world (e.g. see Figure 3.1); yet, its impacts are much worse in developing countries like those in Africa. The devastating damages of resource degradation are more evident from loss of soil productivity, water and air pollution, and contraction of vegetation cover over an area. It is commonly connected with other environmental and socioeconomic hazards such as climate change and widespread poverty.

The sources of land resource degradation can be categorized as underlying and proximate causes. The underlying sources are major causes that promote proximate issues to happen. The proximate causes are secondary issues that are initiated by the primary (underlying) agents. Please refer to Table 3.1 for more understanding.

Table 3.1 Causes and consequences of resource degradation

Major causes	Consequences	Proximate causes	Consequences
Rapid population growth	Increased demand for food & farmland	Intensive use of land	Farmland fragmentation, repeated tillage, depletion of soil fertility
	Increased demand for biomass energy & timber	Deforestation	Forest cover contraction; soil erosion; minimized local climate stabilization
	More demand for pasture & livestock feed	Overstocking & overgrazing	Uprooting & removal of vegetation
Climate change	Decreasing rainfalls, increasing temperatures	Desertification	Contraction of vegetation cover; decreasing crop harvest; poverty
	Sudden, unprecedented & torrential rainfalls	Flooding	Soil & biodiversity losses; health problems; sedimentation & siltation of dams (reservoirs)
Rough topography	Steep slopes	Fast flowing streams	Soil removal from upper catchments
	Depressions	Waterlodging	Soil acidity; cultivation difficulties
Improper land use practices	Poor farming methods	Ploughing up & down slopes	Soil removal from farmlands
	Poor land management	Less use of fallowing, crop rotation, animal manure & excessive irrigation	Loss of soil nutrients & depletion of soil fertility; salinization
Government Policy	Poor tenure policy	Tenure insecurity (lack of proper use)	Resource depletion

3.3.2 Consequences and controlling measures of resource degradation

Rapid population growth and technological advances over the past 50 years have initiated worldwide land-use changes. Forest covers have significantly decreased whilst cultivated lands have increased. The sizes of rain-fed areas expanded; irrigated areas have doubled and permanent meadows and pastures increased. A significant proportion of the world's arable land was destroyed also by soil erosion. Similarly, the per capita farmland needed to adequately feed people had declined. Future improvement of rural livelihoods and income levels would thus be possible largely through the rational use of available resources and increased application of agricultural technologies.

NOTE:

Land resource degradation could finally result in:

- loss of biodiversity (reduction of animal and plant populations),
- desertification of local environments,
- low level of agricultural yields and animal production,
- worsen the levels of hunger and poverty,
- food insecurity and migration, and
- lessening the capacity of the land to function effectively within the ecological system.

Brainstorming Activity 3.5

From the preceding lessons, one could see that land resource degradation is posing a growing concern to the world and could continue to do in the future. If so, what remedial measures should be taken to curb the problem? Think about it independently and tell the answers to your teacher.

The depletion and degradation of natural resources can be checked through land management practices (e.g. see Figure 3.5). The practices include:

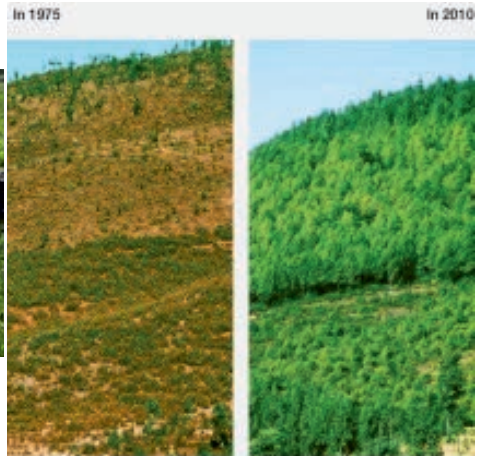
- afforestation: planting of trees on barren lands that were not under forest cover before,
- reforestation: replanting trees in deforested areas,
- area closures: closing deforested areas from livestock contact to restore the previous status,
- terracing: constructing bench terraces on steep lands to reduce the force of running water and to trap down moving soil,
- a check dam is a small or temporary dam or structure constructed across a waterway to control erosion by reducing water flow velocity. It is important to conserve gullied areas.
- mulching refers to the covering of soil with plant residue to let the soil regain some nutrients as the residue decays. It is important to reduce water loss from evaporation.
- shelterbelts: is the planting of trees along a line to break the speed of the blowing wind and reduce its erosivity,
- diversion canals: to divert upcoming floods on farmlands,
- trenches: to trap down-moving water and soil,

- Drainage channels (ditches): to remove excess water from depressed areas,
- Legume-rotation: to replenish soil fertility,
- Addition of animal manure: to replace lost nutrients,
- Inter-cropping: to augment soil fertility,
- Proper irrigation: to minimize soil salinity,
- Addition of chemical fertilizer: to replace lost nutrients, using green-manure: to uphold soil fertility.

a) Stonebunds in May-Leiba catchment, Tigray, Ethiopia

b) Terrace structures over the loess hill slopes of China

Restored gully in Awzet, Farta, Ethiopia.



Restored forest land in Nepal, Asia

Figure 3.5 Soil and water conservation structures

Reflective Activity 3.3

1. Explain the causes and impacts of resource depletion/degradation and suggest how people in your local area should control resource degradation.

3.4 TRANSBOUNDARY RIVERS

At the ende of this section, you will be able to:

- appreciate the distribution of transboundary watercourses;
- examine the prospects and impacts of shared rivers; and
- describe the features of shared rivers.

Keywords:

- **Riparian countries**
- **Shared watercourses**
- **Transboundary**

Brainstorming Activity 3.6

1. Could you please name some transnational rivers shared by two and more countries in the world ?
2. What makes transnational rivers different from inland confined rivers?
3. Draw a sketch map showing the location of transnational rivers in Africa.

3.4.1 Distribution of transboundary watercourses

Transboundary Rivers are watercourses shared by two or more countries. Together with lakes, inland waters, and aquifers, they are named 'transboundary waters'. Oceans, territorial seas, and coastal waters are not included in this category. Worldwide, more than 263 transnational river and lake channels plus numerous trans-state aquifers are currently known to geographers. These 263 transnational watercourses make up around 60% of the world's freshwater flows and nearly one-half of the Earth's terrestrial surface. They pass across the terrains of 145 nations and support about 40% of the global population. About 60% of the space of Africa and South America and nearly 40% of North and Central America falls under inter-state Rivers. (Figure 3.6)

Around 80% of the total area of 44 countries lies within international basins. Twenty of these 44 countries are found in Africa, 13 in Europe, seven in Asia, and four in Latin America. The entire area of some 30 countries falls within the trans-state waters. Ground waters interlinked with 300 transboundary aquifers also support nearly two million people around the world.

Figure 3.6 Trans-state Rivers (Mckinney, 2011)

3.4.2 Prospects and impacts of transboundary watercourses

Internationally shared waters (basins) connect populations of diverse countries and then support the revenues and livelihoods of millions of people across the world. Internationally shared wetlands, lakes, and floodplains provide priceless ecosystem services to people as well as to local ecological systems. The ecosystem services they provide include food, shelter for aquatic life, and control of flooding and pollution. They also develop hydrological, social, and economic integrations among people and countries. They can play a great role in socioeconomic development and help to reduce poverty.

Internationally shared rivers and watercourses provide prospects for collaboration and improvement of regional peace and security in addition to socioeconomic growth. Exhausted, despoiled, poorly developed and unmanaged freshwater courses resulting from rapid population increase may impede sustainable development and hinder the need for partnership between main water-use segments like 'agriculture, industry, energy, navigation, water supply, and sanitation'. Inter-state collaborations and partnerships are the best options to address diverging interests over shared river basins. Nevertheless, shared watercourses appear to be sources of conflict and dialogue among countries despite their implanting potential for cooperation like that of Ethiopia and Egypt over the use of the Nile waters.

3.4.3 Features of shared river basins

As was mentioned earlier, there are 263 watercourses (rivers, lakes, and aquifers) in the world shared by two or more countries. As these watercourses are too many to address in this Grade 11 Geography, 15 major river basins shared by different world countries are presented as a sample in Table 3.2.

Table 3.2 Sample Internationally shared River Basins

River	Source	Drainage size (km2)	Flow volume (Billion Cubic Meter)	Destination	No of riparian countries	Length (km)
Nile	Lake Victoria	3,030,700	84 BCM	Mediterranean Sea	11	6,671
Okavango	Angola	430,00	10 BCM	Namibia	4	1,100
Zambezi	Zambia	1,370,000	230 BCM	Indian Ocean	8	3000
Congo	Central Africa	3,690,000	1,250 BCM	Atlantic Ocean	11	4,700
Indus	Tibet (China)	226	226 BCM	Arabian Sea	4	2,897
Ganges	Himalaya	1,080,000	382 BCM	Bay of Bengal	4	2,600
Mekong	Tibet (China)	795,000	475 BMC	Vietnam	6	›4,800
La Plata	Eastern Andes	3,100,000	884 km3/ year	Atlantic ocean	5	›3,500
Danube	Germany	801,463	6,460 m/s	Black Sea	19	2,850
Rhine	Switzerland	200,000	2300 m3/s	Netherlands (North Sea)	9	1,320
Colorado	USA	632,000	17.14 BCM	Gulf of California	2	2,334
Niger	Guinea	2,230,00	30 BCM	Atlantic ocean	11	4,100
Limpopo	South Africa	414,800	-	Indian Ocean	4	1,750
Amazon	Andes Mts.	6,800,000	220, 800 m3/s	Atlantic ocean	9	6,400
Jordan	Mount Hermon (between Syria & Lebanon)	›18,103	540 million m3 per year	Dead Sea	5	360

Blue Nile Falls

Bahr-Al-Jabal

Victoria Falls, Zambezi

Fishing in the Niger River

Congo River Hydroelectric Dam at Inga Falls

Grand Ethiopian Renaissance Dam

Figure 3.7 Economic value of African rivers.

Dams and Economic projects over the Nile Basin:

- Roseires: Sudan
- Sennar: Second largest dam in the world (Egypt)
- Aswan High Dam: Egypt
- Owen Falls Dam: Uganda
- Tekeze HEP project: Ethiopia
- Tana Beles (Ethiopia)
- Tis Abay (Ethiopia)
- Fincha (Ethiopia)
- Koga irrigation (Ethiopia)
- GERD (Grand Ethiopian Renaissance Dam).

NOTE:

- The world's 263 international watercourses cover nearly half of the Earth's land surface.
- A total of 145 nations include territory within international basins, and 21 countries lie entirely within the international basins.
- There are 13 basins worldwide that are shared between five and eight riparian states. Five basins - the Congo, Niger, Nile, Rhine, and the Zambezi, are shared between nine and 11 states.
- The river that flows through most nations is the Danube, which travels within the territory of 19 nations.

Reflective Activity 3.4

Please answer the following questions:

1. Please draw a sketch map of the world and indicate the geographic site of the 15 transboundary rivers given above.
2. How do countries sharing transboundary rivers cooperate to develop and use resources?
3. Do transboundary rivers become sources of contention among riparian states? If yes, why?
4. What implications do transboundary rivers have on the livelihoods of the households of the riparian countries?

3.5 REGIONAL COOPERATION FOR SUSTAINABLE USE OF SHARED RIVERS

As discussed during the previous lesson, trans-state watercourses provide both opportunities and threats to riparian countries. Most nations are contending with each other during water-sharing actions. This demands mediating and/or coordinating institutions to bring collaboration and negotiation among riparian states. This topic thus focuses on describing the relevance of regional institutions and the role they play in resolving conflicts arising thereof. At the end of this section, you will be able to:

- appraise the importance of regional cooperation for use of Transboundary Rivers;
- appreciate the role of regional institutions in avoiding water use conflicts.

Keywords:

- Regional cooperation
- Regional institutions
- Sustainable use

Brainstorming Activity 3.7

1. What does regional cooperation on sustainable use of shared rivers imply?
2. Do you know regional organizations working on sustainable use of shared rivers?
3. Please go to your school library and read about regional organizations established to take care of natural resources. Prepare a list of such institutions found in different regions of the world and submit it to your teacher.

Rivers and lakes frequently pass across numerous governmental and jurisdictional confines that typically have diverse priorities, intentions, and interests. The issue becomes further intricate when two or more countries are included. Due to political and/or institutional complications, shared resources of a single basin cannot be managed rationally on a long-term basis. This implies that some form of organizing agreement must be considered between the riparian states of the basin. In addition to this, some form of governing rule is required to harmonize the relations between the riparian societies and organizations to achieve effective water use and management over the shared watercourses to maximize human welfare and safeguard the environment.

Some people argue that shared watercourses would be major sources of conflict and war between world countries. But, for rational thinkers conflicts and wars will never benefit riparian states. They rather can benefit more through inter-state formal cooperation. National, regional, or international institutions (organizations) are thus considered basic components for alleviation of potential disputes arising from the use of shared watercourses.

Research shows that there are nowadays plenty of institutions and treaties focusing on the rights, responsibilities, and duties of countries sharing specific international watercourses. There are many bilateral and multilateral examples of this in different parts of the world. Of the 263 shared basins of the world, 176 (67%) had bilateral conventions. Nevertheless, 79% of the covenants of the past were in watercourses crossing three or more riparian countries. Most joint covenants from multilateral basins were also bilateral types (2:1). This indicates that many of the agreements were intentionally excluding one or more riparian countries within a given catchment. Examples of such institutions are provided in the coming paragraphs.

The Nile Basin Initiative (NBI) : was a pact created to coordinate Nile basin resource management and socio-economic development in the riparian states. It was initiated in December 1992 with the creation of a Technical Cooperation Committee for the Promotion of Development and Environmental Protection of the Nile Basin (TECCONILE). It was first initiated by six Nile River riparian states (Egypt, Sudan, Rwanda, Uganda, Tanzania & Zaire). Ethiopia, Kenya, Eritrea, and Burundi were observers at the initial time. Between 1997 and 2001, considerable progress was made in designing structures and institutions for a new regime in the basin. Then the TECCONILE was replaced by the Nile Basin Initiative (NBI) in 1999 at Waterbury in 2002; with Ethiopia joining as a full member.

The NBI was first signed by Ministers of Water Resources of riparian states on 22 February 1999 in Dar-es-Salaam, Tanzania. The main objective of the multilateral pact was to promote:

- Sustainable socioeconomic development in the basin states,
- Equitable utilization and benefit of the basin resources,
- Recognition of the rights of all riparian states, and
- Nile Task – to prepare an inclusive legal Framework for equitable and sustainable allocation of Nile waters and resources.

The Lesotho Highlands Development Authority (LHDA): This water-focused organization was created by Lesotho and the RSA by signing the treaty in 1986. The project aimed to undertake a project to transfer water from the head-reaches of the Orange River to the key industrial areas of the RSA in the Pretoria-Witwatersrand Vereeniging region.

A Joint Permanent Technical Commission (JPTC) and two governmental bodies (the LHDA in Lesotho and Trans-Caledon Tunnel Authority (TCTA) in the RSA) were created to ensure the implementation of the project in their respective areas.

The Zambezi River Authority (ZRA): was a bilateral River basin organization (RBO) created between Zambia and Zimbabwe over the use of the Zambezi River which has many riparian countries. The objectives were to:

- Operate and maintain the Kariba dam,
- Investigate new projects,
- Collect data and link it with the national utilities.

The Kagera Basin Organization (KBO): was created in 1977 by Burundi, Rwanda and Tanzania and later joined by Uganda in 1981. The treaty aimed to strengthen the cooperation of member countries through joint planning and development of the sub-regional potentials in numerous sectors.

SAPP: Southern African Power Pool was created in 1995 to take improvement of the supply of power in the South African region. The 12-country region (Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe) has a large reserve of cheap hydroelectricity (HEP) in its north region (principally the Inga Reservoir) as well as large deposits of low-cost coal in RSA, and the Kariba Dam (on the Zambia/ Zimbabwe border) at the center of the regional scheme that can play the "buffer" role.

SARCCUS: Southern African Regional Commission for the Conservation and Utilization of the Soil: this was a regional organization established by South African countries sharing transboundary Rivers. The objective was to coordinate the conservation of water and soils on the shared River basins.

IJC: The US-Canada International Joint Commission (IJC) is an international institution working on water management in the Great Lakes Region of North America. It was created by Waters Treaty signed between the USA and Canada in 1909. The commission works not only on water sharing but also on the Lake's environmental management and pollution control. The IJC is mentioned as successful in resolving all transboundary issues referred to it.

Reflective Activity 3.5

Please answer the following question:

1. Explain the role of river-based organizations.
2. How were they created and how is their geographical relevance appreciated? What relevance do they have to the riparian countries?

3.6. POTENTIAL AND ACTUAL USE OF WATER IN ETHIOPIA, EGYPT AND THE SUDAN

This topic thus focuses on the evaluation of the potential and actual uses of water among these neighboring countries.

At the end of this section, you will be able to:

- examine the water resource potentials of Ethiopia, Egypt, and the Sudan, and
- evaluate the present water use of the mentioned countries.

Keywords:

- **Actual water use**
- **Conventions**
- **Egypt**
- **Ethiopia**
- **Potential water use**
- **Sudan**

Brainstorming Activity 3.8

Please discuss the issue in groups with your classmates as well as with your teacher.

1. How do you evaluate the water resource potentials of Ethiopia, Egypt and the Sudan?
2. Could you please compare the current water use of the three countries?
3. How do you evaluate the relations and contentions of the three countries over the use of the Abay River? How the relations impact the local people of the three countries?

Ethiopia, Sudan, and Egypt are African countries sharing several socioeconomic, cultural, and natural resources. These three countries have been experiencing similar culture, religion, and even economic characteristics through their long history.

Ethiopia and Egypt were exchanging popes for their Orthodox Churches during their past long history. Ethiopia and Sudan share a long land border in addition to their strong economic ties. The three countries again together share the Nile water and its resources. These three countries sometimes appear to experience conflicts among themselves. The sources of conflict among these neighboring countries originate from land and water resources shared among them. Particularly the main cause of conflict between the three countries emanates from the utilization and development of the Nile waters.

The per capita water use in Ethiopia is about 1,666 cubic meters per person per year. In Sudan, per capita, water use is around 1,981 cubic meters per person per annum. Coming to Egypt, it is low (about 830 cubic meters per person per year). This is less than the 1700 cubic meters of water per person per annum proposed by the World Health Organization (WHO).

Table 3.3 Notable conventions and treaties of Nile basin countries

Year	Parties	Name Treaty	Treaty objectives/contents
Dec. 1925	UK & Italy	Formation of 'Nile Waters Commission' & 'Exchange of notes' (Re-Concessions for barrage at Lake Tana)	The new water Commission named; Italy recognized the 'prior hydraulic rights' of Egypt & the Sudan,
07 May 1929	UK & Egypt	'Exchange of Notes' (Re-Use of the Waters of the River Nile for irrigation).	Egypt claims 'natural & historic rights' over the Nile waters; the UK recognized Egypt's "natural & historic rights in the waters of the Nile".
1934	UK & Belgium	Re-Water Rights between Tanganyika & Rwanda-Burundi	Regulation on utilization of boundary waters, notification of projects, water quality & navigation
1949 & 1952	UK & Egypt	"Exchange of Notes" on the (Re-Construction of Owen Falls Dam)	Construction of the Owen Falls Dam & control of the Nile waters.
1952	Egypt & UK	'Exchange of Notes' focusing on Owen Falls Dam & Aswan High Dam Proposal	Aswan High Dam with 156 BCM/ year storage capacities proposed by Egypt. Own Falls Dam proposed

08 Nov. 1954	Egypt & Sudan	Egypt demands a share of additional water	The first round of negotiations between Egypt and Sudan which end inconclusively
08 Nov. 1959	Egypt & Sudan.	Treaty for full utilization of Nile Waters; Formation of a Joint Technical Commission	All Nile water was distributed to Egypt & the Sudan (Egypt granted 55.5 while Sudan 18.5 BCM per Egypt; Permanent Joint Technical Commission; created
1993	Ethiopia & Egypt	Framework for General Cooperation	Confirmation of intention to cooperate on Nile waters & to refrain from engaging in any activities that cause appreciable harm to the interests of others
Feb. 1999	Ten riparian states	Establishment of the Nile River Basin Initiative (NBI) to serve as a transitional mechanism for cooperation	Promoting sustainable socio-economic development; equitable utilization and benefit of the basin resources; recognition of the rights of all riparian states, and preparation of an inclusive legal framework for equitable and sustainable allocation of Nile waters & resources.
2003	Kenya, Tanzania & Uganda	Protocol for Sustainable Development of Lake Victoria Basin	Cooperation on sustainable development & management of Nile basin. Creation of the Lake Victoria Basin Commission
2010	Riparian countries	The signing of the Cooperative Framework Agreement (CFA)	Creation of permanent Nile River Basin Commission
23 March 2015	Ethiopia, Egypt & Sudan	Agreement on Declaration of Principles on the Grand Ethiopian Renaissance Dam Project (GERDP)	To cooperate based on common understanding, mutual benefit, good faith, win-win, and principles of international law

NOTE:

The Nile River is shared by 11 riparian countries. The basin supports over 160 million people whilst the total population of the riparian states is estimated to be over 300 million. Yet, the use of the Nile waters for hydropower generation and irrigation was in the past exclusively dominated by Egypt and Sudan. Conversely, widespread poverty and lingering political instability hindered upstream countries from effectively using the potential of the Nile. Several bilateral and multilateral conventions were made by the colonial powers and riparian African countries concerning the use and sharing of the waters of the Nile basin. A summary of the many notable conventions is provided in Table 3.3.

Reflective Activity 3.6

Please answer the following questions:

1. How do you explain the resource potential and use in Ethiopia, Egypt, and Sudan?
2. Could you please elaborate on the relations and contentions existing between the three countries over the use of the waters of the River Nile?
3. Explain how relations and contentions between these countries influence the livelihood of their people?

3.7 CONFLICTS OVER RESOURCES

3.7.1 The concept of resource conflict

Natural resources are useable assets essential for human livelihoods. They are crucial for both people and animals. Some examples of natural resources include water, air, land, forests, fish, wildlife, topsoil, and minerals. Access to such natural resources partly decides the wealth and prestige of people and even the position of countries in the international economic system. Some of the aforesaid natural resources are exhaustible with excessive utilization. Resources like diamonds, minerals, and natural oil are available in limited amounts and can be exhausted with use. The market value of such resources rises when their quantities shrink. When the size of natural resources shrinks, asset scarcity occurs. The shortage then triggers conflict among the resource users – what is commonly called 'Natural Resource Conflict'. This topic thus focuses on conflicts rising from resources. this lesson you thus will be able to:

- examine the causes of resource conflict,
- describe the consequences of resource conflict,
- explain conflict resolving methods.

Keywords:

- **Arbitration**
- **Causes**
- **Consequences**
- **Resource conflict**
- **Negotiation**

Brainstorming Activity 3.9

1. What is natural resource conflict?
2. What are the causes and consequences?

Please discuss in groups and tell your answer to your teacher.

Resource conflicts are disputes arising over accessing, controlling, and using materials found in nature. Such conflicts often emerge because people use resources such as forests, water, pastures, and land. Disputes also arise when the interests and needs of users are not met or when the priorities of some user groups are not considered by governments. Such conflicts of interest are inevitable features of all societies. In recent years, the scope and magnitude of natural resource conflicts have increased and intensified.

These conflicts, if not addressed, can escalate into violence and cause environmental degradation and deterioration of livelihoods. Recognizing conflicts is a common feature of resource users. Such conditions are prerequisites for sustainable management and equitable use.

3.7.2 Sources and areas of resource conflict

At a wider scope, four kinds of resource conflicts occur as a general challenge to national stability:

a. Secessionist conflicts in which resource-rich regions seek to split away from the rest of a country;
b. Disputes over resources as part of new national laws and conventions (i.e. in the context of a peace agreement or new constitution);
c. Grievances over standalone projects such as mines and hydroelectric dams; and
d. Cumulative impacts of multiple small-scale clashes, typically over land, livestock,

NOTE:

One of the four potentially contentious issues is typically at the heart of these national or sub-national resource disputes: ownership of the resources; allocation of power for managing access to or developing the resource; the distribution of resource revenues; and environmental and social damage caused by extracting of the resource.

Natural resource conflicts have always been with us due to multiple competing demands. But conflicts can often be managed and resolved. Disputes over the control, ownership and use of natural resources exist all over the world. Such disputes trigger violence and devastation, principally in countries with weak administration, high levels of corruption, and experiencing fierce ethnic and political divisions. Some 40–60 % of the civil wars during the past six decades have been instigated by the control and use of natural resources. Although grievances over the usage of shared resources cause fierce competition among people and countries, they may be markers of change and progress for many reasons; if handled properly and peacefully. Typical examples of conflicts that originated from the seizure and use of natural resources are presented in the proceeding paragraphs.

Water and pasture shortages for instance cause conflicts in many areas of the world. See examples:

- Protests in Pakistan and Bolivia;
- Conflicts in China (in the Shandong & Guangdong Provinces in 2000),
- In Darfur (Sudan), for instance, much of the fighting was due to water scarcity.
- Between Nile riparian countries over the use of Nile water,
- Pasture land conflict: in Ethiopia (between Somali and Afar pastoralists),
- In Afghanistan, the main causes for village-level clashes in 2008 were arising from the use of land and irrigation water.

Bigger bodies of water (oceans, seas, lakes, and rivers) serve for fishing, transportation, development, offshore oilfields, and culture. could also be sources of conflict if not handled wisely. Examples:

- Fishing disputes led to "cod wars" between UK and Iceland in the 1950s & 1970s,
- There are more than 263 shared watercourses throughout the world that could be potential sources of conflict,

The land is the other sphere of resource conflict. Ownership of land provides the chance to access minerals, timber, animals, pasture, and farm plots, plus many other resources. People often have strong 'emotional and symbolic attachments to land and the resources on it'. Land often holds high economic value and socio-cultural prestige. But, due to population growth and environmental degradation, lands that can be used for personal, industrial, or agricultural purposes are becoming increasingly scarce and then initiate conflict among people or countries. Customarily, most wars have been fought for the control of lands: Example:

- Ecuador and Peru have fought several wars over their disputed border,
- Recently, violent conflict over land has occurred in China, East Timor, Kosovo, Rwanda, and Tajikistan,
- Border conflicts and wars were waged between Ethiopia and Eritrea, Ethiopia and Somalia,
- There are still border conflicts between India and Pakistan (over Kashmir); Ethiopia and Sudan, and many other countries.

Timber increasingly gets scarce with mounting populations. Today, 46% of the 30% of world forest cover has been destroyed. Population growth and industrialization are destroying rainforests and causing environmental degradation. Yet, like water and land, the increased demand for timber pushes to conflict. Examples of conflicts over the exploitation of timber are available in Burma, Cambodia, the Democratic Republic of Congo, and Liberia.

Fuel scarcity becomes the greatest concern for developing and developed countries. Many sources warn that oil in Saudi Arabia will rapidly exhaust and the world will soon face the end of the oil era. Moreover, the world's largest petroleum reserves located in Iran, Iraq, Nigeria, Venezuela, and Sudan are facing ardent conflicts. The market value and demand for fuel, especially petroleum, trigger conflicts in those areas. Besides, the developed world's increasing demand for oil and the search for supply deposits may intensify existing conflicts. For instance, Natural Oil in the Middle East caused the Gulf war between Kuwait and Iraq. In Africa, it caused conflict between Cameroon and Nigeria.

Precious stones (minerals) are nowadays becoming conflict minerals when their control and exploitation contribute to armed conflicts. Such conflict minerals have varied commodity values and occur in many geographical locations. For example:

- Diamonds in Western and Central Africa: have been used by several rebel groups as a source of income. The Angola National Union for the Total Independence of Angola (UNITA) and Sierra Leone [Revolutionary United Front (RUF)] in the late 1990s; as well as the rebel groups in Liberia, Ivory Coast, Democratic Republic of Congo, and the Republic of Congo used such minerals for their rebel objectives,
- Amber in Russia, and
- Gold in Indonesia.

NOTE:

Does scarcity alone cause resource conflict? From availability and scarcity, which one causes conflict among people and nations? There are of course two contrasting views concerning the causes of resource conflict (i.e. too much or too little?) among scholars (e.g. between Cornucopian and Neo-Malthusians scholars). For this please read books or internet sources about the diverging views of scholars to widen your knowledge.

Conflicts can arise when:

- User groups are excluded from participating in natural resource management,
- Natural resources are poorly managed and inequitably shared,
- Contradictions arise between local and introduced management systems;
- Confusions develop among users due to the absence of information about government policy and program objectives;
- Contradictions or lack of clarity occur on laws and policies;
- Inequality in resource distribution exists between users; and/or
- Poor policy and unsuccessful program implementation prevail.

3.7.3. Forms of Resource Conflict Expressions

The form and intensity of conflicts vary widely with the place and over time within any community. Some of the forms of how resource conflicts manifest themselves involve the following ways:

- Through breaking rules,
- By the acts of sabotage and violence,
- Sometimes conflicts remain hidden or latent,
- People may allow grievances to rage because of fear,
- By showing distrust, and etc.

Actors of Resource Conflict

Natural resource conflicts occur at various levels and involve a variety of actors:

- Local people in the homesteads over the use of nearby resources,
- Neighboring communities over the control of woodland,
- Villages,
- Community-based organizations,
- Domestic and multinational businesses,
- Governments,
- International development agencies, and
- NGOs over the use and management of large forest tracts.

3.7.4 Conflict handling strategies

The ways how people respond to natural resource conflicts vary considerably. Different communities have different methods of handling conflicts. The mechanisms can be formal or informal, violent or peaceful, equitable or not. Although the specific methods vary, people generally rely on the same basic procedural modes of handling conflicts. Most people use the following strategies:

- Avoidance: acting in ways to keep a conflict from becoming publicly acknowledged,
- Coercion: threatening or using force to impose one's will,
- Negotiation: following a voluntary process in which parties reach an agreement through consent,
- Arbitration: submitting a conflict to a mutually agreeable third party who renders a decision,

- Mediation: using a third party to facilitate the negotiation process (a mediator lacks the authority to impose a solution),
- Adjudication: relying on a judge or administrator to make a binding decision.

Reflective Activity 3.7

Please answer the following question:

1. Explain the resources that trigger conflict among people.
2. What do you think are the causes and consequences of resource conflict?
3. Please suggest how resource conflicts are resolved in your local area.

UNIT SUMMARY

The land is considered as an area of the Earth's surface embracing all aspects of the biotic and abiotic components existing on, above, and below the surface of the Earth. Plants and animals of the biosphere, gases of the atmosphere, the underlying geology and soils as well as the hydrology, plus the results of past and present activities of human beings are attributes of land or considered to be part of the land.

The useable resources of the land are dwindling with excessive use owing to the rapidly growing populations. Managing the depleting resources like soil, forest, and water and properly using non-renewable materials thus becomes mandatory.

There are more than 263 transnational river and lake channels plus numerous trans-state aquifers in the world. These 263 transnational watercourses make up around 60% of the world's freshwater flows and litter nearly one-half of the Earth's terrestrial surface. They pass across the terrains of 145 nations and support about 40% of the global population. About 60% of the space of Africa and South America and nearly 40% of North and Central America falls under inter-state Rivers. Around 80% of the total area of 44 countries lies within international basins. Twenty of these 44 countries are found in Africa, 13 in Europe, seven in Asia, and four in Latin America. The entire area of 30 countries as a whole falls within the trans-state waters. Groundwaters interlinked with 300 transboundary aquifers also support nearly two million people around the world.

Ethiopia, Sudan, and Egypt share the waters of the Nile. Over 85% of the Nile water flows from Ethiopia. But, Sudan and Egypt nowadays challenge the construction of the GERD saying that it might affect their water supply. They often argue Ethiopia should abide by the 1959 agreement signed by the two countries. The mentioned covenant did not allow water to Ethiopia. 58.5 BCM of water was allotted to Egypt while 18.5 BCM was provided to Sudan. The rest was left for losses from evaporation and seepage. Ethiopia will never be forced to accept the treaty signed in her absence. Similarly, the right of Ethiopia was deliberately overlooked in the 1959 treaty. Therefore, there are contentions between the three countries on the use and development of the Nile water.

Natural resource conflicts often occur over the control, ownership, and use of land, timber freshwater, minerals, energy, and hydrocarbons plus fishing rights. They are initiated by failures of policy, mismanagement, and the absence of transparency and equity. They often result in political instability, resource degradation, and even regional fragmentation.

To minimize the negative impact of resource conflicts, there should be equitable use, transparency, and respect for the right of others. Conflicts arising over shared rivers can be handled through:

- Promoting equitable use of basin,
- Avoidance of significant harm to other riparian states,
- Sovereign equality and territorial integrity,
- Information exchange,
- Consultation with other riparian states,
- Prior notification before taking action,
- Joint environmental protection efforts,
- Resolving disputes peacefully through dialogue and negotiations

REVIEW EXERCISES

I . True/ False items:

Instruction: Write 'True' for correct and 'False' for incorrect statements on a separate answer sheet:

1. Land has been the main source of wealth and power for all communities since ancient times.
2. Proper planning and management of land are not required during land-use practices.
3. The Nile is the largest river in the world.
4. Shared watercourses could be both sources of conflict and prospects of collaboration.
5. Water shortages could never be the source of conflict between rural communities.

II. Matching:

Instruction: Please match items listed in Column 'A' with the river basins under Column 'B'

Column 'A'	Column 'B'
1. Bair-Al-Jabal	A) Nile Basin
2. Inga Falls	B) Amazon Basin
3. the Bay of Bengal	C) Ganges Basin
4. Largest river in the world	D) Congo Basin
5. Himalaya	E) Zambezi Basin
6. Victoria Falls	
7. Andes Mts.	
8. GERD	
9. ZRA	
10. NBI	

Multiple choices:

Instruction: choose the best answer from the given alternatives

1. Which of the following is not correct about land resources?

A) The imprints of past and present activities of humans form parts of the attributes of the land

B) Renewable resources easily replenish themselves under proper use

C) Non-renewable resources diminish in size and quality with excessive use

D) Land resources like soil are human dirt that has no significant function in the ecosystem

2. Referring to Figure 3.1 (Unit Three of your textbook), where do you observe a large proportion of damaged pasture and croplands?

A) Europe and Australia
C) Africa and Asia
B) North America
D) South America

3. Among the following, which one causes an immediate depletion of forest resources?

A) Tree planting on degraded hill-slopes
C) Wrong government policy
B) Cutting trees for clearing farmlands
D) Population growth

4. Which of the following land management practices helps to replace lost nutrients from agricultural soils?

A) Addition of Irrigation water
B) Addition of animal manure
C) Construction of drainage ditches
D) Construction of wind barriers (shelterbelts)

5. Identify the correct statement:

A) Forests are among the common-pool land resources facing intensive human pressure
B) Land resources never include air and water
C) River-based institutions are all malfunctioning
D) Resource conflict cannot arise from the need for secession

6. From the following identify the wrong match

A) Policy, tree cutting for timber, rugged terrain
B) Collection of fuel-wood, forest clearing for farming purposes, forest burning
C) Population pressure, policy, conventional tillage,
D) Conventional tillage, erosive rivers, human culture

IV) Short-note writing: Write short-note for each of the questions below

1. Go to your school library (or use internet sources) and find the changing uses of land through changes of time in history?
2. Enumerate the forms (types) of soil depletion (degradation)
3. Name 20 transboundary rivers shared by two or more countries in Africa, Asia, Europe, North America, and South America?
4. Discuss the relations and contentions existing between Ethiopia, Sudan, and Egypt over the Nile waters?
5. Identify regional organizations working on the development and conflict resolution of trans-state waters in Africa, Asia, Europe, North America, and South America.
6. Does resource scarcity alone cause resource conflict? From availability and scarcity, which one causes conflict among people and nations?

V) Fieldwork project: Please make a field visit to your surrounding area and then:

a) Observe the status of land resources (soils, forests, streams, and grasslands) and write a field report on the status of those resources,

b) Study the land-use changes that happened during the past 50 years in the area by asking elderly people who lived for a long time in the area,

c) Check availability of structural resource conservation measures in the area and write a report on that,

d) Study how the local people resolve resource conflicts and check the availability of indigenous institutions involved in natural resource management and in solving resource conflicts.

UNIT FOUR

GLOBAL POPULATION DYNAMICS AND CHALLENGES

Learning Outcomes

At the end of this unit, you will be able to:

- examine the trend of world population growth;
- recognize the key factors behind major population problems;
- compare and contrast the population growth trends of Least Developed Countries and More Developed Countries
- assess the factors underlying international migration.

Main Contents

Introduction

Population study is one of the topics covered by Geographic Education in schools, colleges and universities. Population geography is the branch of geography that deals with population issues. The study of population geography focuses on the size, composition, spatial distribution, and changes in population across time. Three essential processes, namely fertility, mortality, and migration, define the pattern of population growth.

The global population dynamics have their effects on global resource availability and demand. The rapid increase in population over the last few decades has put significant strain on the worldwide ecosystem. The modern world appears to be characterized by/experiences exponential population expansion. This in turn results in inadequate food supply, insufficient supply of non-renewable resources, overexploitation of renewable resources, and environmental degradation. Population geographers have focused their attention on the study of population growth patterns and international migration in response to the imbalanced link between the pace of population expansion and socioeconomic progress. As a result, this lesson covers both population growth trends and some of the issues that come with a high human population increase.

4.1. THE GROWTH OF WORLD POPULATION

At the end of this section, you will be able to:

- illustrate the trend of world population growth; and
- compare and contrast the trends of population growth in MDCs and LDCs.

Keywords:

- **World population;**
- **Growth Trends;**
- **More-developed countries**
- **Less-developed countries;**

Brainstorming Activity 4.1

Please attempt the following questions provided below.

1. How do you understand the demographic transition model (Figure 4.1.)?
2. Why has the largest increase (growth rate) of the world population, in history, occurred when nations began to lower their fertility rates?

According to the demographic transitional model (Figure-4.1), in the first stage countries normally exhibit a population growth with a high level of fertility and mortality. The regular triangular-shaped pyramid used to characterize more developed countries before the seventeenth and eighteenth centuries, while relatively a few less developed countries fall under this category now. The youth population with a small old-age group foretells a rapid population growth as the youthful population enters the reproductive period.

In the second stage, death rates decrease, notably among children aged 0 to 5, while birth rates remain high, indicating significant population growth. The third stage is marked by a decrease in the birth rate, owing mostly to socioeconomic changes, urbanization, and widespread contraception use. At this point, population growth continues at a slower pace. More industrialized countries experienced a demographic transition in the eighteenth century, transitioning from high birth and death rates to low birth and death rates. In the fourth stage, birth rates fall to levels where they are equal to death rates, resulting in a slowly growing population. In the fifth stage, the birth rate rose again but the death rate remained low bringing stable or low population growth.

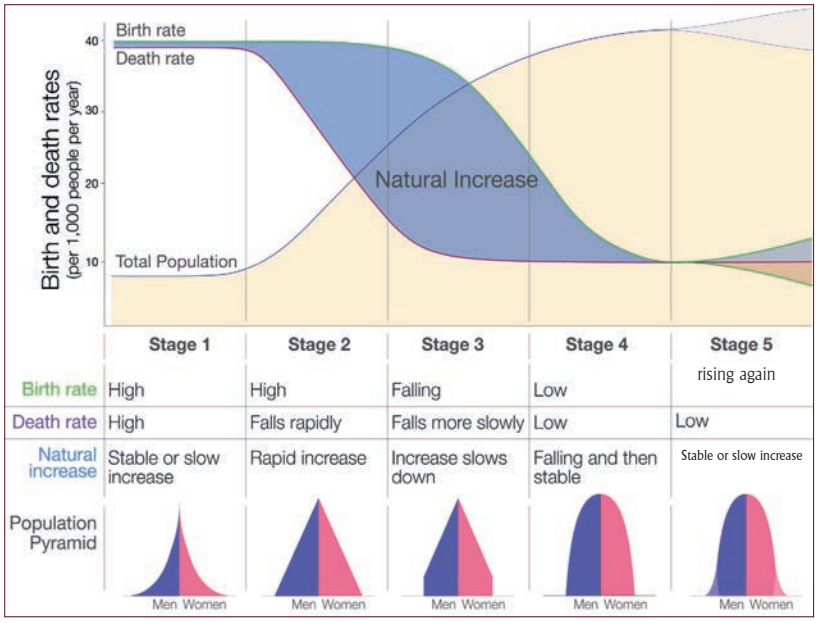
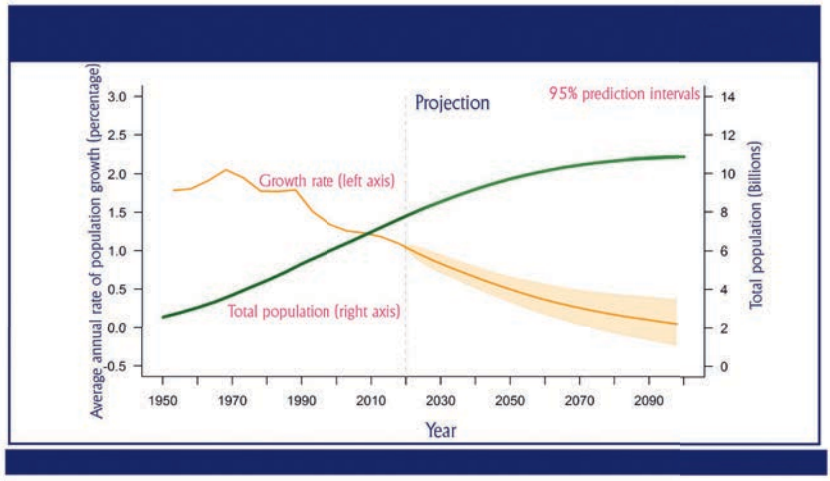


Figure 4.1. Demographic transitional model in five stages

Human population growth was modest until the mid-nineteenth century when birth rates were only slightly greater than mortality rates. The human population has expanded significantly quicker than ever before in the twentieth century.

The majority of developed countries began the twentieth century in the third stage of the model, with dropping fertility, and ended it in the fourth. Less developed countries began the century in the first stage, progressed to the second stage by the middle of the century, and by the last few decades had entered the period of declining fertility. The graph in Figure 4.2 depicts the world's population number and annual growth rate

The global population is still growing at a slower rate than it has been since 1950. From one billion in 1800 to 7.7 billion in 2019, the world's population has increased dramatically. As shown in Figure 4.1, the global population will likely reach 8.5 billion in 2030 (a 10% increase), 9.7 billion in 2050 (a 26% increase), and 10.7 billion in 2100 (42%). Although the most likely scenario is that the world's population will continue to rise during this century, there is a 27% chance that it may plateau or perhaps begin to fall before 2100.



Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

Figure.4.2. Population size and annual growth rate for the world.

The range of possible trends in the three demographic components of population change: fertility, mortality, and international migration, determines the level of certainty of population projections. The "medium variant" estimate anticipates a drop in fertility in countries where big families are still common, a minor increase in fertility in numerous countries where women have less than two live babies on average during their lifetimes, and ongoing mortality decreases.

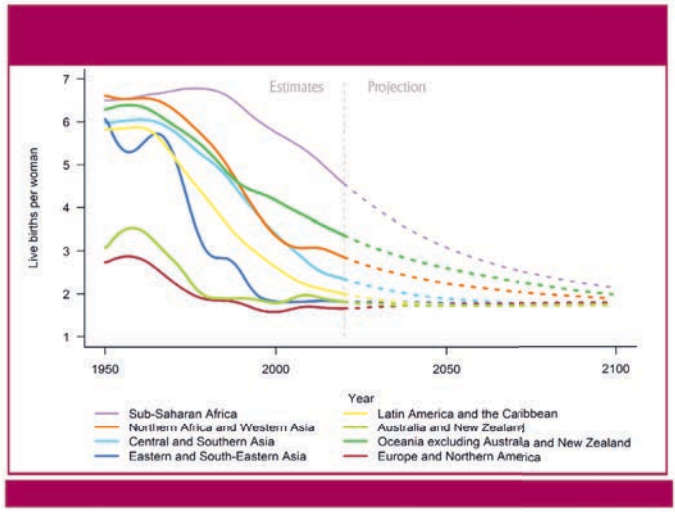


Figure 4.3. Total fertility (births per woman) by Sustainable Development Goal region, estimates, 1950-2020, and medium-variant projections, 2020-2100

Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

Between 1950 and 2020, the average number of live births per woman has decreased significantly in various locations as Figure 4.3 demonstrats. Close to half of the global population lives in Europe and North America, Latin America and the Caribbean, Australia/ New Zealand, and eastern and southeastern Asia, where lifetime fertility is below 2.1 births per woman (roughly the level required for populations with low mortality to have a growth rate of zero in the long run). Fertility remained above the global average in 2019, primarily in Sub-Saharan Africa (4.6), Oceania (3.4) and Northern Africa and Western Asia (2.9). Global fertility is anticipated to decline from 2.5 live births per woman in 2019 to 2.2 in 2050 and 1.9 in 2100, according to the medium-variant estimate shown in Figure 4.3. Sub-Saharan Africa is expected to experience the greatest decline in total fertility.

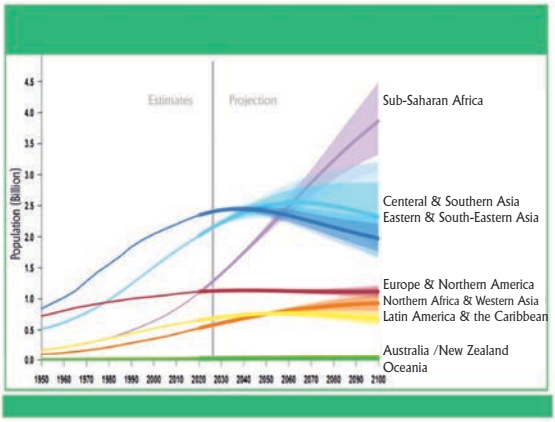
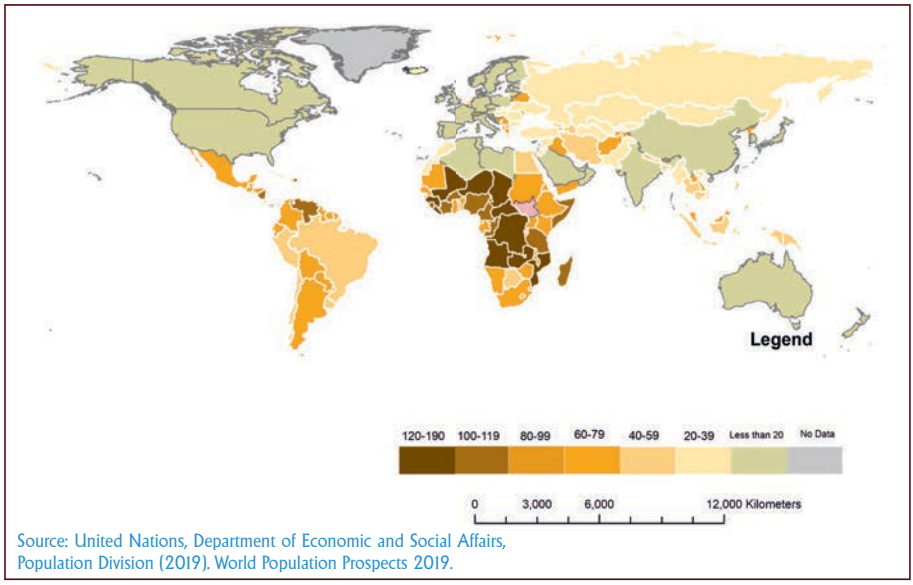


Figure 4.4. Population by Sustainable Development Goal region: Estimates, 1950-2020, medium-variant projections, 2020-2100, with 80 and 95-percent prediction intervals

With a predicted addition of 1.1 billion people between 2019 and 2050 (a 99 % increase), Sub-Saharan Africa could account for more than half of the world's population growth and is expected to continue rising through the end of the century (Fig. 4.4). Eastern and South-Eastern Asia, Central and Southern Asia, Latin America and the Caribbean, and Europe and Northern America, on the other hand, are expected to achieve peak population and begin population decline by the end of the century. By 2050, sustained population expansion will significantly raise food demand, particularly in Sub-Saharan Africa and South Asia.



Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

Figure 4.5. Adolescent birth rate (births per 1000 women aged 15-19 years), 2015-2020

Adolescent fertility (births to mothers aged 15-19 years) remains high in some countries (colored in darker brown on the chart Figure 4.4), including several in sub-Saharan Africa, Latin America, and the Caribbean (Figure 4.5). Adolescent fertility can have negative health and social effects for both young mothers and their children, and it is still a major cause of maternal and child mortality. Between 2015 and 2020, an estimated 62 million babies were born to mothers aged 15 to 19, with 46% of these kids born in Sub-Saharan Africa, 18% in Central and Southern Asia, and 14% in Latin America and the Caribbean.

India, Nigeria, Pakistan, the Democratic Republic of Congo, Ethiopia, the United Republic of Tanzania, Indonesia, Egypt, and the United States of America will see the highest population increases between 2019 and 2050 (in descending order of the expected increase). India is expected to surpass China as the world's most populated country around 2027.

Reflective Activity 4.1

Attempt the following question provided below, think individually about each, and share with your classmate by discussing in a group of five.

1. Figure. 4.2. & 4.3. Visualize population size, based on the concepts and ideas you acquired so far try to comprehend and interpret the population data represented by the two figures and share it with your teacher.
2. Which group is expected to have zero population growth by 2050 (see Figure. 4.4)?
3. Which countries will be responsible for the largest increase in population between 2019 and 2050 (see Figure. 4.4)?
4. In which countries do adolescent fertility remains high (see Figure. 4.5)?
5. Try to read additional recent materials about population size and growth related issues and report your understanding to the class.

4.1.1. Population Trends in Less Developed Countries (LDCs)

Brainstorming Activity 4.2

1. Which countries of the world are expected to contribute the most to population growth in the coming half-century?

As you may remember, the rate of population increase around the world has shown a fluctuating trend over time. Population growth rates in less developed countries (LDCs) were relatively modest in the mid-eighteenth century. Since 1920s the rates of natural increase in the less developed countries (LDCs) rose to approach those in more developed countries, and began to exceed in the 1930s and 1940s. LDCs began their demographic shift from high birth and death rates to low birth and death rates somewhat later in the twentieth century.

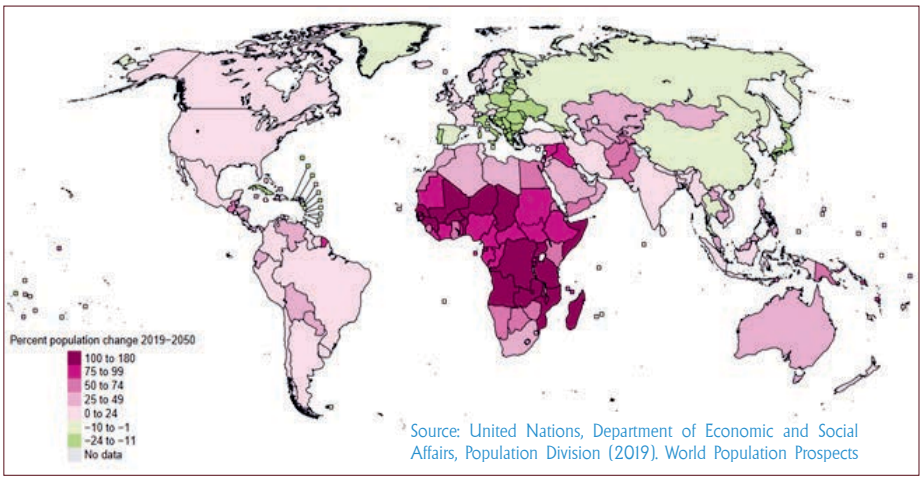


Figure 4.6: Changes in total population between 2019 and 2050 based on the medium-variant projection

Since World War II, significant progress has been made in the provision of medical facilities, disease management, piped water, improved housing, and the spread of education in the less developed world, all of which have led to a decrease in death rates, particularly among young people. As a result, between 1980 and 2010, the population of LDCs nearly doubled. The population of LDCs is expected to rise from 855 million in 2011 to 1.67 billion by 2050, according to estimates (Figure 4.6). African LDCs had the highest population growth rate of 2.8 % per year between 1970 and 2012, which was higher than the worldwide LDC average of 2.5 %.

Between 2019 and 2050, two-thirds of less developed nations are forecast to see population growth with 40 of them expected to rise by more than 50% and 19 likely to quadruple their population due to ongoing high fertility. Rapid population increase is thus one of the most important issues confronting most developing countries. A rapidly rising population adds to the difficulty of eradicating poverty, improving quality of life, combating hunger and malnutrition, and improving the quality and coverage of health and education systems.

The fast growth of many developing world cities has made it nearly hard for governments to provide appropriate infrastructure. Furthermore, the ever-increasing rural-to-urban movement of workers and families is putting immense strain on cities that are unprepared to handle the inflow. Overcrowding, traffic congestion, inadequate sanitation and education facilities, and the emergence of antisocial behavior were consequences of rising population density.

Another effect is the growth of informal communities with no infrastructure or amenities. A related worry is that urbanization is encroaching on lands that were previously used for agriculture.

Increased population density may be beneficial if it results in larger marketplaces, increased economic engagement, more intellectual exchange, and labor division. Recent reductions in fertility have caused the population at working ages (25-64 years) to expand faster than at other ages across most of Sub-Saharan Africa, as well as parts of Asia, Latin America, and the Caribbean, allowing for faster economic growth. To reap the benefits of this "demographic dividend," governments must invest in education and health, particularly for young people, as well as establish an environment that promotes long-term economic growth.

Because of low fertility and, in certain cases, significant rates of emigration, the populations of at least 55 less-developed nations (indicated in green hues on the map, Figure 4.6) are expected to shrink between 2019 and 2050. Bulgaria, Latvia, Lithuania, Ukraine, and the Wallis and Futuna Islands are anticipated to lose the most population between 2019 and 2050, with losses exceeding 20%.

Reflective Activity 4.2

Attempt the qstion set below and first try independently; later on work in a small group (3-5) and share the outcome.

1. When and how do populations become a problem for countries?
2. In what ways could the rapid growth of population pose a challenge for sustainable development in some of the poorest countries?
3. Which countries of the world are expected to exhibit the largest reductions in population size between 2019 and 2050?

4.1.2. Population Trends in more Developed Countries (MDCs)

MDCs' population growth rates are lower than those of LDCs, and they are going lower. Unlike LDCs, the most important concern with MDCs is population stagnation accompanied by aging. As a result, the number of people of working age has decreased. A reduced potential support ratio is the effect of a declining number of working-age populations.

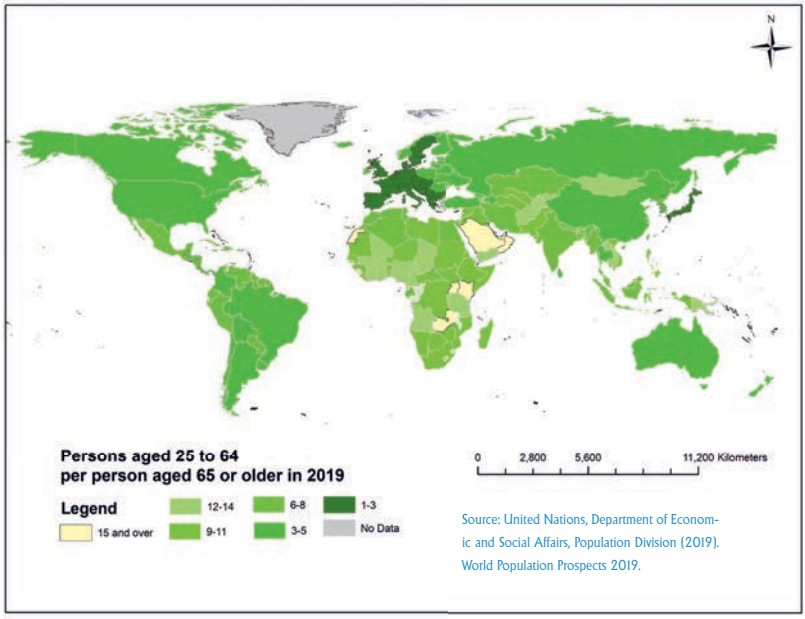


Figure 4.7: Old-age potential support ratio or the number of persons aged 25-64 years compared to those aged over 65 years

Around the world, the potential support ratio is currently decreasing. For example, the potential support ratio in Japan is 1.8, which is the lowest in the world. Furthermore, 29 countries, mostly in Europe and the Caribbean, already have support ratios of less than three (shown in dark green in Figure 4.7). By 2050, 48 countries, primarily in Europe, northern America, and eastern and southeast Asia, are forecast to have potential support ratios of less than two. The low potential support ratio values show the potential impact of population aging on the labor market and economic performance, as well as the economic pressures that many countries will face in the coming decades as they seek to build and maintain public health care, pensions, and social protection for the aged.

4.2. Factors Responsible for Accelerated Population Growth

At the end of this section, students will be able to:

- explain the key factors attributed to population growth in developing countries.

Keywords:

- **Accelerated;**
- **Fertility measurements**
- **Population growth**
- **Mortality measurements**

Brainstorming Activity 4.3

Please look at and attempt the questions provided below.

1. What are the major factors responsible for accelerated population growth?
2. In what ways does migration affect population growth?
3. How does the level of education contribute to accelerated population growth in less developed countries?

Several variables may contribute to faster population increase on a global scale and in developing countries. Among the most important are the advancements in agriculture, which ensured human security and continued life. The growth of organized agricultural communities allowed for more worker specialization, which led to the development of the market economy and urban societies. This was the second major element that significantly boosted the population of those societies. The third major factor of high population rise was accompanied by new social and economic developments. Increased economic output was made possible by revolutions in agriculture and industry, which were accompanied by a quick and steadily increasing population. As a result of agricultural technology, which enabled society to produce more food from limited inputs, population growth rates changed dramatically during the industrial revolution. Over successive generations, as food sources increased, the average level of nourishment increased, and the vulnerability to chronic and communicable diseases decreased.

The overall reduction in the death rate has been the most important factor in the real expansion of the population, thanks to advances in medical knowledge and improvements in public health.

As a result of lower death rates, population growth accelerates at first (i.e., mortality transition). If people from diverse countries travel to a specific section of the world (for example, North America) and establish themselves there, the receiving country may suffer from overpopulation. Higher levels of illiteracy make it more difficult to comprehend the negative consequences of rapid population increase and to employ efforts to slow it down (e.g. use of contraceptives). Most rural societies oppose using family planning measures, owing to a lack of information.

Reflective Activity 4.3.

Please look at the questions given below and first think independently; later share by discussing in a group of five.

1. How does a socioeconomic change affect world population growth?
2. How do you explain the rapid growth of the world population?
3. What are the factors responsible for population distribution across different geographical areas?

4.2.1. Measures of Fertility

Fertility is the actual occurrence of live births and reflects a population's actual reproductive performance. The nature of fertility is determined by some factors. Marriage has undoubtedly been a fertility-promoting institution. The lower the fertility rate, the longer a woman waits to engage in a sexual partnership. Conversely, fertility rates are higher when women marry at a young age due to the increased risk of pregnancy and longer periods during which pregnancy could occur. Contraception is the other major factor that influences fertility in most developed countries.

The "reproductive revolution," which was ushered in by the availability and development of modern and effective family-planning technologies like the birth control pill, made it easier to avoid pregnancy. Finally, infertility is linked to either voluntary or involuntary fecundity. Breast-feeding, for example, reduces (but does not eliminate) the risk of pregnancy for up to twenty-one months after delivery. These determinants explain nearly all variations of infertility when taken together, with the relevance of each determinant varying based on the cultural, economic, health, and social factors present in a community.

In Sub-Saharan Africa, fertility will decline from 4.6 live births per woman in 2019 to 3.1 in 2050, and then to 2.1 in 2100.

Fertility is measured most commonly in terms of crude birth rate (CBR), the general fertility rate (GFR), and total fertility rate (TFR). Each of these factors is briefly described below.

I. Crude Birth Rate (CBR) is the most basic measurement of fertility.

> **(CBR)** is calculated as follows:
> CBR= 1,000(B/p), where B is the number of annual births, and p is the mid-year total population.

The crude birth rate is simple to compute and can be used to determine fertility quickly. However, because it does not take into consideration a population's age and sex structure, it cannot be used to compare populations or regions. This measurement's denominator includes everyone, regardless of their fertility contribution (birth).

> **Case Example 4.1:**
> If the number of live births in a population of 90, 898,000 was 295,500, the crude birth rate is : CBR=(295,500)/90,898,000 x1,000=3.25 birth per 1,000 per year

II. The Total Fertility Rate (TFR) estimates the total number of children a woman will have throughout her reproductive career, assuming (1) that she will live at least through childbearing age and (2) that children will be born at the current age-specific fertility rates. This measure is often used to describe fertility patterns and to compare fertility rates across different regions, and it is a better measure of fertility than the crude birth rate since it takes into account the population's age and sex structure. The following is how TFR is defined:

> TFR=$\sum$[(Bx/Px)x 1,000] x 5 , where Bx is the number of live births to mothers of age x and Px is the number of resident women age x.

The values or age group represented by Bx 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45 +. The age group represented by Px ranges from 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 to 45-49 years. The sum of these age specific birth rates is multiplied by 5 because each age specific group represents a five-year cohort of women.

Case Example 4.2. Total fertility rate of a given area

Age groups	2020 Births	2020 women population	Age-specific birth rate	2020 Female Births
15 -19	10,000	180,000	0.055	5500
20 - 24	18,000	195,000	0.092	10,000
25 - 29	20,000	200,000	0.1	12000
30 - 34	18,000	202,000	0.089	9000
35 - 39	9,000	185,000	0.048	4000
40 - 44	3,000	190,000	0.016	1600
45 - 49	500	160,000	0.003	200
Total	78,500	1,312,000	0.4	42,300

TFR = 0.4x 5 = 2 live births per woman of given area residents in 2020 who live through their reproductive years.

iii. Gross Reproductive Rate (GRR)

The Gross Reproductive Rate (GRR) is comparable to the Total Fertility Rate (TFR), but it only counts female births rather than all births. While total fertility can be used to determine whether a population is growing or shrinking as a result of fertility, the Gross Reproduction Rate (GRR) estimates the number of female offspring a woman will have based on age-specific rates and assuming she survives her reproductive years. In this approach, the GRR can be used to determine whether or not a population is replacing itself. It's calculated as follows:

GRR=TFR x (∑FB)/(∑Bx)

Based on the example 4.2, TFR = 2. Therefore, GRR=2 x (∑FB)/(∑Bx) where ∑Bx =78,500, total birth in 2020, ∑FB =42,300, total female birth in 2020.

GRR=2 x 42,300/78,500=1.077

The GRR values close to 1.0 represent one female exactly replacing herself, so the population growth rate will be equal to 0. Values less than 1.0 indicate that the next generation of women will not replace themselves, while the current generation will more than replace themselves if the GRR is greater than 1.0.

Reflective Activity 4.4

Calculate the TFR and GRR based on the data given below

Age groups	2022 Births	2022 female population	2022 Female Births
15 -19	15,000	190,000	7000
20 - 24	22,000	120,000	14,000
25 - 29	23,000	250,000	12500
30 - 34	20,000	182,000	9800
35 - 39	12,000	195,000	7000
40 - 44	6,500	250,000	3600
45 - 49	3500	170,000	1700

IV. General Fertility Rate (GFR): is a method that helps rectify the weakness of CBR by considering live births, not total births. It measures the number of live births in a year per thousand women of reproductive age. It is calculated as follows:

GFR=B/P1 x 1,000 , where B is the total number of live births during a year, P1 is the mid-year population of women between 15 and 49 years age

Case Example 4.3

The estimated mid-year population of a given country in 2017 was 60,000,000, of which women in their reproductive ages constituted one fifth. In the course of the year, there were 600,000 live births. Calculate the general fertility rate of this population. Given: Number of live births = 600,000 number of women in their reproductive age was one-fifth of total population = (1/5)x 60,000,000= 12,000,000, then GFR=(600,000/12,000,000)x1,000=50 shows that 50 children were born for every 1,000 women in their reproductive years.

The demerit of GFR is that it does not account for the difference in age groups. It is well known that the different age groups are not equally fertile. That is, the child-bearing rate is appreciably higher in the age group of 20-29 than in the 15-19 and 40-49 age groups.

Measures of Mortality

Mortality (the occurrence of death) can be measured in several ways, including the use of crude death rate and infant mortality rate. Key factors that determine the rate of mortality rate include standards of living, nutrition, medical services, personal hygiene, and environmental sanitation.

I. Crude Death Rate (CDR): is a simple measure calculated by the ratio of the total registered deaths of a specified year in a region to the total mid-year population, multiplied by 1000. The crude death rate (CDR) is computed as follows: =D/P x 1,000, where CDR is Crude Death Rate, D stands for total observed deaths, and P is total mid-year population.

Case Example 4.3:
In a given region, the total number of deaths observed in 2020 was 80,000, and the total mid-year population was 16,000,000. Therefore, the result of CDR was:

CBR=80,000/16,000,000 x 1,000=5/1000

II. Infant mortality rate (IMR): is the number of death of infants under the age of one year for every 1000 live births, in a given year

$$IMR = \frac{\text{Number deaths below the age of one year}}{\text{number of live births in the year}} \times 1{,}000$$

Case Example 4.4.

A total of 600,000 babies were born in a certain region in 2020. Of these newborns, 460,000 babies survived their first year of life. Calculate the IMR of this region.
Deaths under age one: 600,000 - 460,000=140,000 babies

IMR=140,000/600,000 x1,000=233.3/1000

Reflective Activity 4.5.

1. In the "A" region, the total number of deaths observed in 2021 is 100,000, and the total mid-year population was 26,000,000. Calculate the crude death rate of the region "A"
2. A total of 400,000 babies were born in region "A" in 2021. Of these newborns, 360,000 babies survived their first year of life. Calculate the IMR of this region.

4.3. International Migration

At the end of this section, you will be able to:

- distinguish between free and forced international migration; and
- identify the countries that constitute the main targets or destinations of international migration and those that are the main senders of international migrants

Keywords:

- **International**
- **Measurements**
- **Migration**

Brainstorming Activity 4.4

Keeping the discussion made earlier in mind attempt the questions raised below pertinent to migration of population and its impacts.

1. What is the nature of population migration both at the international and national levels?
2. How do you assess the impacts of migration from one country to another on the growth of the world population?
3. Which countries of the world are the highest senders of migrants?

The current highly irregular spatial distribution of population can be explained in terms of human ability to adapt to physical conditions (spatial relationships and accessibility); resources (relief, climate, vegetation, soils, water supplies, and mineral deposits); and the influence of demographic (birth and death rates, age structure, population migration flows), cultural (social attitude and institutions), economic development, and historical factors.

Because one country's loss is another's gain, migration has no direct impact on the global population. When people migrate to a country, the entire population of that country is unaffected. The movement of people from one place to another has an impact on population distribution, cultural diffusion, and resource exploitation. The earliest human population moved around for game hunting, traveling, and plant gathering. People with archaic technologies have historically been forced to migrate due to environmental factors such as dwindling resources. Rural populations would be displaced in locations where agricultural land is overused. People in such situations frequently relocate to surrounding urban areas. Furthermore, people migrate in groups (clans, tribes) to obtain seasonal food and rear livestock.

There was a large free migration from all areas of Europe to North America, from Latin regions of Europe to Central and South America, and from Great Britain to Africa and Australia during the 16th and 20th centuries (pre-modern eras). Since World War II ended, the number of forced migrants has grown as individuals seek greater protection from war or natural disasters. Human trafficking is another way to move individuals from one place to another. For the sake of sexual exploitation or forced labor, it is done by force or fraud. The cause of current migration is still large-scale temporary labor force relocations from less-developed to more-developed economies.

Because of the vast number of people who cross international borders, international migration frequently attracts the most political, economic, and demographic attention. Even though immigration has a long history, public emphasis has shifted to the size, sources, and consequences of large-scale migration. International immigration is fundamentally an economic process driven by a mix of 'push' factors in the source country, such as weak job opportunities, big populations, and low salaries.

Migration, like fertility and mortality, has an impact on population growth rates in sending and receiving countries. The annual change in population for every country is equal to birth minus death plus immigrants minus emigrants (B-D) + (I-E). For nearly half a century, worldwide migration has been expanding from less developed to more developed regions for economic (seeking better jobs) and political (seeking asylum or refugee) reasons. Over the previous fifteen to twenty years, the rate of migration towards richer regions has been quite high. Until the 1960s, natural increase accounted for the majority of population expansion in these areas; however, currently, immigration has contributed more to population growth than fertility.

Source: Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

Figure 4.8. The average annual net international migration by SDG region and decade, 1980-2020

International migration has become a substantial component of population change in several parts of the world. Europe, Northern America, and Australia/New Zealand have been net recipients of international migrants for decades, and their net migration has tended to increase with time, whereas Africa, Asia, Latin America, and the Caribbean have been net senders.

The United States has remained the world's most popular destination for migrants for the past five decades. Since the 1990s, the rate of immigration has steadily increased, both legally and illegally (Figure 4.8). Without immigration, the United States' total fertility rate and population growth rate would be substantially closer to those of other more developed countries, with the total population stabilizing much sooner. Positive net migration (the number of immigrants exceeding the number of emigrants) as opposed to negative natural increase (the number of deaths exceeding the number of births) in Belarus, Estonia, Germany, Hungary, Italy, Japan, the Russian Federation, Serbia, and Ukraine during decades, 2010-2020. Northern Africa and Western Asia have both become net recipients of foreign migrants since 2000. The link between net migration and natural increase (Figure 4.9) demonstrates that during the period 2010-2020, the majority of nations experienced a positive natural increase in combination with either net migration (108 countries or areas represented in purple on the map) or net immigration (74 countries or areas shown in pink).

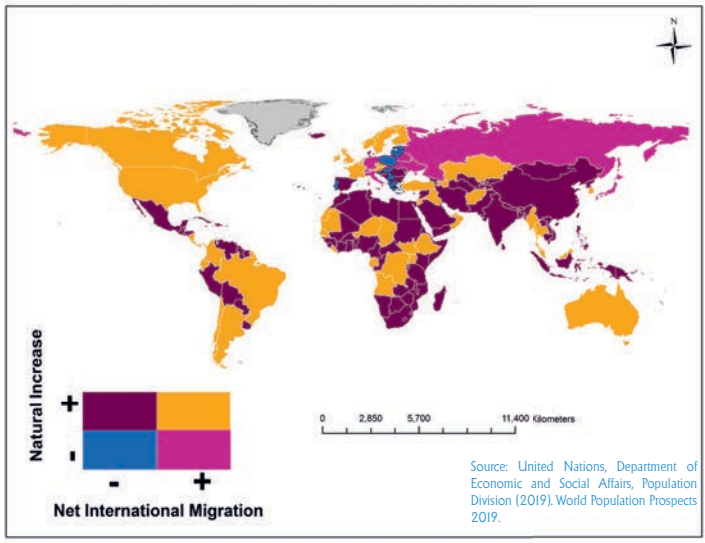


Figure 4.9. Net international migration and natural population increase, 2010-2020.

A negative natural increase may worsen population shrinkage induced by net migration. During the period 2010-2020, eight European nations had both negative natural and net migration. Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Poland, Portugal, Latvia, Lithuania, Moldova, and Romania are among them. A limited number of countries had negative natural growth in conjunction with net emigration (shown in light blue) or net immigration (shown in dark blue) (shown in purple). Other net senders were Central and Southern Asia, Eastern and South-Eastern Asia, Latin America and the Caribbean, Sub-Saharan Africa, and Oceania. Bangladesh, Nepal, and the Philippines, for example, are driven by migrant workers' quest for a job, education, and family reunification, while others are driven by violence, insecurity, and armed conflict (Syria, Venezuela, and Myanmar).

The ability to make more money is one of the benefits of international migration. Although they earn less on average than natives and are primarily employed in low-paying, low-skilled occupations, immigrants are frequently found to be financially better off in their host country than in their home country. On the other side, because of direct rivalry with better competent immigrants in the job market, less-skilled natives may lose out in terms of income and labor prospects. The greatest apparent impact of immigration, however, is the shift in the cultural and racial makeup of receiving countries as immigrants make up a larger part of the population.

Reflective Activity 4.6.

Please look at the question below and first think independently; later share in groups

1. Explain why the distribution of the world population is unsystematic, with some areas being very dense while quite thinly peopled.
2. Discuss the opportunities and challenges of international migration?
3. What are the impacts of international migration?

Measures of Migration

The most common measures of migration that could affect the population growth of an area include immigration rate and emigration rate. The immigration rate is the number of people arriving at a given destination per 1,000 people in a given year.

$$\text{Immigrant rate} = \frac{\text{Number of immigrants}}{\text{Total population at destination}} \times 1{,}000$$

The emigrant rate is the number of departing people from an area of origin per 1,000 people of the area of origin in a given year.

$$\text{Emigration rate} = \frac{\text{Number of emigrants}}{\text{Total population at origin}} \times 1{,}000$$

Net migration rate (NMR) shows the net effect (balance) of immigration and emigration in an area. It can be expressed as an increase or decrease per 1,000 people in the area in agiven year.

$$\text{Net migration rate} = \frac{\text{Number of immigrants-Number of emigrants}}{\text{Total population at the destination}} \times 1{,}000$$

Case Example 4.5.

Assume the number of emigrants and immigrants of country 'A' are 60,000 and 350, 000 respectively. If the total population is 110,000,000, what is the NMR for country 'A"?

NMR=(350,000-60,000)/110,000,000 x1,000 =2.6, implying that the net migration rate 2.6 per 1000 people

4.4. Population Policies

At the end of this section, you will be able to:

- identify the major socioeconomic and demographic problems
- assess the major population policies at the national level in addressing the major socioeconomic and demographic problems in the developing world

Keywords:

- **Population growth**
- **Policies**
- **Socioeconomic development**
- **Migration and distribution**

Brainstorming Activity 4.5

Please think more about the question provided below. Identify the major socioeconomic and demographic problems and explain how these problems need to be addressed by major population policies at the national level in the developing world.

4.4.1 Policies on population growth and socioeconomic development

A series of government declarations, choices, and measures done openly or implicitly to impact population number, growth, distribution, and composition is referred to as population policies. Individual and family decisions about marriage and childbearing, job arrangements, residence, and other issues are influenced by policies. The core objectives of population policies aim to promote both economic development and social or individual welfare. Pro-natalist restricting emigration and stimulating immigration were historically the key areas of focus for population policies. On the contrary, currently restricting immigration, encouraging redistribution, prolonging survival, and being primarily anti-natalist are the major concerns of population policies.

Table 4.1 Direct and Indirect Effects of Population policy

DIRECT OR EXPLICIT	INDIRECT OR IMPLICIT
◈ Government actions taken for demographic outcome. Example: ☞ Provide free family planning services ☞ Increase taxes for each additional child ☞ Migration law: restrict immigration ☞ Raise the age of marriage	◈ Decisions and actions of government indirectly have some demographic effects. Example: ☞ Compulsory secondary education ☞ Restrict child labor ☞ Limit size of houses ☞ Promoting female education and raise status of women ☞ Provide old age security

Inbalances between demographic changes and social, economic, and political goals could be avoided through explicit or implicit population strategies. At the national level, most governments have addressed population policies by:

- firstly, gathering demographic data through censuses, civil registration systems, and surveys; and
- secondly, developing and attempting to execute specific public health and population policies about mortality, fertility, and migration.

4.4.2 Policies on population migration and distribution

The spatial distribution, density, and population strain on agriculture, natural resources, and the environment are all influenced by migration and urbanization. Migration has an impact on demographic net growth as well as socio-economic development in general. As a result, population plans must manage both urbanization and internal migration issues. Policies governing geographical distribution and urbanization have far-reaching implications for a country's long-term growth. For example, the government the following measures:

1. Encourage population redistribution from densely populated urban regions to smaller urban, suburban, and rural areas.
2. Decrease migration from rural to urban areas, as well as to major urban agglomerations
3. Ensure access to basic services and infrastructure for the urban poor,
4. Address the strain population has on environmental sustainability by preventing unintended pregnancies through family planning programs,
5. Address the strain population has on environmental sustainability by improving road safety and promoting public transportation.
6. Promote settlement of under-populated areas, and
7. Relocate population out of environmentally fragile or threatened areas.

Reflective Activity 4.7

Please attempt the question given below: first think independently, and later share by discussing in a group of five.

1. Identify policies on population migration and distribution in selected countries by reading on the issue.

UNIT SUMMARY

As a result of agrarian, industrial, and medical improvements, world population has been growing rapidly and explosively over the last hundreds of years. Although the most likely scenario is that the world's population will continue to rise during this century, there is a 27 % chance that it may plateau or perhaps begin to fall before 2100. The range of possible trends in the three demographic components of population change: fertility, death, and international migration, determines the accuracy of population forecast.

The rapid population growth in LDCs is causing major issues, such as an increase in food demand, an increase in the jobless workforce, a challenge to poverty eradication, congested social services, and the possibility of violence. However, recent fertility reductions have caused the population of working age to expand faster than that of other ages, allowing for quicker economic growth. To reap the benefits of this "demographic dividend," governments must invest in education and health, particularly for young people, as well as foster circumstances that promote long-term economic growth.

Low birth rates in more industrialized countries enable current slow growth, resulting in a population with a higher average age. As a result of population aging, there are fewer people of working age than there are older people. A low potential support ratio is caused by a low number of working-age people.

International migration has already become a major component of population change in some parts of the world. Europe, Northern America, and Australia/New Zealand have been net recipients of international migrants for decades, whereas Africa, Asia, Latin America, and the Caribbean have been and continue to be net senders.

The inequalities between demographic changes and social, economic, and political goals can be addressed by explicit and implicit population policies. Urbanization and internal migration are also issues that must be addressed in population policies.

REVIEW EXERCISES

True /False Item

Instruction: Write "True" if the statement is correct and write "False" if it is incorrect

1. The average number of live birth per woman over a lifetime is higher in Europe than in Sub-Saharan Africa.
2. A demographic dividend occurs when a falling birth rate changes the age distribution.
3. General Fertility Rate measures the number of live birth in a year per thousand women of reproductive age.

Multiple Chioce

Instruction: Choose the correct answer from the given options.

4. Which of the following is correct about the first stage of the demographic transitional model

A. Death rates move downwards, particularly in the age group ranging from 0 to 5, but birth rates remain high thereby indicating a rapid population increase.

B. The declining birth rate is due mainly to the widespread use of contraceptives.

C. Birth rates descend to levels low enough to match death rates thereby bringing population growth to an end.

D. Countries exhibit a population growth with a high level of fertility and mortality.

5. In the less developed world, the death rate among young people marked a substantial decline since the Second World War. What causes this low death rate in less developed countries?

A. The provision of medical facilities

B. Provision of piped water, improved housing, and the spread of education

C. Controlling diseases D. All

6. Which of the following decisions and actions of the government have an indirect demographic effect?

A. Provide free family planning B. Increase taxes for each additional child

C. Promoting female education and raising the status of women

D. Raising the age of marriage

III. WRITE POSSIBLE ANSWERS TO THE FOLLOWING QUESTIONS

1. Reason out why the death rate declines before birth rate in the second stage of the demographic transition model.
2. How do you explain the fact that Sub-Saharan Africa could account for more than half of the growth in the world's population between 2019 and 2050, and is projected to continue growing through the end of the century?
3. How could the rising population growth be a challenge for the less developed countries?
4. How could the growth of the working-age population create opportunities for economic growth in less developed countries?
5. Which countries are the most important destinations for migrants in the world?
6. Research the dependency ratio of Ethiopia in 2020 and describe the impacts dependency ratio on the economic development of the country, given that the total population of the country accounts for 118,204,859 in 2020, out of which 56.55% were categorized as productive age, and 3.54% were categorized in old age.

IV. PROJECT ACTIVITIES:

Please answer each of the questions below by conducting fieldwork and presenting your report to classmates.

1. What do you think about the influence of local cultural values and economic factors on more fertility rate in the local societies?
2. How do you analyze the impact of high population density/ crude density/ on access to social services in the town located in your local area or natural resources available in the rural community of a given Kebele or Woreda?
3. How do you relate age structure, population growth and population density in a given area?
4. Please go to the Woreda statistical office, at www.csa.gov.et(centeral statistical agency website) and get population data, and try to characterize the population composition in the Woreda

UNIT FIVE

GEOGRAPHICAL LOCATION AND ECONOMIC DEVELOPMENT

Learning Outcomes

At the end of this unit, you will be able to:

- describe the effects of geographic location on economic development;
- explain the impacts of extreme climates on poverty;
- identify the challenges facing landlocked countries on development and
- review the levels and hurdles of intraregional trade in Africa

MAIN CONTENTS

Introduction

Geographic parameters are the most important factors in development. Geographic location influences economic development through the distribution and types of geology, relief, climate, soils, and biodiversity. All these geographic factors pose an effect on the growth of agricultural production, industrialization, and commerce. Recently, the effect of these geographic variables has been virtually minimized through the use of modern technology. But still, the poorest countries of the world are found in the tropics where there is a hot climate; infertile soils; water scarcity, and tropical diseases. Geographical location thus appears upsetting development policy choices in society. Yet in response, development looks for lessening geographical barriers through technological advances. This designates that geographic features and development policies are closely linked and tied together. This unit thus addresses the linkage between geography and development. It also explains the bond between climate change and poverty; the challenges of landlocked populations; and the intraregional trade patterns in Africa.

5.1. EFFECTS OF GEOGRAPHIC LOCATION ON DEVELOPMENT

This topic mainly focuses on the study of the influence of geographic location on the development of particular regions and countries. It mainly insists on the explanation of the effect of geographic location on agricultural, industrial, commercial, and service developments.

At the end of this section, you will be able to:

- define the concepts of economic growth and development,
- differentiate between the contrasting views of geographic determinism and possibilism on development;
- appreciate the effect of geographic location on agricultural development;
- explain the influence of geographic location on industrial development; and
- describe the effect of geographic location on settlement and service development.

Keywords:

- Administrative principle
- Agricultural land use
- Least cost
- Development
- Economic growth
- Geographic determinism
- Geographic location
- Marketing principle
- Possibilism
- Service centers
- Settlements
- Transportation principle.

Brainstorming Activity 5.1

1. What is economic growth? What about economic development?
2. How does geographic location influence economic development?

Please think critically and share your idea with your classmates by forming small groups.

5.1.1 Economic growth and development

Economic growth and development are defined by different scholars in different ways. Economic growth is an increase in goods and services or growth of the gross domestic product (GDP) in a nation over a specific period. It mainly focuses on the quantitative growth of the national per capita income; not giving due regard to the standard of living and welfare of citizens. Economic development on the other hand refers to the sustained development of the material well-being of society. Unlike economic growth, development focuses on both qualitative and quantitative development of the country's economy. Economic development enables people to be more educated, healthier, and endowed with good access to quality housing, better sanitation, and employment opportunities. It is often measured using the Human Development Index (HDI).

HDI is a quantitative measure of human wellbeing and development. It is computed using three dimensions: longevity (long and healthy life); access to knowledge and standard of living. Longevity is measured from life expectancy at birth. Knowledge is measured from literacy rates and average years of schooling within the adult age group. The decent standard of living is also measured by real per capita income. To obtain the final HDI result, each of the measurement results of the computed variables is first converted into 0-1 scales. The scaled values are then added to form the HDI. The calculated HDI values thus lie between 0 and 1. Countries scoring higher HDI values are hence considered to be better in human wellbeing and development. In the 2019 United Nations Development Program (UNDP, 2019) ranking of 189 world countries, Norway, Ireland and Switzerland (all in Europe) stood at the top with 0.957, 0.955, and 0.955 HDI scores, respectively. Niger, Central African Republic (CAR), and Chad (all in Africa) assumed the bottom end by scoring only 0.394, 0.397, and 0.398 HDI values. Ethiopia with a score of 0.485 HDI value ranked 173 of the 189 countries.

5.1.2 Geographical determinism and possibilism

Geography and socioeconomic development have strong linkages. There are two contrasting schools of thought on how geographic location and socioeconomic development are linked together. These differing philosophies are Geographical Determinism and Possibilism. Henceforth, we are going to discuss these contrasting issues discretely.

Geographical determinism assumes that the stage of socio-economic development of countries is exclusively determined by the geographic environment (location, climate, and geomorphology).

According to deterministic theorists, countries of the temperate regions are more developed compared to those in the tropical areas because of their geographical location in distinct cold and hot environments, respectively. This type of thinking began during the 15thC AD and persisted until the 1950s. The first adherents of this philosophy were Greek and Roman scholars like Aristotle, Hippocrates, and Strabo. The leading advocates of geographic determinism in the 19th and 20thC were Karl Ritter (1779-1859), Ellen Churchill Semple (1863–1932), and Elsworth Huntington (1876–1947). Later on, many geographers were interpreting socio-economic development through the deterministic approach. Nevertheless, the geographic deterministic school of thought falls under repeated crticism from part of the environmental possibilism followers.

The school of possibilism argues that geographic environment is not the only determinant factor of the lifestyle of people and socio-economic development. According to these scholars, development is determined by the interaction of geographic location and human factors.

Although geographic location and environmental factors play a significant role in socio-economic development, they can be modified into useable opportunities by the creative mind of human beings. They conclude that 'nature is never more than an adviser' and 'there are no necessities but everywhere possibilities'. The leading proponents of this school of thought were Lucien Paul Victor Febvre (1878–1956) and Paul Vidal de la Blache (1845–1918). Their notion is now widely accepted by geographers because the belief appreciates the ability of humans to change their environment using the latest technologies. Nonetheless, it does not mean that geographic location never plays a significant role in the socio-economic development of societies and countries.

Geographic location (where a country finds) has a substantial impact on the socio-economic development of countries. It is 'an integral part of economic geography, regional science, and spatial economics. The location of economic development projects can be fixed through consideration of broader contexts of countries, regions, and global environments. Geographic location thus strongly influences the scope of 'firms in that location' through controlling the distribution of the population (purchasing power); economic patterns; transport costs and trading networks.

The cost of moving goods and services across spatial scales can influence the access of firms to markets. The costs and networks of transportation facilities affect the relative relevance of firms and the scale of decisions concerning innovation and capital investments.

In appreciation of the influence of geographic location on development, this topic presents you with the effect of location on three distinct activities. Three theories each focusing on the three discrete activities questioning 'what economic activities are located where and why are discussed. The theories explore the site selection of firms, and examination of the geographic variation of economic activities. They offer an analysis of the spatial uncertainties and hierarchical structure of economic segments. The theories identify variables that determine the location of specific undertakings over a given spatial patterns. They also describe the allocation of the different parts of the territory among the different product types.

5.1.3 Effect of location on agricultural development

Agricultural production and profitability principally rely on the suitability of land use patterns and environmental resources that are largely related to geographic location. Under this topic, you are going to learn about the hypothetical land-use model (Figure 5.1) developed some 200 years ago by the German theorist named Johann Heinrich von Thünen.

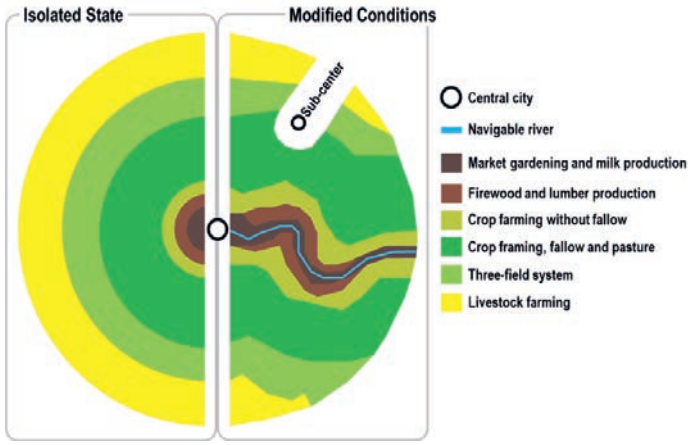


Figure 5.1 von Thünen's hypothetical circular land use model

Johann Heinrich von Thünen developed his agricultural land use theory in 1826 in his book The Isolated State. This earliest known agricultural location theory (von Thünen, 1826), imagined that being near to the market provides ample benefits in agricultural land-use systems. For that, he envisioned a central market city established at the heart of a plain of thorough physical similarities.

The intent of von Thunen in developing this model (Figure 5.1) was to show the system of rising agrarian yield in concentric sectors. His model imagines that farmers nearer to the market city grow crops that have a premier price and provide the highest net incomes.

Heavy and perishable crops (vegetables, fruits & dairy products) are suggested to be produced nearer to the city in the model. Bulky products (firewood & timber) are supposed to cover the next zone for they demand higher transport costs if produced further from the city market. Field crops such as grains are proposed to come from the third zone because they require relatively lower transport costs compared to vegetables and forest products. Ranching of animals is suggested to occupy the fourth zone for they can be self-transporting to market. The final zone beyond the fourth ring is suggested to remain free (unoccupied wilderness) for it is far from the city market.

Johann Heinrich von Thünen (1783-1850)

J.H. von Thünen was a 'German farmer and amateur economist' of the 18thC AD. His proposed market city is located in an 'Isolated State' which is supposed to be 'self-sufficient' or with no external influences. Four concentric zones: intensive farming (dairying); forest gardening; extensive cropping and animal grazing were proposed activities in the model. Farmers were considered equally rational everywhere.

According to von Thunen, when the distance to the market increases, production costs remain the same; transport costs increase but locational rent is assumed to decrease (meaning transport cost and locational rent are inversely related). During his time there was no motor transport; maybe oxcarts were everywhere. As it was pre-industrialization there were no fossil fuels for energy production, refrigerators, and railroads. His interesting illustration of land and transport is somewhat excellent for his time. As one moves closer to the city, the cost of land increases. This is also true at present times. The theory is still important to geography although the isolated self-sufficient State and isotropic surface models unlikely to be found today.

NOTE:

The assumptions of von Thünen were:

- An isotropic self-sufficient state,
- A central market city established at the heart of a plain of physical similarity,
- Rising agrarian yield in four concentric sectors: intensive farming (dairying); forest gardening; extensive cropping and animal grazing,
- The cost of land (location rent) increase nearer to the market,
- Transport costs increase with increasing distance from the market,
- Farmers are equally rational everywhere

5.1.4 The influence of location on industrial development

Industrial production is commonly based on firm location, raw material, and labor inputs, transportation costs and facilities, as well as consumers and market centers. These all demand suitable geographical locations and related characteristics. This part thus presents you with a sample industrial location model (Figure 5.2) developed 100 years ago by the German economist, Alfred Weber

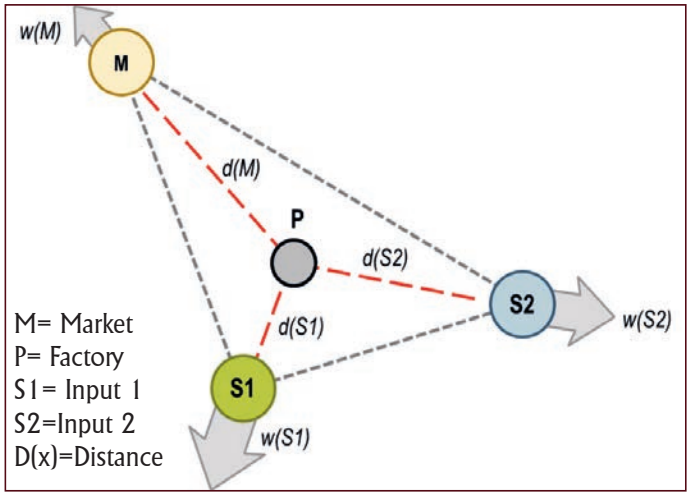


Figure 5.2 Weber's least cost triangular location model

Alfred Weber was a professor of economics at the University of Heidelberg, Germany (from 1907 to 1933). He developed the least cost industrial location model in his book titled Theory of the Location of Industries. The theory was first presented in the German language (in 1909) and later translated into English in 1929. The model is considered the basis of modern industrial location theory.

Like, von Thünen, Weber adopted several assumptions during writing his least-cost location theory. Some of his assumptions include the following:

- Firms choose a suitable location to minimize total costs and maximize profits,
- An isolated region having no external influences,
- Isotropic space (with no variations in transport costs),
- Markets are located in a specific number of centers,
- Perfect competition (large numbers of firms & customers, and small firm sizes to prevent disturbances by monopolies and oligopolies),
- Complete knowledge of market conditions (both for the buyers and suppliers).
- Several ubiquitous natural resources (e.g. water, air, sunlight, sand, etc.)
- Many localized materials: materials found at specific locations (e.g. labor, fuel, minerals, crops, wood, etc.)

Weber assumed three key factors (transport & labor costs, plus agglomeration economies) influence industrial location. He then concluded that the firm location has to consider the three ideal (optimal) factors. He then decided to rely on determining the least transport cost location by adjusting it to consider labor costs and agglomeration economies. The cost of transportation was the most important component of Weber's least-cost location theory. Other factors (labor & agglomeration economies) for him require only consideration of adjustment effects. Thus Weber uses the 'Location Triangle' (Figure 5.2) to solve the mentioned problems.

Alfred Weber suggested that industrial firms have to locate in places where costs of transporting raw materials and finished products are kept low. For that he identified two particular cases:

- Weight losing: this is the case when the weight of the final product is less than the weight of the raw material going into making the product.
- Weight gaining: this is the case when the final product is heavier than the raw materials that require transport.

Based on these raw material categories, Weber had proposed two least-cost firm location types.

a. Industrial firms using pure (non-weight losing inputs) during the process of production can locate nearer to markets. The inputs of such industries are bulk-gaining materials and they do not attract industrial firms to their occurrence locations. Examples of these are cotton textiles, soft-drink bottling, brewery, and beverages, wool, etc. Adding weight during processing for these industries makes the product bulky and more costly for shipping and transportation.

b. Industries using impure gross materials lose part of their weight of raw materials during the production processes. The inputs of these industries are bulk-reducing. Such materials exert a strong influence on the location of industrial firms. Examples are bauxite and iron-ore refineries plus steel and sugar-cane mills. Industries using such raw materials have better locate nearer to their input sources. These enable the firms to carry the heavier raw materials for short distances lightening the finished goods for long distances to the marketplace.

Relying on the aforementioned input-output firm relationships, Alfred Weber developed the material index model by dividing the weight of inputs by the weight of finished products:

$$M = \frac{WIs}{WOs}$$; Where:

MI = Material Index; WIs= Weight of Inputs; WOs= Weight of Outputs.

Then, he concludes:

- If MI ›1, the industrial firm should locate nearer to the source of the raw material,
- If MI ‹1, the firm should locate nearer to the market.

Weber proposes firms using bulky inputs like aluminum refineries should locate nearer to the supply sources; nearer to energy sources or at port sites. According to Weber, industries that use ubiquitous raw materials (e.g. water, solar power) are likely located closer to markets.

Alfred Max Weber (1868-1958)

Alfred Weber was an economist, geographer, and sociologist. His theory was persuasive in the progress of present-day economic geography. He did a reputable job during his time in an industrial location. Nevertheless, his work was focused on heavy industries and forgot the light industrial firms.

Similar to the land-use model of von Thünen, Weber assumed an isotropic landscape model by ignoring the role played by relief features and his 'isotropic space' assumption forgets the diverse transportation modes and costs. The proposed self-sufficient 'isolated state' with no external influences is difficult to find in reality; thus, threatens the validity of his model.

5.1.5. Effect of location on settlement and service center development

In the previous two topics, you learned how the location of land uses and industries were modeled by two German scholars. The topic at hand presents the spatial structure, size, function, and location of settlements and service centers. This was first attempted by another German geographer named Walter Christaller in 1933. Christaller developed his theory by studying settlement patterns in southern Germany. He intended to know how urban settlements evolve and spaced out with each other and how goods and services are exchanged within the different order settlements. While formulating his theory, Christaller presumed an isotropic boundless plain landscape experiencing a uniform physical environment. He assumed also that this isotropic surface is uniformly settled and equally served by transportation in all directions. Travelling and transportation costs for goods and services are explained to be a function of the distance traveled. Farmers earn the same amount of income (equal purchasing power) and similar demand for goods and services. Both farmers and business people in urban areas are also considered rational - seeking to minimize costs and maximize incomes. Perfect competition, equivalent income, and 'shopping behavior' on the parts of consumers are parts of the assumptions. No suppliers will receive excessive profit in the model.

Based on these assumptions, Christaller had developed a geometric hexagonal pattern of settlements and service centers in hierarchical order. For Christaller, the hexagonal structure was preferred for it minimizes the problems of overlapping prevalent in using concentric circular arrangements. His hierarchical model anticipated a well-established urban system containing a large city, a smaller number of towns, and many villages and hamlets in the hypothetical region. Christaller's central place hierarchy assumed uniform distribution and equivalent distance among the different levels of settlements and service centers all-over the 'isotropic' region.

Christaller adopted three principles in his idealized hierarchical hexagonal settlement model of the central places. These include the:

1. Marketing principle (K = 3 system);
2. Transportation principle (K = 4 system);
3. Administrative principle (K = 7 system).

Central Place in Christaller's model refers to settlements or nodal points that support adjacent areas with goods and services. The premise here is that all goods and services are accessed by consumers from the nearest market centers (central places).

This is the marketing principle (k = 3) indicated in number (i) above.

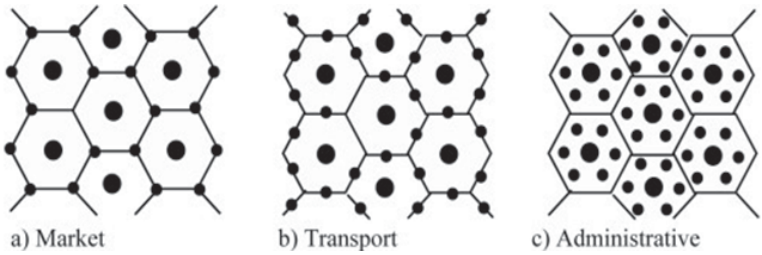


Figure 5.3 Christaller's hexagonal settlement model

The k = 3 system (Figure 5.3a) is where the hexagonal space with the center envisioned that one higher-order central place serves three (two lower-order neighboring centers and itself). Hence, three centers together with the central place itself are served. The objective of the K = 3 system is designed to serve several consumers from a few numbers of service centers. The 3s rule implies 1, 3, 9, 27, 81 …) – meaning that consumers located at equidistant centers from the three higher-order centers (A1, A2 & A3) could acquire one third from each of A1, A2, and A3 centers. As there could be several settlement orders, 1st, 2nd, and 3rd order service centers, correspondingly provide 1st, 2nd, and 3rd order services.

Walter Christaller (1893-1969)

Walter Christaller was a German geographer who wrote a groundbreaking theory titled 'Central Places in Southern Germany' in 1933. His theory consists of the simple concepts of 'centrality', 'threshold', and 'range'. Centrality refers to a pull to a particular center. A threshold is the minimum purchasing power (population & income) required to attract a firm or new service provider. A range is a maximum distance that people travel to acquire goods and services.

Similar to the location theories of von Thünen and Weber, the 'isotropic' surface and alike purchasing power assumptions are perhaps unrealistic. Anyhow, Christaller's central place theory is cutting-edge innovative work even in the present-day world. It is an important theory in geography and economics.

In the K = 4 system, the aim was to lower the travel distance and increase the linkage of the centers served. To decrease travel costs, lower-order settlements are suggested to locate at mid-points of the sides along the roads connecting higher order settlements instead of situating at the edges of the hexagons. This implies that transport routes are lined up along straight courses stretching out from the mid-points. In this case, each central place is supposed to support half of the marketplace of each of six adjoining low-order settlements as they are placed at the edges of the hexagons around high-order centers. The total number of sites served will be thus four – meaning there will be four low-order settlements for each high-order center (see Figure 5.3b) against three in the case of the K = 3 system.

The K = 7 system aims to retain a hierarchy of control between high-order and low-order settlements. Under this system, six low-order settlements in the hexagon will be wholly served, controlled, and enclosed by the central place (by the high-order place). This provides comparable seven market centers. Christaller envisioned this hierarchical model enabling the entire high-order settlements in the hexagon enclosed by further high-order settlements to elucidate both local and regional economics as well as the specialty of urban areas. The system is also named the political-social principle (Figure 5.3c).

Reflective Activity 5.1

1. How do you explain the influence of geographic location on development?
2. Please list the names of geographers that developed theories related to geography and development?
3. Is the cropping pattern in your area related to the von Thünen view?
4. How is the location of industries determined in your area? Does it have a similarity with the assumptions of Alfred Weber?
5. How long do you travel to market centers? Do people in your locality have equal purchasing power like what was proposed by Walter Christaller?

5.2. CLIMATE EXTREMES AND POVERTY

In the preceding topic, you studied the effect of geographic location on economic development. In the current particular topic, you will learn about the effect of one of the geographic factors (extreme climates) on poverty. Climate change and variability drive extreme temperatures and rainfalls that eventually result in extreme environmental changes (events) to happen. Droughts, floods, and plagues are among the extreme environmental events taking place with the changes in weather and climate. These extreme events finally interact with the numerous aspects of human livelihoods. For instance, extreme droughts, floods, and plagues erode the potential of farming livelihoods by lessening crop yields; increasing pathogens; exacerbating insect attacks, and worsening the risk of parasitic weeds.

At the end of this section, you will be able to:

- elaborate the concepts of climate extremes,
- explain how extreme weather and climate events exacerbate poverty,
- describe how flooding events worsen poverty levels, and
- examine the poverty traps and critical thresholds.

Keywords:

- Climate extremes
- Critical thresholds
- Droughts
- Flooding events
- Impacts
- Poverty traps
- Vulnerability.

Brainstorming Activity 5.2

1. How do you explain the linkage between climate extremes and poverty in developing countries? Please discuss in groups and share your ideas with your teacher.

5.2.1 The concepts of climate extremes

Climate extremes refer to excess temperature and rainfall events and environmental hazards happening following those excessive occurrences. They are commonly initiated by recurrent climate changes happening over longer periods. For instance, 'human-induced warming reached' around '1.0^{0}C above the pre-industrial levels in 2017'. It is also estimated to reach 1.5^{0}C by 2040 and 1.75^{0}C at the turn of the 21stC if the current trend of warming continues (see Figure 5.4).

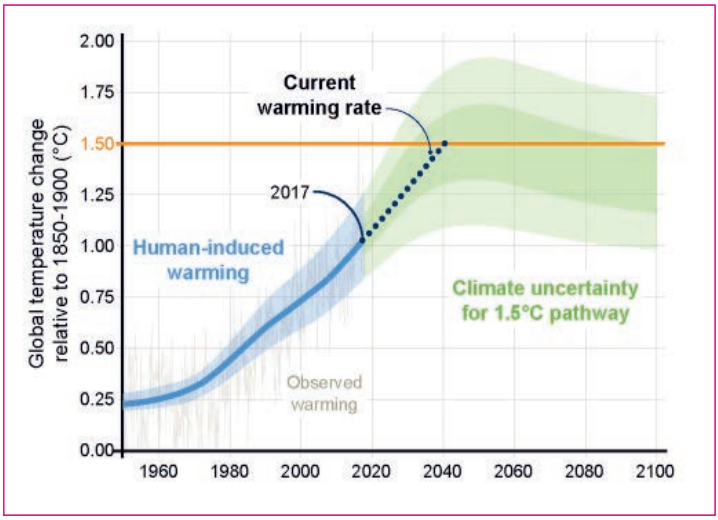
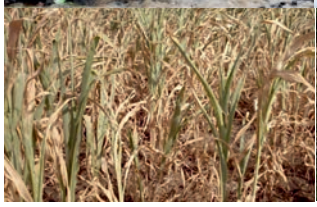


Figure 5.4 Global temperature changes (1940 – 2100) (IPCC, 2018)

a) A house inundated by floodwater due to heavy rainfall from typhoon Goni, 1st November 2020, Albay province, Philippines

Farmers receiving drinking water during a severe drought in the rural areas of Tien Giang, Vietnam

Failed sorghum crop in Ethiopia (UN 26 January 2016)



Livestock death in the Somali region of Ethiopia (25 Jan. 2022)

The temperature increases mentioned above have been connected with more warming in the diurnal lowest temperatures than in the highest ones. Rainfalls have also been increasing during the mentioned period in the middle and high latitude areas. Nevertheless, rainfalls have been showing decreasing trends over the indicated period in tropical and sub-tropical areas. Following those temperature and precipitation changes, extreme climatic events (heat and cold waves, floods, droughts) have been taking place over wider arid and semi-arid areas of the Earth. These extreme events have been finally interacting with the numerous aspects of human livelihoods. For instance, extreme droughts, floods, landslides, crop failures, livestock deaths, water shortages, and plagues have been eroding the potential of farming livelihoods through lessening crop yields; increasing pathogens; exacerbating insect attacks, and worsening the risks of invasive weeds.

5.2.2 Extreme climate events and poverty

The incidence and intensity of the aforementioned climate extremes cause severe challenges in countries with higher levels of poverty. Extreme climatic events seriously affect poor people in those countries in many ways. Extremely poor people receive only 1.90 United States Dollars (USD) per day. About 10% of the global population is estimated to live within this threshold. An estimated 850 million people are quiet living now with ‹1.25 USD daily income of which the majority of those living below this poverty line are in sub-Saharan Africa (SSA). It is estimated also that nearly 1.3 billion people have no access to electricity. Other 900 million people have no access to clean fresh water and some other 2.6 billion lack access to improved sanitation. Similarly, nearly 800 million rural inhabitants lack access to all-weather roads. All these are poverty syndromes intensified by extreme climates. The root causes of such extreme climate initiated poverty conditions are:

- Vulnerability to droughts, flooding, typhoons, and locust invasions,
- Lack of good governance (absence of proper law enforcement),
- Remoteness from service centers (lack of all-weather roads),
- Property right related problems including tenure insecurity,
- Lack of adequate infrastructure and services (roads, water, electricity, education, health),
- Poor access to markets and weak social networks,
- Demographic related characteristics (e.g. household sizes, age & sex compositions & dependency levels),
- Unemployment and underemployment levels, and
- Shelter and nutrition-related problems.

Hitherto, climate extremes intensify community, household, and individual levels of poverty through injuring infrastructure, distorting employment opportunities, and violating health, education, and housing services. Climate change extremes can, in general, impede socioeconomic development, reduce food security and expand poverty.

Exposure to climate hazards (extremes) and poverty levels are commonly derived from growing populations, urbanization (where immigrants reside in marginal hazard-prone areas), settling in coastal and floodplain areas, and the destruction and losses of natural ecosystems.

Poor people in the Developing Countries (DCs) commonly live in peripheral urban areas that are exposed to the risks of flooding and urban waste. In the rural areas poor people often occupy drought-prone environments that are exposed to climate extremes. These poor people often lack access to necessary information and social support opportunities. They lack also the potential and capacity required to cope-up and respond to the climate extremes (Table 5.1).

Climate extremes result in destitution and poverty traps on the poor households by forcing people to consume or sell their assets during disasters and sicknesses. This deters the development of their human capital and undermines their capacity to adapt and cope-with future shocks that eventually lead to the cycle of climate extreme poverty syndromes.

In total, climate extremes cause a shift from ephemeral to lingering poverty due to the absence of active reaction alternatives to the exciting occasions. Households led by females, people living in slums, and children are among the most affected by climate extremes. Poor nomadic pastoralists could fall into lingering poverty when livestock feed supplies diminish due to climate extremes.

Table 5.1 Climate extreme and poverty linkage impacts on human livelihoods

Impact duration	Direct impacts	Indirect impacts
Short-term	Loss of income and earnings	Loss of working persons through death, injury, and illness
	Loss of assets (housing, savings, crops, land & properties)	Loss of labour and low productive output (e.g. crops, industry)
	Forced consumption of limited assets and savings	Loss of assets (physical and social infrastructure damage)
	Limited access to food, water, and healthcare	Diversion of government and private spending to responses
	Abandoning schooling and healthcare plans	Short-term supply chain disruptions
Long-term	Loss of fertile land	More spending on food imports
	Staple food price increment	Increased debt to recovery needs
	Food security reduction (malnourishment & stunting)	Budget allocation for reconstruction and recovery
	Lowering educational attainment and life expectancy	Reduction of exports and increased imports
	Reduce future resilience and coping capacity	Long-term supply chain disruption
	Cause long-term subsidiary impacts	Relocation of productive sectors
		Reduced income and consumption
		Low investment in physical infrastructure and human development (slow socioeconomic development)

Source: Adapted from Wilkinson and Peters (2015).

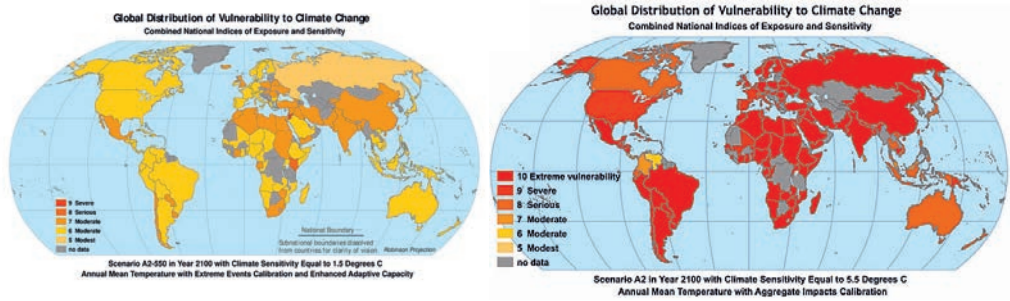


Figure 5.5 Vulnerability to climate change by 2050 and 2100 (UN, 2008)

5.2.3 Flooding Events and Poverty

Spontaneous flash floods often damage walkways, plantations, infrastructures, and stream banks and cause widespread loss of livelihood assets. Field crops and domestic animals are damaged by the floods. These occasions further aggravate food insecurity and livelihood perils over households and then result in chronic poverty. During extreme flooding events, human settlements and urban infrastructures (water and power supply services) will be destroyed. The loss of similar physical assets and property due to extreme flooding events in poor areas generally causes displacements. Such events not only devastate properties but also disrupt the informal social networks of people in the affected areas (e.g. see a sample case from Ethiopia).

CASE STUDY I

Ethiopia: Preventive measures not enough to avoid loss and damage from extreme floods

An increase in the frequency and severity of flooding in Ethiopia is affecting the livelihoods of small-scale agropastoralists who rely on the land for subsistence. A study conducted in the Itang District of the Gambella region found that despite applying a variety of preventive measures against flooding, households were still experiencing severe negative impacts (e.g. lost harvests and livestock, damage to houses and property). Furthermore, relying on social networks to cope in the aftermath of a flood was found to be unsustainable, as repeated floods erode this social capital.

What is the greatest climatic stressor?

Since 2000, households in the Itang area of the Gambella region in Ethiopia have reported dealing with increasingly severe floods. From 2006 to 2012 the region suffered a major flood every year, except for 2009 when they suffered from drought. The floods were especially severe in 2007 and 2012. In both years, the floodwaters that normally retreat by October were still high in mid-November. Households annually experience flooding when the Baro River, a tributary to the Nile and the widest river in Ethiopia, overflows.

However, at least once per season, they also suffer from flash floods that come from excessive rainfall in the upland mountain regions. Due to their unpredictability, these flash floods can be especially disastrous as they are capable of destroying crops and livestock without warning.

What is the impact?

As the region is primarily inhabited by agropastoralists that rely heavily on the land, flooding negatively affected nearly all of the 431 households surveyed. Ninety-four percent of respondents reported that their crops were severely damaged or destroyed following the 2007 flood. In addition to losing crops, 51 percent reported the loss of livestock, whose dairy products and meat are heavily relied upon for sale and consumption. Furthermore, the inability of livestock to graze due to flooded grazing land reduced dairy production in 2007 by half. Large-scale destruction of crops also leads to higher food prices, which make staple foods such as maize unaffordable and force already desperate households to reduce their food consumption.

How do affected people deal with floods?

The research found that households adopt both short- and long-term preventive measures. Short-term measures are undertaken right before a flood and include moving household property and livestock to relatives in unaffected areas, selling livestock before a flood, and harvesting premature crops. Longer-term measures include digging ditches around property and farms, raising the floors of homes, and erecting boundary walls. These preventive measures are effective for minor floods, but as floods increase in severity such measures become inadequate.

In the aftermath of a flood, respondents primarily cope by appealing to their social networks for support (i.e. relatives in unaffected areas), which usually comes in the form of shelter, food, and financial and material assistance. The government and NGOs also provide some assistance (e.g. food and shelter); however, this is rarely sufficient and only available during or immediately after a flood. Following a flood, households also resort to selling livestock and property to pay for food and other necessities.

Taken from Warner et al. (2021)

5.2.4 Poverty traps and critical thresholds

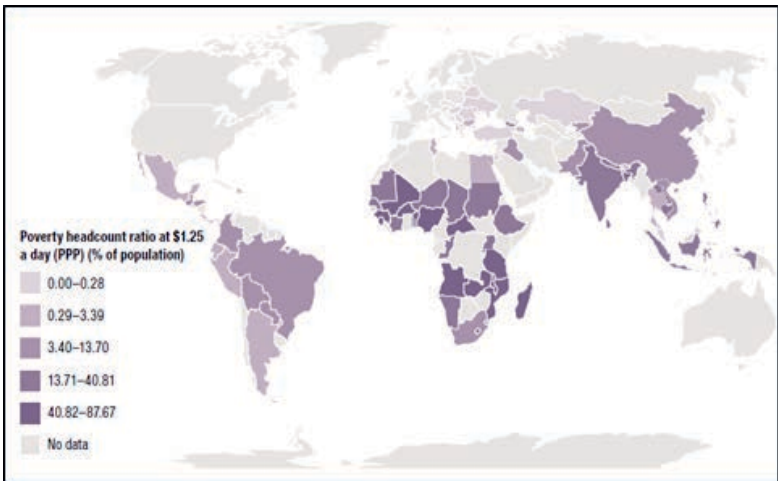
Poverty traps occur when extreme climates push poor people to be poorer and poorer. People repeatedly exposed to damaging droughts, floods, and famines are often hit by poverty traps due to climate extremes. Poverty traps often happen when the impacts of extreme climates frequently hit poor people and persist for tens of years. Grave thresholds or irremediable harms occur from the merger of numerous non-climate related variables. For instance, when the social-network ties of poor people repeatedly break due to lingering climate extremes and poverty, their reciprocal support weakens. Coupled with the already existing poverty, the coping capacity of the poor further weakens and exposes them to aggravated lingering poverty traps (e.g. see a sample case from Burkina Faso, Africa).

CASE STUDY II

Loss and damage example: A dream of peaceful retirement shattered by drought

My name is Ag Ayad Inanchanan. I was born in 1937, and am a veteran of the Burkina Faso army. During my military service, I invested all my earnings in livestock. I thought that would guarantee a peaceful retirement. When I left the army, I had 135 cattle, 87 sheep, and 45 goats. The drought of 1973–74 changed everything. I lost 75 cattle that year because of the scarcity of fodder and drinking water. I was forced to sell some 30 heads also to save the remaining animals and maintain my household. That year, my two brothers lost all their livestock. With no property, they moved in with me and became part of my household. With my herd decimated, I decided to start vegetable cultivation. I was the first gardener in Tin-Akoff along the Beli River. I had seen how that was done when I was stationed in the south. Irrigation allows me to carry on even if the rains fail, but the small profits from gardening do not allow me to reinvest in livestock and expand my herd up to previous levels. It is only enough to maintain my family. Despite my efforts to become less dependent on rainfall, we continue to suffer from the negative effects of drought on our farm. My situation started to worsen again during the drought and locust invasion of 2004. I lost 20 of the 30 heads of cattle I had then. Then, in 2011, I lost 165 small ruminants that drowned in the Beli River when searching for fodder. A big rain that was sudden and brutal washed them away. And this year, 2012, I will not even harvest 1kg of millet from my field due to the invasion of birds in the area. Because I do not have enough animals to sell, I was forced to sell one of my handcarts to cover my food needs. The situation is becoming increasingly catastrophic. I never imagined my life would look like this now when I thought I was going on to a peaceful retirement.

Taken from Warner et al. (2021)



Source: Wilkinson and Peters (2015)

Figure 5.6 Share of population living with ‹1.25 USD per day.

Climate extremes and poverty levels have distinct geography. For instance, Figure 5.6 shows that the highest levels of extreme poverty prevail in SSA, South and Southeast Asia. Some specific areas with the utmost poverty levels saw large annual temperatures and rainfalls (see Figure 5.7). Referring to the indicated map, it appears that some areas show increasing temperatures but decreasing rainfalls (e.g. North Africa, South Africa, and the Mediterranean region). Conversely, increasing annual rainfalls were prevalent in South and East Asia. Many of the mentioned regions experience higher poverty levels. Unlikely the stable annual climates, tropical areas are observed experiencing the largest comparative extreme climatic changes and thus identified as climate change ‘hot-spots’

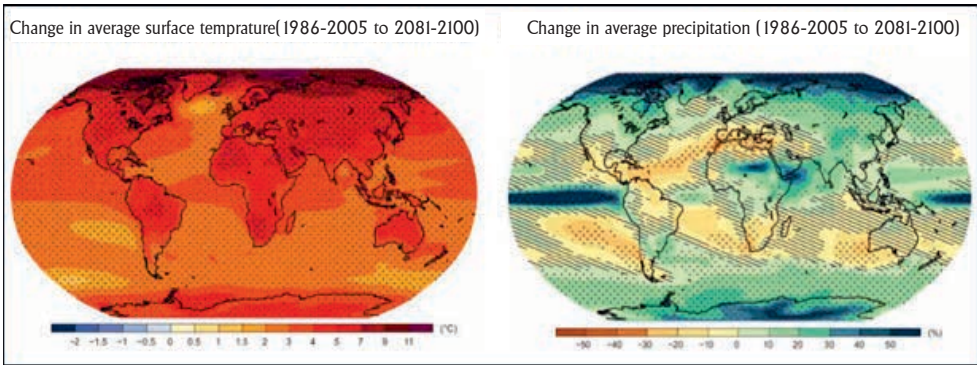


Figure 5.7 Annual surface temperature and rainfall changes

Recent studies on extreme climate and poverty linkages indicated that:

- Extreme weather accompanying climate change is increasing and will probably pose more calamities in the 2030s. Similar hazards, particularly those connected to drought and famine, could be significant sources of poverty during the mentioned time,
- With no rigorous action, there will be nearly 325 million exceedingly poor people living in 49 countries greatly vulnerable to natural hazards and climate extremes in the 2030s (e.g. SSA & South Asia),
- Disaster risk control should be the basic element of poverty-lessening efforts. This has to focus also on caring for livelihoods in addition to saving of lives,
- Future development goals should embrace targets on disasters and climate change.
- Eleven countries that are at most at risk of disaster-induced poverty are Bangladesh, DRC, Ethiopia, Kenya, Madagascar, Nepal, Nigeria, Pakistan, South Sudan, Sudan, and Uganda. Other 10 countries will have a great percentage of people in poverty, high multi-hazard exposure, and inadequate capacity to minimize the impacts (e.g. Benin, Central African Republic (CAR), Chad, Gambia, Guinea Bissau, Haiti, Liberia, Mali, North Korea, and Zimbabwe). Niger, Somalia, and Yemen could also characterize the list. Although their entire exposure to hazards, other than drought is quite low, these countries have high levels of poverty and low capacities of disaster and risk management scenarios. Similarly, Afghanistan, Cameroon, Myanmar, and Papua New Guinea bear high experience to hazard and moderate poverty (with nearly10% of their populations and/or one million people ‹1.25 USD per day poverty line)and limited disaster management capacity.

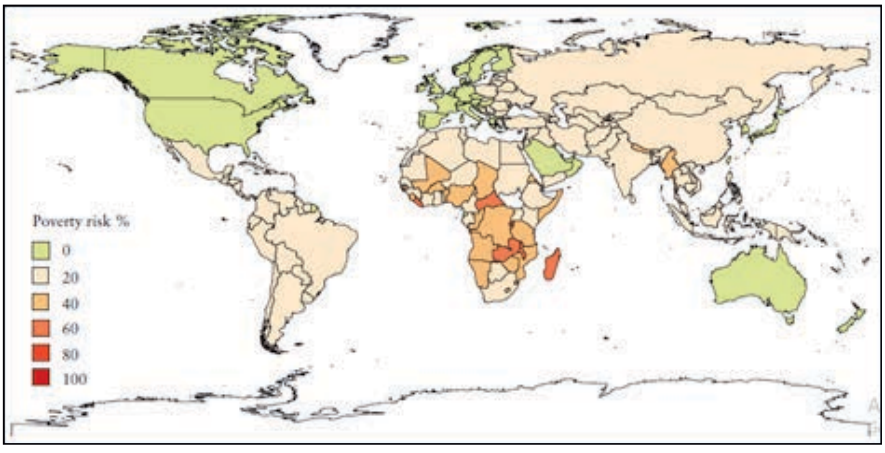


Figure 5.8 Poverty risk at 1.25 USD baselines (percent of people by 2030)

Climate change and variability, in general, drive extreme temperatures and rainfalls that eventually result in extreme environmental changes to happen. Droughts, floods, and plagues are among the extreme environmental events taking place with the occurrences of extreme climates. These events finally interact with the numerous aspects of human livelihoods. For instance, extreme droughts, floods, and plagues erode the potential of farming livelihoods by lessening crop yields; increasing pathogens; intensifying insect attacks, and worsening the risks of invasive weeds. Climate extremes generally destroy the asset base of poor people and households.

NOTE:

- Extreme climate refers to the occurrence of an excessive value of the climatic (weather) elements below or above the normal thresholds over a specific geographic area and time (e.g. excessively low or high temperatures, rainfall, flooding, droughts, hail storms, heat waves, tornadoes, etc.).
- Extreme climates are rare cases but cause disastrous impacts on life and biodiversity.
- Extreme climates damage livelihood assets (water, livestock, and crops) as well as the capacity of people to access financial resources, and health and education services. When the events happen frequently and repeatedly; households face difficulties in coping with the shocks. In such cases, people fall into an endless poverty vicious cycle which can be referred to as a poverty trap – meaning people lack the necessary resources to escape from poverty. This is because the extreme climatic shocks cause both 'ex-post' and 'ex-ante' impacts on the 'incidence' of poverty.

Reflective Activity 5.2

1. How do you explain the effects of climate extremes on poverty dynamics and poverty traps?
2. What kind of disasters and impacts did the people in the Itang District of Ethiopia face from 2006 to 2012? What properties did they lose? How did they cope with the hazards?
3. What shattered the peaceful retirement dreams of Ag Ayad Inanchanan (in Case Study II) What properties did he lose?

5.3 DISADVANTAGES OF LANDLOCKED COUNTRIES

You remember how location affects economic development under the topic 'effect of geographic location on development'. Similarly, interactions between extreme climates and poverty levels; flooding events, and poverty conditions as well as extreme climates and poverty traps were deliberated under 5.2. In the current topic, you are going to learn about the drawbacks faced by landlocked countries in their foreign trade endeavors and overall economic development activities. Landlocked countries have no direct access to the sea for their export-import trade. They are therefore forced to pay much money to get access to seaports. In addition, their commercial activities face frequent delays and interruptions. You, students, have thus been required to search and find more about the challenges and disadvantages of landlocked countries like Ethiopia.

At the end of this section, you will be able to:

- describe the characteristic features of landlocked countries,
- evaluate the drawbacks faced by landlocked countries in their economic development.

Keywords:

- **Disadvantages**
- **Landlocked countries**
- **Sea access**
- **Political disadvantages**
- **Transportation disadvantages**

Brainstorming Activity 5.3

Why do landlocked countries face a disadvantage in their economic growth? Please form groups and discuss the issue with your classmates.

5.3.1 Characteristics of landlocked countries

Landlocked countries are those that do not possess any seacoast. Rivers might run through a portion of the region, and there can be bodies of water within the country's borders. But every border is land-based, rather than water like an ocean shore.

Landlocked states are geographically dispersed across all continents. They occupy the mid-regions of continents and constitute about one-fifth of the world's nations. They fall under the category of geographically disadvantaged nations. They were formed following three historical events: at the end of the First World War; following the end of colonization; and the collapse and splitting of the former Soviet Union (USSR). In the case of African landlocked countries (Figure 5.9), colonization resulted in the drawing of borders then making some areas completely enclosed by other states. Most of the African states have retained these colonial border lines.

Figure 5.9: Distributions of landlocked countries in the world

Of all the countries in the world, 49 of them are landlocked (see some from Figure 5.9). This number is equivalent to one-fifth (20%) of all countries in the world. They are also among the most disadvantaged and underachieving countries in the world. They are generally divorced from the benefits received from locating along the sea coast.

5.3.2 Disadvantages of landlocked countries

When the low economic and social performance of landlocked countries is compared with countries having direct access to sea coasts, the condition indicates the prevalence of strong bondage between geography and development. Lack of direct access to the sea; isolation from major economic centers; inadequate conveyance setups; and clumsy transit practices together impede the ability of landlocked states to grow effectually.

I. Lack of direct access to the sea

Landlocked countries lie far from seaports and lack direct access to the sea. They incur higher transport costs during their participation in foreign trades. The cost of international transport services is a crucial determinant of a country's trade competitiveness. Higher trade costs reduce a country's welfare and inhibit economic growth by making imports expensive and exports none-competitive. Landlocked countries, therefore, suffer noticeable drawbacks when competing in global markets against coastal areas. It has been estimated that doubling transport costs reduces a country's trade volume by around 80%.

Excessive transport costs also impede the trade in services, mainly the export of tourism services. Doubling travel cost reduces the demand for tourism as high as eightfold.

II. Transportation and transit-related disadvantages

Landlocked countries are entirely dependent on their transit neighbors' infrastructure for access to an international market. Where a landlocked country only has access to routes of poor quality, the cost of overland trade is significantly higher than it would otherwise be. Hence, the cost of trade in a landlocked country is heavily determined by the infrastructure levels, and, indirectly, by the level of development of its transit neighbors.

Challenges of poor transit neighbor substructures are mainly severe in western and central Africa. For instance, although boasting of having better domestic road connections, Burundi is severely affected by the poor contiguous transit network of its neighbors. The short direct passage to the sea from Burundi is the so-called Central Corridor over Tanzania (Dar es Salaam). Nevertheless, the transit setup over this route is too poor.

Similarly, many of the western African LLDCs have poor transit neighbor network problems. The derelict transport network corridor in the area shrinks the benefits expected from foreign direct investment (FDI). The best example here is the (CAR). This country has no reliable all-weather road network to the sea. Its transit through Cameroon is impenetrable during the rainy season. Its transit corridor over the Oubangui River of the Democratic Republic of Congo (DRC) is also closed in the dry season due to diminished water flow and for security reasons.

To transit a country, there are hosts of transit and custom charges. Some of these must be paid upfront and some must be paid during traveling. In many cases, these charges must be paid in hard currency, where options are missing to convert local currency to hard currency. Sometimes agency fees at ports for transit freight may exceed that of domestic freight.

The transit and custom charges include transit good licenses, border fees, temporary road licenses, foreign vehicle permits, toll charges, foreign commercial licenses, cost of customs verification of containers, posting of security bonds, involvement with police and escort convoys, and cancellation of bonds.

Currently, there are some successful efforts and strategies in certain areas to ease procedures and lessen administrative charges. For instance, common warrants have been announced in the Southern African Development Community (SADC) and Common Market for Eastern and Southern Africa (COMESA) allowing road freight travel within member countries with no local permits or licenses. Another good example is the Bhutanese transit trade in South Asia. The transit of the Bhutanese trade is handled by its customs and never touched by Indian officials.

III. Political disadvantages

Political issues are also major challenges for the development of landlocked countries next to transportation. The deficiency of negotiating capacity with transit neighbors is one challenge faced by landlocked countries. The lack of access rights during conflict times from transit neighbors seriously affects the mentioned states. Civil conflicts within the countries themselves sometimes cause difficulties even if countries have good relations with those of the transit neighbors. During such conditions, trade routes may be cut due to border closures. The LLDCs often possess little negotiating power over their transit neighbors.

Political relations strongly impact trade and commodity flows in LLDCs. For example, Bolivia has severe transit limitations in Chile as the two countries have weak political relations that have for more than 100 years. Armenia is presently blocked by ethnic Armenians and Turkey whilst conflicts between Ethiopia and Eritrea have denied Ethiopia's use of the port of Assab and Massawa after 1997.

Nevertheless, recent promisingly developments between the two countries may provide Ethiopia the chance of using these two ports for its transit-trade in the future. Ethiopia now uses the port of Djibouti for its transit trade. However, the route never satisfies Ethiopia's wide demand for the transport network is poorly developed. Alternative routes through Kenya, Sudan, and Somalia are characterized by poorly developed transport networks.

Political instability and conflict among the transit nations in Africa have been frequently obstructing their international trade. For instance, civil conflicts have greatly impacted the foreign trade of LLDCs of Africa. Just to mention a few cases:

- **Mali:** affected by regional conflicts since 2012
- **Togo:** protests and internal conflicts in the 1990s;
- **Ghana:** ethnic violence 1993-1994;
- **Sierra Leone:** the 10 years civil war (1991-2002);
- **Guinea:** coups and rebel wars (2008);
- **Liberia:** a decade of violent civil wars (1989-2005);
- **Cote d'Ivoire:** recent political crisis (since the 2002);

The mentioned political instabilities and administrative barriers strongly hindered the foreign trade of LLDCs of Africa. These all cause transit delays and route blockades. For instance, mean transit delays during border crossings all over Africa range from 24-48 hours. In some areas, it can take even weeks. The mean trip from Kampala to Mombasa for instance takes about 21 days. Sometimes, the trip may take 60 days. Note that similar delays take place in other transit and port areas of Africa.

Generally, landlocked countries face dependence based on the infrastructure levels of the transit nations. Fees and direct costs due to administrative burdens and time delays in export trades are also part of the challenges faced by LLDCs.

Reflective Activity 5.3

1. How do you describe and explain the geographical challenge of landlocked countries?
2. How do you see the place of Ethiopia in light of such challenges?

5.4 INTRAREGIONAL TRADE IN AFRICA

In Africa, population growth coupled with higher income and urbanization has derived growing demand for local food markets. The speedy rising demand progression has also created new opportunities and challenges. The opportunities initiated intraregional trade expansion while the challenges pose food security constraints at country levels. Present-day Africa's world trade is dominated by imports of processed food products while the export of untreated nonfood products. This pattern is so common in many countries of the continent. It is so pertinent to investigate whether the current supply capabilities can meet emerging needs.

At the end of this section, you will be able to:

- describe the trade flow trends within Africa,
- identify top exporters and importers of the intra-African trade,
- appreciate the commodity composition of trade flows within Africa, and
- evaluate the intra-African trade policies and the challenges of integration.

Keywords:

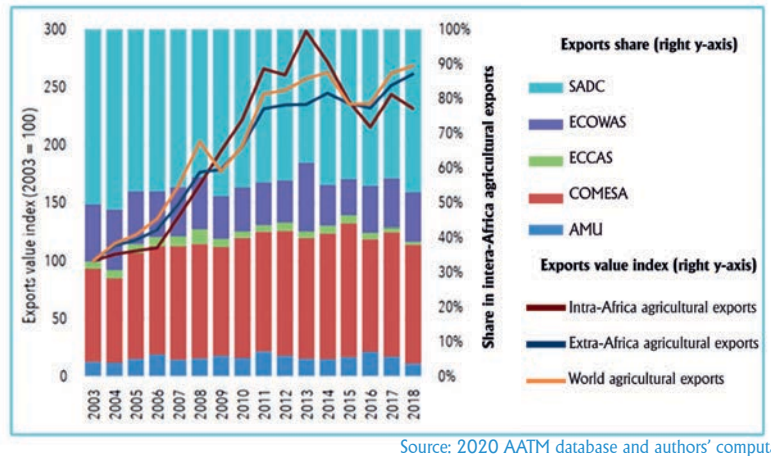
- Intra-Regional trade
- Commodity; Exports
- Imports
- Trade flows
- Trade policies
- Trade challenges

Brainstorming Activity 5.4

Name what types of products African countries exchange in their foreign trade? Just think independently and discuss it with your classmates.

5.4.1. Trade flow trends within Africa

Africa's agricultural exports (Figure 5.10) have increased since the year 2000 in the form of intra-African agricultural trade although participation in world trade has remained low. In the continent, Regional Economic Communities (RECs) have established preferential tariff agreements; free trade zones, or customs unions among some neighboring member nations. The RECs include the: Arab Maghreb Union (AMU), COMESA, Economic Community of West African States (ECOWAS), and SADC. The mentioned RECs comprise 5, 19, 15, and 16 member states, respectively.



Source: 2020 AATM database and authors' computations.

Figure 5.10 Intra-African agricultural exports by region of origin, 2003–2018

The value US Dollars of intra-African food and agricultural trade rose steadily beginning roughly in 2007, peaking in 2013 with a significant decline until resuming a general upward trend in 2016 (see Figure 5.10). The intra-continental exports grew faster annually than extra-continental exports and global exports did from 2008 to 2015 whilst the reverse holds during the subsequent years. When compared to other RECs, ECCAS ships the largest share of its intra-African exports outside of the region. On average, only 46% of ECCAS' intra-continental trade remained within the REC in 2016–2018, which is a significantly lower share than in 2005–2007 (58%). However; ECCAS' total exports are very small compared to the other RECs.

Larger exporters, SADC and COMESA, retained 84% and 66%, respectively, of their intra-African exports within their respective regions during 2016–2018. ECOWAS and AMU also retained 79% and 60% of their intra-African exports within their respective areas, respectively.

ECOWAS experienced the most notable intra-REC export trade spike in 2013; while other RECs underwent a more gradual increase and decline. Only SADC has demonstrated an obvious increase in exports since 2016. In a nutshell, intra-continental agricultural exports have grown steadily over the past two decades, largely by SADC and COMESA member countries.

5.4.2. Top exporters and importers

Table 5.2 presents the top 10 intra-African exporters and importers of agricultural products, in ascending order of their ranks (2016–2018 and 2005–2007). The top 10 intra-African exporters account for roughly 70% of the formal market. Agricultural imports are more widely dispersed, with the top importing countries accounting for only half of formal trade. Across the two time periods, South Africa remained the dominant market player. This country was exporting nearly a third of all intra-African formal exports and importing roughly a tenth of all agricultural goods. South Africa's exports increased over time, while its import share fell. The other top exporters include Egypt, Uganda, Kenya, and Tanzania whose shares increased over time. Côte d'Ivoire, Zambia, Namibia, Tunisia, and Ethiopia were countries whose shares of the overall intra-African exports declined between the two time periods. In addition to South Africa, top importers were Kenya, Egypt, Zimbabwe, Mozambique, and the DRC which all increased their shares in the import market. Namibia, Botswana, Libya, and Nigeria were countries that decreased their shares.

Of ECOWAS countries, Côte d'Ivoire is the sole top intra-African exporter, and Nigeria is the sole top importer. South Africa, Kenya, Namibia, and Egypt are all top exporters and are also among the largest importers accounting for 25% of intra-continental agricultural imports. Egypt ranked the fourth largest importer from 2016 to 2018.

Eastern and Southern African and Maghreb countries lead intra-African agricultural trade. Apart from Côte d'Ivoire as a large exporter and Nigeria as a large importer, other western and central African countries play only a small role compared to major players from the other regions that control 71% and 50% of the agricultural export and import flows, respectively.

Table 5.2. Top 10 intra-Africa exporters and importers of agricultural products, 2005-2007 and 2016-2018

Countries	2005-2007		2016-2018		2005-2007		2016-2018	
	Export share %	Rank	Export share %	Rank	Export share %	Rank	Export share %	Rank
South Africa	29.8	1	32.2	1	11.5	1	8.3	1
Botswana	-	-	-	-	6.9	2	5.3	5
Egypt	5.6	4	8.7	2	2	10	5.4	4
Uganda	3.6	8	6.4	3	-	-	-	-
Kenya	5.3	5	6.2	4	4.3	5	6.7	2
Cote d'Ivoire	6.3	3	4.6	5	-	-	-	-

Countries	2005-2007		2016-2018		2005-2007		2016-2018	
	Export share %	Rank	Export share %	Rank	Export share %	Rank	Export share %	Rank
Zimbabwe					4.2	6	4.8	6
Zambia	4.1	7	3.8	6	-	-	-	-
Tanzania	2.2	10	3.1	7	-	-	-	-
Namibia	6.5	2	2.8	8	6.7	3	5.7	3
Tunisia	4.4	6	2.6	9	-	-	-	-
Ethiopia	2.8	9	0.5	10	-	-	-	-
Mozambique	-	-	-	-	2.6	9	4.3	7
Dem.Rep. Congo	-	-	-	-	3.3	7	3.6	9
Nigeria	-	-	-	-	2.6	8	2.3	10
Libya	-	-	-	-	4.6	4	3.6	8
Total	70.6		71		48.7		50.2	

Source: 2020 AATM database

In terms of trading partners, Ethiopia's top 10 import sources account for 99% of its intra-African imports. The top 10 export destinations account for 98% of Ethiopia's intra-African exports. The top import sources include Morocco, South Africa, and Egypt, while top export destinations include Somalia, Djibouti, and Kenya.

5.4.3. The commodity composition of trade flows

Africa's intra-continental agricultural trade is more diversified than the intraregional trade of South Asia which is relatively less diversified than the intra-European trade. Among the top 20 products exported within Africa, only 6 (maize, wheat, rice, cattle, apples, and vegetables) play key food security and nutritional role for African consumers. The remaining products include sweeteners and fats, beverages and processed foods, and traditional exports such as tea, coffee, palm oil, cotton, and tobacco products.

5.4.4. Intra-African trade policies and challenges of integration

The tariff and nontariff barriers are the main challenges that hinder formal intra-Africa trade (see for example the informal currency exchange case in Ethiopia). In many cases, non-tariffs are more trade-restrictive than tariffs.

The intraregional traders still face high tariffs although significant progress in efforts to promote regional integration has reduced tariff protections. Tapping into Africa's regional trade potential will require coordination between regions. Yet, the said regional coordination requires strong production and processing potential and careful consideration of nutrition-sensitive consumer demands. Both tariffs and non-tariff measures (NTMs) can incentivize trans- shipment and smuggling, or heighten the risk for businesses working to build streamlined, secure, and transparent supply chains.

CASE STUDY III

Informal currency exchange in informal trade in East Africa

In Ethiopia, once prices are agreed upon in the relevant currencies, they are automatically converted into Birr at prevailing black market rates. Both buyers and sellers, including the delalas (brokers), carry small calculators for such purposes. At the time of this study, the value of Birr in the black market was less than the official exchange rate. For instance, the official exchange is Birr 1 = Ksh 13, while the black-market rate is Birr 1= Ksh (Kenyan Shilling) 5–6. Similarly, the black-market exchange rates for the Djibouti franc fluctuated around 30 percent of the official rate. All key informants (operators and local administrators) complain that the value, or purchasing power, of Birr, is falling. The economic implication is that terms of trade are unfavorable to Ethiopia; ICBT export values are substantially lower than the value of imports. This situation is consistent with current trade balances–a large deficit in the trade balance and a shortage in foreign currencies–in the formal foreign trade at the national level in Ethiopia.

Ksh refers to Kenyan shillings
Taken from ECA (2010)

Administrative barriers cause undue time delays that are unworkable for certain agricultural products, notably those that may deteriorate without cold storage and transport. Delays, costs, and administrative burdens discourage private investment in regional supply chains of sensitive agricultural products. They may partly explain also the high reliance on the informal trade of fruits, vegetables, and other time-sensitive goods. If these barriers are removed, time-sensitive agricultural foods (agri-foods) may offer good opportunities to enhance regional trade through the agri-food value chains.

Improving regional agri-food value chains will require due investment in road, transport, and information systems infrastructure. Improving linkages between production and agro-processing areas, and/or between groups of smaller producers and cross-border markets, and can open new opportunities for regional value chains. But this applies particularly if infrastructure investment targets key corridor routes and provides relevant market information for priority regional value chains.

Reflective Activity 5.4

1. What do you think are the major challenges and policy responses to intra-African trade?
2. How do you explain the informal currency exchange practices such as reported in case study III?
3. Do you observe informal transactions in your village? Please discuss this with your class-mates.

UNIT SUMMARY

Geographic location determines development by influencing agricultural, industrial, and commercial activities. Three basic theories are known to geographers in this respect: Agricultural location theory; industrial location theory and the central place theory. These theories are based on different assumptions about how agriculture, industry, and trade are influenced by geographic location, respectively.

Extreme climatic events result in droughts, unexpected rainfall, and sudden floods. These, in turn, cause the loss of biodiversity; death of plants and animals; reduction in agricultural yield, and health problems. The event indirectly threatens human livelihoods. As livelihood assets are reduced, households are exposed to chronic poverty. Poor people in turn negatively impact the natural environment through the harvest of livelihood assets. This again leads to more climate variability and creates a vicious cycle of climate-change-poverty mismatch.

Landlocked countries are those that do not have access to the sea. For instance, Ethiopia is a land-locked country that does not have a seaport. There are over 30 landlocked countries in the World. These countries pay a large amount of money to import and export commodities. This affects their economic development seriously. Ethiopia's foreign trade is also largely affected by the lack of its seaports. It is dependent on Djibouti, Sudan, and other countries for its international trade. This has had a huge impact on its development. Improper government policies; lack of access to improved transportation facilities; and administrative barriers also influence intra-regional trade in Africa in addition to the lack of sea access to international trade in many countries.

REVIEW EXERCISES

I) True/False items: Write 'True' if the statement is correct or 'False' if it is wrong

1. Geographic location is the sole determinant of development everywhere in the world.
2. There is a two-way relationship between climate change and land degradation.
3. Climate extremes have no relation to poverty traps.
4. Most landlocked countries occur in the mid-regions of continents.
5. Intra-African trade patterns are dominated by the exchange of unprocessed agricultural products.

II) Matching: Match items listed in Column 'A' with the geological eras under Column 'B'

Column 'A'	**Column 'B'**
1. Côte d'Ivoire	A) ECOWAS
2. South Africa	B) SADC
3. Algeria	C) COMESA
4. Somalia	D) AMU
5. Burundi	
6. Nigeria	
7. Botswana	
8. Morocco	

III) Multiple choices: For questions 1-5 choose the best answer from the given alternatives

1. Which of the following combinations is not correct?
   A) Karle Ritter-Possiblism; Lucien Paul Febvre - Geographic determinism
   B) Paul Vidal de la Blache - Possiblism; Elsworth Huntington - Geographic determinism
   C) Ellen Churchill Semple - Geographic determinism; Lucien Paul Febvre-Possibilism
   D) Karle Ritter - Geographic determinism; Paul Vidal de la Blache - Possiblism

2. Identify the correct arrangement

A. Weber - Industrial location theory; von Thünen - Central place theory; Chritaller -Agricultural land use theory

B. Christaller - Industrial location theory; von Thünen - Central place theory; Weber - Agricultural land use theory

C. Weber - Circular land - use model; Weber - least cost triangular industrial model; von Thünen - Hexagonal settlement and service center model

D. von Thünen-Circular land-use model; Weber-least cost triangular industrial model; Christaller - Hexagonal settlement and service center model

3. What problems do landlocked countries face in their foreign trade activities?

A) They pay higher transport costs C) Border closures during conflicts

B) Dependency on their transit-neighbors D) All E) None

4. Which of the following is incorrect about the intraregional trade of Africa?

A. Most African countries import unprocessed food items and export finished products

B. African intraregional trade is dominated by SADC member countries

C. Intra-continental exports grow faster than extra-continental exports

D. Most countries export unprocessed agricultural products and import processed food items

5. Among the following which one does not form a barrier to the African intra-regional trade?

A) Improper government policy B) Administrative barrier

C) Lack of access to the improved transportation facility D) None

IV) Short note writing: Give short answers to the following questions

1. Geographic location can never be the sole determinant factor for economic development. Explain?
2. Explain how climatic extremes affect the livelihood of people in your area.
3. Name 16 landlocked countries in Africa, and explain the pattern of their geographic distribution.
4. Enumerate the factors that influence intra-regional trade in Africa.

UNIT SIX
MAJOR GLOBAL ENVIRONMENTAL CHANGES

Learning Outcomes

At the end of this unit, you will be able to:

- describe the nature and characteristics of persistent environmental changes;
- explain the nature and characteristics of emerging environmental changes;
- examine the intricate relationships between poverty and the environment;
- recognize that a sustainable environment is part of sustainable development.

MAIN CONTENTS

Introduction

Human actions have a huge negative impact on the ecology of the planet. Ecological, biological, sociological, and technological limits, for example, could lead to long-term and emerging environmental changes on our planet. The key components of our world's environmental challenges are environmental degradation, poverty, habitat fragmentation, resource overexploitation, forest degradation, and unsustainable development. As a result, you should be aware of ongoing environmental changes, the poverty-environment nexus, as well as environmental degradation and sustainable development, which are all covered in this unit.

6.1. PERSISTENT ENVIRONMENTAL CHANGES

At the end of this section, you will be able to:

- describe the nature and characteristics of persistent environmental changes; and
- distinguish between the nature and characteristics of persistent and emerging environmental changes.

Keywords:

- **Agricultural intensification**
- **Overexploitation of resources**
- **Environmental changes**
- **Habitat destruction**
- **Invasive alien species**

6.1.1. Habitat Destruction

Brainstorming Activities 6.1

Identify the following questions, think independently first, and then share the idea with your classmates through small group discussion.

1. How do you understand the notion of habitat destruction as compared to habitat loss, habitat fragmentation, habitat degradation, and habitat conversion?
2. What are the causes and consequences of habitat loss?

Habitat is the subset of physical environmental factors that permit a particular species to survive and reproduce. All features of the environment surrounding an individual animal at any given point in time are described as habitat.

Landscape modification by humans is by far the most major modern source of habitat loss, fragmentation, and biodiversity loss around the planet. Humans can alter landscapes and habitats spatially through five different methods: perforation, dissection, fragmentation, shrinkage, and attrition. Natural processes can also change landscapes and eliminate habitats for certain animals. Natural occurrences such as floods, volcanic eruptions, earthquakes, and temperature shifts, for example, cause habitat destruction.

The introduction of invasive species into environments is also a major factor in the extinction of native species. Figure 6.1 depicts the world's terrestrial mammals' species richness or biodiversity levels (A) and degree of habitat fragmentation (B), with blue being the least fragmented places and red denoting the most fragmented habitats.

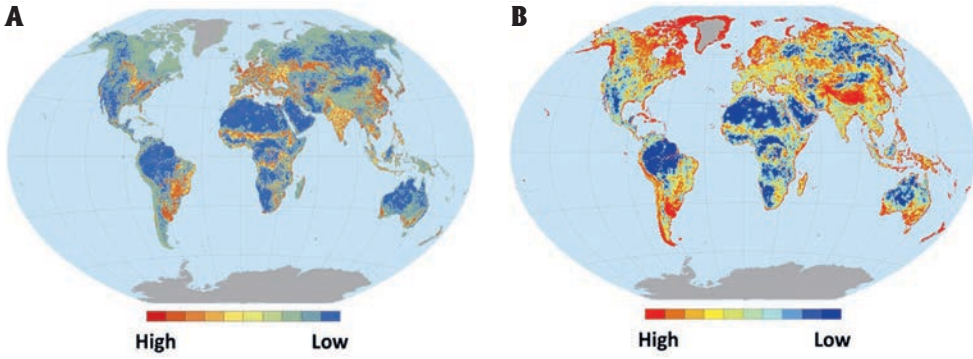


Figure 6.1: Degree of habitat destruction for the world's terrestrial mammals

Access to proper habitat has a profound impact on all organisms' distribution and abundance, as well as their survival, reproduction, and long-term persistence. While the area between remains of natural vegetation cover may extend, some species prefer disturbed settings. Individuals may survive in a deteriorated habitat for a long time even if they are unable to reproduce.

Some types of habitat degradation take a long time to have an impact on a particular species. For example, the loss of huge trees with cavities is a major issue in forest and woodland ecosystems all across the world, threatening many individual species. Long-term population losses as a result of habitat degradation may thus go unnoticed or be extremely difficult to remedy once discovered. Extinction debt refers to the time it takes for a species to become extinct as a result of landscape change.

As a result, understanding what constitutes a habitat for a certain species is critical to addressing habitat loss. This knowledge is required to comprehend why species react to landscape change in the manner they do. Habitat restoration should be conducted by continual management, protection measures, and reconstruction of deteriorated or destroyed regions.

6.1.2. Agricultural Intensification

Brainstorming Activity 6.2

Look at the following questions, think independently, and share with your classmates through small group discussion.

1. What is agricultural intensification?
2. What are the implications of increasing agricultural productivity on natural resources?

Agricultural intensification is the process of increasing agricultural output per unit of input (labor, land, time, fertilizer, seed, and feed or cash). It is especially important when the food supply must be expanded, such as during periods of high population increase. Agricultural intensification was successful in increasing agricultural productivity by using improved seeds (high yielding varieties), inputs (high doses of fertilizers, pesticides, and weedicides), heavy machinery, and copious water for irrigation with good soils, but it failed to address some environmental issues.

Opening up natural ecosystems for agriculture reduces carbon stokes which results in the net removal of nutrients from available soil stocks, and reduces ecosystem variety; hence agroecosystem productivity and natural resource integrity are fundamentally enemies. More land would have been used for agriculture in order to increase agricultural output, thereby destroying forests, marshes, and other ecosystems. The way heavy land use affects on biodiversity in an environment has a strong relationship with its evolutionary history.

When population pressure on land is modest, there is frequently flexibility to control unfavorable interactions and trade-offs by changes in the temporal and spatial arrangements among fields. Due to this, there is a chance for significant "affinity between agro-ecosystem productivity and natural resource." Due to increasing population pressure on the land and a lack of flexibility in land use patterns, soil degradation happens. As a consequence, fertilizer inputs are needed to prime farming systems, which accelerates soil deterioration. When environmental or social issues are involved, intensification that makes more efficient use of resources may be more crucial.

Major negative impacts of agricultural intensification

Since the late 1960s, the green revolution has been a series of research and technology transfer projects that have introduced high-yield crop varieties and employed pesticides to enhance agricultural productivity to alleviate hunger and poverty in the world's most populous countries. The following detrimental consequences of agricultural intensification were observed.

- **Loss of biodiversity:** Monocropping and major reductions in agricultural diversification have resulted from the widespread adoption of a few genetically homogeneous crop varieties (for example, high-yield rice cultivars and dwarf wheat) across huge areas. Only 15 crop species and eight livestock species now provide 90% of all human food. Many key genetic features that had been bred into traditional kinds over thousands of years were lost forever.
- **Reduction of soil quality:** Increased reliance on synthetic fertilizers rather than natural fertilizers (compost, crop residues, green manures, and other organic amendments) has lowered soil quality. Furthermore, nitrate pollution of water bodies causes nitrogen fertilizer leaching.
- **Pesticide hazard:** Pesticides stay in soil, air, surface, and groundwater for long periods, poisoning them. They make their way up the food chain and end up in higher organisms (bio-magnification). Pesticide exposure causes cancer in animals over time (for example, chlorinated hydrocarbons).
- **Soil salinization:** Intensification of water used for irrigation has led to soil salinization, resulting in land toxicity due to the accumulation of sodium ions in soil solution that adversely affects plant growth.
- **Increase in pests and disease:** Indiscriminate use of pesticides was adopted to manage the increased pests and disease problems in crops due to mono-cropping.
- **Soil compaction:** Using heavy farm equipment for sowing, fertilizing, spraying pesticides and herbicides, and harvesting can compact the soil

Due to long-term nutrient mining and soil organic carbon (SOC) depletion, intensively used cropland in a densely populated area in Sub-Saharan Africa is characterized by poor health. Furthermore, feeding zero-grazing cattle with fodder and crop residues reduces nutrient replenishment at the plot level. Low yield in farmers' fields is due to significant depletion of soil nutrients, unsuitable land management techniques, excessive soil erosion, and unaffordable agricultural inputs for all farmers. Agricultural intensification recommended in agriculture if properly applied. As a result, a more environmentally friendly and sustainable agriculture system must be devised to feed a growing global population while also meeting the needs of future generations.

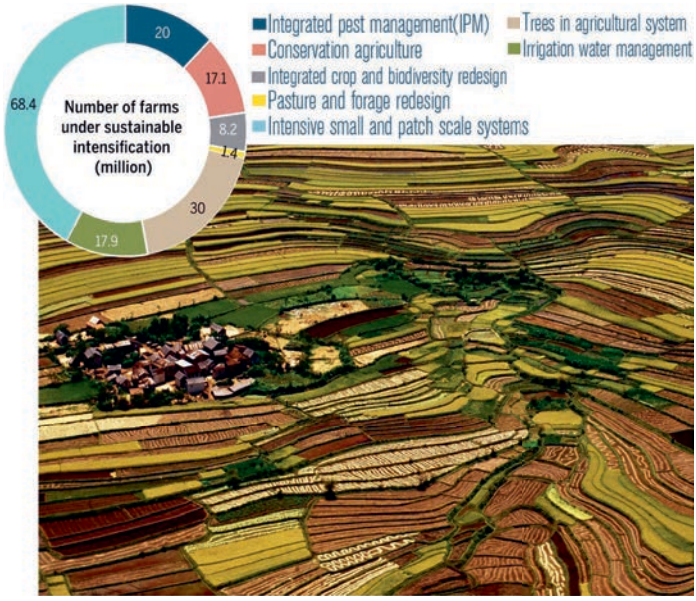


Figure 6.2: Sustainable agricultural intensification systems

Improved fertilizer and water use efficiency through plant and animal breeding programs, as well as the deployment of integrated soil and pest management strategies, could lead to sustainable agricultural intensification. When compared to monoculture agricultural systems, agroforestry can provide additional ecosystem services for sustainably boosting regional food security. There is a need to strike a balance between rising food demands and biodiversity preservation.

6.1.3. Overexploitation of Resources

Brainstorming Activity 6.3

1. Define overexploitation?
2. How does overexploitation occur? Think independently and share with your classmates through discussion

Everything humans do and how they live is intimately related to and dependent on the resource base, which is inexorably and logically linked. There will be resource exhaustion whenever there is an excess of the population over available resources. Over-exploitation occurs when natural resources (wild medicinal herbs, grazing pastures, fish stocks, forests, hunting animals, and water aquifers) are harvested at an excessive rate without appropriate attention to regeneration.

Under such circumstances, stocks are rapidly depleted, and they face economic or ecological extinction. Continued overexploitation has the potential to deplete the resource base. Humans are not the only ones who overexploit natural flora and animals; introduced predators and herbivores can also do so. Because overexploitation is such a broad notion, it may be more acceptable to employ specific concepts. For instance, instead of overexploitation,

- Overfishing occurs when a fish stock has been fished down below the size that on average would support the long-term maximum sustainable yield of the fishery.
- Overgrazing is the situation where land is grazed by large stocks above the carrying capacity of the grazing land
- Over-logging in forest management. Forests are exploited or over-logged when they are logged at a rate faster than reforestation takes place. Some species may go extinct because of the changes in the living conditions of animals as a result of forest overexploitation.
- Over-drafting: occurs if a water resource, such as the Ogallala aquifer is mined or extracted at a rate that exceeds the recharge rate at a rate that exceeds the practical sustained yield. An aquifer that has been exploited is said to be over-drafted or depleted. Hence, when sustainable ecosystem protection is required for rivers, streams, and lakes since recharge usually comes from them.

The exploitation of minerals has become easier, and humans are digging deeper to access different ore due to the advancements in technology in the contemporary era. There has been an increase in the exploitation of minerals, such as phosphorus, gasoline, copper, and zinc, and their production is estimated to decline in the next decades.

Oil mining continues to rise due to the increase in the number of engines that use petroleum thereby magnifying its depletion. The amount of oil remaining would last for only 25 years due to the high rate of oil exploitation. Oil is an essential commodity in manufacturing, planting, mining, and transportation among many activities and its depletion would be devastating. The adverse effects of oil depletion include the fall in business, the high cost of living in developing countries, and uncertainty in the transport sector.

Therefore, to reduce the problem, the manufacturers need to be trained on lean manufacturing through recycling, reusing, and reducing wastage while consumers sensitized on how to adopt re-use, reducing wastage, and recycling techniques. It is better to utilize solar and wind power to reduce the dependency on fossil fuels, which is a major cause of environmental pollution, climate change, global warming, and the destruction of natural habitats.

6.1.4. Invasive Alien Species

Brainstorming Activity 6.4

Identify the questions listed below, think more independently about each, and share your idea with your classmates through small group discussion.

1. How do you describe the nature of invasive alien species?
2. How are invasive species often expanding in the different ecosystems?
3. How do you distinguish between the types of aquatic invasive species?
4. How do you correlate the four phases of invasive plant invasion to the level of cost-prevention or -management (figure 6.7) ?

Invasive alien species include animals, plants, and microbes that infiltrate and invade ecosystems beyond their historic range. They are invaders, outstanding competitors, non natives, exotics, invasive, expand their geographic ranges, nuisance species, and split into multiple species. Some species, such as the rose, modify leaves into thorns, while another plant species might develop fruit only at the top of its canopy, out of reach of a non-climbing predator.

6.1.4.1. Causes of invasive species expansion

The proliferation of invasive species is often exacerbated by climate change. Changes in the species that cause a genetic variation and increase an organism's ability to survive could occur in response to climate change. Flooding can cause a new invasive aquatic or wetland plant invasion but it can also be used to control them. Flooding is a type of disturbance, just like plowing, fire, or any other practice that disrupts the soil profile and denudes the surface of vegetation. Invasive plant species love disturbance because it provides an opportunity for the establishment. Flooding has also been used to a limited extent to control aquatic and wetland invasive plants. In water bodies where the level can be regulated, weeds can be submerged.

6.1.4.2. Habitat basis classification of invasive species

Invasive species can be classified according to where they grow. Most species are **terrestrial** and found on land but others are limited to the **aquatic** environment. Some weeds only infest a particular crop or cropping system, complex plant communities, or growing conditions.

a. Terrestrial invasive species

Phenotypic plasticity is the term used to describe the variance that occurs between individual plants of the same species that are grown in different conditions. Plants exhibiting this behavior is how some scientists prefer to think of phenotypic plasticity. Scientists say the mayapple *(Podophyllum peltatum)*, a herbaceous perennial that grows in rich woodlands, "decides" whether a node will sprout a vegetative or sexual shoot two years before it appears above ground.

Figure 6.3. Mayapple (Podo-phyllum peltatum)

Purple loosestrife (Lythrum salicaria) in the desert, for example, can respond physically to its immediate surroundings; even a desert can have a day of cold rain. This is not always a permanent genetic difference like mutation or adaptation, but rather a transitory change that occurs within the individual plant's life cycle. Variations in the nature and placement of new organs are the most common changes. To acclimatize to lower light levels, one structural modification is to elongate leaf morphology.

Figure 6.4. Purple loosestrife (Lythrum salicaria)

b. Aquatic invasive species

One of the risks of invasive aquatic and wetland plants is that their populations grow enormously year after year with no limits, causing ecosystems to become unstable. Wetlands can get overgrown with invasive plant species to the point where native birds no longer choose to live there. Invasive plant species pose a threat to freshwater supplies. Aquatic and wetland plants compete for sunshine, nutrients, and water with invasive aquatic and wetland plants. They are generally more aggressive than their native equivalents in getting these nutrients and consuming them, leaving little for native plants. As a result, a biologically diversified plant ecosystem has given way to a monoculture of one invading species.

Aquatic invasive plants are modified structurally to live in water. They have been categorized further based on their location in the aqueous environment. These categories are floating, emergent, and submerged.

Floating weeds are plants that rest upon the water surface, and their roots hang freely on the water or sometimes attach to the bottom of shallow ponds or streams.

Emergent species are plants that grow in natural marshlands and can be found around the shorelines of ponds and in the littoral zone of lakes.

They generate larger stems or other support structures in response to the water level. Emergent species are always rooted in very damp soil and stand upright. However, as the water level in a lake or pond rises, emerging species must develop more support tissue. Eventually, buoyancy gives floating-leaved species like waterlines a competitive advantage because they are not forced to build more structures when water depth changes.

Figure 6.5. Mangroves

Mangroves are emergent invasive species that live in saline water and must deal with the problem of salt in the environment in tropical and subtropical locations. The mangrove's competitive adaption is to have its roots above water to obtain oxygen. In fine, frequently wet muck, there is very little oxygen accessible. Roots grow upward above the mud, allowing them to breathe while also supporting the plant. More lenticels equal more oxygen and vice versa.

Figure 6.6. Water hyacinth (Eichhornia crassipes in Lake Tana)

Water hyacinth (Eichhornia crassipes) is another emergent aquatic perennial that develops rosettes of thick, spongy leaves. It's native to South America, but it's now found on every continent except Antarctica, and its distribution is likely to expand as the temperature warms. The water hyacinth can be found in pure strands along the edges of ponds, lakes, canals, ditches, and slow-moving streams, and it flourishes in shallow freshwater marshes. The plants have fibrous and dark roots beneath the water level. A horizontal stem known as a stolon connects the rosettes at the waterline. The hyacinth deoxygenates rivers, killing fish populations, and reducing residents' income and food supply.

Submerged weeds: Although a few floating stems or leaves may exist on the water surface, these plants grow completely underwater.

6.1.4.3. Ecological classification of invasive plants

The invasive plants are often classified using ecological categories related to population behavior. Four phases of invasion are defined as follows.

The introduction is the phase of invasion that results from dispersed weeds arriving at a site beyond their previous geographical range and establishing populations of adult plants. Transportation species become common in an area.

Naturalization is the second phase, during which the species establishes new self-sustaining populations, disperses widely, and integrates into the local flora. Abiotic variables (such as high temperature, high PH, high salinity, NO-3, or NH4+) determine whether an introduced species can survive and reproduce in the new environment.

Colonization is the third step, in which plants in the founding population reproduce and multiply to form a self-sustaining colony. Alien organisms compete for resources by growing quickly and efficiently.

Dispersal is the fourth step of dispersal and establishment in new places, and it is determined by dispersal ability, dispersal vectors, and habitat connectedness. The pace of dissemination can be determined by kinetic production, tolerance to low P and N availability, relatively high salt tolerance, sea currents, and strong shipping activity. The graph shows that it is less expensive to avoid the introduction of invasive species than it is to wait and maintain them once they have become established.

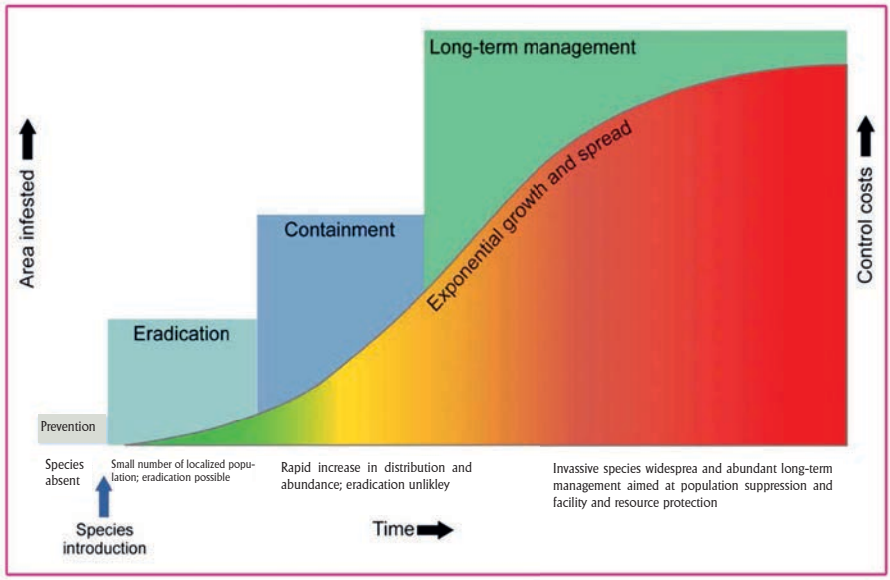


Figure 6.7. The relationship between invasive species spreading and the level of preventation or management cost of the invasive species at different times

During the absence of the species, low-cost prevention is essential. A small number of localized invading species can be eradicated. When there is a rapid rise in distribution and abundance, containment is conceivable but eradication is unlikely. When invasive species are widespread and prolific, long-term control at a significant cost targeted at population suppression and facility and resource protection is an alternative. With time, the contaminated area and management expenses expand rapidly.

What are the major impacts of invasive plants?

Invasive plants are one of the leading drivers of biodiversity loss, species extinction, and the endangerment of natural ecosystems. They are causing native insects, birds, and other species to lose habitat and food supplies.

Invasive species encroachment disrupts normal ecological processes such as plant community succession, as well as native plant-animal connections such as pollination, seed dissemination, and host-plant relationships. They may also endanger human health.

Reflective Activity 6.1

Please tackle the following questions listed below and think independently about each first, and then share your ideas with your classmates through small group discussion.

1. How does a habitat influence a given organism?
2. What are some of the most important factors for habitat fragmentation?
3. How could farmers move from degraded and low productivity conditions to sustainable intensification and thereby improve productivity or natural resource integrity?
4. How does agricultural intensification lead to a reduction in soil quality?
5. How do you understand overexploitation of natural resources, such as fish, water, forests, and minerals?
6. How do you differentiate between the expansion of terrestrial invasive species, such as phenotypic plasticity and Purple loosestrife?

6.2. POVERTY – ENVIRONMENT NEXUS

At the end of this section, you will be able to:

- outline the connection between poverty and environment
- outline the connection between poverty and the environment;
- recognize the cause-effects relationship between land degradation, deforestation, and poverty, and
- be familiar with the land management options to substantially reduce land degradation in your local environment

Keywords:

- **Deforestation**
- **Environment**
- **Land degradation**
- **Poverty**

Brainstorming Activity 6.5

How do you explain the linkage between poverty and the environment (Figure 6.8?)

"Poverty" is a multidimensional concept that includes a lack of access to the whole range of capital assets that can be used to pursue a livelihood.

"Environment" is a broad term that represents natural resources including renewable (they can replenish themselves, provided that the stock, or population, is above a certain limit, or threshold) and non-renewable (the resource cannot replenish itself).

A set of mutually reinforcing relationships between poverty and environmental harm has been identified as the poverty-environment nexus. Figure 6.8 depicts the link between poverty and environmental degradation as a "vicious cycle," in which poverty leads many impoverished people to overexploit and degrade the resources on which they rely to exist day to day. This results in environmental degradation, which exacerbates the scope and depth of poverty. The link has also been shown as a downward spiral, with rising poverty leading to rising environmental damage, and so the poor and the environment's situations become increasingly degraded. Poverty-environment linkages are dynamic and context-specific, reflecting the geographic location, scale, and the economic, social, and cultural characteristics of individuals, households, and social groups.

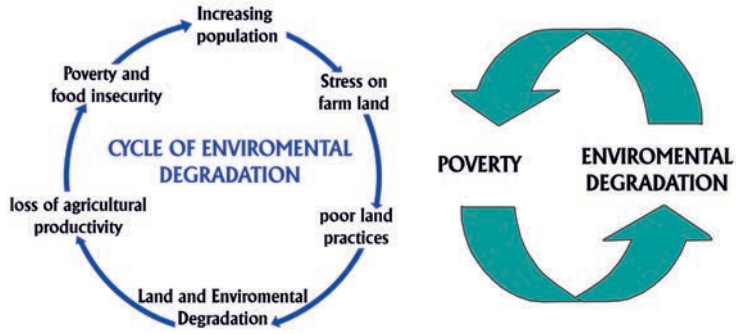


Figure 6.8 'Vicious cycle' between poverty and environmental degradation

Therefore, addressing the issue of poverty requires a good understating of the interactions of the poor with their environment. Poverty-environment mainstreaming therefore aims at achieving the best balance between environmental preservation and poverty reduction for the benefit of the poor and long-term environmental sustainability.

6.2.1. Poverty and land degradation

Brainstorming Activity 6.6

1. How do you explain the linkage between poverty and land degradation (see Figure 6.9)
2. To what extent are you familiar with the land management options to substantially reduce land degradation in your local environment?

"Land degradation" is a persistent decline in land conditions resulting in a long-term reduction or loss of the biodiversity and ecosystem function and services, the productivity of land, its ecological complexity, and human values, caused by direct and indirect human-induced processes.

Soil degradation, biological degradation, vegetation alterations in natural or semi-natural ecosystems, and water resources degradation are major components of land degradation. Land degradation affects people and ecosystems throughout the planet and is both affected by climate change and contributes to it.

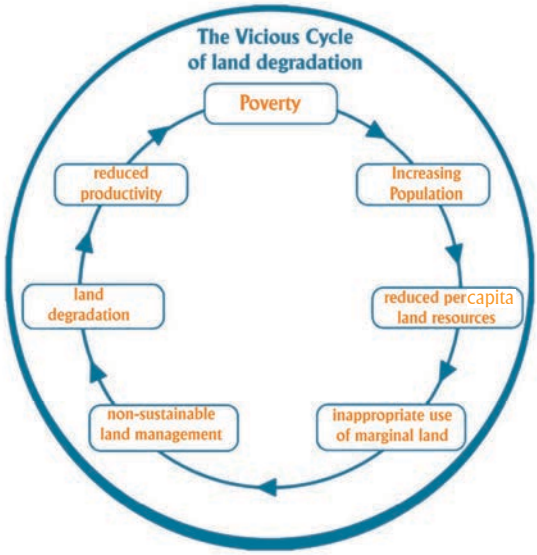


Figure 6.9: The vicious cycle of land degradation

The relationship between poverty and land degradation is complex. Land degradation is caused by both impoverished and non-poor households. Soils in poor countries' humid tropics are poor, leached, and quickly exhausted, resulting in low yields.

The soil resource is being depleted due to water erosion, exhaustion, and soil deterioration caused by overcropping, pollution, salt deposition, and overuse of chemical fertilizers. Soil erosion caused by torrential rain is more likely to occur where natural vegetation cover has been destroyed for farming or where animals have been overgrazed.

Options for land degradation management include soil management, vegetation management, water management, and integrated options. There are several methods for managing soil runoff, pH, salinization, and compaction. Preventing overgrazing, improving cropland management, reducing forest cover loss, maintaining tree stocking density, and maintaining tree species diversity are all options for vegetation management. Water management options include preventing over-extraction and reducing aquifer and surface water depletion, as well as managing landslides and flooding. Management of biodiversity loss, dust storms, invasive species spread, pollution, urbanization, wetlands, and wildlife corridors are all integrated choices.

6.2.2. Poverty and deforestation

Brainstorming Activity 6.7

How do you recognize the cause-effects relationship between poverty and deforestation?

"Deforestation" is the conversion of forest to non-forest land and can result in land degradation.

Poverty causes deforestation; poor people deforest but so do the rich. Added income may not deter poor people from deforestation. Deforestation causes poverty depending on who does it and why, deforestation can destroy or create assets for poor people. The impact of deforestation on access to forest goods and services particularly important to poor households is negative.

Figure 6.10. Deforestation and climate change drive a vicious cycle that exacerbates poverty.

To achieve a balanced linkage between forest preservation and poverty reduction for the benefit of the poor and long-term environmental sustainability, forest strategy and operational policy have three interdependent parts.

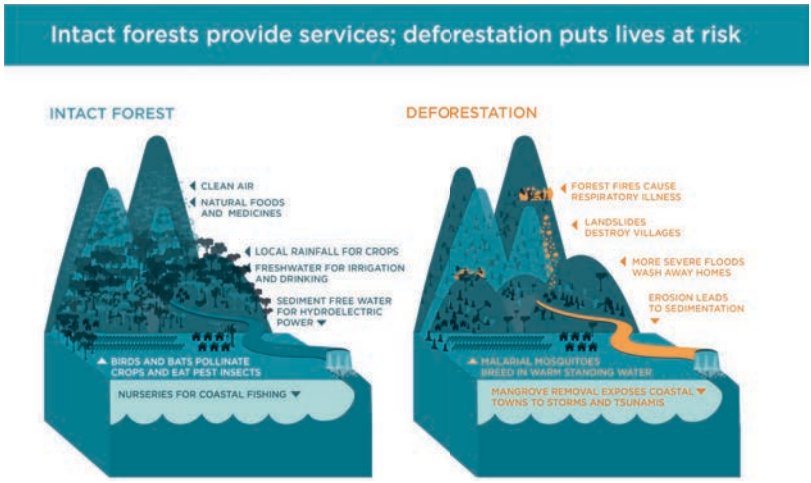


Figure 6.11. Intact forests provide services; deforestation puts lives at risk

The first is harnessing the potential of forests to reduce poverty through strengthening the rights of people especially the marginalized groups to forests and fostering their participation in forest management. Poverty could be reduced by promoting sustainable forestry, community forestry, and agroforestry.

The second is integrating forests into sustainable economic development strategies by improving forest governance and introducing legal and institutional reforms; and encouraging investments that catalyze the production of forest products, including environmental services.

The third is protecting local and global environment values through establishing protected areas, improving forest management in other areas, and developing markets and finance for international public goods such as biodiversity and carbon sequestration.

Reflective Activity 6.2

Please identify the questions listed out below and discuss them by forming small groups and presenting the discussion results to your classmates.

1. How can the best balance between environmental preservation and poverty reduction be achieved for the benefit of the poor and for long-term environmental sustainability?

6.3. ENVIRONMENTAL DEGRADATION AND SUSTAINABLE DEVELOPMENT

At the end of this unit, you will be able to:

- explain the ongoing global efforts to avert environmental degradation and then ensure sustainable development

Keywords:

- **Environmental degradation**
- **Sustainable development**

You will get familiar with and supported in learning about environmental degradation, including its ideas, types, causes, and impacts, in the next discussion. This subsection covers sustainable development as a means of addressing environmental degradation. As a result, consider what is expected of each individual and society to prevent environmental degradation and promote sustainable growth, and express your thoughts.

6.3.1. Environmental degradation

Brainstorming Activity 6.8

Please identify the major types, causes, and effects of environmental degradation?

"Environmental degradation" is the deterioration of the environment through the destruction of ecosystems, habitat destruction, the extinction of wildlife, pollution, and depletion of resources such as quality of air, water, and soil.

Type of environmental degradation

A. Soil degradation is the degradation of soil quality due to poor farming practices, excessive use of fertilizers and pesticides.

B. Water degradation is the pollution of water quality as a result of trash dumped in oceans, illegal dumping, and disposal of large amounts of industrial waste into nearby surface water.

C. Atmospheric degradation includes the air degradation, particle pollution, and the depletion of ozone layer due to increased demand for material goods and consumption levels of world population.

D. Other kinds of pollution, including noise and light pollutions are part of environmental degradation.

Causes of environmental degradation

- **Land disturbance:** land damage is the basic cause of environmental degradation.
- **Pollution:** pollution of the air, water, lands and noise are the harmful causes of environmental degradation.
- **Overpopulation:** rapid population growth demands more food, materials goods, clothes and shelters, and increase overall consumptions levels resulting in an increase in the emission of greenhouse gases which in turn lead to air population and global warming. Excessive numbers of people cause land to be overused, reducing soil cover and soil fertility, vegetation cover and productivity, and setting the preconditions for catastrophic failure of production when the next drought arrives.
- **Landfills:** A large amount of waste disposed into the landfills causes' environmental degradation. Leaks in landfills result in significant soil pollution, and a bad smell of landfills pose a great risk to the health of the environment and the people who live there.
- **Deforestation:** Land clearance is the first and perhaps the most irreversible form of environmental degradation. In the tropics once the forest biomass is cleared, immediate economic and social consequences are severe. Exposed soils erode rapidly, subject to declining fertility, and often contributing to flooding and siltation of rivers and dams.
- **Illegal dumping** waste into rivers, lakes or ocean can cause pollution of water that in turn leads to contamination of fishes and other animals. Waste disposed into forests and soils can contaminate the soil which also leads to ground water contamination.
- **Natural causes,** including earthquakes, tidal moves, storms, and wildfires can crush to nearby animals and plants group to the point where they can no longer survive in those areas.

Effects of environmental degradation

The degree of the environmental impact varies with the cause, the habitat, and the plants and animals that inhabit it.

- Impact on human health: Areas exposed to toxic air pollutants can cause respiratory problems, such as pneumonia and asthma.
- Loss of biodiversity: environmental degradation due to deforestation, global warming, overpopulation, and pollution results in loss of biodiversity.
- Depletion of ozone layer as a result of the presence of chlorofluorocarbons and hydro chloro-fluorocarbons in the atmosphere. The ozone layer is important for protecting the earth from harmful ultraviolet rays.
- Atmospheric changes: Environmental degradation can alter some of the natural process such as the water cycle and the normal processes of animal and plant activities.
- Scarcity of natural resources: environmental degradation through over-exploitation of natural resources, pollution, and deforestation can contribute to the scarcity of resources particularly to arable land, water, genetic resources, medicinal plants, and food crops.
- Environmental degradation has a direct link with long-term food shortage and famine.

6.3.2. Sustainable Development as a Solution to Environmental Degradation

Brainstorming Activity 6.9

How do you explain the link between environmental degradation and environmental sustainability?

"Environmental sustainability" refers to maintaining essential ecological processes and life-support systems (such as soil regeneration and protection, the recycling of nutrients, and the cleansing of waters), preserving genetic diversity (the range of genetic material found in the world's organisms), and ensuring the sustainable utilization of species and ecosystems, on which human survival and development depend.

Environmental degradation is a central issue in sustainable development. Environmental protection through stopping deforestation, government regulation, controlling illegal dumping, recycling and reducing wastes, avoiding plastic waste, and environmental education contribute to sustainable development. Environmental protection is an imperative solution to sustain the quality of aquatic and terrestrial ecosystems.

Adapting for sustainability is the most basic response to environmental degradation. The livelihood of people in highly variable environments tends to exhibit considerable self-reliance and flexibility, as well as a high degree of careful adaptation to local environmental resources and environmental change. Diverse crop varieties, diverse cropping systems, and integrated management of crops and livestock are important adapting mechanisms for sustainable production. Besides, conserving the earth's vitality and diversity, improving the quality of life, reducing non-renewable resource depletion, and developing environmentally-friendly behavior are internationally accepted principles of sustainable development.

UNIT SUMMARY

Persistent environmental change is the most pressing issue confronting our planetary systems today. Persistent environmental changes include habitat loss, agricultural intensification, and the spread of invasive species. Habitat loss could come from landscape modification due to human activity and natural processes. Habitat destruction has the potential to reduce biodiversity globally. An excessive rate of natural resource extraction without adequate attention to regeneration can lead to the loss of natural ecosystems. Natural ecosystems for agriculture intensification result in environmental issues such as constant carbon stock reductions, net nutrient loss from available soil stocks, and ecosystem variety reduction. Another environmental issue caused by climate change and flooding is the proliferation of invasive species on water surfaces and drylands.

In less developed countries, rising poverty leads impoverished people to overuse and destroy the natural resources on which they rely to exist day to day. As a result, both the poor and the environment's position may deteriorate further. To address sustainable development, the optimal balance between environmental preservation and poverty reduction for the poor's benefit as well as long-term environmental sustainability must be achieved. Sustainable development entails preserving the vitality and diversity of the earth, promoting human well-being, limiting nonrenewable resource depletion, and encouraging ecologically responsible behavior.

REVIEW EXERCISES

I. Multiple Choice

Instruction. Choose the best answer from the given alternatives

1. Which one of the following is incorrect?
   - A. Agricultural intensification is an increase in agricultural production per unit of inputs
   - B. Agricultural intensification is most critical when there is a need to expand the food supply during periods of rapid population growth
   - C. When population pressure over land is low, the potential for 'friendship between agroecosystem productivity and natural resource' is high
   - D. A sustainable and environmentally friendly agriculture system needs to be developed to feed a growing world population only
   - E. All

2. Which one of the following is a mismatch
   - A. Overfishing fished down below the size that on average would support the long term maximum sustainable yield
   - B. Over-logging logged at a rate faster than reforestation
   - C. Over-drafting Ogallala aquifer is mined at a rate that exceeds the recharge rate
   - D. None

3. Which one of the following does not belong to aquatic invasive species
   - A. Purple loosestrife
   - B. Emergent plants
   - C. Floating weeds
   - D. Eichhornia crassipes
   - E. None

4._____is the phase of competing of the alien species through fast growth and efficient resource use
   - A. Dispersal
   - B. Colonization
   - C. Naturalization
   - D. Introduction

5. Which one of the following is wrong about the vicious cycle between poverty and environmental degradation
   - A. Environmental destruction further exacerbates the extent and depth of poverty
   - B. Increasing poverty leads to increasing environmental degradation
   - C. Downward spiral relationship
   - D. None

6. Which one of the following is different from the others

A. Respiratory problems, such as pneumonia and asthma
B. Loss of biodiversity
C. Scarcity of arable land, water, genetic resources, medicinal plants, and food crops
D. Deforestation

Instruction: Write the appropriate answers for the following questions

1. How do you explain habitat loss?
2. How do you manage the habitat of a given organism?
3. How do you explain the phrase extinction debt?
4. How does agricultural intensification result in biodiversity loss
5. What are the causes and effects of overexploitation of natural resources?
6. What are the impacts of terrestrial and aquatic invasive species expansion?
7. How do you distinguish between land degradation and environmental degradation?
8. List the types of environmental degradation.

III. Fieldwork Projects:

- Alternative One: Please carry out field observation on some degraded land, forest, or environment and write a report on why such level degradation happened. What are the effects of such degradation on local farmers' agricultural production, fauna habitat fragmentation, invasive species expansions, loss of biodiversity, and other ecological processes, such as erosion?
- Alternative two: Please observe landfills, river basins, and industrial and commercial areas and write a report on how these areas affect human health and biodiversity in the adjacent areas

UNIT SEVEN

GEOGRAPHIC ISSUES AND CONCERNS

Learning Outcomes

At the end of this unit, you will be able to:

- describe the population growth-related challenges of the Developing Countries (DCs) and the remedial measures,
- examine population-related public concerns of our contemporary world,
- evaluate the ever-unrestrained problems of unemployment and underemployment,
- describe environmental degradation and its role in desertification,
- identify areas frequently affected by drought and famine,
- examine the threats deforestation poses to our world, and
- appreciate the emerging digital divide between different regions of the world.

MAIN CONTENTS

Introduction

Population dynamics are closely linked with national and world development challenges and their solutions. In the contemporary world, the greatest challenge is to meet the needs of large and growing populations while ensuring the sustainability of environmental resources. The linkages between population dynamics, inequalities, and resource degradation are major contemporary geographic issues. This unit; therefore, presents and discusses on some of the major geographic issues and public concerns of our current world. These include population-related public concerns of our contemporary world; land degradation and desertification; unemployment and underemployment; drought and famine; deforestation and the worldwide digital divide.

7.1. POPULATION-RELATED CONCERNS OF OUR CONTEMPORARY WORLD

The population-related concerns of our present world are principally family sizes, household income levels, education access, rates of population and economic growth (standard of living), unemployment, and underemployment. This topic thus focuses on these important variables that pose a significant impact on household livelihoods. You are hence expected to grasp basic knowledge of these essential components.

At the end this section, you will be able to:

- identify major population growth-related challenges of the Developing Countries (DCs),
- assess remedial measures to the population dynamics in the DCs.
- evaluate the relationship between family size and education access in the developing and developed world,
- describe the mismatch between population growth and the rate of economic growth,
- show how population growth affects economic growth (living standards of people) in the developing world, and
- assess remedial measures to the population dynamics in the DCs.

Keywords:

- Economic growth rates
- Education
- Employment
- Family size
- Household
- Household income
- Population growth rates
- Underemployment
- Unemployment

7.1.1 Population Growth-Related Challenges in the Developing Countries (DCs) and Remedial Measaures

Brainstorming Activity 7.1

Referring back to unit four of your textbook, please discuss the following questions in groups:

1. Why are population dynamics becoming major contemporary world issues?
2. How do you explain the dynamics of the world population?
3. Identify major challenges of DCs related to population changes?
4. What do you think would be the solutions for the challenges posed by growing populations?

The population growth-related challenges

Higher population growth rates in the more developed countries (MDCs) were reached many years ago. The natural growth rates have been continuously declining in those countries for numerous decades. The highest population growth rates in the DCs on the other hand were experienced from 1960 to 1990. Yet, population growth rates have been falling in all countries for the last 20 years. Nevertheless, the highest population growth is predicted to happen in the DCs. This will probably worsen the poverty levels in those countries. The situation could add stress on the basic economic and social services like health, education, and the environment in the DCs. From the DCs, sub-Saharan Africa (SSA) will face the most rapid rate of population growth in the coming decades coming. Most rapid population increases during the coming decades are also assumed to occur in urban areas (in cities & towns) of the DCs. The increased urban population often comes with more challenges and prospects.

Generally, population pressure and rapid urbanization in the DCs would probably result in severe socioeconomic and environmental challenges. For instance, it can result in:

- Rapid environmental change (land degradation, resource depletion & air pollution),
- Biodiversity loss, habitat destruction, species contraction,
- Extended urbanization (expansion of slums and squatter settlements in urban areas),
- Chronic poverty and malnutrition (food insecurity and water scarcity),

- Health and related problems (poor health which likely results in higher rates of mortality),
- Lack of better education,
- Increased rural-urban migration,
- Housing and shelter shortages,
- Inequality and marginalization,
- Climate change and related hazards, and
- Transportation shortages.

NOTE:

Resource distribution, polarization, and marginalization are among the acute problems facing DCs currently. For instance, only 5% of the world's population enjoys 23% of the world's energy supply. Conversely, 40% of the world population has no access to suitable hygiene services. Another 1.2 billion people lack basic facilities at all.

The remedial measures

The following are the promising strategies to solve the challenges posed by growing populations in the DCs (i.e. to bring population dynamics into the development agenda):

- Ensuring appropriate investment in human capital throughout the life course of citizens to realize the dividends of the demographic transitions (e.g. better education, employment, and health services),
- Promoting healthy aging and economic well-being in old age: providing enabling and supportive environment to the old age group to integrate them into the development process,
- Sustainable urban planning for growing populations: ensuring appropriate infrastructure (education, health & similar services),
- Giving special attention to vulnerable populations: enhancing the adaptive capacity of people affected by droughts, famines, and climate change hazards,
- Ensuring international negotiations and collaborations on migration among source and destination countries,
- Consolidation of rural-urban relations via sustainable integrative development planning,
- Diagnosing the diversity of demographic situations and their varied implications,
- Changing fertility patterns: through girls' and women's education; accessing reproductive health services,
- Equal opportunity for citizens: fair access to employment, and socioeconomic benefits.

Reflective Activity 7.1

Attempt the following questions by forming groups.

1. How do you describe the world population dynamics?
2. How do you compare the major challenges of population dynamics in MDCs and DCs?
3. How do you realize the possible ways to bring population dynamics into the development agenda in counties of SSA?

7.1.2 Family Size, Education, and Income of Families

Brainstorming Activity 7.2

Complete the following questions thoughtfully before reading the text descriptions.

1. What is the difference between household and family?
2. Illustrate how household size affects education and income?
3. How do you evaluate education access levels in developing countries?

Family refers to members of households who have kinship or blood relationships and/or those bound together through marriage. It includes all related individuals (parents, children, aunts, uncles, grandparents, etc.). Family covers;

- Married couples without children,
- a married couple with one or more unmarried children, and
- One parent with one or more unmarried children - representing the concept of a "nuclear family".

Household: refers to groups of persons who are living together and make common supplies of food, shelter, and other essentials required for living. It may comprise people with no blood or marriage relationships but share similar shelter or housing units. A household may comprise other than one family. It can consist of one or more than one non-related person, or exclusively of non-related individuals.

Yet, a family cannot embrace more than one household. The household is generally the principal unit in society. Choices concerning childbearing, education, healthcare, living engagements, division of labor, saving and even migration are often decided at household scales.

Basic household types can include:

- a single person household: comprise only one member,
- Couple only household: comprise married or in-partnership couple only,
- Couple with children household: holds married or in-partnership couple and their children only,
- Single parent with children household: comprise a single parent and children,
- Extended-family household: comprise all members that are related to each other plus one or more members outside of the nuclear family unit,
- Non-relative household: include at least one member who is not related to the head.

NOTE:

The couple-only, couple-with-children, and single-parent-with-children configurations are each example of households in which all members belong to the same nuclear family unit.

Household composition refers to the description of households based on age, relation to the head, number of marital pairs, or nuclear families it holds. It has a significant influence on the welfare activities of family members and individuals. Configuration and size of the households are connected to childbearing, education, healthcare, expenditure urgencies, and consumption arrangements.

Worldwide mean household numbers range from 2 to 9 persons. The minimum and maximum sizes range from less than 3 individuals per household in Europe and North America to greater than 5 individuals per household in Africa and the Middle East, respectively. Please note that the size of households can differ with the conditions of fertility and marriage; permanency and mobility; 'home-living among young people'; occupation patterns; local culture and norms, and migration.

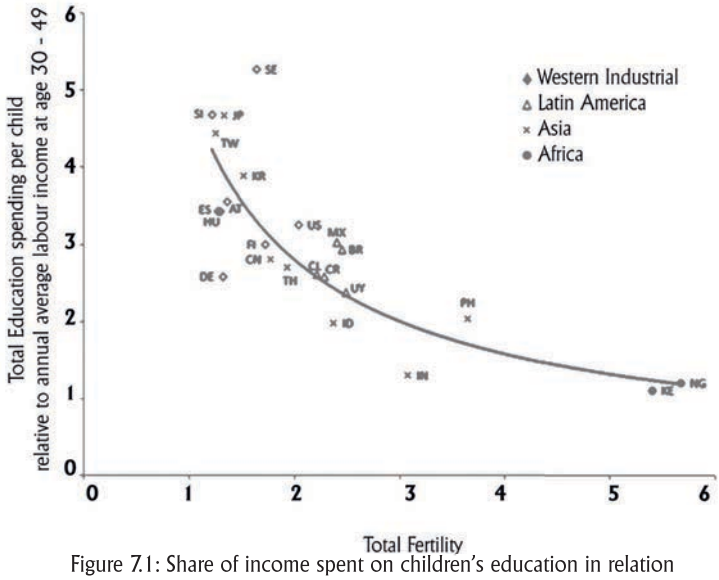


Figure 7.1: Share of income spent on children's education in relation to labour income versus total fertility

Source: Derived from estimates produced by the National Transfer Accounts Project.

Increased size of children (age 5-14 years) conveys extra load to households in the DCs. Households with large family sizes in those countries are forced to pay more money for schools and teachers; and the purchase of educational materials. This may influence the quality of education. Countries with higher levels of births are liable to have higher levels of illiteracy among girls (aged 15–24 years) than those countries with intermediate birth rates. Spending more years in schooling delays the probability of childbirth and enables smaller family sizes. Households with an extended number of children are more likely to invest less money for child education and healthcare which thus pushes to continual poverty (see Figure 7.1). Educating women thus helps to minimize the rate of births. Limiting the size of families similarly contributes to the attainment of better education.

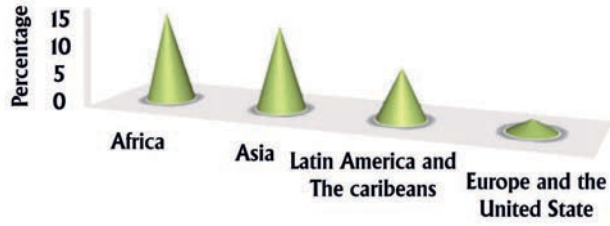


Figure 7.2. Percentage of households with both children under 15 years of age, and older persons aged over 60 years

Source: United Nations database on household size and composition, 2017

Multi-generational households belong to housing units hosting co-residence of families of three or more generations. Such households provide co-residence to children (‹ age 15 years) and elders (› age 60 years). Such families are frequent in Africa (14%) and Asia (13%); but rare in the USA and Europe which is around 2% (Figure 7.2). Similarly, skipped generation households refer to the co-residence of elders (grandparents) with grandchildren; however, not parents of the grandchildren.

Household income: household income consists of all earnings, whether monetary or in-kind (such as goods and services), collected by households or their members annually or at frequent intervals. However, it excludes bonus gains and other irregular and typically one-time earnings.

Income distribution is uneven across the world scales. Income from wealthy countries emerges from 16% of the population and accounts for 55% of the world total. DCs account for 72% of the world population but contribute only 1% to the global total. For instance, mean incomes from North America and the European Union are about 16 and 11 times larger than that of SSA, respectively. Nevertheless, the per-capita incomes of DCs are increasing faster than the MDCs. Nonetheless, the absolute average per-capita income gap between DCs and MDCs had increased from about $27,600 in 1990 to over $42,800 in 2018. Mean income gaps (inequalities) between citizens of DCs are too large.

Lower economic growth rates and more employment losses excessively affect people in the DCs. Enormous employment and income losses rapidly push an immense rise in poverty. Low-income households often hold a large number of children and investment is low on human capital. They are frequently exposed to a meager food supply and poor health. Households with fewer children and more income, invest more money per child for nutrition, health, and education. Recently, the Coronavirus (COVID-19) pandemic has been worsening disparities within countries.

7.1.3 Rate of Population and Economic Growth

The problems of growing populations and food supplies have been the main concern of people since historical times. Some people perceive that the relationship between population and economic growth is direct while others believe the relationship is indirect. There are thus two major contrasting views concerning the relationship existing between population growth and economic development. These are:

1. The pessimistic Malthusian and neo-Malthusians views and
2. Optimistic anti-Malthusian views.

Brainstorming Activity 7.3

Please attempt the following questions in groups and tell your answers to your teacher.

1. How do you evaluate the linkage between population and economic growth rates?
2. Have you ever heard about Malthus's theory of population growth and food production?

1. Malthusian and neo-Malthusian views

Thomas Robert Malthus (1766-1834)

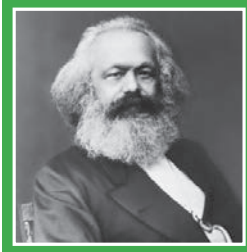
Thomas Malthus was an English economist and clergyman during the 18thC AD. He argued that rapid population growth results in resource scarcity and economic stagnation. Malthus thought population growth and food production are inversely related. He assumed that population grows faster than food supplies and leads to poverty and hunger. Malthus argued that population multiplies in a Geometric progression (1…2…4…8…16…32…) while food production increases constantly in an Arithmetic progression

Malthus thought these contrasting trends create a condition where population number outstrips food supplies that eventually causing resource scarcity, hunger, disease, and war plus resource conflicts - that he called catastrophes. He considered the catastrophes are inevitable positive checks of population growth emerging to equalize the imbalance between population and economic growth. Malthus proposed preventive checks in place of the inevitable positive checks to control population growth. Preventive checks to Malthus are moral restraints that include delayed marriage, avoidance of making sexual meetings, and having fewer children. Thomas Malthus developed his theory in 1798 in his treatise titled: "An Essay on the Principles of Population".

Unlike Malthus, Neo- Malthusians have different view on the preventive check i.e, family planning need to be addressed. They argue that there is an imbalance between rates of population and economic growth. They believe that rapid population growth retards economic progress.

2) Anti-Malthusian views

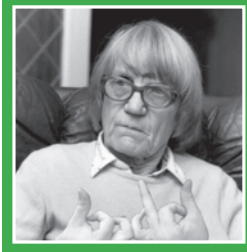
These are of two types: a) Marxist view; and b) Boserupianview



Karl Marx
(1818 – 1883)

Karl Marx was a German philosopher and political writer of the 19thC AD. He was among the socialist (communist) theorists that oppose the theory of Thomas Robert Malthus. According to Karl Marx, production in the capitalist economic system is not targeted at meeting people's needs; but an accumulation of capital.

The system considers the poor unnourished people as a 'surplus population'. Capitalism uses the 'surplus population' for securing job competition among the jobless to cut wages and maximize profits for the ultimate capital accumulation. Marx, finally, suggests socialism as the best solution to growing populations and increasing food demands. He advocated the establishment of socialism; a new social system with differing economic structures and socio-political orders.



Esther Boserup
(1910 – 1999)

Esther Boserup was a Danish economist of the 20th C. She argued that population growth can be compensated through food production using induced technology and innovation. She developed this anti-Malthusian theory in a thesis titled: "Theory on Population and Agriculture" in 1965; against Thomas Malthus. Boserup argues population is an important variable that positively influences agricultural development through the application of innovative technology.

Boserup and her supporters argue population growth could not be regulated by the shortage of food supplies and necessities as reported in Malthus (1798). According to these scholars, the increasing demand for food supplies from growing populations encourages agricultural innovation and the use of technologies in farming to keep pace with the growing needs. In this context, Boserup confirms that necessity is the mother of invention.

Anti-Malthusians are in general optimists who consider population growth shall not slow down economic development. They argue that an increase in population is an opportunity rather than being a predicament for economic development. They add that resource limitations initiated by increased populations could be minimized by the creativity (inventiveness) of the human mind.

NOTE:

The connection between population and economic growth rates is intricate. Having more people provide the potential to engage abundant human labour in the production of material goods and services. Engaging large labour in the production sector likewise offers enormous economic benefits. In this context, population growth endows the potential for economic development.

On the other side, if the rate of economic development exceeds the rate of growth in the human population, per-capita income will increase. Slowing-down the rate of population growth past lowering fertility rates may thus result in the "Demographic Dividend". This means, the number of working-age population increases compared to the dependent population. The Demographic Dividend then allows investing more in health and education. It again pushes to increase labour productivity and help DCs to sustain a steady macroeconomic situation. If the working population properly engaged in production activities, production and per-capita income will rise up swiftly than in the previous.

Nevertheless, the rapid falls in population growth rates were observed not to promote full potential economic development in many DCs (e.g. in Latin America and the Caribbean region). This implies that birth reduction alone never brings full development; though it potentially speeds up economic progress. Sustainable economic growth thus depends not only on fertility declines. It relies on the availability of veracious institutions, sound socio-economic policy, human capital, job opportunities, equity, and fair income and wealth distribution. Rapid population growth brings a higher youth dependency ratio and inequality. It is often linked with challenges such as chronic poverty, poor health, low education access, more hunger, and malnutrition.

7.1.4. EMPLOYMENT, UNEMPLOYMENT AND UNDEREMPLOYMENT

Brainstorming Activity 7.4

1. Why is unemployment becoming such a critical problem in society; particularly in DCs?

a) Concepts and definitions

Employment: employment refers to the occupation of individuals or groups of people in certain income-making activities for earning money or useable products to satisfy personal and household livelihood needs. The occupation could be permanent or temporary depending on the type of employment. The type could be also self-employment (working in one's own business); working in public services (through monthly wages); occupation in private companies or corporations; and/or working in any income-generating activities on a daily; monthly or annual basis.

The universally regulated age of employment is ≥15 years (completion of compulsory training). Nevertheless, the age limit can vary from country to country depending on the level of development. The minimum age limit for employment in Ethiopia is ≥ 18 years. In most cases, age ≥18 years is commonly accepted to be the minimum age of occupation by many countries so as not to endanger the morale, health, and wellbeing of citizens.

Unemployment: unemployment can literarily be conceived as joblessness or having no occupation to harvest money or products for supporting self-living or household livelihoods. It is the occasion when an active working person or persons lack the opportunity to get an appropriate occupation for producing livelihood support resources.

Unemployment levels have recently been taken as signals of economic development, market recital, and social wellbeing. The rates of unemployment in general terms may vary from country to country and from region to region. DCs for instance, face the highest rates of unemployment compared to MDCs. This is because DCs are characterized by higher rates of population growth and urbanization. They lack the necessary economic structure to engage the growing job demand beyond agriculture. Higher levels of unemployment could be indications of economic disaster. Lower levels of unemployment may equally be indicators of an 'overheated economy'.

Addressing youth unemployment problems in DCs like those in Africa is becoming a formidable policy contest nowadays. Large numbers of university graduates in those countries lack employment opportunities due to deficiencies in 'employable skills' (skill discrepancies) with the demands of the employment market.

NOTE:

The unemployment rate for any region or country can be computed as:
(Number of unemployed individuals)/(Sums of employed and unemployed individuals) x 100=unemployment rate of a year
Case Example: Given that the number of unemployed people is about 2,350,000 and those employed are 56,000,000 in Ethiopia in 2022, the unemployment rate is estimated as:
(2,350,000)/(56,000,000+2,350,000) x 100=2,350,000/58,350,000x100=4%.
This implies that from hundred people, four individuals are unemployed in the country in 2022.

The DCs require to urgently nurture sustainable development programs to host the unemployed youth population. The agricultural development activities in those countries have to be supported by non-farming enterprises. This may create economic diversification and a wide range of opportunities for youth employment.

Underemployment: refers to the condition where productivity and duration of occupation remain below the expectations, preferences, and capacities of employed persons. It includes the inadequacy of time to cover the work (time-related underemployment); and/or incompatibility of 'occupational skills' and payments (inadequate employment situations) to the employed persons. Both aforementioned impressions reflect 'under-utilization of the worker's capacities.

To generalize, employment and unemployment hold the basic life affairs of individuals and households in society. For instance, unemployment poses distressing effects on individuals and households' livelihoods. It upsets not only the unemployed individual but also household members as well as the broader community. Unemployment mainly distresses the living conditions of elders at the retirement age.

The Economic Dependency Ratio (EDR): relates the number of non-workers (unemployed and underemployed) to the number of workers or employed in a given country, representing the share of the dependent population. It is computed as:

$$\text{Economic Dependency Ratio (EDR)} = \frac{U+I+\text{Age 0-14 years}}{E} \times 100$$

Where U=unemployed persons (age ≥15 years), I = persons not in the labor force or underemployed (age ≥15 years), E= employed persons (age≥15 years), and age 0-14 years = children age 0-14 years. For instance, the economic dependency ratio of the urban population of Ethiopia in 2018 was:

Economic Dependency Ratio (EDR)=(1,770,294+5,682,453+3,757,574)/7,518,855 x100=149, implying that 149 dependents could be supported by 100 employed persons in terms of food, clothing, health, education, and others. Table 7.1 indicates the economic dependency ratio of the urban population by activity status and sex in Ethiopia in 2018.

Table 7.1: Economic Dependency Ratio (EDR) of urban population of Ethiopia by activity status and sex in 2018.

Sex	**Urban total population**		**Activity status**			Economic dependency ratio/ EDR
	All aged	Aged 0-14 Years	Employed	Unemployed	Economically not active	
Male	8,734,738	1,878,340	4,213,920	584,585	2,040,242	107
Female	10,038,297	1,879,235	3,304,935	1,185,709	3,642,210	203
Total	18,773,035	3,757,574	7,518,855	1,770,294	5,682,453	149

Source: CSA, 2018

Reflective Activity 7.2

Attempt the questions given below first individually and then discuss the answer with your classmates.

1. How do you explain the linkage between family size and level of socio-economic development?
2. What is the difference between unemployment and underemployment?
3. Why has participation in the global labor market been steadily declining?
4. Why does addressing youth employment remain a daunting policy challenge in Africa?

7.2. LAND DEGRADATION AND DESERTIFICATION

Land degradation is the long-term alteration of the quality and quantity of the land over a given geographic area. It leads to the loss of the biological mass including forests, pastures, and meadows. Land degradation affects soils and water resources as well as causing air pollution and scenic deterioration. Extreme climatic patterns, droughts, plagues, pathogens, and floods are manifestations of land degradation and desertification. This topic thus focuses on these pressing issues.

At the end of this section, you will be able to:

- identify the forms of land degradation,
- describe consequences of land degradation, and
- evaluate the relations between land degradation and desertification.

Keywords:

- **Causes;**
- **Desertification;**
- **Impacts**
- **Land degradation**

Brainstorming Activity 7.5

1. What is land degradation?
2. What is desertification?
3. How do you explain the cause and effect relationship between land degradation and desertification?

7.2.1 The forms of land degradation

Land degradation refers to the long-term lessening of productivity of land resources, ecological integrity, and the worth of humans. It involves the deterioration of physical, chemical, and biological processes (Figure 7.3).

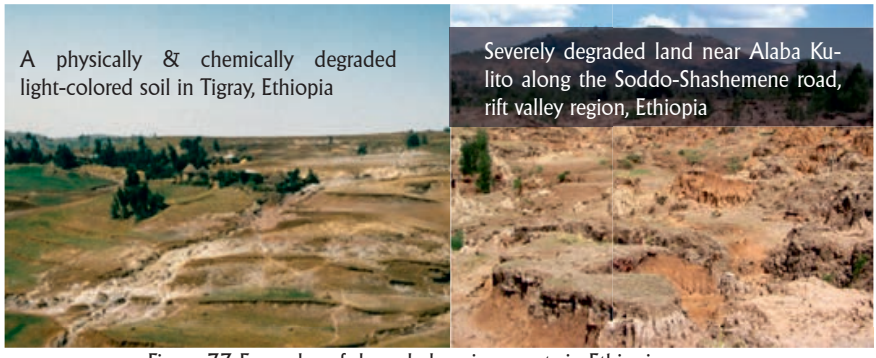


Figure 7.3 Examples of degraded environments in Ethiopia

Physical degradation: this involves the physical breakdown and alteration of land resources. land resources are often physically deteriorated as a result of mechanical damage through detachment, translocation, pollution, wastage, and excessive use. This type of degradation manifests itself through compaction, crusting, hardening, thinning, and sealing of soils. It causes a textural and structural changes in soils including color changes (e.g. see Figure 7.3). Water dries up and shows a physical change of color when degraded. The size, density, and composition of plant species also decrease with excessive use.

Chemical degradation: this introduces a relative change in the constituent components of the Earth's resources. Chemical degradation causes a chemical change in the constituent minerals of land resources. It involves the loss of nutrients from soils; eutrophication of freshwater and quality alteration in the biomass. When soils are chemically altered, they become acidic or alkaline due to changes in Hydrogen (H^+) and Hydroxide (OH^-) ions, respectively.

Biological degradation: biological degradation comprises the alteration of the biological mass due to human and natural causes. Natural forests can be altered by the excessive use by humans. Deforestation, overgrazing, and spraying harmful chemicals degrade forest resources. It results in the contraction of the sizes, species composition, and quality of the forest resources.

7.2.2 The Causes of Land Degradation

Land degradation is caused by natural and human factors. The natural factors include the alteration of landscapes by a volcanic eruption, flooding, and tsunami. The human factors are population pressure and anthropogenic induced climate change; improper farming practices; land use/cover changes; rapid urbanization; weak policies and institution, and unsustainable use and management of environmental resources.

7.2.3 Impacts of Land degradation

Land degradation damages freshwater and marine ecosystems plus the livelihood of households and communities. It drives climate change through the release of greenhouse gases (GHGs) and minimizes rates of carbon sequestration. Humans whose livelihoods directly depend on raw resources are more affected by land degradation. Those people with lower adaptation choices will be more susceptible to climate changes posed by the degradation of land resources. Land degradation and climate change cause risky livelihoods accompanied by food insecurity and poverty. In Afar the bounds of adaptation levels, land degradation, and climate change hazards instigate ever-increasing harms and unwelcomed vagaries like forced resource conflicts, poverty, and migration.

NOTE:

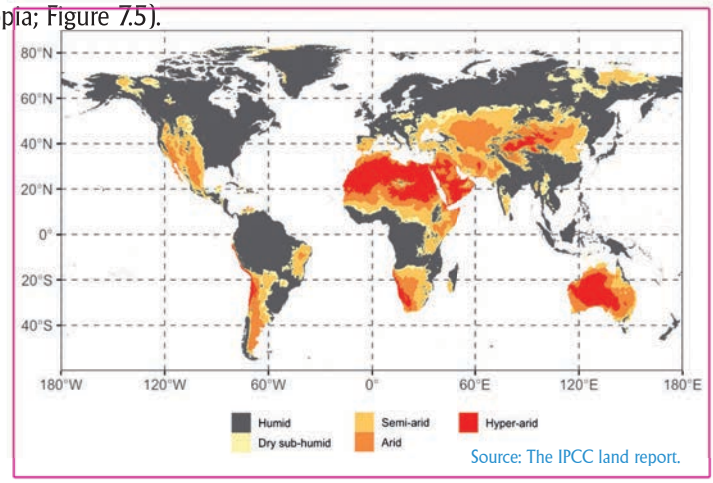
Land degradation can be minimized through:

- Afforestation and reforestation: planting trees on barren and deforested areas,
- Controlling unsustainable tree cutting for fuel and construction,
- Limiting the expansion of farming to marginal lands, and
- Using alternative energy sources to reduce tree cutting for fuel.

7.2.4 Desertification

Desertification is land degradation in dry, arid, semi-arid, and dry sub-humid areas. Its variation from land degradation is mainly geographic for the latter can occur including in the wetter areas of the Earth. The size and intensity of desertification have been increasing in recent decades mainly in the dry, and arid areas (see Figure 7.4).

Deserts often occur naturally adjacent to cold ocean currents and at the interior of continents. Desertification posed by land degradation is rather derived from anthropogenic forces. Population pressure; policy and socioeconomic settings; expansion of farming to drylands; forest burning; and inappropriate land use and management practices are among the anthropogenic causes of desertification. Human-derived climate change exacerbates the intensity of desertification. Desert landscapes are characterized by increased aridity, barren and saline soils, and sparse vegetation (e.g. see desert and drought-affected environments in Ethiopia; Figure 7.5).



Delimited based on the Aridity Index (AI):

humid AI › 0.65;

dry sub-humid 0.50 ‹AI ≤ 0.65;

semi-arid 0.20 ‹ AI ≤ 0.50;

arid 0.05 ‹ AI ≤ 0.20;

hyper-arid AI ‹ 0.05.

Figure 7.4: Geographical distribution of drylands,

Like land degradation, desertification poses several impacts on the environment and human livelihoods. For example, it:

- Lessens the productivity of agriculture and household incomes;
- Minimizes the provision of dryland ecosystem services;
- Causes contraction of the biological diversity;
- Leads to the expansion of invasive plant and animal species;
- Increases soil salinity (accumulation of dissolved salts in groundwater);
- Raises greenhouse gas emissions.

Figure 7.5 Desert landscapes in Ethiopia's Afar & Somali Region

As you can see desertification causes many ecological and socioeconomic impacts. So, how can it be minimized? The following measures are suggested to restrain its effects:

- Application of indigenous and local knowledge(ILK): e.g. dry farming and irrigation;
- Using site-specific technological options,
- Water harvesting (planting pits, micro-basins, micro-ponds),
- Diversification of farming and income sources;
- Growing drought-resilient and short maturing crops,
- Application of terracing, relay cropping, intercropping, and reduced tillage practices,
- Livelihood diversification: non-farm and off-farm work,
- Enhancing early-warning mechanisms.

Reflective Activity 7.3

Attempt the following activities independently and share your answer with your classmates through small group discussion.

1. Why is land degradation such a critical problem for rural households in developing countries?
2. How do you distinguish between desertification and land degradation?
3. What are the major strategies that can be used to reduce land degradation and desertification?

7.3. RECURRENT DROUGHTS AND FAMINES

Drought is a prolonged deficiency of moisture and water for certain activities. It is often allied to rainfall abnormality that commonly causes a serious hydrological imbalance. Drought can be categorized as metrological, hydrological, agricultural, environmental, and/or socioeconomic based on intended specific purposes.

Famine is accompanied by severe and prolonged hunger due to a lack of edible items as the result of drought or any other risk. It is commonly linked to drought or perhaps the two complement each other. Both cause a wide range of devastations on the environment, population, health, and livelihoods. This topic thus focuses on these two environmental catastrophes.

At the end of this section, you will be able to:

- Identify areas prone to droughts and famines, and
- evaluate the relationship between droughts and famines

Keywords:

- Famines
- Impacts
- Mitigation measures
- Recurrent droughts

Brainstorming Activity 7.6

Attempt the questions listed below before reading the descriptions given and share your ideas with your teacher.

1. How do you understand the linkage between drought and famine?
2. Why are drylands highly vulnerable to recurrent droughts?
3. Why are developing countries highly vulnerable to famines?

7.3.1. Drought

As can be seen from the preceding paragraph, drought is the persistent absence of rainfall that causes water shortage for certain activities. It results in hydrological imbalance and abnormal dry spells due to long periods of dry weather. As mentioned earlier, the definition of drought can vary with the variations of the intended objectives of different professions. For instance, in the science of metrology, drought is primarily defined as an extended shortfall of rainfall. Hydrological drought on the other hand relates to the under-normal water flow in the lakes, streams, and underground sources. Agricultural drought is defined as the deficit of moisture on the topsoil. This is because the absence of moisture on the topmost part of the soil affects the growth of crops. The aforementioned three drought types in combination form the environmental drought. They together lead to the imbalance between demand and supply in society; commonly named socioeconomic drought. Socioeconomic drought thus links to the supply and demand of material goods (like water, fodder, food crops, fish, and energy). It has also strong links with the features of meteorological, hydrological, and agricultural droughts.

Droughts are very common in arid drylands. They frequently happen in those areas through the occurrences of extreme climatic events.

The persistent occurrence of anticyclones or advection of hot and dry air masses exacerbates the conditions of the drier areas. Rainfall reductions and excessive moisture losses because of high-temperature levels in the drier areas causally drive the occurrence of droughts.

a) Global Trends and Patterns of Drought

The global trends (frequency & intensity) of droughts have been increasing in West Africa and the Mediterranean region since the 1950s. Conversely, droughts have been showing decreasing trends in Central America, North America, and northwest Australia. Due to climate change, the intensity and frequency of droughts have also been shown to exacerbate the severity of meteorological and agricultural droughts over the drylands of the world.

b) The Impacts of Drought

The following are the direct and indirect effects of drought:

- droughts directly affect agricultural production (e.g. see Figure 7.6),

Drought affected livestock (Eastern Ethiopia)

Crop failure due to drought in Ethiopia

Water crisis due to drought (Ethiopia)

Figure 7.6 The effects of climate change-induced drought and famine in Ethiopia.

- They reduce water supply (dry-up wetlands),
- Reduce plant diversity and composition,
- Cause the loss of biodiversity and natural ecosystems,
- Droughts indirectly affect business, employment opportunities, and income,
- They cause health hazards to humans and animals,
- Cause rise in food prices, food insecurity, malnutrition, widespread famine, starvation, and poverty,
- Raise school dropout rates,
- Migration, social unrest, and even conflict in extreme cases.

c) Response and mitigation strategies of drought

The responses for drought occurrence include the use of:

- Improved drought monitoring services,
- Better water and crop management strategies (e.g. the use of groundwater supplies),
- Creation of public awareness and education,
- Watershed management and local planning strategies,
- Developing early-warning capacities.

NOTE:

The aforementioned drought mitigation measures and responses can be accomplished through:

- Soil and water conservation (SWC) practices: (e.g. crop rotation, row cropping, terracing, minimum tillage, trenches, shallow wells, shelterbelts, mulching, and reclamation of salt-affected soils), and
- Herd management: reduction of livestock heads and parasite control.

7.3.2. Famine

Famine is persistent and acute hunger or starvation caused by food and water scarcity over a geographic area. It is a widespread and severe state of malnourishment, starvation, illness, and death of a significant part of the population. It is caused by natural and human factors. Recurrent droughts, landslides, floods, tsunamis, locust invasions, epidemics, an unfair share of resources, inequalities, plus wars, and conflicts result in famines and starvations among human beings. Famines may cover considerable periods lasting from some months to a few years

Famines can be minimized by using the following strategies:

- Accessing humanitarian aid: this involves the donation of food and other necessities including healthcare to address the immediate and basic needs of the victims (e.g. see Figure 7.6),
- Rebuild communities: taking rehabilitation and restoration measures,
- Strengthen local food system resilience: working on sustainable food access options,
- Focus on long-term economic strategies: promotion of long-term socio-economic development measures (e.g. diversification of the economy; expansion of employment options; liberalizing the market and product distribution patterns; etc.).

Reflective Activity 7.4

These questions help you discuss about drought occurrence, types of droughts, and mitigation strategies of droughts. Thus, attempt them individually and then share your ideas in groups.

1. How does drought occur?
2. How do you relate and differentiate the drought types?
3. What are the key strategies of famine prevention?

7.4 DEFORESTATION

Forest ecosystems provide a wide range of services. They stabilize local climates; control flooding, and filter human and natural wastes. Forest trees minimize soil erosion at local, regional, or global scales. They also uptake and store the world's carbon stocks and serve as heat and waste sequestration. Forest resources again serve as a habitat for the Earth's known terrestrial species. Nevertheless, deforestation (excessive tree cutting), encroachment of farming into the communal forest areas, and mismanagement largely reduce their services despite the enormous benefits that they provide. The topic at hand thus focuses on deforestation.

At the end of this section, you will be able to:

- identify the causes of deforestation,
- describe the consequences of deforestation

Keywords:

- Deforestation

Brainstorming Activity 7.7

Form groups and discuss the following questions:
1. Distinguish between forest degradation and deforestation
2. What are the direct and underlying drivers of deforestation?
3. What are the effects of deforestation?

Deforestation refers to the removal of forest trees and their products through commercial logging; clearing and burning of vegetation for farmland expansion; and/or cutting trees for construction and fuel-wood demands (see Figure 7.7).

7.4.1 Causes of deforestation

The sources of deforestation can be classified as underlying and proximate causes. The underlying causes are indirect sources but play a principal role in deforestation to happen. One of these is climate change (change in rainfall levels & patterns). The other is purely anthropogenic. It includes population pressure, cultural and socioeconomic variables, and government policy types. For instance, flawed policies cause tenure insecurities, weak law enforcement, and wrong allocation of rights. Regressive cultural practices lead to unsustainable use of forest resources. Weak economic policies push poor investment patterns and promote the rate of deforestation. High population growth transpires additional demand for resources and expansion of farming to the virgin lands through the emergence of new landless households.

The proximate causes are direct drivers of deforestation. They include:

- Clearing and burning of forest trees for farmland expansion;
- Fuel-wood collection and timber production;
- Expansion of new settlements and infrastructural developments;
- Mining and quarrying activities;
- Commercial logging practices; plus
- Overstocking and overgrazing.

Figure 7.7 Ways of deforestation and vegetation

7.4.2 Consequences of deforestation

When forests are removed:

- Long-term carbon stock reduction may happen,
- Loss of biodiversity and other products will occur,
- Destruction of biomes and wildlife habitats happens,
- Disruption of the natural hydrological cycle and river ecosystems may ensue,
- Droughts and famines may transpire,
- Erosion, flooding, and sedimentation can take place,
- Soil nutrient depletion may take place; and
- Global warming and climate change may become worse.

The risks of deforestation can be minimized through the proper use of available forests and by planting trees in degraded areas. Running afforestation and reforestation programs; area closures; controlling forest burning; restricting commercial logging; using alternative energy in place of firewood, and using rubber panels in place of timber help to minimize the rapid loss of forests.

Reflective Activity 7.5

Try the following questions individually and then share your idea with your teacher

1. Differentiate between deforestation and forest degradation.
2. How do you understand the connection between proximate and underlying causes of deforestation?
3. How do you justify sustainable forest management?

7.5. THE WORLDWIDE DIGITAL DIVIDE

The digital divide refers to the gap existing among persons, households, companies, and geographic areas with diverse socioeconomic backgrounds related to access to information about economic and political opportunities and the use of the internet for a wide variety of purposes. Access gaps to computers, televisions (TVS), mobile phones, and internet services are important indicators of the digital divide. On the international scale, telecommunication services provide universal access to narrow the gap of the digital divide. This topic is thus aimed at familiarizing students with these disparities.

At the end of this section, you will be able to:

- explain the emerging digital divide between different regions of the world.

Keywords:

- Digital divide
- ICT

Brainstorming Activity 7.8

Discuss the activities below in groups and share your ideas with your classmates.

1. What is a digital divide?
2. Identify factors intensifying the global digital divide.

The digital divide is the breach between persons, families, companies, and geographic regions at varied socioeconomic levels concerning retrieving relevant information for getting access to a wide range of economic and political opportunities. It mainly relates to the difference in getting access to information communication technologies (ICTs) and the use of the internet for a wide variety of activities. On an international scale, availability of the universal telecommunication access plays an important role narrowing the gap of the worldwide digital divide. Access to TVs, computers, mobile phones, and the internet is an imperative sign of the digital divide.

Although ICT utilization has been vividly expanded over the past decades, access appears to diverge widely between regions; and also between countries. For instance, access and exposure to internet technology are at the lowest among the countries in South Asia, and SSA is equated to MDCs. The possible reasons for the growing gaps are:

- Income and financial shortages,
- Poor quality Vs. expensive connections,
- Low level of education (lack of digital literacy and poor technical knowhow),
- Limited access to ICT,
- Lack of knowledge and understanding of the technology, and
- Absence of opportunity to learn how to use computers.

NOTE:

The digital divide among information "haves" and 'have not mainly relies on income and education. Factors such as family size, age, sex, cultural and linguistic experiences plus geographic location likewise play imperative roles. Governments should play the principal role in narrowing the breach by making and organizing reachable e-services and plausible ICT. Implementing a cohesive and citizen-oriented style might lead governments to enhance fair opportunities in the use of ICTs.

Consequences of the digital divide:

- Damage to old business takes away jobs (because digital works need more education),
- Broadens income inequality (worsening income disparity among individuals & countries),
- Exacerbates the hazard of personal security (cyber terrorism, criminal networks, illegal money, hate speech, fake news, etc.).

Advantages of digitalization:

- Travel reservations, translations, support and customer services, telemedicine and e-learning,
- Social networking,
- Provision of affordable education and learning materials for students,
- Real-time weather and market information for poor farmers and fishermen,
- Training for teachers, medical diagnosis and information for those living remotely, and
- Financial services for the unbanked services previously out of reach for remote areas and underserved populations.

Reflective Activity 7.6

Consider the questions listed below individually and then share your feelings with your classmates.

1. How could bridging the digital divide take place?
2. What are the opportunities and challenges of digitalization?

UNIT SUMMARY

The main themes of this unit were major geographic issues and public concerns of the current world. Accordingly, population-related concerns (like family size, education, and income; population and economic growth rates; unemployment and underemployment); environmental degradation and desertification; drought and famine; plus deforestation, and the worldwide digital divide were considered major current issues and each discussed separately.

From the contemporary population-related concerns of our present world, family sizes, household incomes, and education are influencing each other. Family sizes have a significant impact on household income and education access for children. Household incomes have also an influence on family nutrition and education access for children. The composition of families has a substantial impact on the well-being performance of individuals and households. Households with lower incomes often host many children. They invest very little in family nutrition and child education. This type of family structure is very common in DCs. High population growth in the affected countries impacts the quality of life through greater dependency ratios.

The relation existing between population and economic growth rates is viewed as inverse by Malthusian and neo-Malthusian theorists. The mentioned relationship on the other hand is considered positive by anti-Malthusian theorists such as Karl Marx and Easter Boserup. Present-day realities show that DCs have experienced the highest rates of population growth accompanied by rapid urbanization and emigration. They have also limited financial resources and weak institutional capacities. These conditions destabilize the capacity of the DCs to plan for and respond to the 'unfolding' population dynamics and seem to justify the Malthusian geometric theory of population growth and food production.

Employment and unemployment hold the basic life affairs of individuals and households in society. Unemployment poses a distressing effect on individuals and household livelihoods and communities. Unemployment problems are wider in DCs compared to the MDCs of the world.

Youth unemployment rates are very high in those countries. A large segment of the youth population engages in defenseless jobs in the affected countries. Sound policy, economic diversification, creation of more employment options, and fair distribution of resources are among possible solutions to the problem in the DCs.

Environmental degradation and desertification are other major worrying geographic issues at present. They are mainly promoted by growing population pressures on environmental resources and ecosystems. The competition for land resources (e.g. for cropland, grazing pasture, water, energy, settlement, etc.) exacerbates environmental degradation and desertification risks. Expansion of farming to marginal areas; conventional farming practices; non-responsive policies and overuse of resources are the main drivers of environmental degradation and desertification. Unsustainable land-use practices in the drylands aggravats desertification and pushes people in poverty. This in turn minimizes the capacity to invest in sustainable environmental management and leads to the syndrome of desertification. Coupled with climate change, these practices result in droughts and famines.

Climate change most possibly increases the incidence and harshness of meteorological and agricultural droughts in the drylands. Recurrent droughts, frequent floods, insect infestations, epidemics, unfair sharing of resources, conflicts and wars cause and increase the severity of famines.

Deforestation and the digital divide are also other important geographical concerns in the present time. Deforestation characterizes the clearing of forest trees through careless actions. The digital divide widens information gaps among individuals, countries, regions, cities, and businesses. Exposure to the digital gap occurs due to variation in socioeconomic, cultural, and financial resources (i.e. level of the digital economy). Nonetheless, its impact is so great for it make differences in getting opportunities and benefits.

To generalize, population dynamics are closely linked with national and world development challenges and their solutions. The greatest challenge in the present-day world is to meet the needs of large and growing populations while ensuring the sustainability of environmental resources. The linkages between population dynamics, inequalities, and resource degradation are thus emerged to be major existing geographic issues of the world.

REVIEW EXERCISES

Please tackle the following questions and submit the answers to your teacher within two days of the completion of the unit. Try to answer the questions accordingly.

I) True/False items: Write 'True' for correct statements and False for the incorrect ones

1. In the demographic history of the world population, the highest growth rate was recorded in 1962
2. The age and sex structure of the world population is predicted to change from the pyramid to box nature by 2100 AD
3. The shortest doubling time of world population was observed around the year 2000 AD
4. There is no difference between family and household.
5. The occurrence and impacts of land degradation and desertification are almost similar

II) Matching: Match the items listed under Column 'A' with those given under Column 'B'

Column 'A'	**Column 'B'**
1. People with kinship relationships	A) Household
2. Joblessness	B) Household income
3. Land degradation in dry, arid, and semi-arid areas	C) Family
4. People sharing a similar shelter but may not have blood relations	D) Employment
5. Persistent and acute hunger or starvation	E) Unemployment
6. Money earned by household members	F) Desertification
7. Persistent absence of rainfall and moisture	G) Drought
8. Married couples with or without children	H) Famine
9. Clearing farmlands	I) Deforestation
10. Working in one's own business	

III) Multiple choices: For questions chose the best answer from the given alternatives

1. Which of the following demonstrates the temporal dynamics of the world population?
   - A. Higher births and lower deaths at the early stages
   - B. Higher births and higher deaths in the 21st C
   - C. Stationary population due to lower birth and death rates in modern times
   - D. The stagnant population during the 1950s

2. At which stage of the demographic transition do parents have extended families (many children)?

A) 1st stage B) 2nd stage C) 3rd stage D) 4th stage E) 5th stage

3. One of the following is not among the indicators of environmental degradation

A. Change of color on water, soil, and plant leaves
B. Nutrients loss from soils; eutrophication of freshwater and quality alteration of biomass
C. Drying of watercourses; uprooting of vegetation; soil compaction
D. Greening of plant leaves; deeper soil profile; developed streams

4. Which one is true about the worldwide digital divide?

A) It makes no difference between individuals
B) It mainly creates gaps between MDCs
C) One of its sources is the variation in knowhow and education
D) Financial resource plays no role in making difference between countries

5. Which of the following is not the result of rapid population growth?

A) Rapid environmental change and biodiversity alteration
B) Extended urbanization (expansion of slums and squatter settlements)
C) Better education improved health and sanitation
D) Chronic poverty and malnutrition (food insecurity and water scarcity)

6. What strategies should be designed to solve the challenges of rapid population change?

A) Ensuring pertinent investment in human capital development
B) Avoidance of sexual contact and stop giving birth
C) Promoting positive checks of population change
D) Promoting births through incentives

7. Which of the following is not true?

A) Drought causes livestock death and famine in eastern Ethiopia
B) Famine can be prevented with only the provision of food donation
C) Shifting cultivation commonly leads to the problem of deforestation
D) Droughts and famines are more disastrous in desert areas

IV) Short-note writing: Write a short answer to the following questions

1. Explain the temporal dynamics of the world population starting from the year 1800 to 2100.
2. What were Malthus's basic presuppositions?
3. Describe what is meant by underemployment?
4. Differentiate between drought and famine; explain their occurrences.

V) Fieldwork project: Please make a field trip to a nearby village and make an observation on environmental resources, signals of land degradation, and conservation measures. Ask elders about the population dynamics of the village for the past 50 years. Then, compile a comprehensive report on the following issues and present it to your class. Your teacher will help you with how to do it.

1. Compile a report on the change in the population of the study village over the past 50 years.
2. Write a short report on the status of land resources (streams, springs, forests, agricultural and grazing lands, and soils) of the area.
3. Organize a summary of the livelihoods of the local people, the size of families, and the schooling of children.
4. What is the most pressing issue in the area? Report it to the class with possible solutions.

UNIT EIGHT

GEO-SPATIAL INFORMATION AND DATA PROCESSING

Learning Outcomes

At the end this unit, you will be able to:

- depict different relief features on a topographic map;
- explain the basic concepts of geographic information system;
- describe the components of GIS;
- acquainted with the main tools of available GIS software; and
- open, add, and display spatial data on ArcMap

MAIN CONTENTS

Introduction

Geography education based on exploring real-world issues is well-suited to make a significant contribution to our students' overall learning and development of 21st Century skills in particular. For instance, the discipline has given its name to a powerful computer-based data handling software and cartographic programs for displaying spatially referenced data. The uneven landforms, and reliefs with different heights, are represented on maps with the help of contour lines. With this background, geography can provide a real context for the use of Geographic information systems in high schools. Geographic information systems (GIS) provide powerful mapping tools for drawing, processing, and analyzing the data.

In this unit, you learn about how different landforms such as plateaus, mountains, hills, valleys, ridges, and others are represented on contour maps. In addition, the chapter cover concepts related to components, importance, and some application of GIS.

8.1. Representation of relief features on topographic maps

At the end of this unit, you will be able to:

- define relief in geography and topography map;
- examine how contour lines are used to represent relief features on maps and types of contours; and
- draw different relief features on a topographic map.

Keywords:

- **Contour**
- **Hachures**
- **Relief features**
- **Topographic map**

8.1.1. Basic Concepts of Relief and Topographic Map

Brainstorming Activity 8.1

Attempt the following question individually, and share your understanding in small groups.

1. What is a relief, and what features constitute relief?
2. How do you explain topographic maps and ways of representing relief features on maps?

Relief is typically defined as the difference in elevation between the highest point and the lowest point on the landscape in meters. Earth's surface is uneven in shape and elevation throughout the world. The physical shape or surface of the earth is referred to as a relief feature or landform of the earth. The major landforms (continents and oceanic) are formed due to the earth's movement of crustal plates (see Unit One). Landform features are distinctive three-dimensional objects on the earth's surface formed by erosion and deposition processes. They are also a part of the earth's crust that has resisted erosion effectively and has remained somewhat in their original state. The landform features include plateau, escarpments, hills, mountains, volcanoes, peaks, structural domes, saddles, cliffs, valleys, gullies, washes, gorges, depressions, floodplains, and alluvial fans.

A map is a graphical representation of a part the earth's surface in the correct positions relative to coordinate reference system at an established scale. Maps are always smaller in size than the environment they represent, and this reduction is expressed in terms of map scale. Map scale represents the relationship between distance on the map and their corresponding ground distance in the form of statement scale or ratio form.

A Topographic Map is a detailed and accurate illustration of natural and man-made features on the ground, such as water bodies, rivers, lakes, forest areas, urban and settlement areas, roads, railways, power transmission lines, contours, elevations, and other human-made features. It is a two-dimensional representation of the earth's three-dimensional landscapes. Colors, classes of features, lines, symbols, letters, numbers, and map scale are major elements of topographic map construction.

8.1.2. Methods of representing relief features

(a) Hachures

What is hachure?

Hachures are short disconnected lines that represent slopes drawn in the direction of the ground slope or water flows. They commonly illustrate the steepness of slopes. The hachure lines are drawn thicker and put close together when the slopes are steep, while the hachures are spaced wide apart and thinner when the slopes are gentle. Hachures representing steep slopes are shorter than those representing gentle slopes. Initially, they were used to represent mountain ranges and peaks, plateaus, and valleys on simple sketch maps or small-scale maps. Hachures are used to show depressions and small banks or escarpments that are prominent but not high enough to be shown by the selected contour interval; and similar relief features.

Figure 8.1 Landform relief representations by hachures

Hachures have **significant limitations.** For instance, hachures do not indicate the height and exact gradients, and they give only qualitative information. Hachures are laborious to draw and can be difficult to read and interpret. They are not used alone; instead, they are used in combination with contour lines to illustrate escarpments, depressions, and craters.

(b) Contours or isohypses

A Contour is an imaginary line connecting places having equal elevation on the ground surface above a datum or mean seas level.

NOTE

Note: Mean sea level (m.s.l.) is the average level of the sea, as calculated from a large number of observations taken at equal intervals of time. It is the most common standard level from which all heights are measured.

It is a universal method to illustrate the relief without hiding the other features drawn on the topographic map. Contours are commonly drawn at regular intervals in brown color and accurate way of illustrating relief on a topographic map. Generally drawn at 20 m interval in 1:50,000 and 100 m interval in 1:250,000 toposheets and never cut across each other

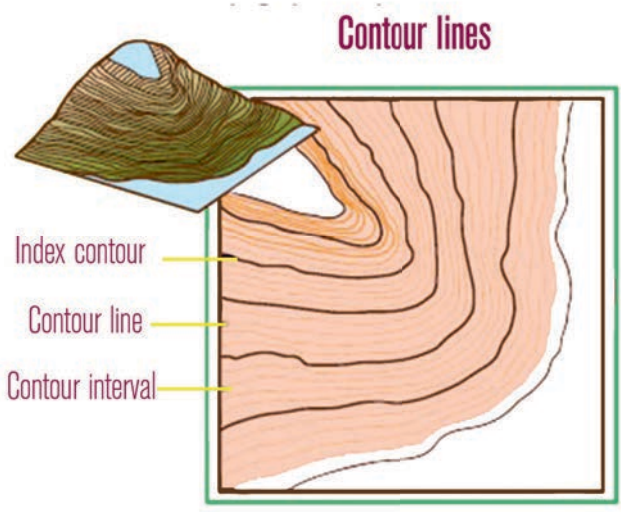


Figure 8.2 Contours representation of relief features

In Figure 8.2, index contour is started from zero elevation or mean sea level and represents every fifth heavier contour line than other contour lines. The finer or thinner contours falling between the index contours are intermediate contours or contour lines. In most cases, there are four contour lines between index contours, and their values are calculated by dividing the difference in elevation between two consecutive index contours by five if there are four intermediate contours.

There are **general properties of contours:**

a. Contours cannot merge or cross one another on maps except at vertical cliffs, waterfalls, and hanging cliffs.
b. Contour lines never branch; rather branching lines on the map could represent rivers, roads, and boundaries.
c. They are always numbered in the direction towards which altitude increases.
d. Evenly spaced contours represent a uniform slope, widely spaced contours represent a gentle slope, and closely spaced contours illustrate a steep slope.

Contour lines are generated from **spot heights.** A spot height is a statistical point that represents the specific altitude of a place at that particular point. Reading contours is a skill that helps us to understand the actual landscape. Contours can illustrate different types of landform reliefs, such as mountains, hills, plateaus, valleys, ridges, gorges, spurs, and others. These landform reliefs can be recognized from the shapes of their contours.

Reflective Activity 8.1:

Please answer the following question:

1. Identify the general pattern and the arrangement of each contour line and describe the major land-form reliefs represented in Figure 8.3.

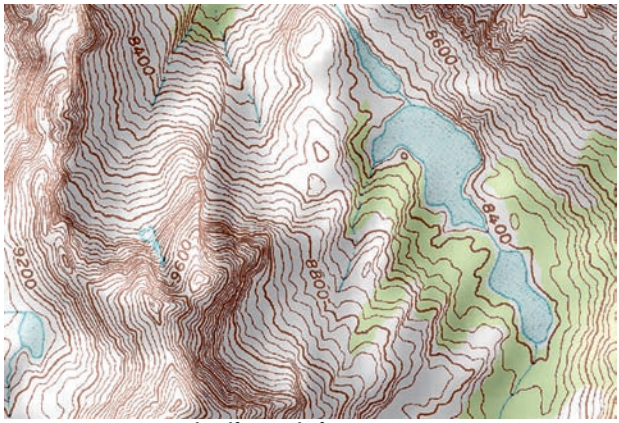


Figure 8.3. Contours represent major landform reliefs

8.1.3. Major Relief Features (Landforms) and Contour Representation

(a) Hill, Mountain and Mountain Range

A hill is one of the most basic landform features. It is a rounded surface rising above its immediate surroundings. From a high elevation point or hilltop, the ground slopes downward in all directions. A hill is shown on a map by contour lines forming concentric circles. A series of increasingly small, closed contours at higher elevations, with a height of less than 1,000 m indicates a hill. The inside of the smallest closed circle or contour at the highest elevation is the location of the hilltop. An inward-curving concave hillside has contours more closely spaced at the top of the hill with a progressive widening between contours downslope. An outwardly curving convex hillside has contours more widely spaced at the top of the hill and more closely spaced down the hillside. **Mountain** is a landmass that projects well above its surroundings, higher than a hill. The closed contours with elongated shapes with increasing values towards the center with no specific tips illustrate **mountain ranges.**

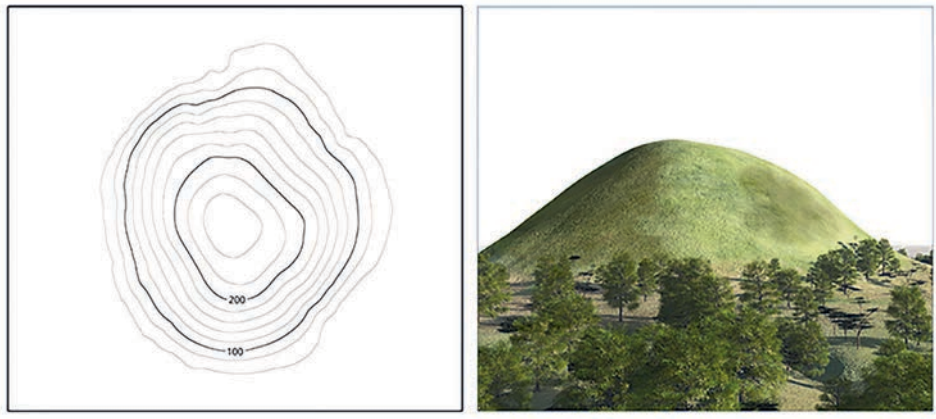


Figure: 8.4. Hill contours

(b) Ridge

A long and narrow hillside or a sloping line of high ground with two or more peaks shown by an elliptical contour line is called a **ridge.** When you stand on the centerline of a ridge, you do have low ground in three directions and high ground in one direction with varying degrees of slope. The contour lines form a ridge that tends to be U-shaped or V-shaped as the closed end of the contour line point away from the high ground.

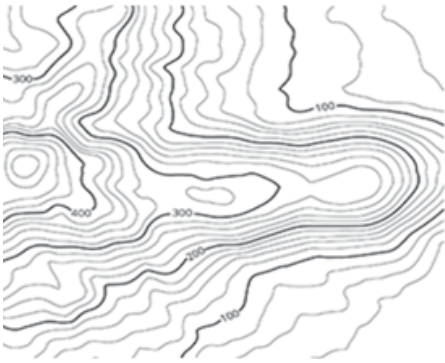


Figure: 8.5. Ridge contours

(c) Valley

A valley is a stretched-out long and narrow groove in the land usually formed by streams or rivers. It is a long depression with a slope formed by the vertical erosion of the river within the stretch of upland.

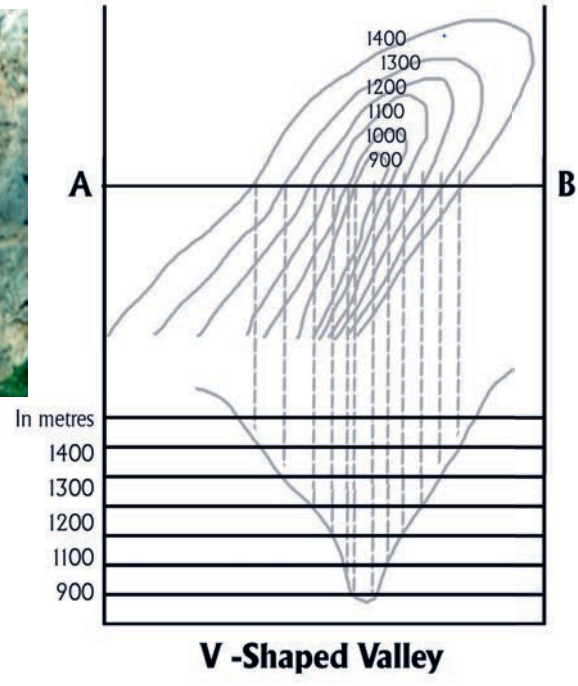


Figure: 8.6. Valley contours

A Valley is bounded by two higher elevation areas. It begins with high ground on three sides, while the fourth direction offers low ground. The closed end of the contour line (U or V shape) always points upstream or toward high ground. Contours with "V" shapes, with upward bending and values increasing upward represent valleys. Contours in a valley are parallel to the stream until they cross it at the base of each V. The higher level the valley, the longer contour parallels the stream before crossing it. In a very flat valley, the contour may parallel the stream across the topographic map without crossing it, making it difficult to determine the direction of water flow.

(d) Saddle

A saddle is a dip or low point between two areas of higher ground. It is not necessarily the lower ground between two hilltops; it may be simply a dip or break along a level ridge crest and lower ground in the other two high ground directions.

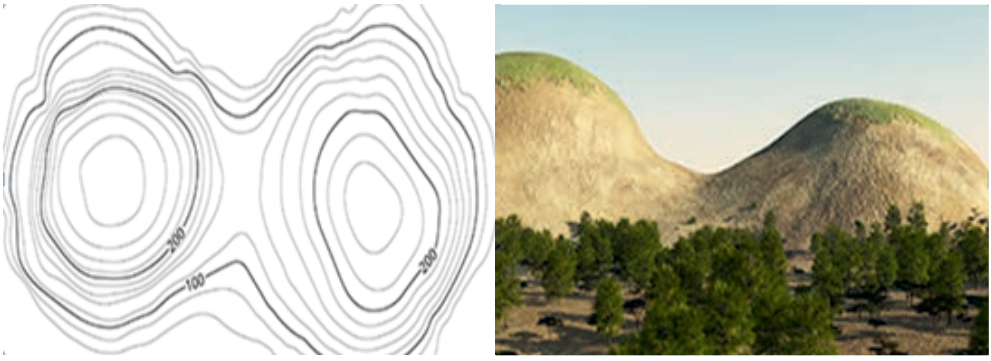


Figure: 8.7. Saddle contours

(e) Depression

Depression is an area with low ground surrounded by higher ground in all directions. On maps, depressions are represented by closed contours with more or less circular shapes that have tick marks pointing towards the low ground. The values decreasing towards the center represent depressions. Depression contours merely represent special cases of the standard contours on the map and thus share the same interval and elevation values. Contoured depressions are different from hills by short ticks at right angles to the contours, pointing towards the center of the depression.

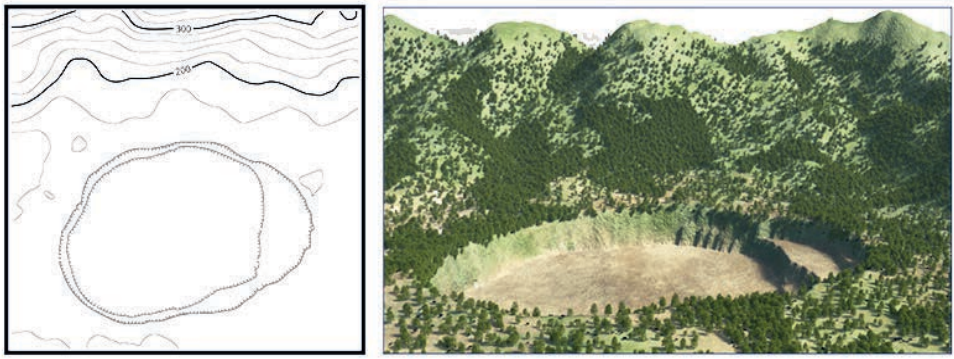


Figure: 8.8. Depression contours

A special type of depression contour called a cut contour is observed, when a roadway or railway cuts through the raised landscape, drastically lowering the terrain to form a level bed. Cuts are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the cut line. This contour line extends the length of the cut and has tick marks that extend from the cut line to the roadbed if the map scale permits this level of detail.

(f) Plateau

A plateau is an elevated land represented by closed contours roughly rectangular in shape with increasing values towards the center. Plateau contours with the top being very wide closed. When the plateau is formed in the foothills is referred to as a piedmont plateau. If a plateau is enclosed by mountains, it is called an intermontane plateau. Plateaus are higher in altitude than plains.

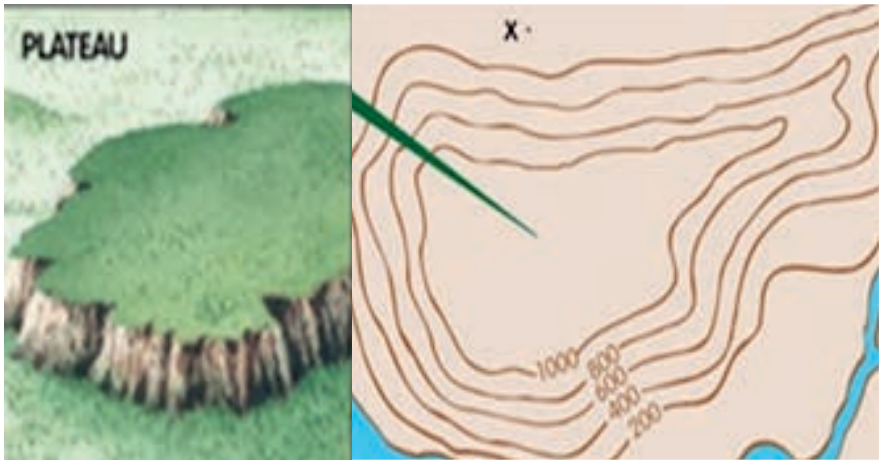


Figure: 8.9. Plateau contours

A gorge is a very steep valley at higher elevations formed by river erosion. It can be identified by closely converging contours in the river course.

(h) Spurs

A spur is a short continuous sloping line of higher ground, normally jutting out from the side of a ridge. It is a projection of land from higher to lower ground, often formed by two rough parallel streams, which cut draws down the side of a ridge. The ground sloped down in three directions and up in one direction. Contour lines on a map depict a spur with the U or V directing away from the high ground. Contours with "V" shapes, with downward bending and values increasing upward represent spurs.

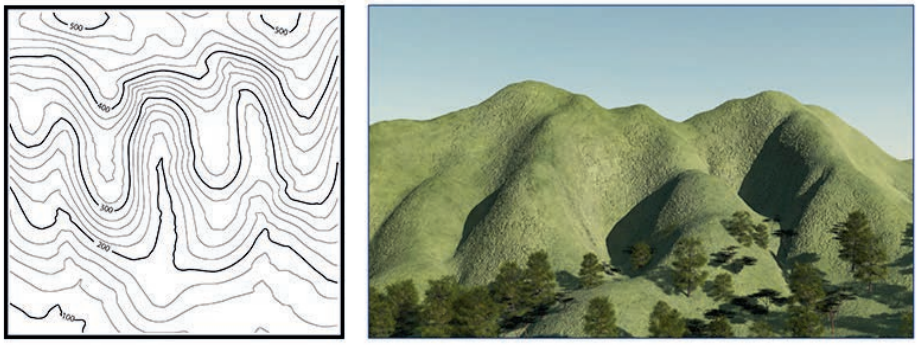


Figure 8.10. Spur contours

(i) Cliff

A cliff is a steep sloped or near vertical feature exposure of a valley or coast. When the cliff slope is so steep or truly vertical, the contour lines on the slope merge into a single contour called carrying contour of contours, to represent the vertical or near vertical form of the hillsides. The last contour line has tick marks pointing toward low ground. If the cliff is overhanging, such as for the waterfall in this illustration, the lower-elevation contours cross behind those at the top of the cliff. In this special situation, the lower-elevation contours in the undercut are shown with dotted lines to indicate that they aren't visible from the top of the cliff. Cliffs are also shown by contour lines very close together and, in some instances, touching each other.

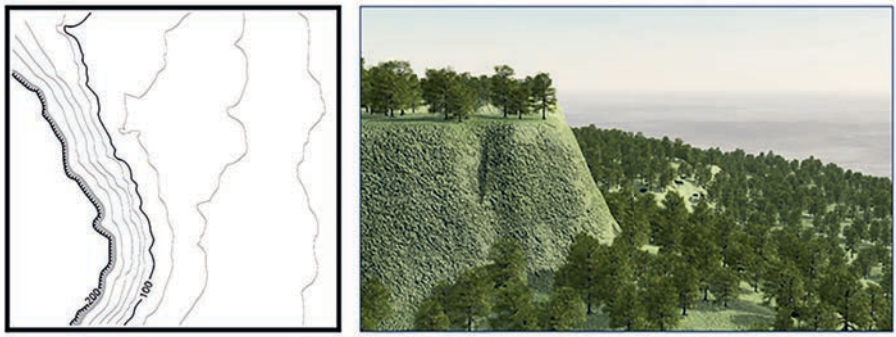


Figure 8.11. Spur contours

(j) Fill

Fill is a man-made feature resulting from filling a low area usually to form a level bed for a road or railway. Fills are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the fill line. This contour line extends the length of the filled area and has tick marks that point toward the lower ground. If the map scale permits, the length of the fill tick marks are drawn to scale and extend from the baseline of the fill symbol.

8.1.4. Catchment representation on contour map

A drainage basin/catchment area refers to the entire geographical space that is drained by the major river and its tributaries. A drainage system is a system that is made up of all the river basins that flow in the same direction. The major river in a river basin is the longest of all the rivers in the basin. The other small streams that supply water to the main rivers are called tributaries. The point at which the tributaries meet with the major river is called confluence. The point at which the major river in a basin starts is called the source of the river. Likewise, the point at which the river empties itself into an ocean, a sea, or a lake is called the mouth of the river. A drainage basin and its watershed can be identified on a contour map. This can be done by observing the patterns and shapes of the contour lines that are used to represent the topography of the mapped area.

Some rules are considered when using contour lines to determine watershed boundaries. These include, a contour line never going up or downhill, contour lines never crossing each other, the steeper the slope the closer together the contour lines, and the rules of the "V"s. Water flows down on all sides of the hill. Water flows from the top of the saddle or ridge.
The following steps can help you identify a drainage basin and its divide on contour maps.

- First identify the course of the main river and the outlet point of the watershed on the map, and then draw a circle at the outlet or downstream points of the watershed.

- Second, highlight the watercourse of tributaries of the main river and their flow direction on the map.
- Third, look at the ridge lines and saddle or contour lines near the origin of the tributaries and find high points and ridges; and Put "X" at the high points.
- Fourth, visualize surface flow direction from high points and draw arrows to indicate direction of flow.
- Fifth, trace outline of watershed beginning at outlet, connecting high points. Mark these points with solid or broken lines to show the river basin and its watershed.

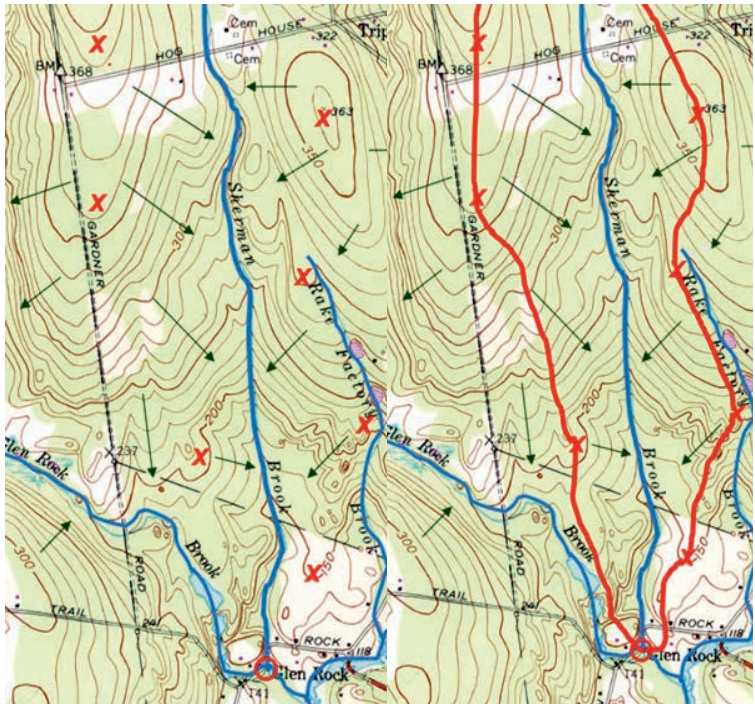


Figure: 8.12 Basin or catchment and associated drainage patterns"

8.1.5. Drainage pattern representation on the contour map

How do you identify different type of drainage patterns on the contour map? Dendritic patterns are usually formed in areas of homogeneous rock which comprises horizontal strata rock masses. They are characterized by a tree-like shape with branches.

In which landforms are trellis drainage patterns largely formed? Could you identify such drainage patterns using contour map? Trellis drainage patterns develop in areas where harder and softer rocks alternate. The pattern of this drainage pattern is greatly affected by tectonic forces (folding and faulting).

In which relief feature does radial drainage pattern usually found?

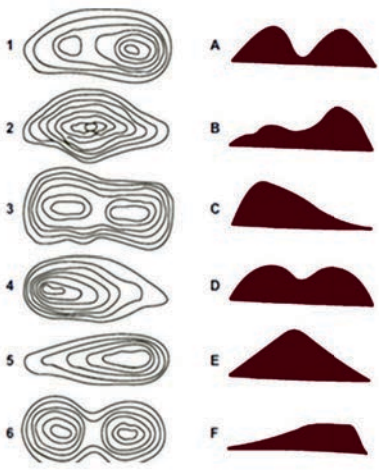
A radial drainage pattern occurs when rivers flow in all directions away from a raised feature. Centripetal drainage patterns are found in areas where rivers flow from surrounding high ground towards a central basin.

Reflective Activity 8.2.

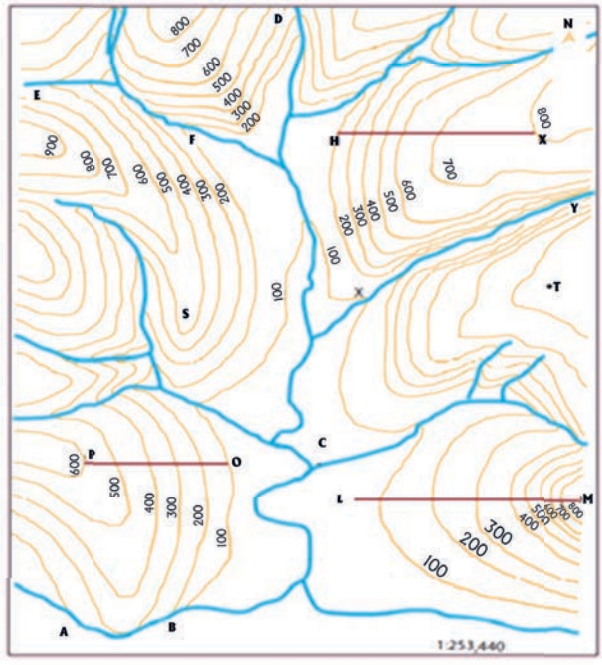
Please tackle the the following question below independently and then discuss in a small group

1. Describe the type of land reliefs represented by evenly spaced contours, widely spaced contours, and merging contours.
2. What is the difference between spur and valley?
3. Match the following figures with respective contour lines by referring figure A

A



B



4. By referring to the above contour map (B), try to identify the relief features that are represented by the numbers indicated below and justify how you identified the feature.

	Feature	Justification
The type of slope from L to M		
The type of slope from H to K		
What does letter C show?		
The type of slope A to B is		
The landform represented by the letter 'S' is		
The type of slope from 'O' to 'P'		

5. Could you identify the drainage basin or catchment on the contour map?

6. Identify different types of symbols and signs that represented different features in the urban settlement.

7. Observing Field and representing real topography features on maps.

8. Draw your local community or school maps and describe different symbols representing different features on the map

8.2. Basic Concepts of Geographical Information System (GIS)

8.2.1. Definition and Importance of GIS

At the end of this section, you will be able to:

- describe the basic concepts of GIS;
- explain the importance of GIS;

Keywords:

🗝 **GIS**

Brainstorming Activity 8.2

Consider these points:

1. What is meant by GIS
2. What is the major importance of GIS?

A geographical Information System (GIS) is a computer-based system for capturing, preparing, storing, checking, retrieving, manipulating, analyzing, and displaying geographically referenced data or geospatial data. GIS integrates hardware, software, and geospatial data to analyze relationships, patterns, and trends in the form of maps, and charts to support decision-making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records.

GIS can be applicable in environmental science and social science, including population, public health, crime study, and market planning. One of the major benefits of GIS is that it provides a platform to integrate complex and diverse information into a simple and illustrative a map. A GIS can be used to merge diverse data sources, such as project-specific information, socio-economic data, census, and statistical and spatial base data (administrative boundaries, roads, cities, infrastructure, etc.). A GIS is also used to manage critical data and to inform the decision-making process. It provides a platform for project planning, monitoring, reporting, and data sharing, as well as for visualizing and disseminating information.

The potential for using GIS to promote teaching and learning in Geography within schools is considerable. GIS has immense importance to address fundamental problems and issues, such as climate change, increasing food production, vanishing natural resources, and natural disasters. It is important to address local geographical issues or problems, such as the siting of facilities (schools, hospitals, and retail development), the management of emergency services, and the conservation of natural resources.

Furthermore, GIS is used to integrate information, propose solutions and visualize scenarios, such as the site of the new service center, the route of a controversial rail link, tourist information services, and for health monitoring. Most of the time, GIS is applied for the mapping and analysis of network services, suitable sites for urban development, transport management, suitable agriculture, disaster management, planning and community development, irrigation management, and wildlife management. It is important to examine the spatial relationship between deprivation and crime in parts of a city, determine the rate and extent of vegetation destruction, determine the relationship between rock type and relief in an area, and identify areas with a high risk of slope erosion in a region.

8.2.2. Components of GIS

At the end of this section, you will be able to:

- explain the relationship between major components of GIS; and
- explain how GIS is organized as a system.

Brainstorming Activity 8.3

Reflect on each of the questions below

1. What are the major components of GIS
2. How do you describe the linkage between major components of GIS, including software, hardware, people, data, and method?

Working with GIS involves integration of five key components, including hardware, software, data, people, and methods.

(a) Hardwares

One major component of GIS is hardware. The hardware consists of the technical equipment needed to run a GIS task. The hardware part is divided into two: i.e. Input and Output. The input includes a computer with high capacity in terms of processor speed, memory, and data storage capacity. GIS runs on a wide range of hardware types from centralized computer servers to desktop computers used in a standalone or networked configuration. Global position systems (GPS), mobile phones, scanners, and digitizers are also included in the input part of the hardware. The output port of the hardware includes the printer, plotter, and hard disc.

Figure 8.13: Components of GIS

(b). Software

GIS software provides the functions and tools needed to input, store, manage, analyze, and display geographic information. GIS software package provides means for deriving new geoinformation from existing spatial and attribute data. Environmental Systems Research Institute (ESRI) product software, such as ArcView, ArcInfo, and ArcGIS are commonly used. One popular software application is ArcGIS.

The ArcGIS desktop environment includes ArcMap, ArcCatalog, ArcScene, and ArcGlobe applications. A very capable open-source (free) GIS software is QGIS. It encompasses most of the functionality included in ArcGIS. The key software components are database management systems (DBMS), tools for the input and manipulation of geographic information, and tools that support geographic query, analysis, and visualization. A DBMS is a software package that allows the user to set up, use, organize, store, manipulate, maintain and integrate a database. A Database is an organized collection of large data sets stored and accessed electronically from a computer system.

(c) Data

What is data in GIS?

Data is the most important component of GIS. Geographic, spatial, data and related tabular data can be collected from the field or acquired from a data provider organization.

Any data bearing a definable relationship to space can operate in a GIS package. There are two main methods used to store data in a GIS: **Raster** images and vectors. Rasters are used for the storage of aerial photographs and imagery of various kinds. In raster data format each object is represented in the form of a cell /grid and it has a separate reflectance value /color/. The data type consists of rows and columns of cells, with each cell storing a single value. The resolution of the raster data set is its cell width in ground units. Rasters are used to represent continuous layers, such as elevation, slope and aspect, soil, vegetation, temperature, rainfall, and so on. ArcGIS can utilize raster data formats, such as jpg, tiffs, etc.

Spatial data refer to the shape, size, location, and orientation of geographical feature. They are generally multi-dimensional and autocorrelated. In a GIS, geographical features are often expressed as a **vector** representing discreet data.

Different geographical features are expressed by different types of geometry. For instance, geographical features, such as wells, airports cities, schools, and health posts can be expressed by a single zero-dimensional point. There is no measurement of point features. Geographical features, including rivers, roads, railroads, trails, and others are expressed by one-dimensional lines or polylines. Line features can measure distance. Geographical features that cover a particular area of the earth's surface, including lakes, national parks, administration boundaries, watershed boundaries, buildings, or land uses are represented by two-dimensional polygons. Polygon features can measure perimeter and area. Data consisting of a single feature geometry type can be stored in the Shapefile format. A collection of feature classes such as points, polylines, and polygons within a geodatabase that shares a common coordinate system is called a feature dataset. Vector data are excellent for capturing and storing spatial details. Geographical or spatial data can be acquired from existing data in paper form through digitizing or scanning, survey data by the use of a global position system (GPS), and remotely sensed data/Arial Photography and Satellite images/.

Non-spatial data or attributes are associated with the feature but independent of all geometric considerations. Non-spatial data can also be stored along with the spatial data represented by the coordinates of a vector geometry or the position of a raster cell. Attribute data are additional characteristics of the spatial data or the features. For example, non-spatial data that they are independent of the location of the lake but describe further characteristics of the lakes, including lakes depth, water quality, pollution level, name, area, volume, and others. Data input in GIS contains entering the spatial data, and non-spatial data, and linking the two together.

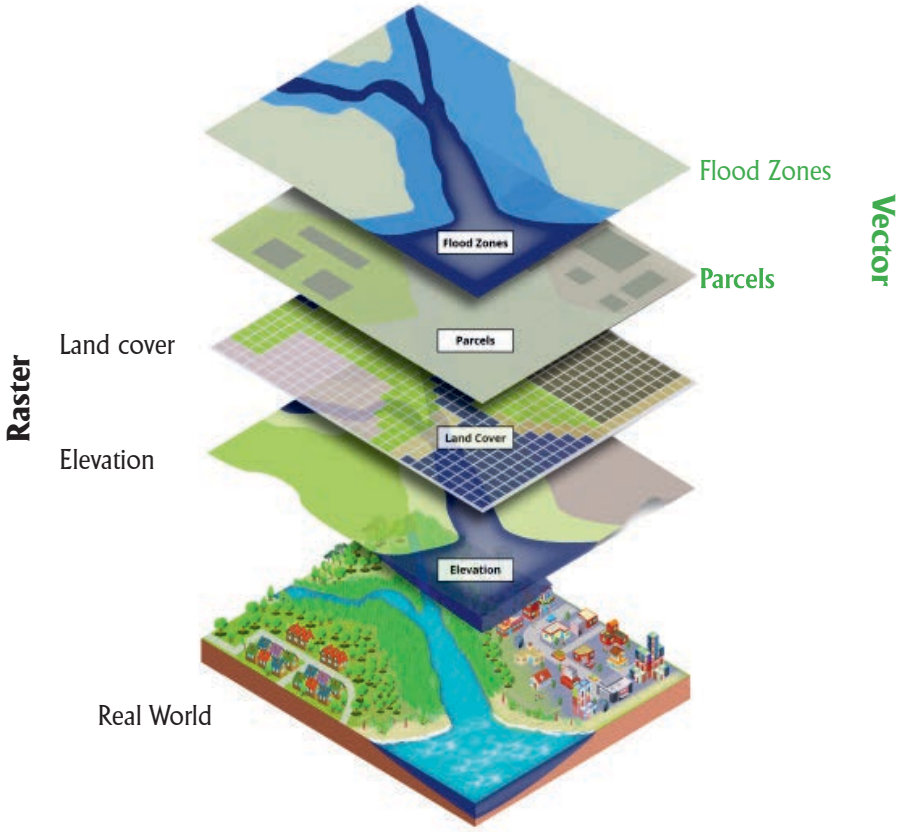


Figure: 8.14. GIS layered Vector and Raster data types

(d) People

The people are the component that makes the GIS work. People associated with a GIS can be categorized into GIS users and GIS specialists. GIS Users are people who use and View GIS data to browse a geographic database for referential material, perform professional services, and make decisions. **GIS specialists** are the people who make the GIS work. They are responsible for collecting, managing, and analyzing the geographic data and provide technical support to other. Technical specialists who design and maintain the system, and people who use GIS to perform their everyday activities are users of GIS. GIS technology has limited value without the people who manage the system and develop plans for applying it.

(e) Methods

Successful GIS operates according to well-designed plan and rules, which are the models and operating practices unique to each organization.

Reflective Activity 8.3

Try to address the following question independently and share it with your classmate in a small group discussion.

1. How do explain the difference between vector and raster data?
2. Describe the similarity and difference between spatial data and attribute data?
3. How do understand the representation real world in the ArcMap Figure: 8.15?

8.3. ArcMap and Main Tools

At the end of this unit you will be able to:

- master the basic steps of opening, saving and closing of ArcMap document in a computer;
- describe the functions of main tools of ArcMap;
- use Arc Map menu to add, and display data; and
- map different geographical issues and distributions.

Keywords:

- **Adding;**
- **ArcMap;**
- **Closing;**
- **Displaying;**
- **Opening;**
- **Removing;**
- **Saving; Tools**

Brainstorming Activity 8.4

Reflect on the following questions individually.

1. What is an ArcMap?
2. What is an ArcMap document?
3. How do you open and save a new session of ArcMap?

8.3.1. Opening, Saving and Closing ArcMap Documents

ArcMap is a program in which we add data, make maps, perform analysis, edit GIS data, access Arc catalog and ArcToolbox, use geoprocessing tools, integrate GPS field data, etc. It is the primary application and interface associated with ArcGIS software.

Map Exchange Documents (MXD) are ArcMap document files that contain a map, specify the GIS data used (including pointers to the file location for each dataset), display information (symbology and labeling), and other elements used in ArcMap. An ArcMap document does not store data but rather only refers to the data you use. When you "Add Data" to your map document, you only add a reference to the original data source.

How do you open ArcMap?

The ArcMap application is accessible by single clicking on the ArcMap Icon in your start menu to open the software. You can double-click an ArcMap document (.mxd file) on desktop short cut to start ArcMap with the desired map. By default, ArcMap begins with a new, empty map document.

How do you save a map in ArcMap?

After you finish working on a map, you can save it and exit ArcMap. You save a map as a document and store it on your hard disk. ArcMap automatically appends a file extension (.mxd) to your map document name. You will need to provide a name and save it into a folder location if you haven't saved the map before. You can also save the map with its data using a map package, which can be used to share your map and its related data with other users.

How do you close an opened map in ArcMap?

Click the File menu and click Close. Opening a new map also closes the current map.

8.3.2. ArcMap Main Tools and their Role

Brainstorming Activity 8.5

Consider the following question on your own:

How do you distinguish between ArcCatalog, Arc-Toolbox, Toolsets and tools?

a. ArcMap Menus and Tools

1. **New Project** – Opens a new (blank) ArcMap Document. (This creates a new .mxd file)
2. **Open Project** – Opens an existing document.
3. **Save project** – Saves the current ArcMap document. Please note the mxd does not contain any data directly, rather it only links to the data being used. This may be important when sharing your .mxd file with others who may need internet access for base data.

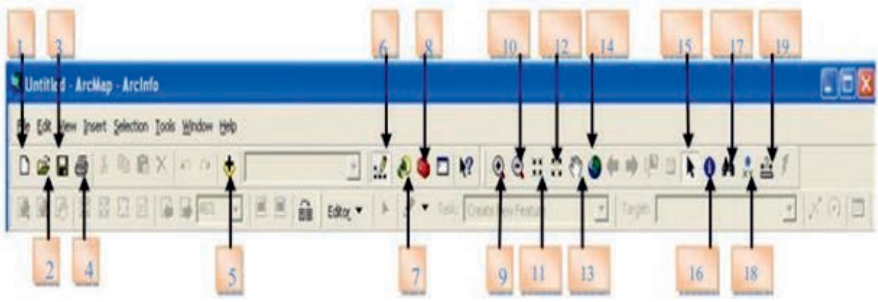
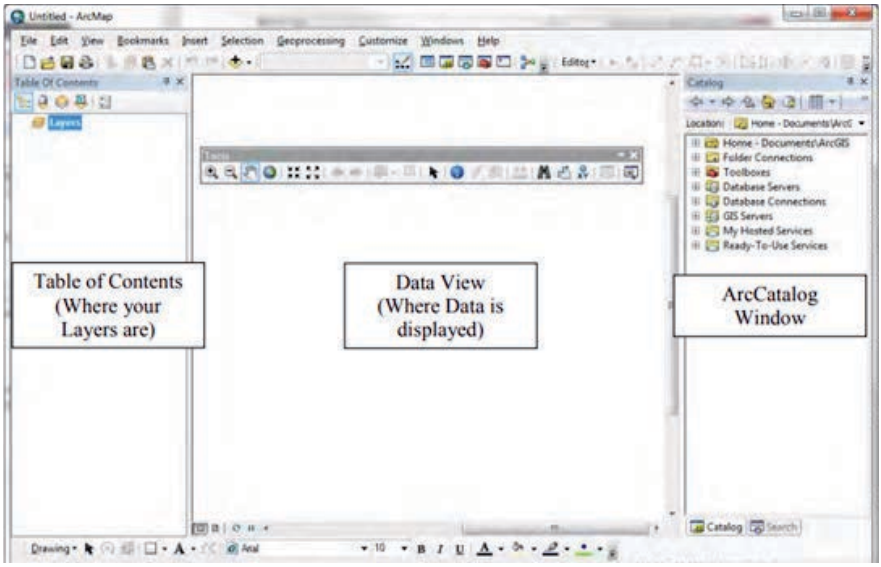


Figure: 8.18: ArcMap Menus and Tools

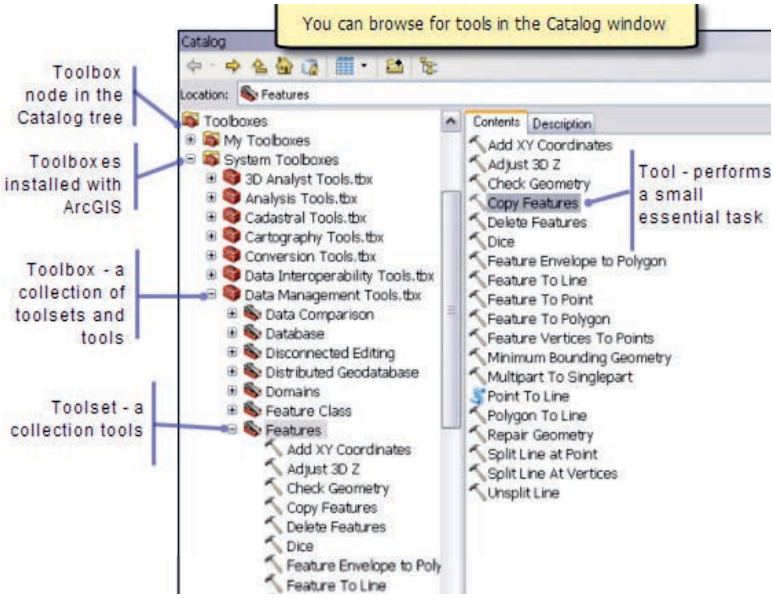
4. **Print** –Print the map view.
5. **Add layers** – This tool allows a user to add GIS data to the document. This data may be stored locally, accessed through a network or provided as a service over the internet.
6. **Edit function**
7. **ArcCatalog** is used for GIS Data management tasks such as creating new shapefiles, copy shapefiles, delete shapefiles and others.
8. **ArcToolbox**
9. **Zoom in** – allows a user to zoom into an area either by clicking on the desired location or by holding the right mouse button and drawing a rectangular box over the desired area of interest.
10. **Zoom out** - allows a user to zoom out of an area either by clicking on the desired location or by holding the right mouse button and drawing a rectangular box over the desired area of interest.
11. **Fixed zoom out** -to indicate how much to zoom out to the feature.
12. **Fixed zoom in**- to indicate how much to zoom in to the feature.
13. **Pan** - Select the hand and pan the map view in the desired direction
14. **Full extent** allows a user to expand the map view to the full geographical extent of the data located within the project.
15. **Select element** allows a user to choose a selection shape (circle, rectangle, line or polygon) to select features of an active data theme
16. **Identify** Select the identify button, and then select a data theme by clicking on that theme and making it active. Use the identify tool to query the active data theme.
17. **Find tool** allows a user to perform a string query on any data theme located within the map view.
18. **Add XY-** allows a user to drop a point and generate the X, Y coordinate for a specific location in a map.
19. **The measure** tool measures distance in specified units from one location to another.

The following figure illustrates the ArcMap basic interface and explains the various menu items and features found throughout the viewer interface.



b. ArcToolbox

ArcToolbox is an integrated application developed by environmental system research institute (Esri). It provides a reference to the toolboxes to facilitate user interface in ArcGIS for accessing and organizing a collection of geoprocessing tools, models and scripts. All ArcToolbox tools support all data types, including geodatabase, shape files and coverage.



- Toolboxes are containers for toolsets and tools required to perform any advanced geoprocessing tasks are organized in a logical way. A toolbox cannot contain another toolbox. The common toolboxes present within ArcToolbox are:
- Analysis Toolbox provides a powerful set of tools to perform various geoprocessing operations, such as overlays, create buffers, calculate statistics, and perform proximity analysis of all types of vector data.
- Cartography Toolbox designed to produce data and support map production for specific maps in a way that meets a specific cartographic standard.
- Conversion Toolbox contains tools that convert data between various formats.
- Coverage Toolbox contains a powerful set of tools to perform various geoprocessing operations that only use coverage as input and will only output data as coverage.
- Data management Toolbox contains a rich and varied collection of tools that are used to develop, manage, and maintain features classes, datasets, layers; and raster data structures are grouped in this toolbox.
- Geocoding Toolbox contains tools to assist in accomplishing common geocoding tasks such as, creation, maintenance, and deletion of address locators, as well as the actual geocoding of addresses.
- Linear Referencing Toolbox contains a series of tools for creating, calibrating, and displaying the data used for linear referencing.
- Spatial Analyst Toolbox contains tools to create, query, map, and analyze cell-based raster data; perform integrated raster/vector analysis; derive new information from existing data; query information across multiple data layers; and fully integrate cell-based raster data with traditional vector data sources.

Toolsets are a logical container of tools and other toolsets. Tools are a single geoprocessing operation, including dialog, models and scripts. A tool can be stored at toolbox level or within the toolset. Presence of Tools depends on the Extensions available. All the Toolboxes, Toolsets and Tools within the ArcToolbox are sorted alphabetically.

ArcCatalog is primarily used as a file manager, and to develop metadata for our GIS data. Metadata is information that explains your data to people who may want to use it and understand the different field attributes associated with the data set, the data projection, how the data set was created, any analysis performed on the data set, etc. There are two ways to access ArcCatalog: as a standalone application from the start menu or your desktop.

Reflective Activity 8.3:

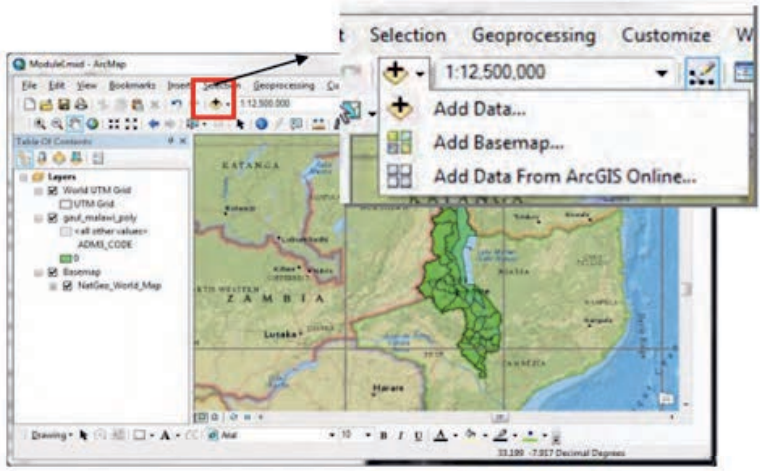
Consider the following questions individually, then then in a group:

1. What are the main functions of ArcCatalog in ArcMap?
2. How do you differentiate between Table of contents, data view and ArcCatalog windows?

8.3.3. Adding, Removing and Displaying Data

a. Adding Data

One of the first steps performed when creating a new map document is to add GIS data. This data could be local data that you have previously created, or have been provided with; these formats could include shapefile, geodatabase, tabular data, or others. In addition, data can be sourced from the internet through data providers or streamed through online data services. There are two primary methods of adding data to your opened ArcMap Document. The **first method** is to use the ArcCatalog Window, browse your data, and drag and drop the file into your project. The **second method** is to use the Add Data button. To add data, we use the additional data pull-down menu which has three commands. Add Data opens the add data dialog box, where you can add local data, or connect to a known data server or service. **Add Basemap** opens the base map dialog box, where you can select from a variety of pre-made base maps published by ESRI and other groups. **Add Data** from **ArcGIS Online** opens the ArcGIS Online portal, allowing you to browse through numerous base maps and data services provided by any number of groups.



When you want to add local data, you can use the Add Data button on the ArcMap toolbar to add data to your map. Click Add Data, browse to and select the data you want to add, and then click Add. Once the data are added, you will notice that the data layers are placed into the Table of Contents (TOC) in a specific order. They are organized in the TOC by geometry type: Point features are on top of line features, which are on top of polygon features, and polygon features would be on top of raster datasets.

b. Removing Data

The instruction to remove data is given as follow. First locate the file you wish to remove in the Table of Contents in ArcMap. The Table of Contents is the list of data layers that appears on the left side of the ArcMap window. Secondly, make right-click on the file name for the layer that you wish to remove and a context menu will appear. Choose Remove from the menu.

c. Displaying Data

Maps can be displayed in data view and layout view. Each view allows you to view and interact with the map in different ways. Data view provides a geographic window for exploring, displaying, and querying the data on your map. You work in real-world coordinates and measurements in data view. Layout view allows working with the map layout elements, such as titles, north arrows and scale bars, and along with the data frame, arranged on a page. In layout view, you work primarily in page space (typically, inches or centimeters) except when you are interacting with a data frame in your layout. An alternative way to switch your display is to click View › Data View or View › Layout View from the main menu in ArcMap.

Reflective Activity 8.4

Attempt the following activities related to laboratory-based GIS data.

1. Add point, polyline, polygon, and raster data in the data view window of the ArcMap.
2. Organize point, polyline, polygon, and raster data in the Table of a Content window of ArcMap.
3. Remove the added data from the data view window of the ArcMap.
4. Display map through Layout view and work with the map layout elements, such as titles, north arrows, and scale bars, along with the data frame.

UNIT SUMMARY

The height difference between different landform features in a given geographical area refers to relief. The uneven landforms with different heights are represented on topographic maps with the help of hachure and contour lines. Hachures are small straight lines drawn on the map along the direction of maximum slope, running across the contours. They are used in combination with contour lines to illustrate escarpments, depressions, and craters. Contours are an imaginary collection of lines connecting places having equal elevation on the ground surface above a datum, showing mountains, valleys and landforms. Contour lines forming concentric circles on the map represent a hill.

The closed contours with elongated shapes with increasing values towards the center with no specific tips illustrate mountain ranges. A long and narrow hillside or a sloping line of high ground with two or more peaks shown by an elliptical contour line is called a ridge. Contours with "V" shapes, with upward bending and values increasing upward represent valleys. On maps, depressions are represented by closed contours with more or less circular shapes that have tick marks pointing towards the low ground. Contoured depressions are different from hills by short ticks at right angles to the contours, pointing towards the center of the depression. An elevated land represented by closed contours roughly rectangular in shape with increasing values towards the center is a plateau.

Contours with "U or V" shapes, with downward bending and values increasing upward represent spurs. The contour lines on the slope merge into a single contour or are shown very close together to represent cliffs. Contour lines extend the length of the filled area and have tick marks that point toward lower ground. A contour topographic map can be produced using a Geographic information system (GIS).

GIS is a computer-based system for capturing, preparing, manipulating, analyzing, and displaying geospatial data. Working with GIS helps to integrate hardware, software, data, people, and methods. ArcMap is one of the applications of the ArcGIS desktop environment. ArcMap is a program in which we add data, make maps, perform analysis, access Arc catalog and ArcToolbox, use geoprocessing tools, integrate GPS field data, etc. The ArcMap application is accessible by single-clicking on the ArcMap Icon in your Start Menu to open the software. The ArcMap display window contains menu tools, ArcToolbox, ArcCatalog, and others. Once the ArcMap is opened, adding GIS data is one of the first steps performed when creating a new map document. Spatial data is added to the data view displaying window. The added data can be analyzed using different geoprocessing tools and tools from ArcToolbox. Layout view allows working with the map layout elements, such as titles, north arrows, and scale bars, along with the data frame, arranged on a page.

REVIEW EXERCISES

1. Compare and contrast the contour and hachure for representing relief features.
2. Describe the general properties of contours.
3. How do you identify different slopes on contour maps?
4. By referring to the following contour map, try to identify the relief features that are represented by the numbers indicated below and justify how you identified the feature.

	Feature /	Justification
The relief represented by number 1		
The relief represented by number 2		
The relief represented by number 3		
What does number 4 represent?		
The landform represented by the number '5' is		
The landform represented by the number '6' is		
The landform represented by the number '7' is		
The landform represented by the number '8' is		
What does number 9 represent?		
The relief represented by number 10 is		

5. In which landforms where trellis and radial drainage pattern largely formed?
6. Undertake the following project activities in a group.
   - A. Produce or display map of Ethiopia on ArcMap.
   - B. Making zonal or district map using ArcMap software
   - C. Go to the fields and generate spatial data using global position system (GPS), and try to produce point, polyline and polygon feature using ArcMap software.