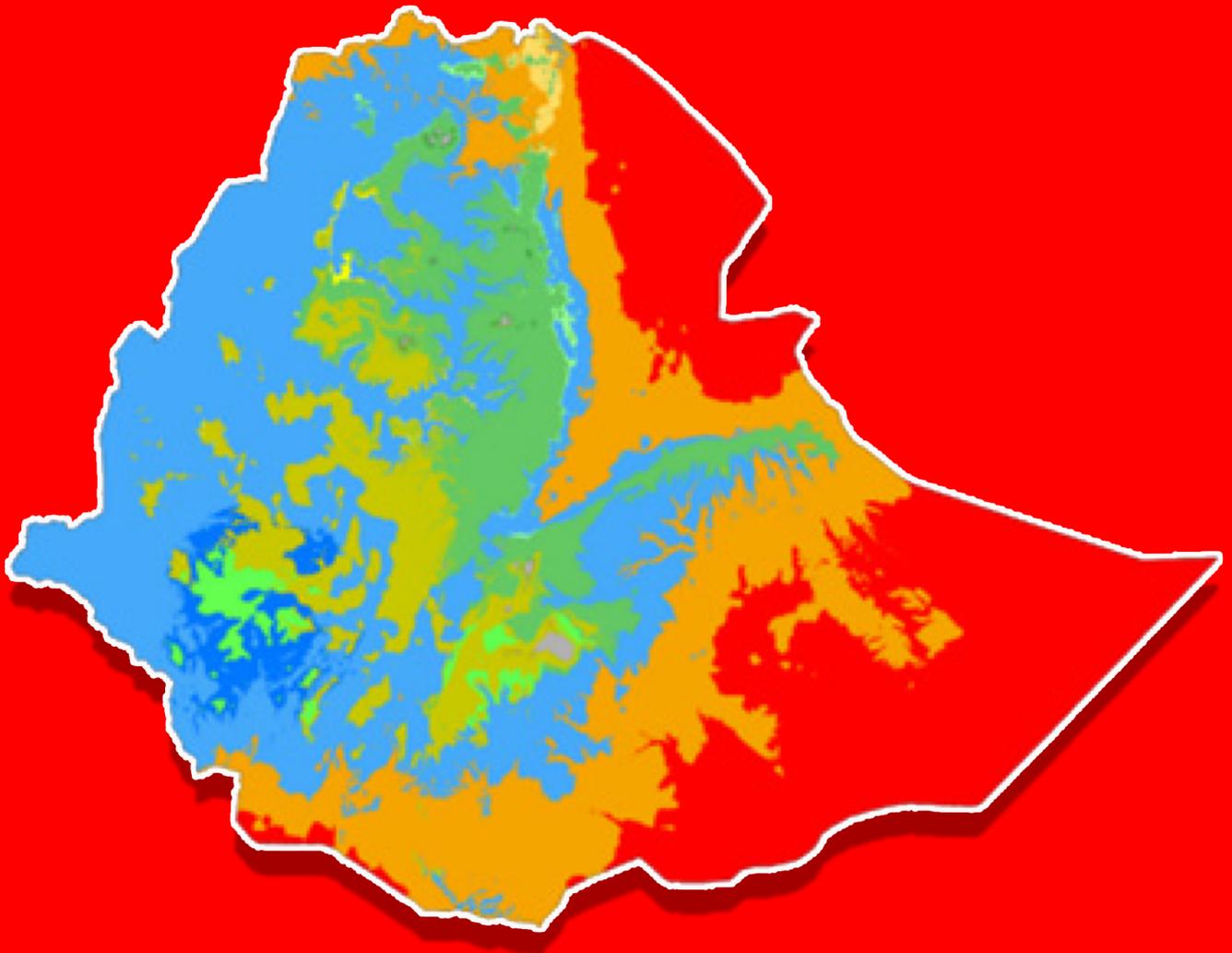




GEOGRAPHY

GRADE 11

DISTANCE LEARNING MATERIAL



MODULE ONE



**FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION**





FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

GEOGRAPHY

Grade Eleven

Distance Learning Material

MODULE ONE

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GENERAL INTRODUCTION

Dear learner; before directly discussing specific units, it is logical to remind you about the concept of geography and related issues. Geography is a word initially coined from two Greek terms: 'Geo' and 'graphy'. 'Geo' means "Earth" while 'graphy' is a form of writing or picture. Yet, it is a distinctive school subject compared to other sciences by 'virtue of its definition and central purpose'. Learning geography integrates the study of physical and human aspects from spatiotemporal perspectives. The principal goals center on inquiry, explanation, and description of the Earth's physical and human features. In the science of geography, these physical and human features interact with one another and vary from place to place; and again, over time.

Geography is often referred to as spatial science bridging various disciplines for it encourages a 'holistic' approach in the identification, examination, and description of similarities, interactions, and variations of diverse environmental variables. Multidimensional environmental problems are pondered in a geographic study in an inclusive and all-encompassing approach. Geography employs diverse inquiries and skills to illustrate the spatiotemporal variation and relationship of geographic wonders. It emphasizes geospatial patterns and processes to comprehend the dynamic Earth. Geographers seek to cultivate esteemed skills that can provide exceptional prospects for professionals in the contemporary and future world. They seek to develop a deeper knowledge of 'where things are located ... about other things in the globalized world. The following inquiries are often asked by geographers: Where is something located? Why is it there? How did it get there? How does it interact with other things? Nonetheless, it does not mean that geography is simply a mysterious assemblage of role-play facts; it is fairly the study of spatial aspects of human existence. By the way, can you imagine how important is the knowledge of geography regarding the interaction humans have with the Earth?

Geography is an overall integrative subject connecting the physical and human dimensions of the Earth through studying places, people, and the environment. Learning geography qualifies people to think critically and spatially about how to make a living in the globalized world. Thinking spatially and critically enables people to handle problems concerning Global, local, physical, and human dimensions at nearby and distant locations. Geography thus offers a unique opportunity for the philosophy and practice of education. Learning geography helps people to realize the responsibilities of human beings in handling the natural environment for luxurious livelihoods.

Dear learner; this grade 11 distance learning material is presented in two major modules (Module One & Module Two). Module one is about the formation of the earth's continents, world climates, land resources, and dynamics of the world population. Module two presents the relationship existing between geography and economic growth, global environmental issues, global public concerns, and skills in geospatial technology.

MODULE INTRODUCTION

Dear learner; as indicated in the general introduction, the Grade 11 geography you are attending is divided into eight units presented in two modules. In module one, you are going to study the formation of the Earth's continents; the Earth's climate and world climatic regions; classification, use, and management of land resources and resource use-related conflicts, and world population and related problems. With these basic contents, you are expected to study very well at your pace; be aware of and appreciate the formation of the Earth's continents, Earth's climate, land resources, and Earth's population dynamics. Dear learners, the four units of the module are expected to be covered by 56 hours.

MODULE OBJECTIVES

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

To develop an understanding and acquire knowledge of:

- the theories, and processes involved in the formation of the Earth's continents
- the Earth's geological history
- the relative distribution and mass of continents and oceans over a geological period
- the factors influencing world climatic regions
- the local, and Koppen's methods of climate classification
- the effects of population pressure on land
- the socioeconomic factors behind major population problems
- the underlying factors of international migration

2. To develop skills and abilities of:

- Sketching the diagram how the relative distribution and mass of continents and oceans over a geological period
- Illustrate climates of an area based on Koppen's classification methods
- Review the local and Koppen's methods of climate classification
- Demonstrate world climatic regions on a map
- Analyze the relationships between resource overuse, environmental degradation, and population growth
- Compare the annual water uses of Ethiopia, Sudan, and Egypt
- Showing the trend of world population growth
- Compare the population growth trends of LDCs and MDCs

3. To develop the habits and attitudes of:

- Explain the assumptions and processes involved in the formation of the Earth's continents
- Explain the climate classification efforts in Ethiopia
- Explain why renewable or non-renewable resources are under immense pressure
- Explain how unfair water use could lead to regional conflict

MODULE CONTENTS

UNIT ONE

FORMATION OF THE CONTINENTS

- 1.1. Formation of the continents
- 1.2. Geological time scale
- 1.3. Distribution of the continents and oceans
- 1.4. Changing position of the continent and oceans over geological time scale.

UNIT TWO

CLIMATE CLASSIFICATION AND CLIMATE REGIONS OF OUR WORLD

- 2.1. Criteria for climate classification
- 2.2. Koppen's climate classification
- 2.3. World climatic regions
- 2.4. Factors Influencing the world climatic regions
- 2.5. Local/indigenous climate classification of Ethiopia

UNIT THREE

NATURAL RESOURCES AND CONFLICTS OVER RESOURCES

- 3.1. The functions and management of land
- 3.2. Resources under pressure
- 3.3. Land resource depletion and degradation
- 3.4. Transboundary rivers
- 3.5. Regional cooperation for sustainable use of transboundary rivers
- 3.6. Potential and actual use of water in Ethiopia, Sudan, and Egypt
- 3.7. Conflicts over resources

UNIT FOUR

GLOBAL POPULATION DYNAMICS AND CHALLENGES

- 4.1. The growth of the world population
- 4.2. Factors responsible for accelerated world population growth
- 4.3. International migration
- 4.4. Population policies

MODULE ASSESSMENT METHODS

- Formative assessment
- Open-ended questions
- Checklist
- Self-test exercises
- Feedback on learning-in-process
- Peer and self-evaluation
- Summative assessment
- Assignment
- Mid-term examination
- Final examination

UNIT ONE

FORMATION OF THE CONTINENTS (10 hrs)



UNIT INTRODUCTION

Dear learner; in this unit, you are going to study the development stages of the Earth's Continents; the timescale of the Earth's geological processes; and the relative position (distribution) of the Earth's Oceans and Continental landmasses. With these basic contents, you are; therefore, expected to study very well at your pace, be aware of and appreciate the formation of the Continents, the Earth's Geologic timescales, and the relative position/distribution of the Earth's Oceans and Continental landmasses.

UNIT LEARNING OUTCOMES

Dear learner, at the end of this unit, you will be able to:

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

SECTION ONE

FORMATION OF THE CONTINENTS

(4 hours)



Section Overview

Continents are major landmasses of the Earth separated by water bodies (Oceans and seas) or by other natural features like mountains. They cover about 29% of the planet Earth. The Earth with its biophysical constituents (the lithosphere, hydrosphere, atmosphere, and biosphere) form part of the planets which together with other space bodies form part of the Solar System (Sun System). The formation of the continents is thus attached to the formation of the Earth and that of the Solar system. Studying the formation of the continents so begins with the study of the formation of the Earth and the entire Solar system. This section; hence, presents you how the Earth and its Continents evolved. Dear learner; the topic takes you to the wider scientific wisdom of the origin of the Earth and its Continents.

Section Learning Outcomes

After the completion of this section, you will be able to:

- examine how the Earth was created;
- describe how the Earth's Continents evolved; and
- explain major features that appeared related to Earth's continent formation.

Keywords:

- Big bang;
- Continents;
- Continental drift;
- Mid-oceanic ridges;
- Pangaea;
- Rodinia;
- Sea-floor spreading;
- Solar system.

1.1 Evolution of the Earth and the Solar System (3 hours)

Dear learner; the Earth, together with other planets and their moons, form the planetary system. The Sun and the planets together again form the Solar System (see Figure 1.1). The formation of the Earth is thus attributed to the similar 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. Hence, consider Figure 1.1 to internalize how planets were created and took their present position.

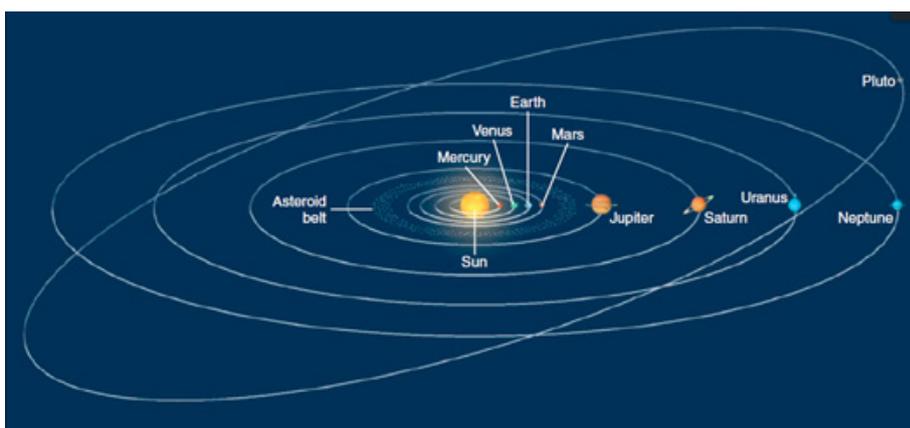


Figure 1.1 The Solar System (Sun & Planets) [Wicander & Monroe, 2010]



1. What do you imagine about the formation of the Earth and Solar System?
2. What do people say about the formation of the Earth and Solar System?
3. Can you explain the different views and theories of the Earth and the Solar System?

We find from Earth Science literature that 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. The puzzling secrets of the creation of the Earth and its Continents have yet not got valid acceptance. Among the various assumptions and theories proposed about the formation of the Universe and the Earth, the “Big Bang” theory 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. The first cosmic rocks solidified and created the first Earth at about 4500 to 3900 Ma. Following that, initial land masses gathered to form the early Continent called ‘Rodinia’ (Figure 1.2).

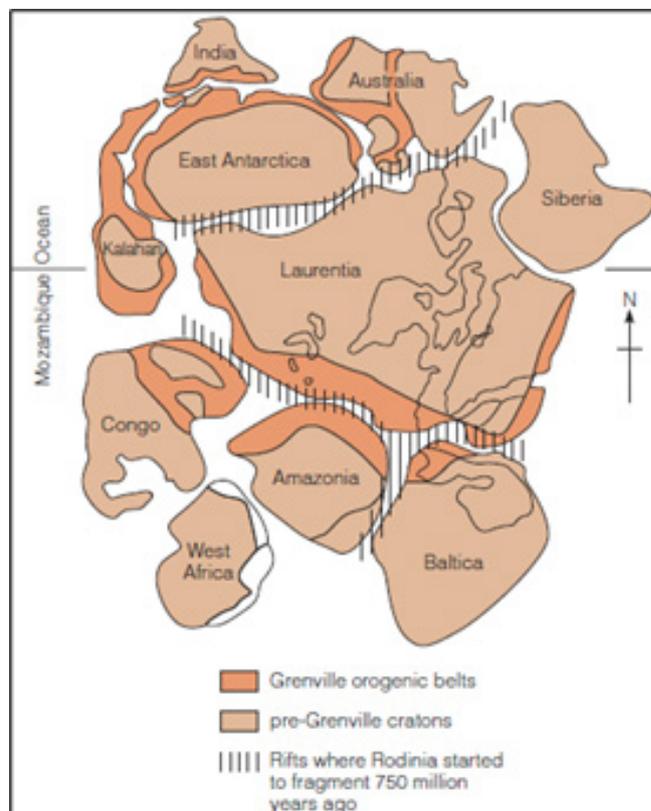


Figure 1.2 Neoproterozoic Supercontinent; Rodinia at about 750 Ma (Wicander & Monroe, 2010)



1. Dear learner; when and how the first Continents evolved? Refer Table 1.3 above and Figures 1.2 & 1.3, then, imagine how the first Continents evolved.
2. Try to relate Figures 1.2 & 1.3 with the notes provided.

During the late Cambrian period (514 Ma), the Gondwana Supercontinent 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 yielded 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 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 then retained their present position during the Quaternary period (Figure 1.3).

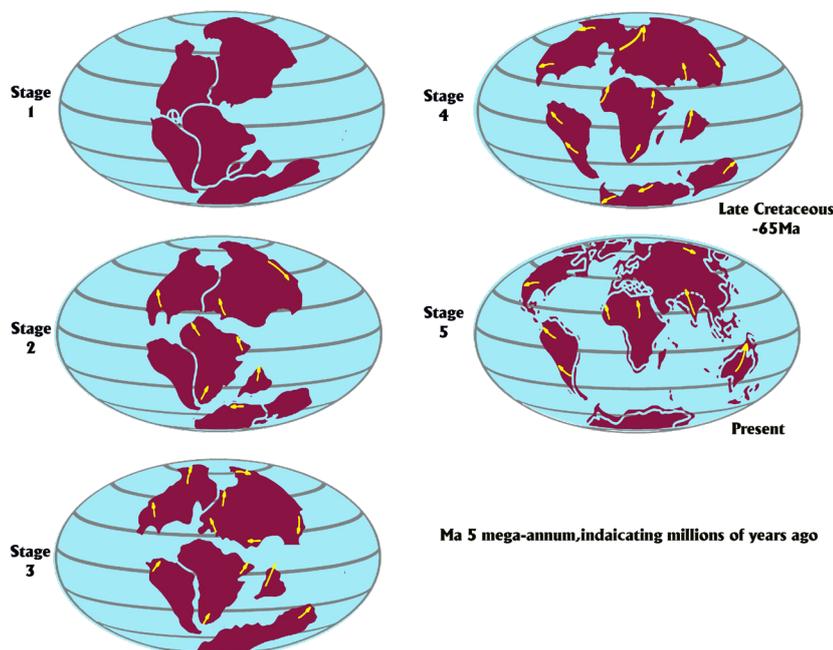


Figure 1.3 Continents at different Geological times (Gabler et al., 2007)



1. How the present-day Continents retained their current position? Dear learner; please read the notes carefully and integrate the discussions with the stages of Continent development shown in Figure 1.3.

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 Himalayan ranges. Some 100 Ma, Australia had separated from Antarctica and this 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.



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.

Additional information is available online for you at: <https://www.youtube.com/watch?v=6-vHe4599NE>

Activity 2.1.



Dear learner, please attempt the following questions

1. How were the Continents formed?
2. How did the present-day Continents come into being?
3. How did the Earth's Continents separate and emerge from the Pangaea?
4. What is Continental Drift? How does it happen?

Feedback to Activity 1.1

1. The continents were created through material collisions and continental drifts.
2. The Earth first evolved about 4.5 billion years ago. The first cosmic rocks solidified and created the first Earth at about 4500 to 3900 Ma. Following that, initial land masses gathered to form the early continent called 'Rodinia' at about 3800 Ma. At about 514 Ma the Gondwana Supercontinent had evolved around the South Pole. Next to this four major continents (Gondwana, Baltica, Siberia, and Laurasia) came into being around 458 Ma. Then the Laurasia continent collided with the Baltica and closed the lapetus Sea during the mid-Silurian (425 Ma). The continual collision had then yielded the Pre-Pangaea continent during the early Devonian period, at about 390 Ma. At about 306 Ma. The Supercontinent (Pangaea) had come into being at about 255 -210 Ma. From 210 -180 Ma, this Supercontinent started to break apart. 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 then retained their present position during the Quaternary.
3. The present-day continents were separated from Pangaea through continental Drift.
4. Continental drift is the moving apart of continents one from the other. It happens by Sea-floor Spreading at mid-Ocean-ridge locations due to rising magma.

Section Summary

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. In 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. Today, there are seven continents named Africa, Antarctica, Australia (Oceania), Asia, Europe, North America, and South America. Of these continents, the largest continent is Asia and the smallest continent is Australia.



Checklist 1.1

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	The formation of the Earth has no connection to the formation of other planets.		
2	The Earth is not a member of the Solar System.		
3	Do you know the earliest (pre-Pangaea) continent?		
4	Pangaea was the supercontinent that existed about 200 million years ago.		
5.	Do you know the two major subdivisions of the Pangaea continent?		
6	Can you write the meaning of continental drift?		

Self-test Exercise 1.1

Dear learner; we hope you enjoyed reading the notes about the formation of the Earth's Continents and thereby engaged in learning by doing the respective activities. We think you found everything interesting and relevant. So now, do the questions given below to evaluate how far you understood the lesson you studied. General Direction: Carefully identify and attempt the following (eight) questions according to their respective intent (8 points)

Part I) True/False

Instruction:

Answer questions 1-3 by writing 'True' if the statement is correct; or 'False' if the statement is wrong (3 points).

1. All people living in different parts of the Earth have almost similar perceptions about the formation of the Earth and the Solar System.
2. The formation of the Earth and its continents has no connection with the formation of other planets.
3. Pangaea was first divided into Gondwanaland and Laurasia.

Part II) Multiple Choices

Instruction:

Answer questions 4 and 5 by choosing the best one from the alternatives given (2 points)

4. Which of the following was the earliest supercontinent?
 - A) Rodinia
 - B) Pangaea
 - C) Baltica
 - D) Siberia
5. Of the following, which one is true about the concept of the Big Bang?
 - A) The Super Continent containing all of Earth
 - B) A theory that suggests the Universe was created by an abrupt space explosion
 - C) Theory confirming that the Earth was created by Continental Drift
 - D) Super landmass covering all of Europe and Asia.

Part III) Short Answer Writing

Instruction:

Give short answers to questions 6-8 (10 points)

6. The present-day continents of the Earth have retained their current position during the _____ period (1 point).
7. _____ and _____ are the largest and smallest continents on the Earth, respectively (2 points).
8. What causes continental drift? Explain? (6 points)

Answer Key to Self-test Exercise 1.1

Dear learner; we hope you did well in the self-testing. So now, you are at the stage of completion of the second section of the module. Thank you for doing the self-test questions. Now, please compare your answers with the feedback given and make corrections for any errors, if available.

№	Part I) True/False
1	False
2	False
3	True
4	A
5	B
6	Quaternary
7	Asia and Australia
8	Continental drift is caused by seafloor spreading initiated by upwelling magma at mid-oceanic ridge locations.

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. If you did, then you should go on to the next section. What do you think?

SECTION TWO

THE GEOLOGICAL TIMESCALE (3)



Section Overview

Dear learner; in this section, you will be introduced to the Earth's history and the major changes that occurred over time. Geological timescale is the timeframe showing the likely age of the Earth and its associated features. It focuses on the geological history of the Earth as condensed in the geological timescale. Major Earth-forming processes, resultant landforms, and the evolution of interrelated life forms are dealt with in detail in the discussion. An attempt is made to present the necessary information about the meaning of the geological timescale and rock dating methods (absolute and relative age of rocks). The evolution of the different land features and life forms during the four geological eras of the Earth is also assessed.

The lessons contain several questions, self-test exercises, and feedback. Hence, you are advised to perform each activity keenly and timely before passing to the next section. You need to think critically about the issues raised and compare your answers with the feedback given before starting the succeeding lesson. This may help you organize your knowledge and construct meaningful skills about the subject matter you are learning.

Section Learning Outcomes

Dear learner; upon the successful completion of this section, 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 the relative and absolute ages of the Earth's rocks; and
- examine the geological eras of the Earth.

Keywords

- Absolute age;
- Epoch;
- Geological Era;
- Geological timescale;
- Isotope;
- Half-Life;
- Period;
- Radioactive decay;
- Relative age.

1.2.1 Meaning of the Geological Timescale



1. Dear learner; can you now define what geological timescale is and how is it established?

Dear learner; geological timescale is the time frame (timetable) showing the possible age of the Earth and its associated life forms. It provides a review of the Earth's history and the major changes that occurred over time. The geological timeframe is developed by Earth scientists through the study of the 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



Dear learner:

1. Can you describe how scientists determine the relative and absolute age of rocks?
2. What rules do scientists follow to study the relative age of rocks?

Dear learner; the determination of the relative age of rocks 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 the 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-scale interpretations

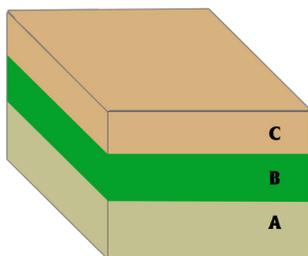
Geologists employ three basic principles (rules) during the study of the relative age of rocks. These are:

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

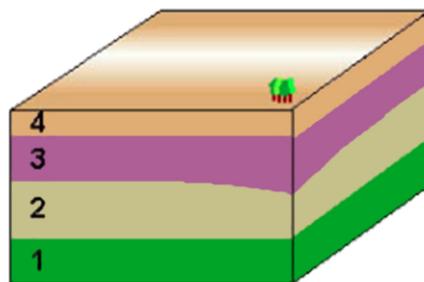


1. Dear learner; what is the Principle of Original Horizontality?

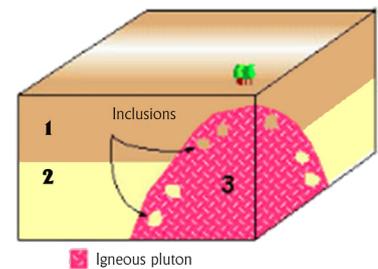
The principle of Original Horizontality indicates that layers of sediments are originally placed horizontally under the action of gravity. This means that except for the disturbed sequences, sedimentary rocks are always deposited in nearly horizontal beds. In the hypothetical Figure 1.4a, below the rock layers, A, B & C must have been developed in horizontal beds because they have the same orientation. If the beds are no more horizontal, they must have undergone deformation after formation.



a) Original Horizontality



b) Superposition



c) Cross-Cutting Relationships

Figure 1.4 Sketches showing the layering of sedimentary rocks
<https://www.kean.edu>



1. Dear learner; just describe the Principle of Superposition using a sketch diagram?

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).



Dear learner; do you imagine how an igneous intrusion distorted the horizontal sedimentary strata in Figure 1.1c through cross-cutting?

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 sedimentary layers 1 and 2.



Dear learner; we encourage you to examine all the illustrations represented by Figure 1.1 and try to relate to similar sedimentary rocks you have known.

Additional information is also available online for you at:
<https://www.youtube.com/watch?v=CunN7ARpsAQ>



Dear learner:

1. What is absolute age?
2. How it differs from the relative 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. For instance, the element Potassium (K) exists in three different forms (^{39}K , ^{40}K , & ^{41}K). This happens due to the presence of different numbers of neutrons (20, 21, & 22) in the nucleus of the atom. The numbers 39, 40 & 41 are the atomic masses of the element K, all determined by adding the neutrons to its atomic number which is 19. Here, you have to note that the variation in the mass number occurs due to the difference in the neutrons; but not the number of protons.



Dear learner; what is radioactive decay?

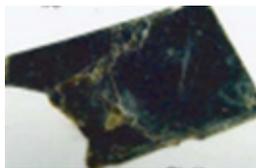
Radioactive decay stands for the conversion of unstable (Parent) elements into daughter (Stable) elements through the gaining or losing of particles in their nucleus. For instance, Potassium-40 (^{40}K) decays into Argon-40 (^{40}Ar). Similarly, Carbon-14 (^{14}C) changes to Nitrogen (^{14}N). Rubidium-87 (^{87}Rb) converts also to Strontium-87 (^{87}Sr). Likewise, Thorium-232 (^{232}Th) and Uranium-235 (^{235}U) change to Lead-208 (^{208}Pb) and Lead-207 (^{207}Pb), respectively (see 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 (238U)	Lead - 206 (206Pb)	4.5 billion years
2	Rubidium - 87 (87Rb)	Strontium - 87 (87Sr)	48.8 billion years
3	Potassium - 40 (40K)	Argon - 40 (40Ar)	1.25 billion years
4	Uranium - 235 (235U)	Lead - 207 (207Pb)	704 million years
5	Carbon -14 (14C)	Nitrogen - 14 (14N)	5,730 years



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.



Biotite



Uraninite



Zircon



Hornblende



Glauconite

a) Example of rocks used in radiometric dating



Trilobite fossil
(Cambrian)



Ammonite fossil
(Jurassic)



Crinoid fossil
(Carboniferous)



Dinosaur fossil
(Cretaceous)

b) Some index fossils used in geological dating



a) Relative age of rocks



b) Scientists studying rocks under field conditions (Montana, USA)



c) Radiocarbon dating

Figure 1.6 Practical rock dating examples: a) Relative age of rocks; b) Scientists studying rocks at field conditions (Montana, USA); & c) example of part of the radiocarbon dating process



1. How was the Geological timescale of the Earth established?
2. What are Eons and Eras? Explain?

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 (see Figure 1.5 a & b). The scale divides the age of the Earth into Eons, Eras, Periods, and Epochs. 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.



Dear learner; be focused while reading the content note like this and critically relate to illustrative figures, tables, maps, models and examples given so that you can realize the concepts and ideas meaningfully. Figure 1.3 visualizes the process of studying and estimating the age of Earth.

Additional information is also available online for you at:

<https://www.youtube.com/watch?v=rWp5ZpJAIAE>

https://www.youtube.com/watch?v=5_vKvJO7Kqw



Dear learner; referring Table 1.1, what is Half-Life? Refer to Table 1.1 above and reflect on what Half-Life mean for you and compare your reflection to the explanation given next.

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

№	№ of isotopes	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

1.2.3 Geological Eras

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 subdivided into three Geological eras named Paleozoic, Mesozoic, and Cenozoic (see Table 1.3).



1. What are Geological eras for you student?
2. By referring Table 1.3, can you name the four geological eras?
3. Which one of the four Geological eras is the recent; and what are its unique features?

Geological eras are longer time units covering hundreds of Ma in the geological timescale. They are four in number and are further classified into periods that cover millions of years (Table 1.3). The four geological eras 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 the 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. They are often found along with continental Shields or Cratons (Figure 1.7). The Hadean Eon of the Precambrian covers the time 4500 – 3900 Ma and not much is known about it. Archean is the other Eon covering some 1400 Ma (3900 – 2500 Ma). The latest of the three Eons is the Proterozoic lasting from 2500–570 Ma.

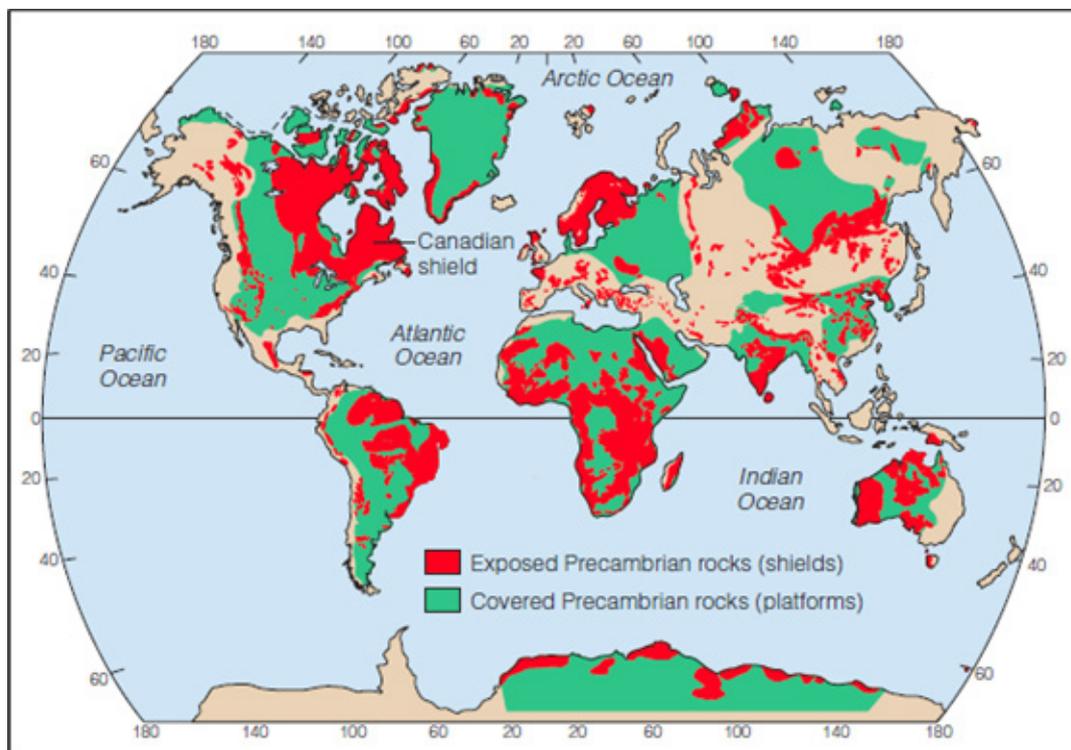


Figure 1.7 Distribution of Precambrian rocks (shields) [Wicander & Monroe, 2010]

EON	ERA	PERIOD	EPOCH	AGE (Ma)*	MAJOR EVENTS
PHANEROZOIC	CENOZOIC	QUATERNARY	Holocene	Present – 0.01	Modern Humans
			Pleistocene	0.01 – 1.6	Ice Age
		NEOGENE	Pliocene	1.6 – 5.3	Early Hominids
			Miocene	5.3 – 23.7	
		PALEOGENE	Oligocene	23.7 – 36.6	Extinction of Dinosaurs
			Eocene	36.6 – 57.8	
	Paleocene		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	Formation of Pangaea Coal deposits, the first reptiles
		PENNSYLVANIAN		286 - 320	
		MISSISSIPPIAN		320 - 360	
		DEVONIAN		360 - 408	The first amphibians
		SILURIAN		408 - 438	The first land animals; the first land plants; the first fish
		ORDOVICIAN		438 - 505	
		CAMBRIAN		505 - 600	The first shelled animals
PROTEROZOIC	PRECAMBRIAN			600 - 2500	Formation of the oldest known rocks and solidification of the earth
ARCHEAN					
				2500 - 3900	
HADEAN				3900 - 4500	

*Ma: Million years ago

Crawford (1998); Wicander & Monroe (2010); <https://www.kean.edu/~csmart/Observing/04.%20Geologic%20time.pdf>

Geologic%20time.pdf

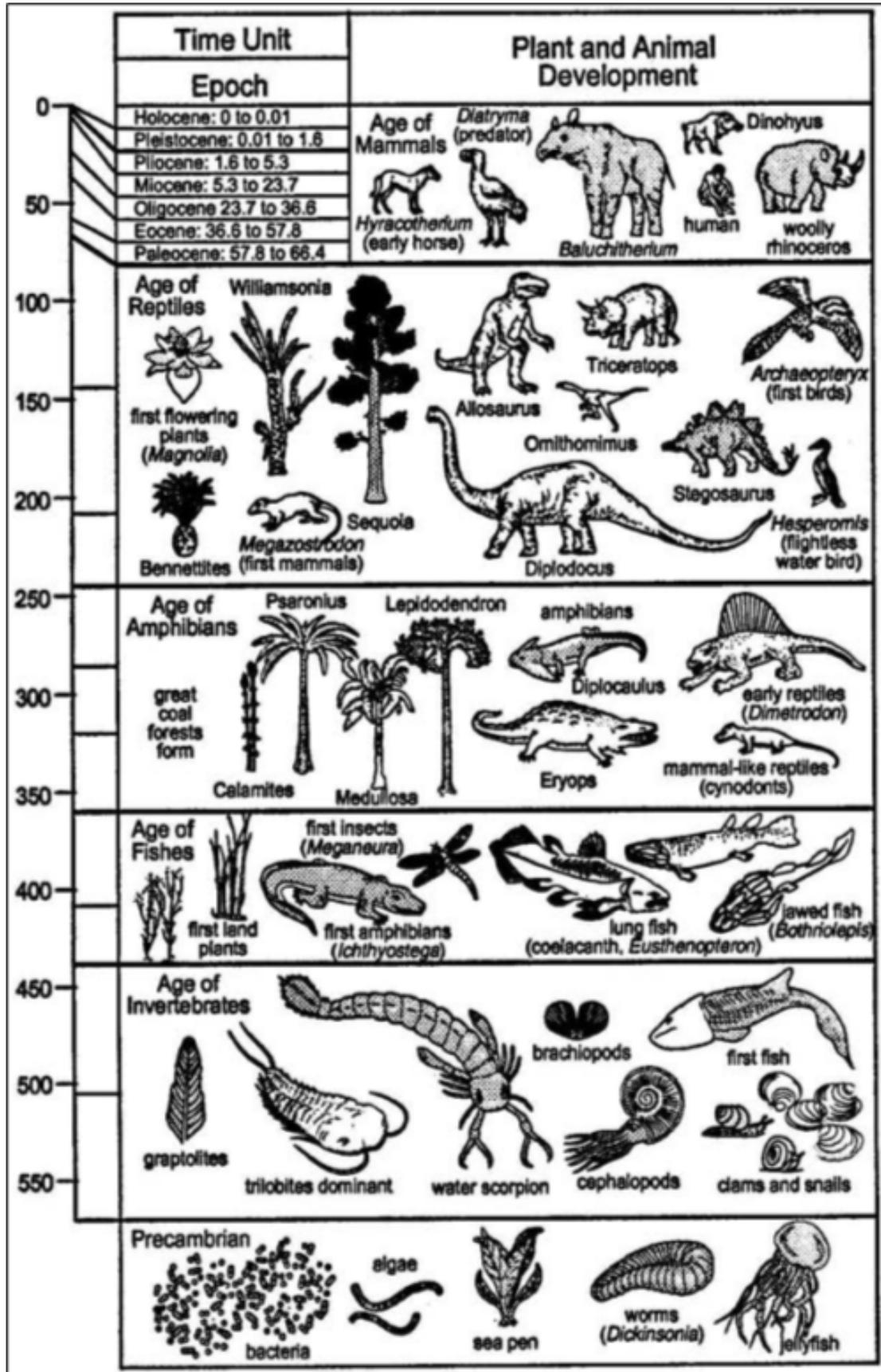


Figure 1.8: Life forms evolved during the different geological eras (Crawford, 1998)



Dear learner; I hope you comprehend what Geological eras are and the associated processes from Table 1.3. Then, can you identify what processes occurred during the Precambrian and Paleozoic eras?

The Paleozoic era covered the time 600 – 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 the Earth's species. Due to that, around 75% of the Amphibian species have perished.

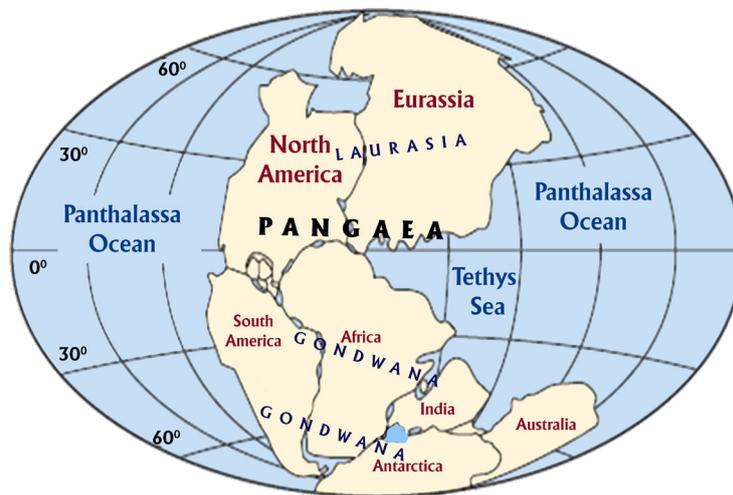


Figure 1.9 The Supercontinent (Pangaea) (Gabler et al., 2007)



Dear learner;

1. What were the major occurrences of the Mesozoic era?
2. What is Pangaea?
3. How Gondwanaland and Laurasia separated from the Pangaea?

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 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).



Dear learner; we hope you are getting a good understanding about the Geological history of the Earth. So now, can you tell what happened during the Cenozoic era and how this era differs from the other Geological eras?

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 dominantly succeeded on Earth. It is commonly named an era of recent life and the age of mammals. 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.

Activity 1.2.

Please attempt the recommended response to the following question.

1. What is the geological timescale?
2. How was the age of the earth established?
3. How do scientists determine the age of the earth and its products?



Feedback to Activity 1.2

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions. Please compare your answers with the feedback given below.

1. The geologic timescale is the division of the geologic processes and life forms based on standard time units through the study of fossil remains imprinted on rock layers. It refers to the timeframe (timetable) showing the possible age of the earth and its associated life forms. The scale divides the age of the earth into Eons, Eras, Periods, and Epochs.
2. The age of the earth was established through the study of the absolute and relative age of the earth's rocks and life forms. Rock sequences, radiometric and radiocarbon dating methods are used to establish the age of the earth and its materials.
3. Scientists determine the age of rocks by studying the earth's rocks. They determine the relative age of rocks by studying layers of sedimentary rocks using three principles: Original Horizontality; Superposition; and Cross-cutting relationships. Absolute ages are determined from the spontaneous decay of unstable radioactive isotopes derived from igneous and metamorphic rocks.

Section 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 is divided into four Eras. Eras cover longer 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 is 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.



Checklist 1.1

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Do you understand the meaning of the geological timescale?		
2	Can you write the difference between the relative and absolute age of rocks?		
3	Can you list down the three principles used by scientists to study the relative age of rocks?		
4	The absolute age of rocks is given in numerical values through the analysis of the spontaneous decay of radioactive isotopes.		
5.	Geological eras are longer time units covering hundreds of Millions of years in the geological timescale.		
6	Precambrian and Cenozoic are the recent and oldest geological eras, respectively.		
7	Modern man and flowering plants existed during the Precambrian era.		
8	Can you identify the major occurrences of the Paleozoic era?		
9	The first earth evolved during the Mesozoic era.		
10	The oldest rocks on earth created during the Cenozoic era?		

Self-test Exercise 1.2

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions I–IV given below to evaluate how far you have understood the lesson you studied.

Part I) True/False

Instruction:

Answer questions 1-5 by writing 'True' for the correct statements or 'False' for the wrong statements (5 points).

1. A rock layer that cross-cuts another rock layer tends to be younger than the rock it cross-cuts.
2. In an undisturbed sequence of sedimentary rock layers (beds) or lava flows, the underlying bed is always younger than the overlying rock layer.
3. Radioactive decay occurs when elements recombine to form new minerals during the processes of metamorphism or when magma cools.
4. The geological timescale divides the age of the earth into Eons, Eras, Periods, and Epochs.
5. Continental shields (cratons) mainly occupy the recent volcanic surfaces of the continents.

Part II) Multiple Choices

Instruction:

For questions 6-10, choose the best answer from the given alternatives (5 points)

6. When the age of rocks is determined through the analysis of the sequence of sedimentary beds without giving due regard to the exact time of origin, the process is referred to as:
- A) Relative dating B) Absolute dating C) tree-ring dating D) radiometric dating
7. The absolute age of rocks is determined through:
- A) The study of layering and deposition of sedimentary rocks
B) Analysis of the spontaneous decay of radioactive isotopes
C) Examining the hydrological cycles
D) Studying human artifacts alone
8. The geological time before the emergence of life on Earth is classified as:
- A) Cenozoic B) Palaeozoic C) Mesozoic D) Precambrian
9. Which one of the following is true about the Geological timescale?
- A) It is established through speculation and superstition
B) Covers the time before Christ only
C) It is classified into eras, periods, and epochs
D) Established by studying the layering of sedimentary deposits only
10. When do you think Pangaea first evolved?
- A) During the tertiary period
B) At the end of the Palaeozoic
C) By the end of the Cenozoic
D) During the Precambrian

Part III) Matching

Instruction: Match the occasions shown under 'A' with the instances given under 'B' (10 points)

No	A		B
11	Conversion of unstable element into stable element by gaining or losing of particles in their nucleus	A	Isotope
12	The supercontinent containing all of Earth	B	Precambrian
13	The Eon in the geological timescale which is not much known	C	Phanerozoic
14	Common species of the Cenozoic era	D	Trilobite
15	Presence of an element in different forms	E	Half-life
16	Common species of the Paleozoic era	F	Absolute age
17	The age of rocks given in numerical values	G	Pangaea
18	The latest Eon in the geological timescale	H	Modern humans
19	The time before Cambrian in the geologic timescale	I	Radioactive decay
20	The time which is taken by the parent element to convert into the daughter element	J	Hadean

Part IV) Short Answer Writing

Instruction: Give short answers to questions 21-23 (10 points)

- 21. Mass extinction of the Dinosaurs happened during the end of _____ Era (1 point).
- 22. How was Pangaea splitting into Laurasia and Gondwanaland during the Mesozoic era? (3 points)
- 23. Show how Eons, Eras, Periods, and Epochs differ from each other? (6 points)

 **Answer Key to Self-test**

Dear learner; we hope you did well in the self-testing. Now, you are at the stage of completion of the first section of module one. Please compare your answers with the feedback given and make corrections if there are errors in your answers.

No	Part I) True/False	No	Part II) Multiple choices	No	Part III) Matching		
1	True	6	A	11	I	16	D
2	False	7	B	12	G	17	F
3	True	8	D	13	J	18	C
4	True	9	C	14	H	19	B
5	False	10	B	15	A	20	E

Part IV) Short Answer Writing	
21	Mesozoic
22	Pangaea was splitting into Laurasia and Gondwanaland by continental drift
23	Eons are longer time units (covering billions of years) in the geological timescale. They are subdivided into four: Hadean, Archean, Proterozoic, and Phanerozoic. Eras are the second larger time units next to the Eons. They cover hundreds of Ma. They are four in number and further classified into periods that cover millions of years. Periods are time units covering millions of years but much shorter than eras. They are 13 in number and each is divided into relatively shorter periods named epochs. Epochs are the shortest time units in the geological timescales covering thousands to millions of years.

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. Review and check the extent to which you have achieved the intended lesson objectives of the section. If you did well, then you should go on to the next section. What do you think?

SECTION THREE

DISTRIBUTION OF THE EARTH'S CONTINENTS AND OCEANS (2 hours)



Section Overview

Continents and Oceans are major constituents of the planet Earth. They correspondingly cover nearly 29 and 71% of the total area of the Earth. Yet, their relative distribution over the Globe is not even. Dear learner; this section focuses on the discussion of the relative size and distribution of the Continental landmasses and Oceanic basins over the Globe.

Section Learning Outcomes

Dear learner; 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 position of the Continents and Oceanic basins.

Keywords:

- Continents;
- Oceans;
- Oceanic trenches.

1.3.1 Relative Size of the Continents and Oceans

The surface area of the Earth is estimated to be 510,072,000 km² and the area of the Oceans is about 363,000,000 km². 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.



1. How do you find the surface area of the Earth and Oceans?
2. Which one is bigger, Continents or Oceans?

1.3.2 The Distribution of the Continents and Oceanic Basins

The distribution of Continents and Oceanic basins 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.



1. How do you find the distribution of the Continents and Oceans over the Globe?
2. What effect does the distribution of the Continents and Oceans have on the Earth's climate? Explain?

Dear learner; please read the notes given and compare with the map (Figure 1.10) and then imagine how the Continents and Oceans are arranged over the Globe.

THE CONTINENTS

Continents are major landforms of the Earth separated by water bodies (oceans and seas) or by other natural features like mountains. They cover about 29% of the planet Earth. 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 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 parts. Asia has 48 countries and accommodates two-thirds of the world's population. It has the highest mountains (the Himalayas), the deepest depressions (the Dead Sea), the driest desert (the Lut desert), the highest precipitation (Assam), and a long tradition of

Australia

Australia is the smallest continent in the world. It is surrounded by water on all of its sides and is 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% 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.

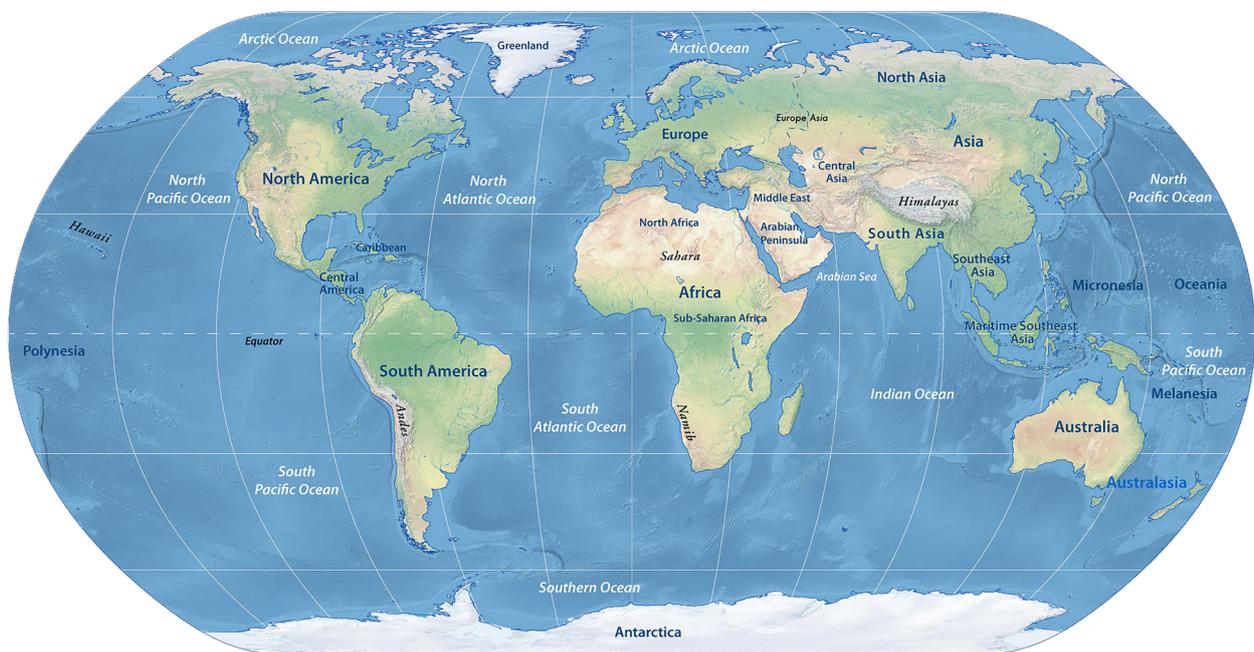


Figure 1.10 Continents and Oceans of the World

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 is 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 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.



1. What are the Earth's major Oceans and their relative sizes?
2. How do you see the impact that these Oceans have on humans including in your area?

THE OCEANS

Dear learner; if you were challenged by the preceding questions, it is desirable because it stimulates thinking and prepares you for progressive learning. It is hoped that Figure 1.10 above supports your comprehension of the major Oceans. In this regard, 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.

The Arctic Ocean



How wide is the Arctic Ocean? Where is its location and its deepest point?

The Arctic Ocean is the world's smallest Ocean with an area of 14,056,000 km². 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.

The Atlantic Ocean



How large is the Atlantic Ocean? Could you please show its location and the deepest point with referring to Figure 1.11?

The Atlantic Ocean is the world's second-largest Ocean with an area of 76,762,000 km². 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 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).

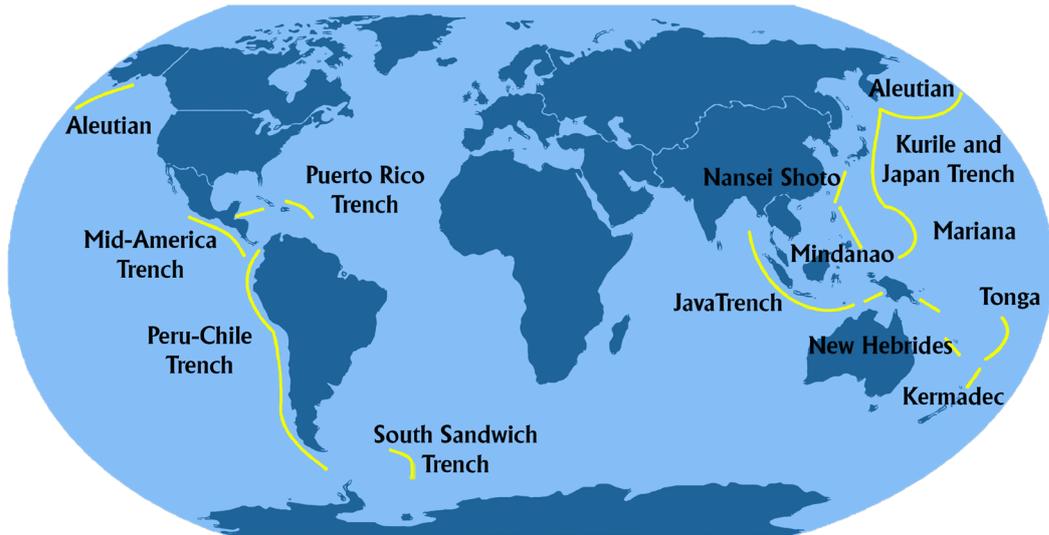


Figure 1.11 Trenches (deepest parts of the Oceans)



Dear learner; could you please write the names of the major Rivers that drain into the Atlantic Ocean?

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.

The Indian Ocean



Where is the location of the Indian Ocean and what are its unique features compared to the other Oceans of the world?

The Indian Ocean is the world's third-largest Ocean and it has an area of 68,566,000 Km². 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 Red Seas 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.

The Pacific Ocean



How large and deep is the Pacific Ocean?
Where is its deepest point?

The Pacific Ocean is by far the world's largest ocean basin with about 155,557,000 km². 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.

The Southern Ocean



Why the Southern Ocean named the world's newest Ocean?
Explain?

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 km² and an average depth ranging from 4,000 to 5,000 m. The deepest point in the Southern Ocean is unnamed, but it is at the south end of the South Sandwich Trench (Figure 1.11) and has a depth of 7,235 m.



Dear learner; please compare the notes you read with Figures 3.1 & 3.2 to validate your understanding on the lesson you are studying.

Additional information is also available online for you at:
<https://www.youtube.com/watch?v=Qyq9534JtQo>

Activity 1.3

1. How do you explain the distribution of Continents and Oceans over the Globe?
2. What are the major Oceans and Continents of the world?
3. How do you relate your home continent to other continents?

Feedback to Activity 1.3

1. The size and distribution of landmasses and water bodies are not even across the Earth. Water bodies cover over 71% of the Earth. The relative distribution of land to Oceans is around 1:1.5 and 1:4 in the northern and southern hemispheres, respectively. This indicates that the relative size of the Oceans is much larger in the southern hemisphere than it is in the northern hemisphere.
2. The major Continents of the world are Africa, Antarctica, Australia (Oceania), Asia, Europe, North America, and South America. The world's major Oceans are likewise the Arctic Ocean, Atlantic Ocean, Indian Ocean, Pacific Ocean, and Southern Ocean.

Section Summary

At this point, you need to think back about the lesson objectives set for you and the learning contents you covered and consolidate your understanding. In this connection you might recall, continents and Oceans are the major constituents of the planet Earth. They correspondingly cover nearly 29 and 71% of the total area of the Earth. Today, seven continents and five Oceans makes-up the Earth. Yet, their relative distribution over the Globe is not even. 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. Arctic and Southern Oceans are centered at the North and South Poles, respectively. The formerly Tethys Ocean disappeared with its remnants forming the Mediterranean Sea or being replaced by the Indian Ocean.



Checklist 1.3

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	The size of the continental landmass is larger in the northern hemisphere than in the southern hemisphere.		
2	Over 70% of the earth is covered with water.		
3	There are five continents and seven known oceans on Earth.		
4	The present-day continents and oceans are created by continental drift.		
5.	Australia and Asia are the largest & smallest continents in the world, respectively.		
6	Do you know the largest ocean on the earth?		

Self-test Exercise 1.3

Dear learner; we hope you enjoyed reading the notes and doing the activities in section three. We think you found the components of the lesson meaningful and relevant. Thus now, attempt the questions given from 1-16 to evaluate how far you have understood the lesson you studied.

General Direction: Carefully identify and attempt the following (16) questions according to their respective intent (16 points)

Part I) Matching

Instruction: Match items 1-8 with the five Oceans given under column 'B' (8 points)

No	Column 'A'	Column 'B'	
1	Known for its waters that have been historical checkpoints	A	Southern Ocean
2	Nansen Basin	B	Atlantic Ocean
3	Challenger Deep	C	Indian Ocean
4	Cape Verde	D	Pacific Ocean
5	Sunda Double Trench	E	Arctic Ocean
6	Mariana Trench		
7	South Sandwich Trench		
8	Puerto Rico Trench		

Part II) Multiple Choices:

Instruction: Choose the best answer from the given alternatives for questions 9-15 (7 points)

9. Which of the following is Not True about the distribution of Continents and Oceans over the Globe?

- A) Oceans are larger bodies of salty water over the Globe
- B) Oceans cover around 71% of the Earth's surface
- C) Continents cover a larger area in the southern hemisphere than in the northern
- D) The distribution of Continents and Oceans is uneven over the Globe.

10. The deepest point on Earth is found in the:

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

11. Which of the following is True about the characteristics (features) of the Oceans?

- A) The Pacific Ocean is the smallest in the world
- B) The Arctic is the shallowest Ocean in the world
- C) The Southern Ocean is surrounded by Asia, Europe, and North America
- D) The Atlantic is the largest and deepest Ocean in the world

12. Which Ocean is considered the newest (youngest) in the world?

- A) Southern Ocean B) Indian Ocean C) Arctic Ocean D) Atlantic Ocean

13. Which Ocean has the warmest surface Ocean temperatures and is known for causing the monsoon weather patterns?

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

14. Andaman, Arabian, Flores, Java, and the Red Sea are parts of the:

- A) Arctic Ocean B) Indian Ocean C) Southern Ocean D) Atlantic Ocean

15. Which Ocean receives more freshwater from continental runoff than any of the other Ocean basins?

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

Part III) Short Answer Writing

Instruction: Write a short answer for the questions (5 points)

16. A) _____Trench in the Pacific Ocean forms the deepest part of the Earth (0.5 points).

B) What makes the Arctic Ocean unique from the other Oceans? (1.5 points)

C) Why does the Indian Ocean experience the warmest Ocean Surface temperature? (1.5 points)

D) Write the name of the shallow Seas found in the Atlantic Ocean and then identify their ideal geographic location (1.5 points).

Answer Key to Self-test Exercise 1.3

Dear learner; we hope you did well in the self-testing. So now, you are at the stage of completion of the 3rd section of module one. Thank you for doing the self-test questions. Please compare your answers to the feedback given and make corrections for any errors, if available.

No	Part I) Matching				Part II) Multiple Choices			
1	C	5	C	9	C	13	C	
2	E	6	D	10	D	14	B	
3	D	7	A	11	B	15	D	
4	B	8	B	12	A			

Part III) Short Answer Writing	
16A)	Mariana Trench in the Pacific Ocean forms the deepest part of the Earth.
B)	The Arctic Ocean is unique from the other Oceans because it is mostly packed by polar icecaps due to its high latitude location
C)	The Indian Ocean experiences the warmest Ocean surface temperature because it is located along the equatorial areas.
	<p>The shallow Seas found in the Atlantic Ocean basin are the Baltic Sea, Black Sea, Caribbean Sea, Gulf of Mexico, Mediterranean Sea, and North Sea. The ideal geographic location for each is indicated below:</p> <ul style="list-style-type: none"> • Baltic Sea: Central Europe (between Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Germany, and Denmark). • Black Sea: Eastern Europe (between Turkey, Bulgaria, Romania, Ukraine, and Russia). • Caribbean Sea: in Central America (between the Gulf of Mexico, South America, Mexico, and the Atlantic Ocean). • Gulf of Mexico: in Central America (between the USA, Mexico, and the Caribbean Sea). • Mediterranean Sea: Between Africa, Europe, and the Middle East. • North Sea: Northwest Europe (between the UK, Netherlands, Germany, Denmark, and Norway).

SECTION FOUR

CHANGING POSITION OF CONTINENTS AND OCEANS OVER GEOLOGICAL TIMES

(1 hour)



Section Overview

Dear learner; I hope you remember that the Earth and its Continents have evolved since 4.5 billion years ago. The first Continents: Gondwana, Baltica, Siberia, Laurasia; 'Rodinia' and Pangaea had successively evolved from 514 to 210 Ma. Nevertheless, those ancient Continents were not geographically stationary and static. They have been undergoing several changes since their formation. For instance, the latest Super Continent, Pangaea, and the accompanying Super Ocean, Panthalasa, have been correspondingly divided into seven Continents and five Oceans through continental drift. This specific section thus acquaints you with the changing positions of Continents and Ocean basins over the geologic times.

Section Learning Outcomes

Dear learner; 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



Dear learner:

1. What is your perception about the position of the Earth's Continents and Oceans?
2. Are they static or dynamic?
3. What do you know about relative position of Contents and Oceans of our Earth?

Please compare your answer of the given questions with the notes above and imagine how far your understanding is effective.

Dear learner; 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 big water the body named Panthalasu. During this time, Laurasia was located around the equator whereas Gondwana was located around the South-Pole.



How did the Earth's Continents and Oceans change their positions over the Geological times? Explain?

Dear learner; please relate your response of this question with the preceding and next notes.

During the second stage, in the late Triassic period ($\approx 180\text{Ma}$), 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 the rifted area between the continents (see Figure 1.3).

During the late cretaceous (70 Ma), the separation between Eurasia and North America increased. These two big continents are positioned almost north of the tropic of cancer. Africa, South America, Arabia, and India are separated and positioned around the equator. Antarctica is 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 Americas, Eurasia, and Australia. The Arctic Ocean covers areas north of the Arctic Circle and areas between North America, Europe and Asia.



1. Why Continents and Oceans changed their positions over the Geological times?
2. What forced them to change their prior locations?

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).

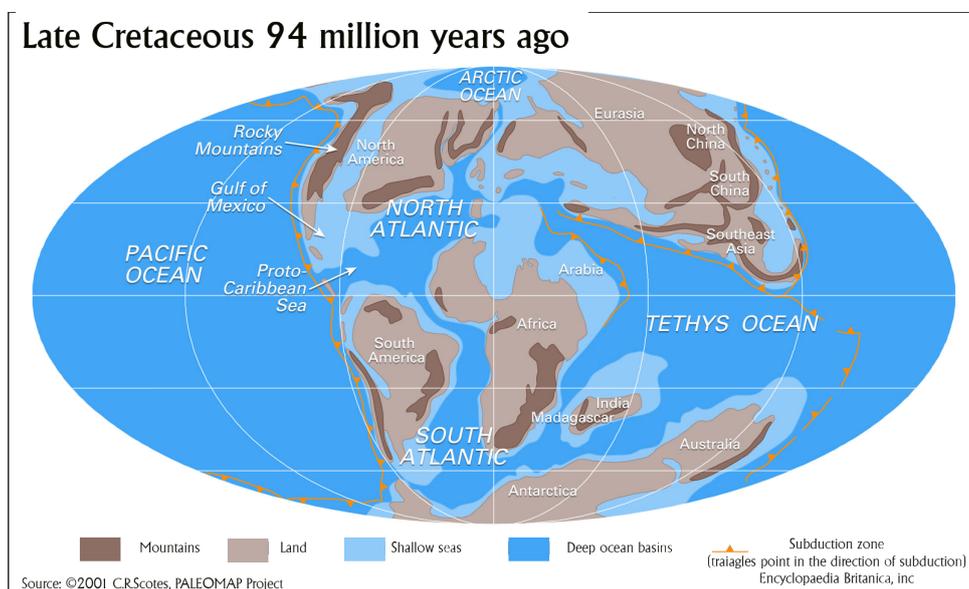


Figure 1.12 Location of Continents and Oceans during the late Cretaceous



Dear learner; what are the seven Continents?

Can you identify them?

How do you explain the present day position of the Earth's Continents and Oceans?

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



Dear learner; how do you feel about this unit? Once again I would like to remind you to analyze all learning aids included in the module and refer for more understanding. Hence, seek ways of using the online resources such as the video links included for you.

Use the online links given below for additional information:

https://www.youtube.com/watch?v=wYYakyS_HOg

<https://www.youtube.com/watch?v=v7KtuqDaPVO>

Section Summary

Dear learner; the Continents and Oceans are not geographically stationary and static. They have been undergoing several changes since their formation. The ancient Super Continent and Oceans have been broken into smaller Continents and Oceans through continental drift. Due to continental drift, the Earth and its Continents as well as the Ocean basins have been continuously changing their shapes, sizes, and positions 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 on the planet Earth. Many 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.

Activity1.4

1. How were the Earth's Continents and Oceans evolved?

Feedback to Activity 1.4

Dear learner; The Earth's Continents and Oceans evolved through Continental Drift.



Checklist 1.4

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	The earth and the continents are static and fixed.		
2	Do you know why the continents are moving?		
3	Plate Tectonics (Continental Drift) changes the shape, size, and position of the Continents and Ocean basins.		
4	The Gondwana continents were positioned around the south pole during the Mesozoic era.		
5.	The Laurasia continent was located around the equator during the Mesozoic era.		

Self-test Exercise 1.4

Dear learner; we hope you enjoyed reading the notes and doing the activities in section four. We feel you find them all fascinating and made you curious. Now, do the questions given from 1-7 appraise yourself on how far you understood the lesson you studied?

General Direction: Attempt questions 1-7 based on the instructions given.

Part I) Multiple Choices

Instruction: Choose the best answer from the given alternatives (5 points)

- Which of the following is not true about Continents and Oceans?
 - During the late Proterozoic 650 Ma (when Rodinia first evolved), the Continental landmasses were centered around the north-Pole and equator
 - During the mid-Ordovician (458 Ma), when Gondwana, Baltica, Siberia, and Laurasia collided, Panthalassa, Iapetus, and Paleo-Tethys Oceans were occupying areas north of the equator, at the equator, and south of the equatorial areas, respectively
 - At the time when pre-Pangaea formed, from early Devonian to late Carboniferous (390 – 306 Ma), Pantalassic and Paleo-Tethys Oceans were dominating the Globe
 - Today, most continents occupy areas north of the equator while Oceans dominate the southern hemisphere
- Which is correct?
 - The Atlantic Ocean is now located between Asia and the Americas
 - The Pacific Ocean divides Africa and Eurasia from the Americas
 - The Arctic and Southern Oceans are centered at the North and South Poles, respectively
 - The Indian Ocean covered the area between Eurasia and the Americas
- Identify the correct statement?
 - All the Earth's Continents and Oceans are geographically permanent and immovable
 - The Super Continent Pangaea had evolved before the motherland Rodinia
 - Rodinia was equivalent to Pangaea in size, shape, and composition
 - Plate tectonics changes the shape, size, and position of the Continents and Oceans

4. Which theory disproved the Orthodoxy view of the geographical permanency of Continents and Oceans?
 A) Big Bang B) Plate tectonics C) Evolution D) Revolution
5. Which of the given Oceans were dominating the Globe before the evolution of the present-day Continents?
 A) Atlantic, Pacific, and Arctic C) Indian Ocean and Southern Ocean
 B) Arctic and Indian Oceans D) Panthalsa, Iapetus, Rheic and Paleo-Tethys

Part III Short Answer Writing

Instruction: Give short answers to the following questions (6-7) (5 points)

6. Dear learner; from the five Oceans you studied, which one is located nearer to your home country?
 7. Outline the seven Continents of the Earth and identify the Continent where your country is found?

Answer Key to Self-test Exercise 1.4

Dear learner; we hope you did well in the self-testing. You are now at the stage of completion of the 4th section of the module. Thank you for doing the self-test questions. Please compare your answers with the feedback given and make corrections for any errors, if available.

1. A 2. C 3. D 4. B 5. D

6. The Ocean found nearer to my home country- Ethiopia is named the Indian Ocean

7. The seven Continents are:

- ◆ Africa,
- ◆ Antarctica
- ◆ Asia
- ◆ Australia (Oceania)
- ◆ Europe
- ◆ North America
- ◆ South America

The Continent where my country found in Africa

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 is 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 is 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. In 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/on 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 on the planet Earth. Many 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.

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UNIT TWO

CLIMATE CLASSIFICATION AND REGIONS OF OUR WORLD (16 hours)

UNIT INTRODUCTION

Dear learner! Welcome to the second unit of geography for grade 11. In this unit, you will learn about climatic classification and global climatic areas. The unit also presents approaches, climatic region classification criteria, and elements that influence global climatic regions. As a result, you should make an effort to understand the content offered/presented independently. The climate is a multifaceted and abstract notion that contains data on all aspects of the global environment. It varies 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 requires climate classification to recognize, clarify, and simplify climatic similarities and variations between geographic regions. Most classification schemes are intended for global or continental scale use and identify climatic zones based on the criteria.

Expected learning outcomes of the unit

Dear learner, at the end of this unit, you will be able to:

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

SECTION ONE

CRITERIA FOR CLIMATE CLASSIFICATION (1 hour)

Section Overview

Dear learner, this section will introduce you to the criteria for climate classification. Climate classification helps identify expected weather patterns for a specific place, contrasting exceptional and typical daily meteorological variables, and expressing climate variability and change over time. Different types of climate classification, including ancient Greeks, genetic, and empirical (including Köppen and Trewartha) employ several environmental parameters. For instance, climatic areas are typically classified using data on soil, vegetation, temperature, and precipitation, as well as air masses. Dear learner, it is a good idea to start the sub-content with appealing questions that encourage you to think critically about the topic. As a result, it is hoped that this section will help you learn more about the key criteria used to classify climates.

Section learning outcomes

Dear learner, at the end of this section, you will be able to:

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

Keywords:

- Climate classification;
- Criteria



Dear learners, what do you think of the ancient Greeks' criteria for classifying climates?

Compare your thought to the text description that follows. 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.



Dear learners, what are your thoughts on the criteria employed in genetic classification systems?

A genetic classification method is used to classify climates based solely on the main driving forces that influence climate. The activity and characteristics 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 are used to classify climate using the genetic method. While genetic systems are more desirable from a scientific viewpoint, they are more difficult to execute and less effective all around because

they do not rely on straightforward observation. Air mass ideas are the most frequently used genetic systems. Have you drawn meaning out of your reading up to this? Depending on your response, try to adjust your approaches and style of studying for deep comprehension.



Dear learners, what do you think of the empirical classification system's criteria?

A classification system known as empirical classification employs data input to determine the climatic type based on predetermined class boundaries. For instance, Köppen and Trewartha's methods have the benefit of being easy to implement in areas with high-quality and plentiful climatic data.

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. Dear learner, you have now completed the first section of this unit. As a result, try answering the following questions to see how well you understand this section.

Dear learner, you have now completed the first section of unit 2. As a result, try to answer questions in activity 2.1 to see how well you understand this section.

Activity 2.1.

Dear learner, please try to write a brief response to the following questions.

1. How do you comprehend climate?
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?
5. Compare and contrast the Köppen and Trewartha's climatic classification systems' criteria

Dear learner, thank you for taking the time to answer the activity. Hopefully, you have written responses to the activity questions on hand. Please compare your responses to the feedback provided below.

Feedback to Activity 2.1.

1. The climate is the long-term average of all meteorological conditions in a specific location, such as temperature, winds, air pressure, clouds, rainfall, and humidity.
2. Climate classification is a method for recognizing, clarifying, and simplifying climatic similarities and contrasts between geographic locations so that we can better comprehend the Earth's climates.
3. The ancient Greeks divided the world into three zones based on their perceptions of habitability, which included temperature and worldwide sunshine distribution, or the Earth-Sun Relationship. Frigid Zone (extremely cold temperatures), Temperate Zone (ideal climate and habitable areas), and Torrid Zone (extremely hot temperatures) (warmer areas).
4. The activity and properties of air masses, circulation systems, fronts, jet streams, solar radiation, topographic effects, and other factors that contribute to the geographical and temporal patterns of climatic data are classified using a genetic classification approach. Empirical categorization systems (Köppen and Trewartha's) rely on data input to establish climatic types based on predetermined class boundaries.
5. Both are empirical classification schemes that use temperature and precipitation as input data to classify the climate. Trewartha's classification, unlike Köppen's, blends the empirical foundations (average temperature and precipitation) with genetic classification methods (effect of water surfaces on the climate of a given area).

Section Summary

Dear learner, kindly asks yourself to describe the lesson's key points before summarizing everything else. You can mention the following points in your summary. The classification system used by the ancient Greeks was based on a concept of habitability that took temperature and dispersion of sunlight into account. Considerations include air mass activity and characteristics, circulation patterns, fronts, jet streams, solar radiation, topographical effects, and genetic climate classification. The annual, monthly, and seasonal patterns of temperature, precipitation, and other factors are the foundation of the Köppen climatic classification system. Temperature, precipitation, and the effects of a region's land and water surfaces on the climate are all considered in Trewartha's classification. Dear learners, you can bring different weather and climate characteristics that are used as classification criteria by using your observations and experiences.



Checklist 2.1

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you identify criteria used by the ancient Greeks to classify world climate?		
2	Did you identify criteria used by the Köppen climatic classification system?		
3	Did you identify the criteria used by Trewartha's climatic classification system?		

Self-test Exercise 2.1

Part one: Multiple-Choice Item

Instruction: Dear learner please answer questions 1—5 by choosing the best one from the given alternatives for each.

1. According to ancient Greek perceptions of habitability, _____ offers the best climate and habitat.
A/ Frigid Zone B/Temperate Zone C/Torrid Zone D/ all
2. Which of the following was not used as the foundation for ancient Greek climate classification?
A/ The Earth-Sun relationship B/ temperature C/ precipitation D/ B & C
3. What is the most commonly used genetic system of climate classification criterion?
A. Air mass ideas B/ temperature C/ precipitation D/ A & B
4. Which classification system is not empirical
A. Genetic B/ Köppen C/ Trewartha's D/ none
5. Which criterion is not considered by the Köppen classification system
A. temperature B/ precipitation C/ water surfaces impact D/ all

Part Two: True or False Item

Instruction: Dear learner please complete the question that follows by saying “True” if the Sentence is “Correct” and Say “False” if the Sentence is “Incorrect”

1. The Earth-Sun relationship served as the foundation for ancient Greek climate classification
2. Precipitation and air mass characteristics form the basis of the Köppen climate classification system.
3. Trewartha's classification solely takes into account temperature and precipitation.

Answer Key to Self-test Exercise

I. CHOICE ITEM

1. B 2. C 3. A 4. A 5. C

II. 1. True 2. False 3. False

Learner, how did you find the lesson? I think it was thrilling and engaging for you. Did your self-test go well? If you selected yes, move on to the following section.

SECTION TWO

KÖPPEN'S CLIMATE CLASSIFICATION

(5 hours)

Section Overview

Dear learners, this section focuses on the Köppen climate classification system, which is widely used for classifying global climate due to its simplicity and strong alignment with climatic areas, natural vegetation, and soil types. The Köppen method, which is based on dominant vegetation types, recognizes that most vegetation types respond immediately to climate inputs, particularly temperature, and precipitation fluctuations. Köppen observed and mapped the ecotone (the zone where two biomes meet), then used temperature and precipitation data to develop equations defining the climatic boundary between the two biomes.

Section learning outcomes

Dear learner, at the end of this section, you 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;
- Simplified Köppen;
- Modified Köppen

2.2.1. The Simplified Köppen's Climate Classification System



Dear learners, how do you use the simplified Köppen's Climate Classification System?

Hopefully, you have attempted the preceding questions. Relate the points you made to the following descriptions. 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. These include:

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 that dominates most of the year.
3. Meso-thermal or Mid-latitude Mild (C): Average temperature of the coldest month is below 18°C (64°F) and above -3°C (27°F).
4. Micro-thermal or Mid-latitude Cold (D): The average temperature of the warmest month exceeds 10°C (50°F), and the coldest monthly average drops below -3°C (27°F).
5. Polar Climate (E): It has extremely cold winters and summers. The average temperature of the warmest month is below 10°C (50°F). Given that all months are cold, there is no real summer season.

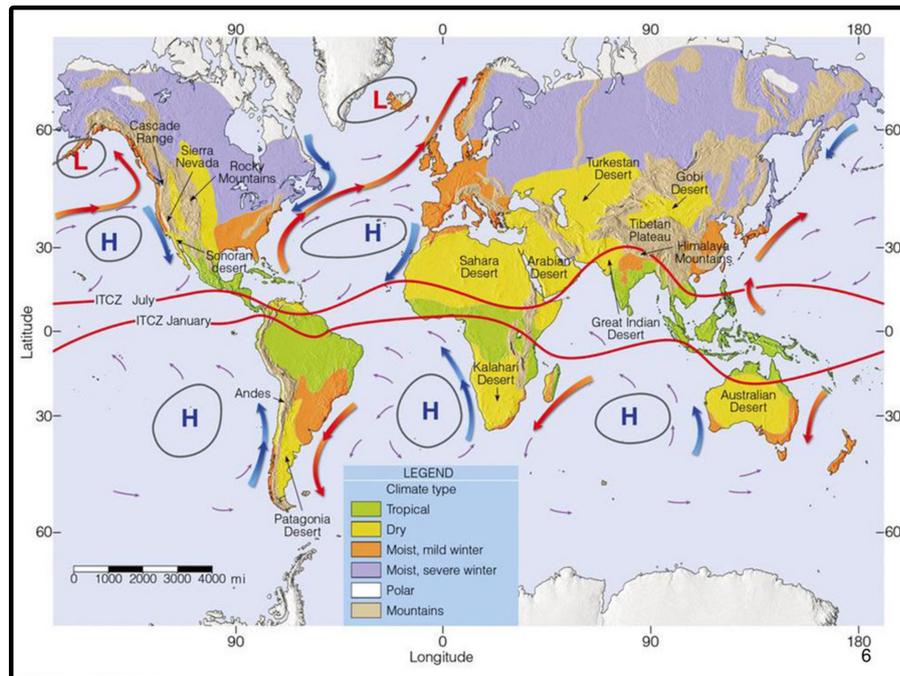


Figure 2.1: A simplified overview of the major climate types, according to Köppen



Dear learner, how does the simplified Köppen's climate classification system differentiate the climatic zones?

Climates A, C, and D promote tree growth, whereas climates B and E, which are too dry and cold, respectively, 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. Dear learner, note that a climatic classification approach and its respective characteristic and distribution are explained and illustrated herein. As a result, you are required to thoughtfully engage in reading and examining figures, maps, and related resources suggested so that you can understand the learning contents as intended.

Dear learner, you have now completed the simplified Köppen's climate classification system. As a result, try to answer questions in activity 2.2.1 to see how well you understand this section.

Activity 2.2.1

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?

2.2.2. Modified Köppen Climatic Classification Systems

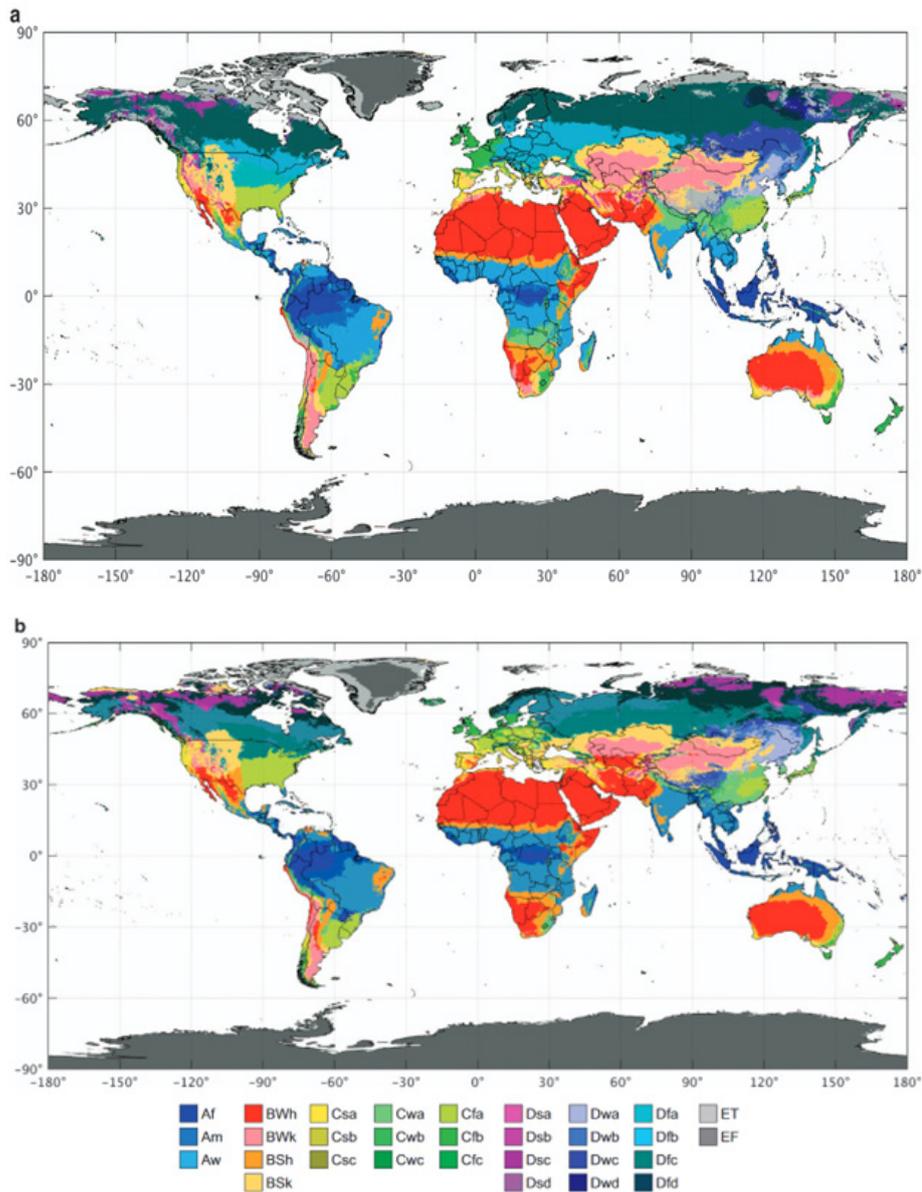


Figure-2.2. Improved Köppen-Geiger classifications of our world: Part (a) shows the present-day map (1980–2016) and (b) the future map (2071–2100).

Using air temperature (OC) 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, caused by the rising levels of greenhouse gases in the atmosphere.

Köppen-Geiger climate classification map for Ethiopia (1980-2016)

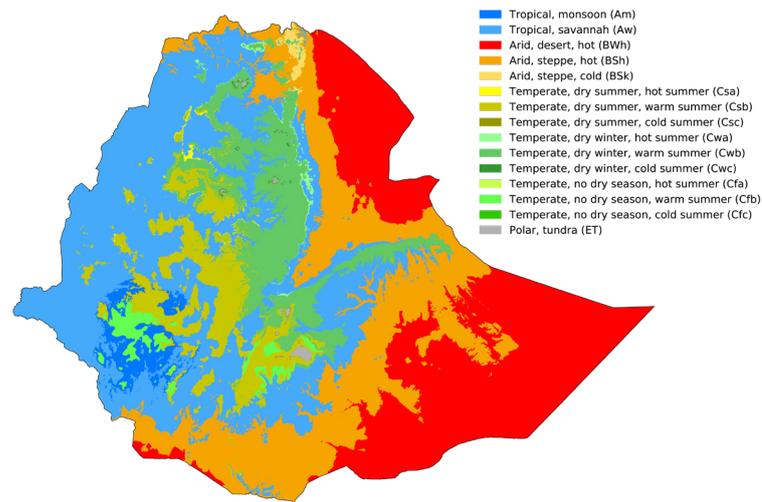


Figure 2.3. Köppen-Geiger climate classification map for Ethiopia (1980-2016). Based on your experience how do you interrelate the climatic regions' features and humans' living?

Dear learner, while reading the following note go back and forth between reading and referring to figure 2.2a & b, as well as figure 2.3, for more conceptualization and understanding. 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, and "w" denoting dry winter climates).

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.

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 the Amazon rainforest and Congo basin.

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 is found in regions such as parts of India and South east Asia.

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. 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: Dear learners, please look over the case example provided and try your activity.

If a location's average annual precipitation is 80 inches, the Am/Aw boundary is =

$3.94 - 80/25 = 3.94 - 3.2 = 0.74$ 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 development 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 region, where the dryness of Somalia is caused largely by the direction of the continent concerning the atmospheric circulation, is an exception to the typical trend for aridity to be related to subsidence. Based on yearly temperature and the wettest month of the year, the dry climate is classified into two minor classes.

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 300 North and South, where warm, dry air sinks because of subtropical high zones. Vast deserts such as the Sahara or Gobi are included.

Dry Semi-arid 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 ($^{\circ}\text{F}$). 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 coast, and the great basin are semi-arid deserts.

Case Example. 2.2: Dear learner .please consider/check the provided case example and try your activity,

If the temperature of a place is 90°F , the annual value of precipitation for dividing the boundary between BS and BW climates will be $r=0.44 \times 90 - 8.5/2 = 15.5$ 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°C (64.4°F) and by the letter "k" when the mean annual temperature is less than 18°C (64.4°F). Desert climates are further divided into hot/tropical/desert (BWh) climates, which have an average annual temperature greater than 18°C (64.4°F), and middle latitude cold desert climates (BWk), which have an average annual temperature less than 18°C . Hot dry semiarid or tropical steppe (BSh) climate, with a mean annual temperature above 18°C , and cold dry semiarid or middle-latitude latitude cold steppe climate (BSk), with mean annual temperature below 18°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 $21-32^{\circ}\text{C}$ ($70-90^{\circ}\text{F}$). Furthermore, daily temperature swings are considerable.

Mid-latitude Mild or Mesothermal (C)

Learner, based on your preceding readings, imagine the nature of the Mid-latitude climate region (C) and its classification before moving into the details of the subsection. Warm and humid summers alternate with mild winters in this region, which is located between 25 and 40° 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 climates 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), 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 characterized by humidity, short dry summer, and persistent presence of mid-latitude cyclones (causing heavy precipitation during mild winters).

(ii) Cw Climate: Dry winters, with the wettest month of the summer season receiving 10 times more precipitation than the driest month of the winter season. In China, it is the most common climatic type.

(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 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 fewer than 10°C. 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°C (32°F) but less than 10°C. (50°F). 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°C (32°F) or below.

Highland Climate



Dear learner, why are tundra and polar conditions sometimes observed in low latitude or tropical regions?

Because of 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° 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. Recall from your experience and reading exposures, attempt to interpret the illustrative information represented by Figure 2.3 below, about the highland climate found in low latitude (tropical) regions.

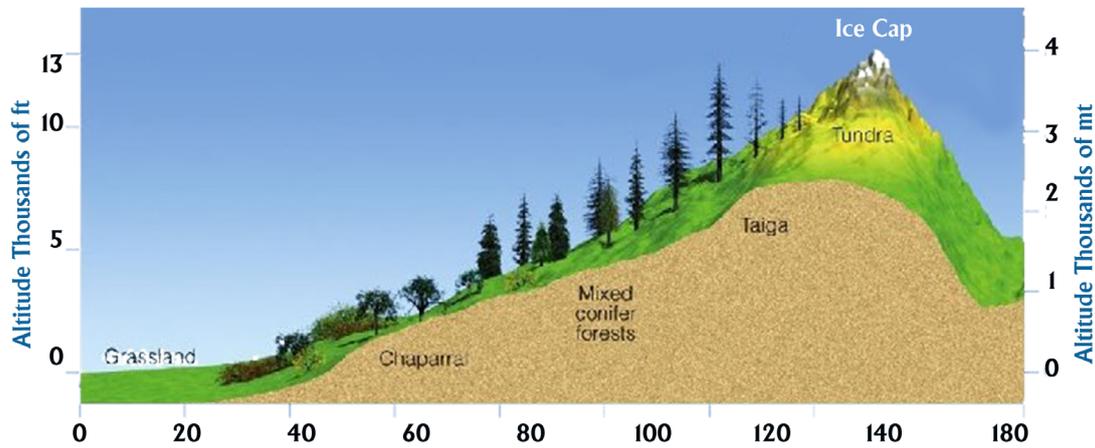


Figure 2.4: Altitudinal zone of highland climate

The afro-alpine zones on the highest parts of the Ethiopian plateaus, for example, have a highland climate. The Senate Plateau (Bale Zone), Semen 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). For further comprehension please try to visit the online sources indicated below:
<https://earthobservatory.nasa.gov/images/91739/ethiopias-sanetti-plateau;>
[https://www.youtube.com/watch?v=iOf5UUjPVY8.](https://www.youtube.com/watch?v=iOf5UUjPVY8)

The Merits and Demerits of the Köppen's System



Dear learner, why has the Köppen scheme been criticized by several people?

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

- ◆ extreme events, such as a periodic drought or a common cold spell, are as 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 he based his A, C, D, and E zones on mean temperature, whereas his 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 scheme 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.

Dear learner, you have now completed section two. As a result, try to answer questions in activity 2.2.2 to see how well you understand this section

Activity

Dear learner, please take some time to answer the questions below.

1. how can you tell the difference between a basic Köppen system and one that has been modified?
2. Recognize and describe the modified Köppen climatic classification that characterizes the world's regions.
3. Discuss the advantages and disadvantages of using the Köppen climate classification system.
4. Using the modified Köppen climatic classification system, describe and show Ethiopia's climatic division on a themed

Dear learner, Thank you for spending the time to respond to the activity. Hopefully, you have written responses to the activity questions on hand. Please check your responses against the feedback provided below.

Feedback to activity 2.2.1

1. It is used because of its simplicity, as well as the close correlation between climatic zones, natural vegetation, and soil types.
2. Ethiopia's climate is classified as highlands or mountains with a dry climate, according to a simplified Köppen classification.
3. Climate types A, C, D, and E are characterized by temperature; however climate type "B" is defined by dryness rather than coldness as the governing element of vegetation.

Feedback to Activity 2.2.2

1. By combining appropriate first, second, and third-order subdivisions, the modified Köppen–Geiger climatic types are created. To classify regional climates more precisely, those primary (first) climatic types were subsequently categorized into second and third-order subcategories

2. the fourteen modified Köppen climatic classifications are described as follows.

- ◇ Tropical wet or equatorial rainforest climate (Af): climate with year-round precipitation and daily highs of around 32°C, with an average nighttime temperature of 22°C.
- ◇ Tropical monsoon climate (Am): a climate with yearly rainfall similar to or greater than Af, but with the majority of precipitation falling during the 7–9 hottest months to maintain rainforests.
- ◇ The tropical wet and dry climate, often known as savanna (Aw), is characterized by a protracted dry season in the winter.
- ◇ Desert (BW): A real dry environment dominated by xerophytes flora that covers 12% of the earth's land surface.
- ◇ Dry Semiarid or Steppe (BS): A grassland environment that encompasses 14% of the Earth's land surface.
- ◇ The climate gets more precipitation than the BW from the inter-tropical convergence zone or mid-latitude cyclones.

- ◇ A hot/tropical/desert climate (BWh) has an average annual temperature of more than 18°C (64.4°F)
- ◇ A middle latitude cold desert climate (BWk) has an average annual temperature of less than 18°C.
- ◇ The climate is hot, dry, semiarid, or tropical steppe (BSh), with mean annual temperatures above 18°C.
- ◇ With a mean annual temperature below 18°C, a cold dry semiarid or middle-latitude cold steppe climate (BSk) exists.
- ◇ Warm, muggy summers with frequent thunderstorms; and precipitation from mid-latitude cyclones during the mild winter season) Humid subtropical (Cfa)
- ◇ The marine west coast (Cfb) was marked by humidity, a brief dry summer, and the presence of a mid-latitude cyclone (causing heavy precipitation during mild winters).
- ◇ Cw Climate: Dry winters, with the wettest month of the summer season receiving 10 times more precipitation than the driest month of the winter season.
- ◇ The wettest month of the winter season receives three times more precipitation than the driest month of the summer season, with the driest month of the summer season receiving less than 1.2 inches of precipitation.
- ◇ Cs (Mediterranean): The primary rain comes from mid-latitude cyclones during the winter season. Extreme summer aridity is caused by the sinking airs of the subtropical highs.

3. Dear learner, here are the Köppen climatic classification system's merits and demerits.

The merits:

- ◇ It provides a clear, quantifiable, and straightforward scheme for assigning a given location to a specific climate sub-group based on temperature and precipitation.
- ◇ It acknowledges the relationship between vegetation kinds and climate.
- ◇ Using the modified Köppen climatic classification system, describe and display Ethiopia's climatic division on a themed map.

Demerits:

- ◇ It does not consider extreme events, such as a periodic drought or a common cold spell, as significant in controlling vegetation distribution as the mean conditions upon which Köppen's scheme is based;
- ◇ It does not consider sunshine and wind as important to vegetation distribution;
- ◇ It is inconsistent because he used mean temperature for his A, C, D, and E zones, whereas his zone B is based on the precipitation-evaporation ratio;
- ◇ It is insufficiently comprehensive since it ignores the climate of mountainous regions and fog-affected areas, and
- ◇ the borders of Köppen's climatic classifications are overly empirical.

3. The modified Köppen climatic classification system is provided as follows to show Ethiopia's climate division on a themed map.

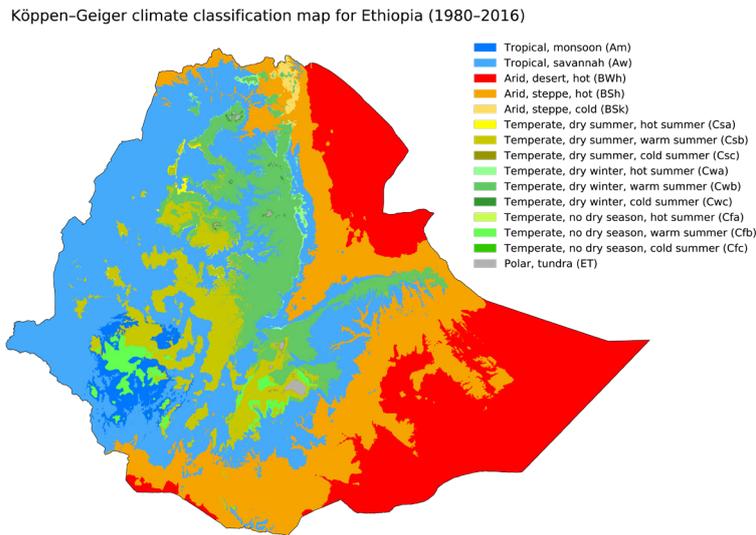


Figure.2.4: Köppen climate types of Ethiopia
 Source: Becket al.: Present and future Köppen-Geiger climate classification maps at 1 km resolution, scientific data 5:180214, doi:1038/data.2018.214 (2018)

According to the modified Köppen climatic classification scheme, Ethiopia’s climate is divided into fourteen categories. BWh (arid desert hot), Bsh (hot semi-arid), Bsk (cold semi-arid), Csa (temperate, dry summer, hot summer), Csb (temperate dry summer, warm summer), Cwa (humid subtropical or temperate dry winter, hot summer), Cwb (subtropical highlands or temperate dry winter, warm summer), Cwc (cold subtropical highlands or temperate dry winter, cold summer (polar, tundra).

· the relationship between the modified Köppen climate classification scheme and Ethiopia’s agroecological zones?

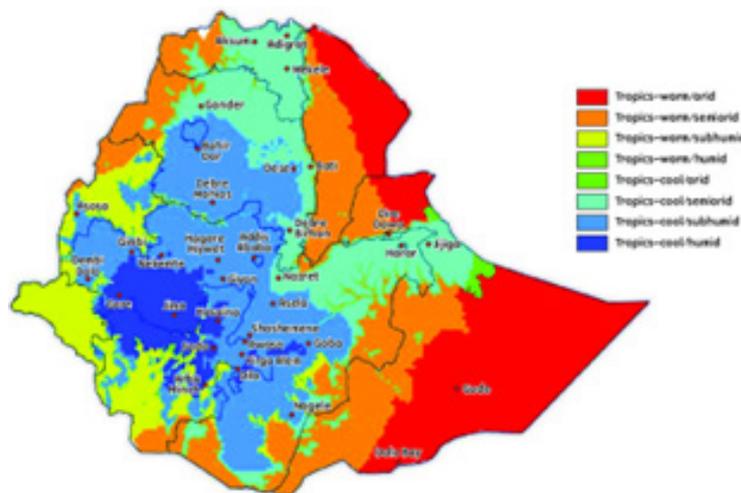


Figure 2-5: Agroecological zones of Ethiopia based on the Global 16 Class classification system.

Dear learner, you can explain the relationship between the modified Köppen climate classification scheme and Ethiopia’s Agroecological zones by comparing figures 2.1 and 2.2.

Section Summary

Dear learner recalls and outline the main themes of the lesson, and then consolidate your understanding by summarizing all important points. The following can be mentioned. Based on data on temperature and precipitation, the Köppen method classifies terrestrial climate into five distinct classes: Tropical climate (A), Dry Climate (B), Meso-thermal or Mid-latitude Mild (C), and Micro-thermal or Mid-latitude Cold (D).

The modified Köppen classification system divides A, C, and D climates into second-order subdivisions based on average monthly and yearly precipitation. The characteristics of summer temperatures are defined by the third-order subdivisions of the Mesothermal and Microthermal climates. In the case of a B climate, the second-order subdivision is "W" if the dry climate is truly a desert and "S" if it is merely semi-arid. The milder arctic subtype "T" for the tundra climate and the ice cap climate "F" (frozen) are second-order subdivisions for the "E" climate.



Checklist 2.2

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Have you recognized each element of the simplified Köppen climate classification system?		
2	Did you distinguish between simplified and modified Köppen's climate classification system?		

Self-test Exercise 2.2

Part One: Multiple-Choice Item

Instruction: Choose the Best Answer

1. Which climatic zone has no true winter season? A/ A B/ B C/ C D/ none
2. Which climatic zone has no summer season and is cold all year? A/ C B/ D C/ E D/ none
3. In which climate stimulates tree growth A/ D B/ B C/ E D/all
4. From the third-order subdivisions of Mesothermal and Microthermal climates, which indicate hot summers
A/ a B/ b C/ c D/ A&B
5. One of the following is not used to determine the boundary between BW and BS is__
A. annual precipitation B/ temperature C/ Air mass D/ none

Part Two: True or False Item

Instruction: Complete the questions that follow by saying “True” if the Sentence is “Correct” and Saying “False” if the Sentence is “Incorrect”

1. Annual precipitation and the rainiest month’s precipitation determine the difference between Aw and Am climates.
2. Dry climates are caused solely by their location in trade wind belts.
3. In the Mediterranean climate, extreme summer aridity is caused by the sinking airs of the subtropical highs.
4. Tundra and polar conditions may be seen in low-latitude areas due to the effects of altitude.

Answer Key to Self-test Exercise 2.2

1. Multiple Choice Items: 1. A 2. C 3. A 4. A 5 / C
2. True/False Items: 1. False 2. False 3/ True 4/ true

How did you find the lesson, learner? You seemed to enjoy it and find it quite exciting and interesting. I hope the self-evaluation went well. If so, go to the next section.

SECTION THREE

WORLD CLIMATIC REGIONS (4 Hours)



Section Overview

The Köppen classification and the seasonal dominance of air masses have been used to split the world's climatic zones into three major climate groupings. The three types are low-latitude climate, mid-latitude climate, and high-latitude climate. Dear learner, it is a good idea to start the sub-content with brainstorming activities that encourage you to think critically about the topic. You will study the world's climatic areas in this section.

Section learning outcomes

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

-  describe the major world climate regions, and
-  compare and contrast the elements of weather in different regions of our world.

Keywords:

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

2.3.1. Low-latitude Climatic Regions

i. Tropical wet region



Dear learner, how would you describe a tropical wet region?

Along the equator between 60N and 60S, the tropical wet climate prevails. 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 30C, and monthly temperatures ranging from 24 to 28°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



Dear learner, how do you describe a tropical dry region?

The region can be found between 60 and 150 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.

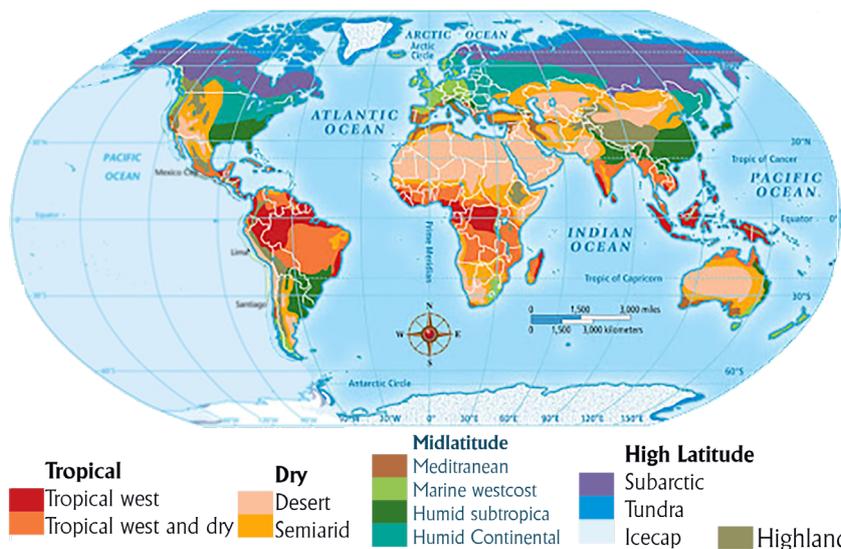


Figure 2.5: World climate region

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).

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



Dear learner, how do you differentiate between a steppe climate region and a dry desert?

Dear learner, the region lies between 15o and 25o north and south latitudes. 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).

2.3.2. Mid-latitude Climatic Region



Dear learner, how do you describe the mid-latitude climatic region? What types of climates are there in the region?

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

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

The climatic zone is located between 30° and 55° 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 afternoon heating. 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°C, 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° 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° and 50° 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 (see Figure. 2.5). Dear learner at this point, please rethink the concepts and issues you have read and relate to Figure 2.5 message and check your understanding before moving to the high latitude climate type.

2.3.3. High-latitude Climate



Dear learner, how do you distinguish polar tundra from Polar Ice caps?

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 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.

2.3.4. Highlands Climate



Dear learner, how does the highland climatic region differ from other climatic regions?

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.

Dear learner, you have now completed the fourth section of this module. As a result, try to answer questions in activity 2.4 to see how well you understand this section.

Activity 2.3

Dear learner, please attempt all the questions provided below

1. Distinguish the temperature and precipitation character between the subtropical dry desert and steppe region from mid-latitude desert and steppe.
2. In your perspective, what is the importance of the classification of our world into different climatic regions?
3. Explain the relationship between elevation, precipitation, and temperature in the highland climate.
4. Based on your experience, how do you relate the variation of climatic characteristics and humans living in different parts of the world?

Dear learner, have you attempted any of the questions in Activity 4.2? If you answered yes, please compare your response to the feedback from Activity 2.4.

Feedback to Activity 2.3

1. Compared to their subtropical counterparts, mid-latitude temperatures have a broader range of daily annual temperatures. The mid-latitude steppe has a similar temperature range to the mid-latitude deserts but receives a little bit more precipitation.
2. The purpose of climate classification is to develop a useful framework for arranging climatic information and understanding the many global climate changes. Monthly or seasonal climate statistics are broken down into their parts. Similar climate zones can be found on the surface of the world. The climatic resources of a region can be roughly estimated using this classification. It is helpful to have pertinent information about things like the potential plant species to utilize or the heating and cooling needs of adjacent homes. Region identification is crucial for calculations of how much the atmosphere has changed due to human activity in a certain spot.
3. The air is often warm at the earth's surface and cools down as one rises since the atmosphere warms up from the bottom up. The atmospheric pressure keeps dropping as the altitude rises because the weight of the air reduces.

The ability of airborne particles to expand increases with decreasing gravity, further reducing air pressure. In the upper troposphere and lower stratosphere, there is essentially little atmospheric pressure. Although the thin atmosphere makes flying relatively effortless, the shortage of oxygen makes survival at this altitude challenging. Higher-altitude places receive significantly more precipitation than low-lying areas because temperatures and air pressure decrease with altitude. Please remember that precipitation will only happen if there is sufficient moisture in the air. Rain is the most frequent type of precipitation when condensation takes place at a temperature above zero.

Section summary

Dear learner, this request for a summary of the section's important themes for you. For example, you can summarize as shown below. The tropical wet, tropical wet and dry, arid desert (BWh), and steppe (BSh) climate zones are examples of low-latitude climate zones. Mid-latitude Climatic Region, which comprises the Mid-latitude Steppe (BSk) and Desert (BWk), as well as the Mid-latitude Wet and Summer-Dry Regions (Cw and Dw) (Cs). The high-Latitude climate of the Polar Tundra (ET) and Polar Ice Cap (EF).



Checklist 2.3

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Have you dealt with the main climatic zones of the world?		
2	Have you compared and contrasted the weather conditions in other parts of the world?		

Self-test Exercises 2.3

Part one: Multiple-Choice Item

Instruction: Choose the best answer from the given alternatives

- The following region is affected all year round by the equatorial westerlies and the intertropical convergence zone
A. Tropical wet region B/ Tropical dry region C/ Mid-latitude desert D/ Polar Tundra
- Which climatic region is principally influenced by the continual fight between tropical air masses moving towards the poles and polar air masses moving towards the equator
A. Dry desert and steppe B/ Mid-latitude C/ Low-latitude D/ None
- Cold winters, cool summers, and a summer rainfall regime characterize the _____ climate region
A. Polar Tundra B/ Polar Ice Cap C/ Highlands Climate D/ Tropical dry region

Part Two: True/False Item

Instruction: Dear learner, if the Sentence is “Correct” Say “True” and if the Sentence is “Incorrect” Say “False”

- In the winter, the polar climate is dominated by frontal weather linked with a mid-latitude cyclone.
- During the winter, the equatorial borders experience convectional rainfall in the Mid-latitude wet region.
- The subtropical highs’ sinking air generates exceptionally dry and heated weather in the region during the summer in the Mid-latitude summer-dry

Part three: Writing Item

Instruction: Dear learner please provide a short answer to the following questions

- Why do mountainous regions have a nearly limitless variety of local climatic variables?
- Identify low-latitude climatic regions

Answer Key to Self-test Exercise 2.3

Choice Item: 1. A 2. B 3. A

True/False Item: 1. True 2. False 3. True

Short Answer

- Because of variations in atmospheric conditions with height and exposure to the sun’s rays
- The tropical wet region, Tropical wet and dry region, and Dry desert (BWh) and steppe (BSh) region

Dear learner, have you answered these given questions? If you answered no, please reread this section and attempt to answer the questions listed above. If you answered yes, congratulations. Continue to the next section.

SECTION FOUR

FACTORS INFLUENCING THE WORLD CLIMATIC REGIONS (5 Hours)



Section Overview

Dear learner, certain factors have an impact on the weather and climate at a particular location as well as the general state of the atmosphere at that location. Similar climatic conditions appear to be spread out extensively around the globe, giving the appearance of an erratic global climate distribution. For instance, we anticipate significant seasonal temperature variation in regions of the mid-latitudes. The majority of tropical locations experience little seasonal variation in temperature, however, they may experience seasonal changes in precipitation. These discrepancies are influenced by numerous climate controls. In this section, you will learn about the factors that affect the climatic zone of our planet. The factors that affect a certain location's climate are known as climate controls. It is advantageous to start the sub-content with questions that stimulate you to consider the subject critically. A region's climate is influenced by a variety of variables, including the quantity of sunshine and how it varies with latitude, the distribution of land and water, ocean currents, prevailing winds, the location of high and low-pressure zones, mountain barriers, and height.

Section learning outcome

Dear learner, 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;
- Continentiality;
- Centrifugal;
- Elevation;
- Latitude;
- Ocean Circulation;
- Subtropical High Pressure

a. Latitude (seasonality)



Dear learner, why does latitude have anything to do with climate?
The forthcoming discussion clarifies this more for you

On any given day, solar energy insolation strikes the earth at a decreasing angle from 90° (direct overhead) to 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°). 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°-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 distribution.

b. Combined Effects of Revolution, Rotation, and Tilt



Dear learner, 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 2.6?

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 sector 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 (look at Figure 2.6).

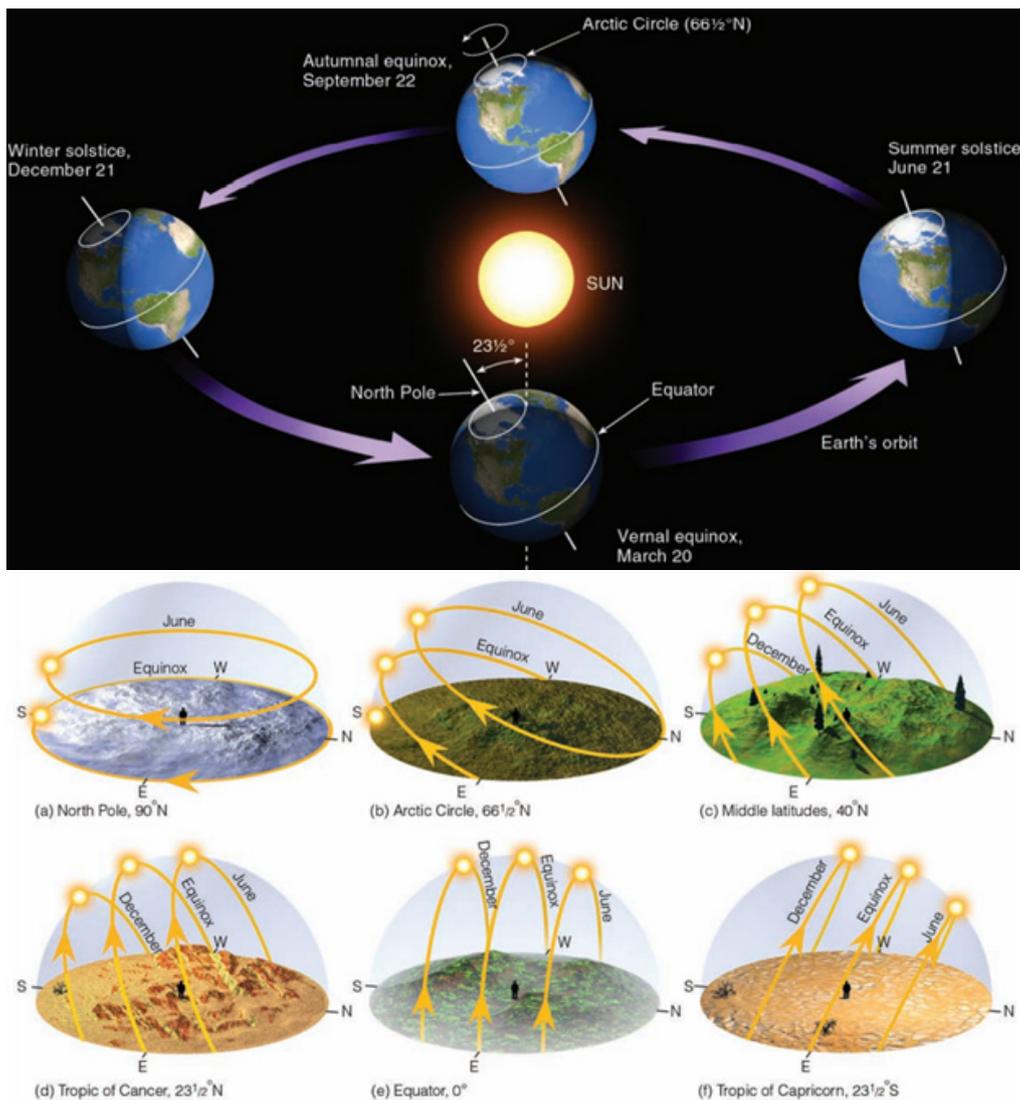


Figure 2.6 Relationships between Earth's axis and the circle of illumination during the year

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). Dear learner, it is hoped that you have critically examined all the visualized representations covered by Figure 2.6 and understood the content intended very well.

c. Continentality (distance to large water bodies)



Dear learner, 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 on 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.

d. Atmospheric Circulation



Dear learner, 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 its location relative to atmospheric circulation. This means one location may be affected by atmospheric circulation from a certain direction more often than another.

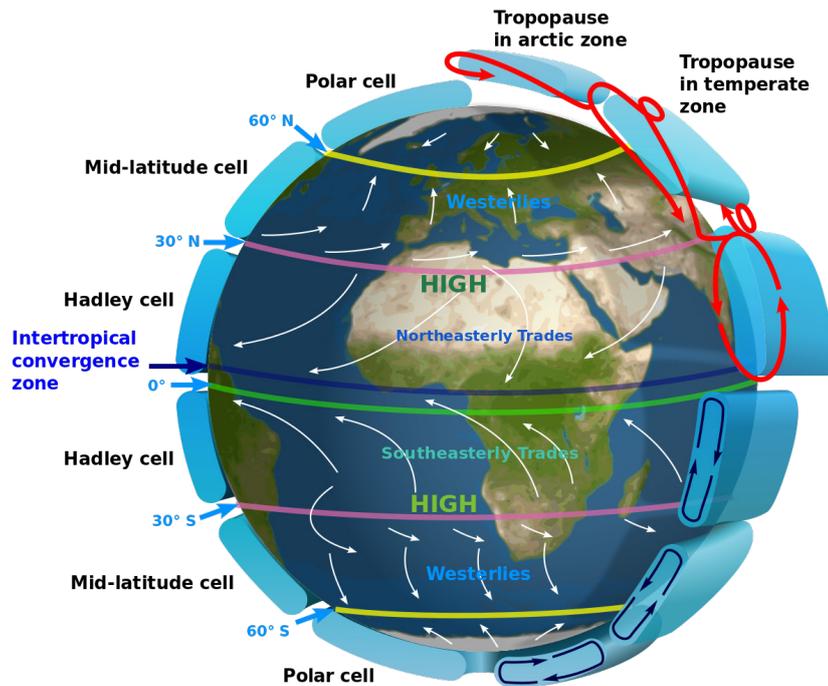


Figure 2.7: Global Atmospheric Circulation

According to the second law of thermodynamics, the job of atmospheric circulation is to balance energy inequities across latitudes (Figure 2.7). 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 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.

e. Seasonal Movement of Subtropical High Pressure



Dear learner, how does climate vary in response to the seasonal movement of subtropical high pressure represents? Try to reflect

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° 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 for more understanding]

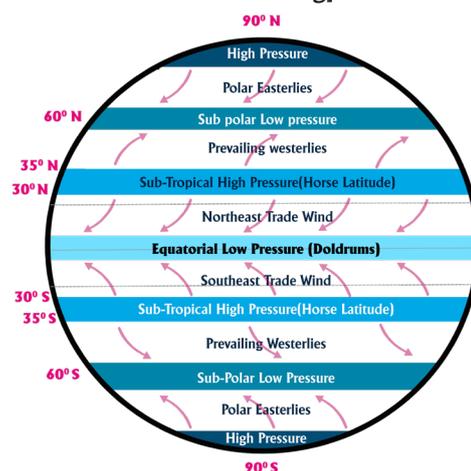


Figure 2.8 Subtropical high belts

f. 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 surface; for example, mountains have a lot of friction, while ocean bodies have less or no friction.

g. Ocean Circulation



Dear learner, how do ocean circulations affect climate distribution?

As you might imagine student, ocean circulation, like air circulation, is a process of balancing energy on the surface. Surface currents are the most important oceanic circulation effects on climate; they generally follow the winds generated by semi-permanent pressure zones in the atmosphere. Figure 2.9 below illuminates ocean circulation features.

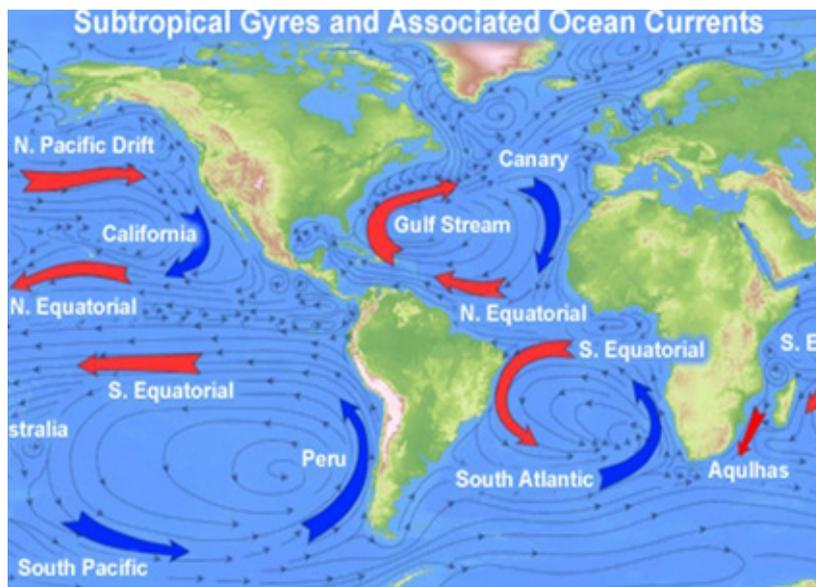


Figure 2.9. Ocean circulation

h. 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.



Dear learner, how does temperature decrease as height rises?

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

Example 2.5: If the altitude of Ras Dejene mountain is 4620 m above sea level and assuming that the temperature at sea level is 30 °C. What will be the expected temperature at the top of the mountain?

1000 m = 6.4 °C

4620 m = ?

The temperature at sea level - $(\text{Elevation} \times \text{normal lapse rate or } 6.4 \text{ } ^\circ\text{C} / 1000)$ = temperature at the top of the mountain.

$(4620\text{m} \times 6.4 \text{ } ^\circ\text{C}) / (1000 \text{ m}) = 29.570\text{C}$. Therefore, the temperature at the top of the mountain = $30\text{C} - 29.570 \text{ C} = 0.430\text{C}$.

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

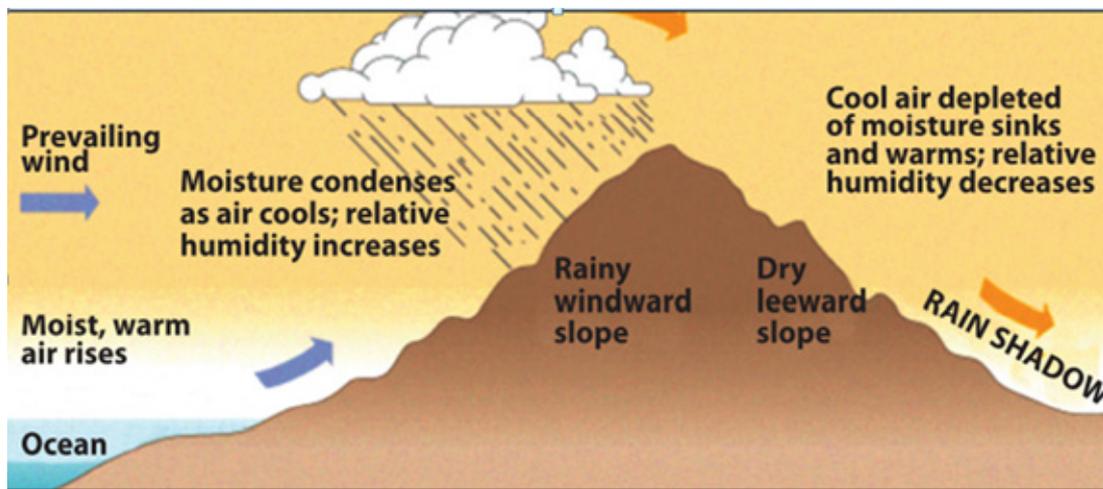


Figure 2.10: Orographic rainfall type

Dear learner, you have completed the fourth section of unit 2. As a result, try answering the questions in Activity 2.4 to ascertain how well you understand this section.

Activity 2.4.

Dear learner, please first think and then attempt all questions provided below.

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?

Dear learner, thank you for taking the time to answer the question in activity 2.5. You should have written answers to the activity questions on hand. Please compare your responses to the feedback provided below.

Feedback to Activity 2.4.

1. Windward (upwind) sites of water bodies tend to have more dramatic temperature changes than leeward locations (downwind). Some insolation is required on the lake surface to evaporate water rather than to heat surfaces.
2. More than half of any parallel latitude in the northern hemisphere is in darkness in December, whereas more than half in the southern hemisphere is in the sunshine.
3. According to the second law of thermodynamics, the goal is to balance energy inequalities between latitudes. In either the vertical or horizontal directions, atmospheric mass or air travels from additional air, i.e. high-pressure regions, to lower-pressure locations.

Section summary

Dear learner, the following points can be used to summarize. Latitude affects day length all through the year. The surface has more time to heat the more hours there are of sunshine. Due to the combined effects of revolution, rotation, and tilt, a region's distance from the equator determines how much the difference in day length from December to June will vary, while its distance from the pole or a high latitude determines how much the difference will vary. Over the planet's largest landmass, seasonal extremes are at their highest. More rain can fall in coastal areas that are exposed to prevailing winds that are laden with moisture that has evaporated from the ocean. One region may experience the effects of atmospheric circulation from a certain direction more often than another. The most significant impacts of oceanic circulations on climate are surface currents, which frequently follow the winds generated by semi-permanent pressure zones in the atmosphere. The climate varies significantly over short distances due to rapid changes in altitude and, consequently, temperature, as well as the amount of solar exposure throughout the year.



Checklist 2.4

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you visualize the effects of many influences on the establishment of global climate zones?		
2	Have you identified the causes behind the development of the world's climatic re-gions?		

Self-test Exercises 2.4

Part one: Multiple Choice Item:

Instruction: Dear learner, please answer questions 1-3 by choosing the best response from the given alternatives for each item.

1. Which one is incorrect about Subtropical High Pressure (STH)
 - A. source of surface westerlies
 - B. its migration has climatic implications
 - C. receive the most heat from the sun
 - D/ all
2. _____ is when other factors cause air to shift its trajectory and speed.
 - A. Coriolis Effect
 - B/ Centrifugal acceleration
 - C/ friction
 - D/ none
3. Why high diurnal temperature ranges are prevalent at high elevations
 - A. A decrease in mass and density compared to other areas that are lower in elevation
 - B. latitude difference
 - C/ The influence of intertropical convergence zone (ITCZ)
 - D/ All
4. _____ is located in low-pressure zones that receive the most heat from the sun
 - A. The intertropical convergence zone (ITCZ)
 - B. Subtropical High Pressure (STH)
 - C/ Ocean Circulation
 - D/ None

Part Two: True / False Item

Instruction: Dear learner, please complete the question that follows by writing "True" if the Sentence is "Correct" or "False" if the Sentence is "Incorrect"

1. Arctic and Polar Regions at high latitudes have very distinct seasons, with chilly summers and lengthy days.
2. Greater continentality confronts prevailing winds (trade or westerlies) that are rich with moisture from the ocean evaporated and can get more rain.
3. Circulations that result in varying climates across space are produced by horizontal differences in atmospheric pressure
4. Compared to regions near large bodies of water, inland areas heat up and cool down more quickly.



Answer Key to Self-test Exercises 2.4

Multiple Choice Item:

1. C 2. A 3. A 4. A

True/False Item:

1. True 2. False 3. True 4. True

SECTION FIVE

LOCAL CLIMATE CLASSIFICATION OF ETHIOPIA

(1 Hour)



Section Overview

Dear learner, this section will introduce you to the local climate classification of Ethiopia. The local climate of Ethiopia is classified according to height, temperature, and duration of the agricultural season. According to the meteorological system, the nation is split into five main climatic zones: Bereha, Kolla, Woina Dega, Dega, and Wurch. Dear learner, this section focuses on the classification of Ethiopia's regional climate.

Section learning outcomes

Dear learner, 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 that of Köppen.

Keywords:

- Local;
- Climate classification;
- Ethiopia

Dear learner, based on your prior reading and experience, refers to the following text about the Ethiopian traditional climate classification. Ethiopia's local climate classification is based on height, temperature, and growing season length. The country is divided into five primary climatic zones: Bereha, Kolla, Woina Dega, Dega, and Wurch, according to the climatic system (Figure 2.11).

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 °C. Strong winds, high temperatures, low relative humidity, and limited cloud cover characterize the climatic zone.

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°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.

A subtropical warm-to-cool-humid zone is referred to as Woina-Dega. It encompasses the temperate highlands, which are located between 1500 and 2300 meters above sea level. The average annual temperature is 15°C to 20°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.

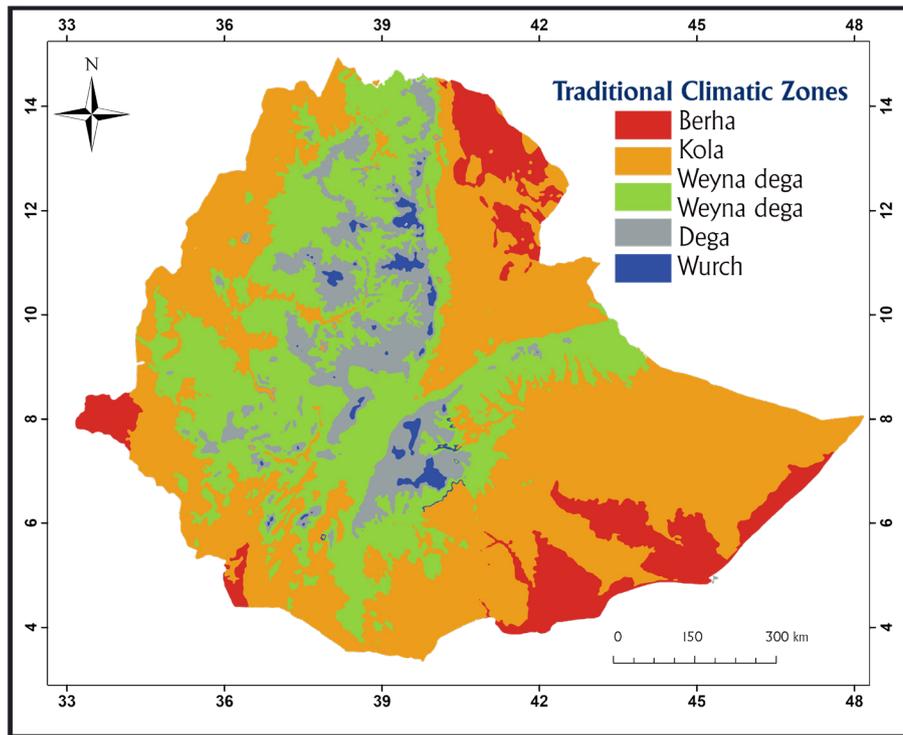


Figure-2.11: Traditional climate zone of Ethiopia

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 °C and rainfall ranging from 40 to 80 inches. Wheat, highland pulses, and highland oil seeds are the most common crops.

Wurch refers to an Alpine climate found at elevations greater than 3300 meters above sea level. This climatic zone includes Afro-alpine plateaus (Senate plateaus), Semen Mountain (Ras Dejen mountains), Guna Mountains, Choke Mountains in Gojjam, and Amare Saint in south Wollo. The yearly average temperature is below 10 °C, and annual rainfall is between 35.2 and 80 inches. In the climatic area, barely is commonly produced. Now, you are expected to strengthen your understanding of the learning content covered here. In this sense try the following activity

Reflective Activity 2.5.

Dear learner, please answer the following question in the context of your local administration unit.

1. Identify and reflect on the different agro-ecological zones of Ethiopian highlands distributed in your local weredas and kebeles
2. What are the major crops grown in different traditional agroecological zones of your local Woreda or kebele?
3. Why are crops rarely grown in the desert and Kur (>3700 meters above mean sea level) agroecological zones if your local administration unit includes desert and Kur traditional agroecologies?

Section summary

Dear learner, you may use the following points to summarize the section. Kolla denotes a warm to the hot semi-arid environment; Bereha denotes a hot lowland or desert climate; Dega implies a cold temperate highland climate; Wurch denotes an Alpine climate located over 3300 meters above mean sea level; and Woina-Dega denotes a subtropical warm-to-cool-humid zone.



Checklist 2.5

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Are you able to define the many climate types that exist in Ethiopia?		
2	could you contrast the Köppen categorization system with the techniques employed locally?		

Self-test Exercise 2.5

Part one: Multiple choice

Instruction: Choose the Best Answer from the given alternatives

- _____ describes a semi-arid environment that is warm to hot
A. Kolla B / Woina dega C / Dega D/ Kur
- In the wurch climatic zone, _____ is commonly produced
A. Barley B/ Wheat C/Highland pulses D/ Teff
- A subtropical warm-to-cool-humid zone is referred to as
A. Kolla B / Woina dega C / Dega D/ Wurch



Answer Key to Self-test Exercise 2.5

Choice Item:

1. A 2. A 3. B

UNIT SUMMARY

To clarify and summarize the idea of a varied range of climates, climatologists split climatic areas. Frigid, Temperate, and Torrid Zones are how the ancient Greeks divided our planet into three habitable regions. The most widely used classification scheme in recent times is Köppen's, which has a strong alignment with the vegetation and soil domains. Natural vegetation, temperature, and precipitation are the three main factors used to categorize the world's climate. The Köppen approach, which is based on dominant plant types, states that the majority of vegetation types react instantly to climatic inputs, especially temperature, and precipitation.

Climates are categorized using the relationship between flower types and their characteristics. A (tropical or mega thermic), 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) are the five basic terrestrial climatic types according to the Köppen classification system (hekiostherms, polar). The modified Köppen-Geiger climatic categories are produced by combining the necessary first, second, and third-order subdivisions. Geographers like the Köppen technique because it establishes the connection between climatic and vegetational types. The plan's shortcomings include its inability to take into account crucial meteorological factors including precipitation intensity, cloud cover, and the frequency of wet days, as well as daily temperature extremes, air masses, and winds. Trewartha created a straightforward method of climatic classification that included genetic and empirical classification methods.

Latitude (seasonality), the combined influence of the revolution, rotation, and tilt; continentality; atmospheric circulation; seasonal movement of subtropical high pressure; Coriolis effect; ocean circulation; and elevation are the main factors that control the distribution of the world's climate. Height, temperature, and the length of the growing season are used to categorize the local climate in Ethiopia. According to the meteorological system, the nation is divided into five main climatic zones: Bereha, Kola, Woina Dega, Dega, and Wurch.

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UNIT THREE

NATURAL RESOURCES AND CONFLICTS OVER RESOURCES (16 hours)

UNIT INTRODUCTION

This unit presents the importance of land as a natural resource, its functions, and its 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. The unit likewise appreciates the water resource potential and use of Ethiopia in comparison to neighboring countries like Egypt and Sudan. It finally winds up by giving a brief explanation of conflicts arising over the use of natural resources. Then, students, recognize the learning topic and issues highlighted and continue reading the sections that follow.

UNIT LEARNING OUTCOMES

Dear learner; after the completion of this unit, you will be able to:

-  describe the importance of land as a natural resource;
-  identify 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.

SECTION ONE

THE FUNCTIONS AND MANAGEMENT OF LAND

(2 Hours)



Section Overview

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. Generally, 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 natural resources (often referred to as land resources) and is viewed also as an environment. Dear learner; this section presents a wide range of definitions, functions, and management of land and its resources.

Section Learning Outcomes

Dear learner; 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 on the importance of land management.

Keywords:

- Land;
- Land management;
- Natural resources;
- Non-renewable resources;
- Renewable resources.

3.1 The Importance of Land as a Natural Resource

Dear learner; now it is hoped that you started thinking about the place of land resources in human livelihoods. This section presents more details about the types of land resources. 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.



How land is defined as an environmental resource?

Dear learner; please make a reflection on this question before reading the next descriptions.

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.



How land resources are classified into different groups?

Land resources are useable materials that occur naturally in the environment. They are derived from the Earth / Lithosphere, Biosphere, Atmosphere, and/or HydrospherLand resources are often classified into different groups based on different parameters. For instance, biotic and abiotic resources based on their origin; renewable and no-renewable resources based on their form of regeneration; stock and flow resources based on their current use and future availability; ubiquitous, unique, common, and rare resources based on their distribution and volume; and potential, actual and conditional resources based on the stage of development.



What are renewable 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.).



What are non-renewable resources?

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.



Dear learner; how did you internalize the meaning and difference of renewable and non-renewable resources? Please summarize your understanding points based on the question raised.



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

3.1.2 The Functions and Management of Land

The land is the sole source of livelihood resources and comprises the basic constituents of the environment. Sustainable use and management of land resources have thus to be an integral part of the activity of land users. Land as a natural resource offer diverse environmental and ecological functions and is managed in different ways. The detailed functions and management of land are dealt with in the ongoing notes. Dear learner; please concentrate on the core contents and try to connect your understanding with your prior experience for further comprehension.



What are the different functions of land?

Dear learner; 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 waste,
- ◆ economic asset: can be converted into a capital resource,
- ◆ cultural asset: serve as a host of traditional and religious sacred amenities.



Dear learner;

1. Please reflect on the importance of land and the corresponding responsibilities expected of humans before reading the text on land management;
2. What is land management? Why do we need a resource management? Explain?

Land management refers to the proper use and protection of land resources to provide optimal benefits 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. To that end, it has to be built upon national, regional, and local needs and aspirations. The prime objective of land management is to control land degradation and balance resource exploitation and regeneration.



Dear learner; please attempt the following questions that prepare you for the next study.

1. How is land management practiced?
2. What are the essential dimensions of land resources?
3. What are the responsibilities of humans while using land resource?

Dear learner; your reflection on the above questions is hoped to stimulate your thinking. 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; the 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.

Activity 3.1

Dear learner; please attempt the following questions that prepare you for the next lesson.

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?

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions.

Feedback to Activity 3.1

Please compare your answers with the feedback given below.

1. Dear learner; land as a resource is a broad concept for it can be viewed differently from different perspectives. It can have a wider range of meanings and interpretations. For instance, it can be viewed as a natural resource, an environmental reserve, a legal object, an economic asset, and/or cultural wealth (resource). It is the ultimate resource and the 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 natural resources (often referred to as land resources) and is viewed also as an environment. It is; therefore, an essential wealth for human livelihoods.

2. Land resources are commonly classified into different groups based on their replacement capacity (regeneration potential); stages of their development; the volume of distribution; origin; and use. Based on these factors, they may be sub-grouped as follows:

- ◇ regeneration capacity: renewable and non-renewable;
- ◇ stage of development: potential, actual, and conditional;
- ◇ distribution and volume: ubiquitous, unique, common, and rare;
- ◇ origin: biotic and abiotic; and
- ◇ current use and future availability: stock and flow resources.

3. We study land resources because they are the ultimate resource and the foundation of all forms of human activity for without them, life on Earth cannot be sustained. It is the source of all wealth; food, shelter, space to work on, and room to relax. It is an essential source of human livelihood.

Section Summary

The land is considered 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.

As a resource, land serves several purposes and tends to provide many functions, including as means of production; a sink of wastes, and as a host of traditional and religious sacred amenities. Dear learner; land as a useable natural resource thus requires proper handling and management. Land management in this sense 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. The management of land can be also materialized through the protection of soils, water, natural vegetation, and air.



Checklist 3.1

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Land resources are useable materials that occur naturally in the environment.		
2	Do you know how land resources are classified into different groups?		
3	Did you comprehend the difference between renewable and nonrenewable re-sources?		
4	Did you understand the concept of sustainable land management?		
5	Can you write the functions of land?		

Self-test Exercise 3.1

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found everything interesting and pertinent. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

Instruction:

Multiple Choices: choose the best answer to the following questions

1. Which of the following is not correct about land resources?
 - A) The imprints of past human relics are forming parts of land attributes
 - 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 soils are human dirt that has no significant function
2. Which of the following is not a resource?

A) Indigenous trees in the wild forests	C) Soil in agricultural lands
B) Freshwater in the rivers and lakes	D) none of the above
3. In what form land management could be applicable?
 - A) By dumping local springs and shallow ponds
 - B) Through soil and water management
 - C) By excessive cutting of available forests
 - D) By converting virgin lands to settlements
4. Which of the following is not correct about the function of land?
 - A) Land serves as an agricultural resource
 - B) Land has no acknowledged function
 - C) Land plays the function of sinking wastes
 - D) Land serves as a means of saving wealth
5. Which one of the following is true about land use and management?
 - A) Responsible planning and management are not required during land-use practices
 - B) Land management should never consider cultural, economic, and political settings
 - C) Land has been the main source of wealth & power for communities since ancient times
 - D) Awakening and educating the immediate beneficiaries of land need not get recognition

Answer Key to Self-test Exercise 3.1

Dear learner; we hope you did well in the self-testing. Now, you are at the stage of completion of the first section of module three. Please compare your answers to the feedback given and make corrections for any errors if available and then proceed to the next section

1. D
2. D
3. A
4. B
5. C

SECTION TWO

RESOURCES UNDER PRESSURE

(3 Hours)



Section Overview

There are numerous resources provided by the environment for human use and ecosystem services. Among these soil, water, and forests are under the intense pressure of degradation induced by increased populations, in addition to increased food, fiber, and fuel demands. Dear learner; this section is about the identification of resources that are seriously affected by human use and those that fall under intense pressure. Hence, you are advised to concentrate and study all the details of the section.

Section Learning Outcomes

Dear learner; at the end of this section, you will be able to:

-  identify renewable and non-renewable resources under immense pressure; and
-  describe the consequences of resource depletion.

Keywords:

- Afforestation;
- Soil degradation;
- Water stress;
- Watershed management.

3.1 Main Resources under Intense Human Pressure

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, soil, 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.

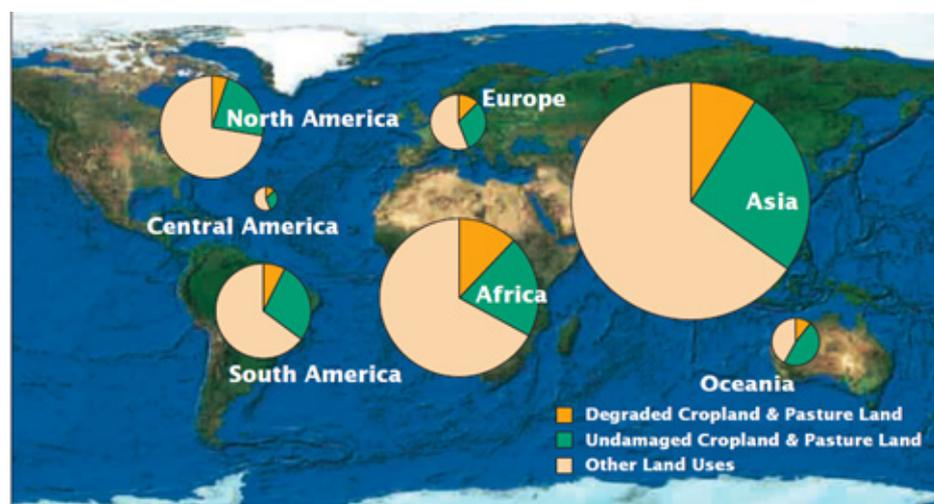


Figure 3.1 Degradation of land resources at global scales (pasture, crop, and other land uses)



1. What are the principal resources found under intense human pressure?
2. According to Figure 3.1, which continents of the world appear more exposed to land degradation? Why?

Dear learner; it is hoped that you have tried the questions posed and drawn out relevant points. Try to relate your thinking to the following discussions. The principal resources found under intense human pressure are soil, water, and forests. Soil is an essential agricultural resource. It is frequently losing its 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 topsoil; crusting and compaction; plus pollution and soil salinity. The main forms of soil degradation (depletion) are:

- ◆ physical (crusting, compaction, depth reduction),
- ◆ chemical (salinization, alkalization, acidification), and
- ◆ biological (loss of soil biota, a decline of soil organic carbon).

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

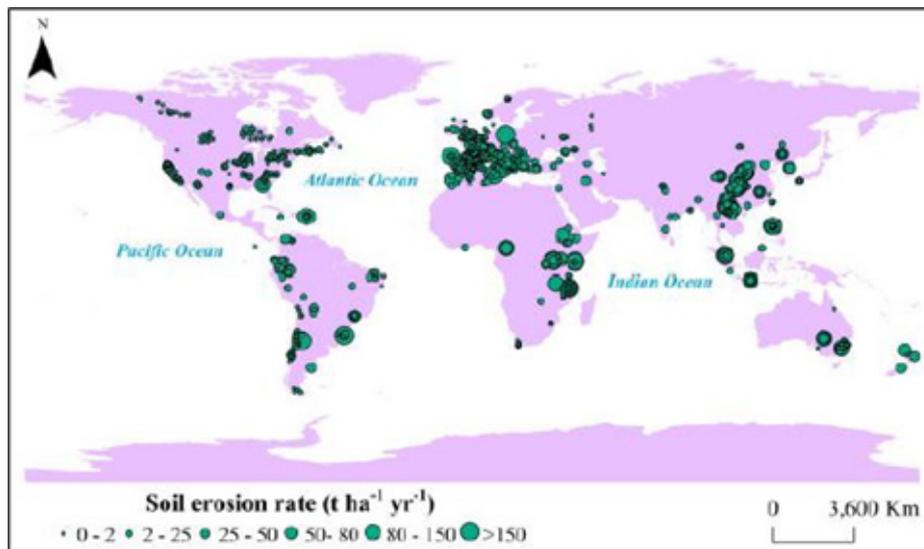


Figure 3.2 Soil erosion at global scales (Li & Fang, 2016; in IPCC, 2019)

Dear learner; we hope you got relevant information about how the indispensable agricultural resources; soils, are depleting through natural degradation or excessive human use in the preceding paragraphs. The following paragraphs present you with water resources that are seriously affected by intense human pressure next to soils.



1. Dear learner; what are the uses of water and how does population pressure impact water resources? Explain?

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 C, 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 the extremely threatened by domestic and industrial wastes. Particularly those found closer to urban areas 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 eutrophication and toxicity over the animals inhabiting those hydrologic ecosystems.



Does population pressure cause the depletion of water resources? If 'Yes', how?

Due to the spectacularly rising populations, water scarcities and effluence of the sources are emerging turbulent. 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.

Water Stress by Country:2040

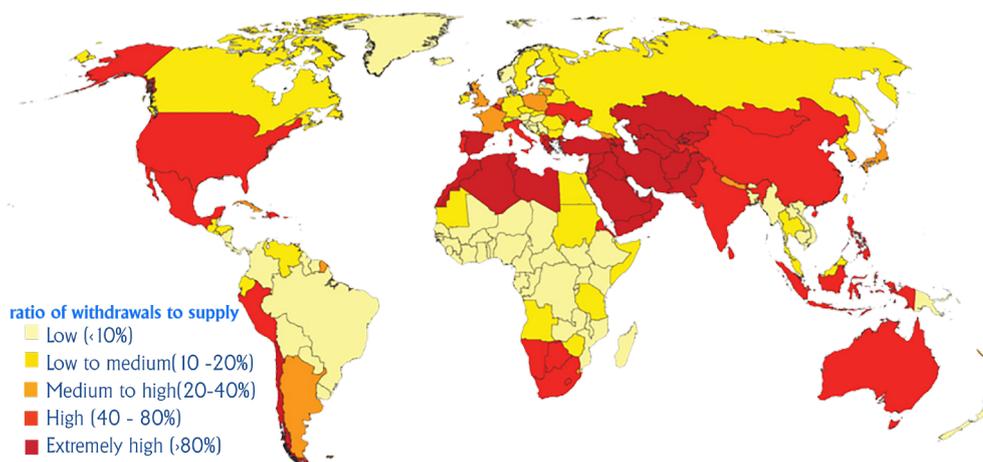


Figure 3.3 Water stress is feared to take place in the middle of the 21st Century (Maddocks et al., 2015)



Dear learner; could you please explain the relationship existing between population growth and water resources?

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 the withdrawal of wastes to river and lake systems,
- ◆ locating industries far from rivers and lakes,
- ◆ desalination of seawater to minimize stress on streams and lakes,
- ◆ recycling of wastewater through careful treatment,
- ◆ using porous pavements to avoid the drain of wastewater into watercourses from impervious surfaces in urban areas, and
- ◆ watershed management.



Dear learner; review and check your learning progress focusing on your understanding of water resources and population pressure and the measures required to manage water resources. Next, human population and another important resource-forest resource will be presented.



How does human population affect 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.



Dear learner; could you please explain the rate of forest degradation?
What is your observation from your area about forest damage?
Explain?

Dear learner; compare your viewpoints to the text explanation presented here. 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.



Dear learner; please note critically the severity of forest exposure to great damage these days and think of what should be done next. What remedial measures are available to safeguard the endangered forests?

As you might recall, forests constitute the largest terrestrial ecosystems on 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 the livelihood of the people of the world; primarily those of poor developing countries will be endangered soon. Remedial measures are mandatory to conserve these endangered resources. The following measures could be taken to protect 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 the 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).



Dear learner; what additional natural and indigenous (traditional) forest resource management measures can be recalled from your experiences and observations?



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.

Activity 3.2

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?

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions.

Feedback to Activity 3.2

Please compare your answers with the feedback given below.

1. The land resources facing immense human pressure are soils, freshwater (rivers, lakes, ponds, and wetlands), community forests, and grazing grounds that are shared by any member of the community. They are the common-pool resources lacking responsible ownership and management.
2. Renewable resources facing immense human pressure are soils, forests, freshwater in rivers, lakes, ponds, wetlands, and grazing grounds shared by many people. Non-renewable resources facing intense human pressure include fossil fuels (Natural oil & Coal) and precious metals such as diamonds, Gold, and Tantalum.
3. The extent of land resource degradation is so great. For instance, research outputs indicate that rapid population growth and technological advances over the past 50 years have caused worldwide land-use changes. Forest cover had decreased by 15% whilst the proportion of cultivated land increased by about 13% between 1961 and 2007. In the same period, the size of the rainfed area expanded from 1,230 to 1,265 million ha. The irrigated area has doubled and permanent meadows and pastures increased by some 10%. Nearly 33% of the world's arable land was destroyed by soil erosion according to research released by the Food and Agricultural Organization (FAO). Similarly, the per capita farmland needed to adequately feed people is estimated at 0.50 ha. But, the current per capita cultivated land in developing countries is decreased to about 0.2 ha. This is also estimated to decrease to 0.1 ha by 2050 in the absence of further expansion. Global irrigation water use is expected to increase by around 11%, and the irrigated areas will grow from 321 million to 377 million ha from the year 2007 to 2050.

Due to the spectacularly rising populations, water scarcities and effluences of the sources are for instance emerging turbulent. The dearth of water is currently distressing many arid and semiarid areas of the world where population pressure is somewhat extensive including parts of the Middle East, Africa, and Asia (see Figure). This is a shortage pronounced by a demand for water which is intensifying sooner nowadays than at any time in the Earth's history. This fact is a dearth that looks probably to blow out and perhaps would upsurge in the future. The outcome would likely be a worldwide water crisis that might transpire in the middle of this century as far as demand surpasses the existing supply over wider areas of the world.

Land resource depletion (degradation) could at a large result in the loss of biodiversity, desertification, reduction of agricultural productivity, hunger and poverty, food insecurity and migration, and lessening the capacity of the land to function effectively.

4. People can control the depletion (degradation) of natural resources through the proper use of available resources. Good stewardship (responsible planning and management of land) is essential to preserve land resources for present and future populations. Sustainable utilization and management of available resources thus become the key undertaking for the control of the degradation and depletion of land resources. Since land management is happening through the protection of its resources (soils, water, & forests), the control of resource degradation/depletion has to base itself on the management of soils, freshwater, natural vegetation, and grazing land as well as environmental and atmospheric pollution. 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; the use of renewable power sources (e.g. hydropower) for industrial and home energy requirements help to reduce environmental pollution. Land management should also 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.

Section Summary

There are several resources provided by the environment for human use and ecosystem services. All are 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 through unwise and careless uses. They face the prime impact of rapid population growth and increased rural-urban migration.



Checklist 3.2

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Can you identify the principal resources under intense human pressure?		
2	Do you know the world's continents that are more affected by human-induced land degradation?		
3	Can you list down the forms of soil degradation?		
4	Can show the world regions more affected by soil erosion?		
5	Do you able to explain the relationship that exists between population growth and water resources?		
6	Could you identify the world regions that would be heated by water stress in the 21st century?		
7	Could you explain the rate of forest degradation over the Globe?		
8	Could you identify the methods of soil conservation?		
9	Do you know the measures used in your area to replace the lost forests?		
10	Do you know the measures of water conservation?		

Self-test Exercise 3.2

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

Instruction: Multiple Choices: choose the best answer from the given alternatives.

1. Which of the following most likely put pressure on natural resources?
 - A) Population pressure, climate change, and globalization
 - B) Population growth control and regional cooperation
 - C) Limitation of the release of greenhouse gases
 - D) Global climate convention
2. Which of the following is not true about soil resources?
 - A) Soils are essential agricultural resources
 - B) Nearly 33% of the world's arable land and soils have been destroyed by soil erosion
 - C) Soil depletion reduces productive capacity and environmental quality
 - D) The principal form of soil depletion relates only to crusting and compaction
3. Which of the following causes water pollution?
 - A) Management of the watersheds
 - B) Plastic bags, exotic water plants, and Oil spills (leakages)
 - C) Adopting laws restricting the withdrawal of wastes to river and lake systems
 - D) Developing safe waste disposal sewerage systems
4. Which of the following is not a factor for forest dwindling in the world?
 - A) Forest clearance for large-scale plantation agriculture and livestock ranching
 - B) Increasing demand for biofuels and mining
 - C) Watershed management and the use of wind power for energy production
 - D) Rapid urbanization and globalization
5. In which regions of the world do you think crop and pasture lands are more degraded?

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

Answer Key to Self-test Exercise 3.2

Dear learner; we hope you did well in the self-testing. Now, you are at the stage of completion of section two of module three. Please compare your answers to the feedback given below and make corrections for any errors; if available, before jumping to the next section.

1. A
2. D
3. B
4. C
5. A

SECTION THREE

LAND RESOURCE DEPLETION AND DEGRADATION

(3 Hours)



Section Overview

Land resource degradation is the overall decline of the quality and quantity of natural assets like soils, water, and biological mass. It commonly happens when human beings put intense pressure on the mentioned resources. Sometimes, natural hazards like earthquakes, volcanic eruptions, landslides, and floods cause the degradation of resources. Nevertheless, the rapid growth in world population and swift advances in modern technology during the past 50 years have principally instigated worldwide land-use changes. Dear learner; by studying this issue 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.

Section Learning Outcomes

Dear learner; 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:

- ◇ Resource degradation;
- ◇ Resource management.

3.3.1 Concept of Land Resource Degradation and the 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. Dear learner; based on the preceding guiding questions set, try to extend your reading and internalizing effort.



How is the scale of land degradation over the Globe? Dear learner; please refer to Figure 3.4 representing instances showing status of land degradation in different parts of the world and construct your understanding ahead.



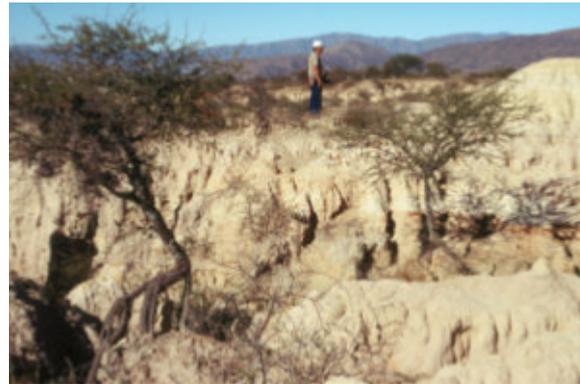
a) Degraded land in the Atsbi-Womberta area, Tigray, Ethiopia. (Gebremedhin et al, 2010)



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



c) Erosion on cotton plantation farms 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 3.4); 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.



What are the underlying and proximate causes of land degradation?

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 & over-grazing	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 & silting of dams (reservoirs)
Rough topography	Steep slopes	Fast-flowing streams	Soil removal from upper catchments
	Depressions	Waterlogging	Soil acidity; cultivation difficulties
Improper land-use practices	Poor farming methods	Plowing 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 Land 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 rainfed 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. The succeeding notes present you with the consequences and controlling measures of land resource degradation.



What are the specific consequences of land degradation and how could land resource degradation be controlled?

Land resource degradation could 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.

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

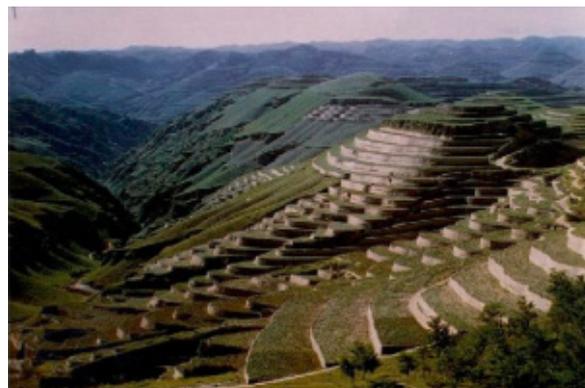
- afforestation: planting of trees on barren lands that were not under forest cover before,
- reforestation: replanting trees in deforested areas;
- area closures: closing deforested areas from livestock contact to restore the previous status;
- terracing: constructing bench terraces on steep lands to 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: 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; and
- addition of chemical fertilizer: to replace lost nutrients, using green manure: to uphold soil fertility.



Dear learner; please refer to Figure 3.5 and interpret the messages it portrays



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



b) Terrace structures over the loess hill slopes of China

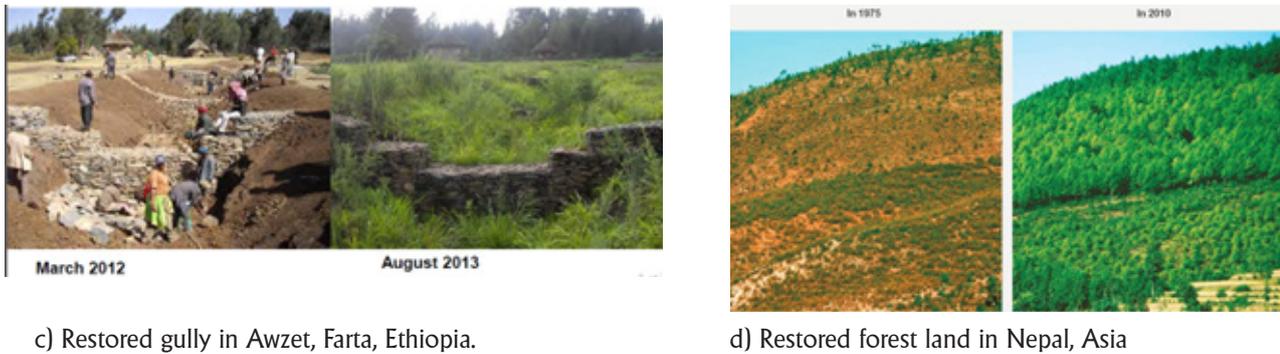


Figure 3.5 Soil and water conservation structures



Dear learner; loss of biodiversity, desertification, food insecurity hunger and poverty are the main results of land degradation. Afforestation and reforestation, area closures, terracing and check-damming are also among the controlling measures used by the land users.

Additional information is available online for you at:

<https://www.youtube.com/watch?v=v1k6BKsTElc>

<https://www.youtube.com/watch?v=4lt9NwND-zI>

https://www.youtube.com/watch?v=G4H1N_yXBIA

Feedback to Activity 3.3

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions. Please compare your answers with the feedback given below.

1. Dear learner; the causes of resource degradation/depletion are classified into underlying and proximate factors. The underlying factors are population growth; climate change; rugged topography, regressive land-use practices, and government policy. These are the major factors that promote proximate practices to happen. The proximate factors are subsidiary issues initiated by the aforementioned primary agents. The details are provided in Table 3.1.

Dear learner; the consequences of land resource degradation also include loss of biodiversity, desertification, the decline of land productivity, hunger and poverty, food insecurity, migration, and lessening of the capacity of the land to function effectively.

2. Dear learner; measures such as afforestation and reforestation, terracing, controlled grazing, use of animal dung, and chemical fertilizer be used to minimize the impacts of land resource degradation.

Section Summary

Land resource degradation is the overall decline of the quality and quantity of land resources (soils, water, and biological mass). It commonly happens when human beings put intense pressure on the mentioned resources. Sometimes, natural hazards like earthquakes, volcanic eruptions, landslides, and floods cause the degradation of resources. Nevertheless, the rapid growth in world population and swift advances in modern technology during the past 50 years have principally instigated worldwide land-use changes. For instance, forest covers have significantly decreased whilst cultivated lands have increased during the past decades.

The sizes of rainfed 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.

Activity 3.3

1. What are the causes and consequences of land resource degradation?
2. What remedial measures should be taken to curb the problem?



Checklist 3.3

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '√'.

No	Questions	Yes	No
1	Can you identify the causes of land degradation?		
2	Do you know the underlying and proximate causes of land degradation?		
3	Can you list the consequences of land resource degradation?		
4	Do you know the land management practices used to overcome the effects of land resource degradation?		
5	Tree planting does not help to reduce land resource degradation.		

Self-test Exercise 3.3

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

Instruction:

Multiple Choices: choose the best answer from the given alternatives.

- Among the following, which one causes an immediate depletion of land resources?

A) Tree planting on degraded hill-slopes	C) Wrong government policy
B) Cutting trees for clearing farmlands	D) Population growth
- Which of the following land management practices helps to replace lost nutrients from agricultural soils?

A) Addition of irrigation water	C) Construction of drainage ditches
B) Addition of animal manure	D) Construction of wind barriers (shelterbelts)
- 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, rugged topography, human culture
- Which of the following is not resulting from land resource degradation?

A) Drying of wetlands	C) Intact and preserved forests
B) Declining potential of agricultural lands	D) Food insecurity and poverty
- Assume that rapid population growths and technological advances have strongly reduced the productive potential of agricultural lands; thereby, affecting the livelihood capacity of rural households. So, how rural livelihoods of households could be improved in the future?

A) By taking loans from the World Bank
B) Receiving food aid and international donation
C) By expanding farming to the virgin lands
D) Through rational use of available resources

Answer Key to Self-test Exercise 3.3

Dear learner; we hope you did well in the self-testing. Now, you are at the stage of completion of section three of module three. Please compare your answers with the feedback given and make corrections if there are errors in your answers.

1. B 2. B 3. A 4. C 5. D

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. Review and check the extent to which you have achieved the intended lesson objectives of the section. If you did well, then you should go on to the next section. What do you think?

SECTION FOUR

TRANSBOUNDARY RIVERS (2 Hours)



Section Overview

Transboundary Rivers are watercourses shared by two or more countries. As they are shared by several countries, they connect the 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. International waters are also sources of cooperation and contention among nations. Dear learner; this section thus presents you the distribution, prospects, impacts, and features of transnational rivers and watercourses.

Learning Outcomes

Dear learner; at the end 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.

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. Dear learner; attempt all the start-up questions intended to challenge you and/or stimulate your thinking and interest.



How is the distribution of international rivers and watercourses?

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 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 (see Figure 3.6) and South America and nearly 40% of North and Central America fall 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 some 30 countries falls within the trans-state waters. Groundwaters interlinked with 300 transboundary aquifers also support nearly two million people around the world.

International River Basins

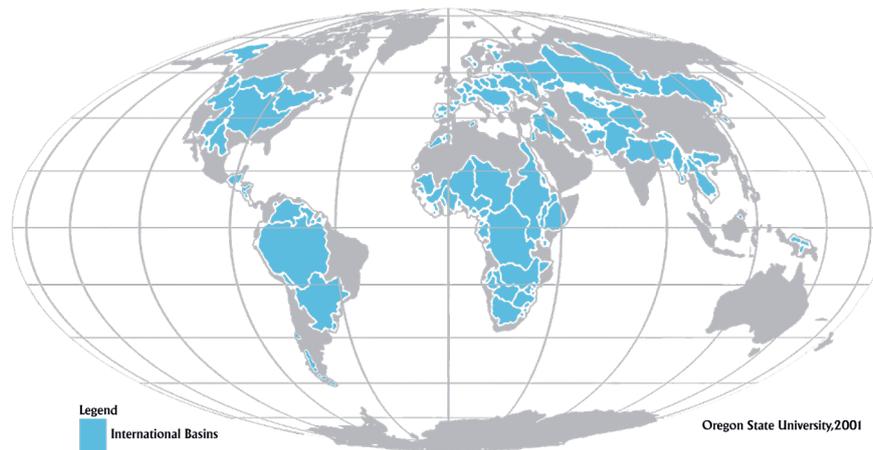


Figure 3.6 Transnational River Basins (Mcknney, 2011)

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 module, 14 major river basins shared by different world countries are presented as a sample in Table 4.1. Dear learner, you are expected to identify and reflect on guiding questions, different illustrative means, and examples included in the module to deepen your understanding. For instance, Figures 3.6 and 3.7 support you in visualizing the concepts.



What are the main features of the known transboundary rivers?

Table 3.2 Sample of internationally shared river basins

River	Source	Drain- age size (km ²)	Flow volume in BCM*	Destination	No of riparian countries	Length (km)
Nile	Lake Victoria and Lake Tana		84	Mediterranean Sea	11	6,671
Okavango	Angola	430,00	10	Namibia	4	1,100
Zambezi	Zambia		230	Indian Ocean	8	3000
Congo	Central Africa		1,250	Atlantic Ocean	11	4,700
Indus	Tibet (China)	226	226	Arabian Sea	4	2,897
Ganges	Himalaya		382	Bay of Bengal	4	2,600
Mekong	Tibet (China)	795,000	475	Vietnam	6	4,800
La Plata	Eastern Andes		884	Atlantic ocean	5	3,500
Danube	Germany	801,463	203.86	Black Sea	19	2,850
Rhine	Switzerland	200,000	72.58	Netherlands (North Sea)	9	1,320
Colorado	USA	632,000	17.14	Gulf of Cali-fornia	2	2,334
Niger	Guinea	2,230,00	30	Atlantic ocean	11	4,100
Amazon	Andes Mts.	6,800,000	6968	Atlantic ocean	9	6,400
Jordan	Mount Hermon	>18,103	0.54	Dead Sea	5	360



Blue Nile Falls (Abaya Fuafuata)



Victoria Falls, Zambezi River (UNEP, 2006)

Figure 3.7 Features (waterfalls) of the Blue Nile Zambezi Rivers



Do you know the Nile River? Can you identify the source and destination?



Bair-Al-Jabal (Mountain Nile) & Juba, South Sudan [https://www.britannica.com/place/Nile -Rive](https://www.britannica.com/place/Nile-River)



Fishing in the Niger River (UNEP, 2006)



GERD <https://www.pietrangeli.com/gerdp-hydroelectric-plant-ethiopia-africa>



Congo River Hydroelectric Dam at Inga Falls

Figure 3.8 Economic Prospects of Some African Rivers



Dear learner; can you identify the dams and economic projects found within the Nile basin? Please refer Table 4.1 and Figure 3.8 and relate your observation with the short-notes given below.

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)
- ◇ The Grand Ethiopian Renaissance Dam (GERD).

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 Zambezi, are shared between 9 and 11 states.
- ◆ The river that flows through most nations is the Danube, which travels within the territory of 19 nations.



Dear learner; could you please conceptualize and summarize the notes you read about the distribution, features, prospects and impacts of transboundary rivers with giving special emphasis to the Nile River?



Dear learner; at this stage, you are expected to take time and check your learning progress thoughtfully. This will assist you to internalize what you learn about the rivers.

Activity 3.4. Dear learner,

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?

Feedback to Activity 3.4

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions. Please compare your answers with the feedback given below.

1. Examples of Transboundary Rivers:

◇ Nile	Mekong	Danube
◇ Congo	Indus	Rhine
◇ Zambezi	Ganges	Colorado
◇ Niger	de la Plata	Limpopo

2. Unlike transboundary Rivers, inland watercourses never cross national borders and are not shared by many nations. They are not sources of conflict between different countries. Transboundary Rivers cross national borders and are shared by two or more countries. They sometimes promote cooperation among riparian states but also cause conflict at other times.

Section Summary

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. Today, more than 263 transnational river and lake channels plus numerous trans-state aquifers are known to geographers. 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.



Checklist 3.4

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '√'.

No	Questions	Yes	No
1	Did you understand the lesson about transboundary rivers?		
2	Can you name some transboundary rivers found in the world?		
3	Do transboundary rivers promote relations between countries?		
4	The Nile is a transboundary river		
5	Do you know the key economic projects found along the Nile River Basin?		

Self-test Exercise 3.4

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

General Direction: Attempt the succeeding questions based on the specific instructions.

Part I) True/ False Items

Instruction: Write ‘True’ for the correct and ‘False’ for the incorrect statements

1. The Nile is the largest river in the world.
2. Shared watercourses could be both sources of conflict and prospects of collaboration.
3. Water shortages could never be the source of conflict between rural communities.

Part II) Matching

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

Column ‘A’	Column ‘B’
4. Bair-Al-Jabal	A) Nile Basin
5. Inga Falls	B) Amazon Basin
6. the Bay of Bengal	C) Ganges Basin
7. Largest river in the world	D) Congo Basin
8. Himalaya	E) Zambezi Basin
9. Victoria Falls	A) Nile Basin
10. Andes Mts.	
11. GERD	
12. ZRA	
13. NBIE	E) Zambezi Basin

Answer Key to Self-test Exercise 3.4

Dear learner; we hope you did well in the self-testing. You are now at the stage of completion of the 4th section of module three. Now, please compare your answers with the feedback given and make corrections if there are errors in your answers.

I. True/False	II. Matching		
1. False	1. A	5. C	9. E
2. True	2. D	6. E	10. A
3. False	3. C	7. B	
	4. B	8. A	

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. Review and check the extent to which you have achieved the intended lesson objectives of the section. If you did well, then you should go on to the next section. What do you think?

SECTION FIVE

REGIONAL COOPERATION FOR SUSTAINABLE USE OF SHARED RIVERS (2 Hours)



Section Overview

As you observed 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. Dear learner; this topic so focuses on describing the relevance of regional institutions and the role they play in resolving conflicts arising thereof.

Section Learning Outcomes

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

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

Keywords:

- Regional cooperation;
- Regional institutions;
- Sustainable use.

3.5.1 The Need for Cooperation on the Use of Shared Rivers

Most nations sharing similar River basins are often contending with each other during water-sharing actions. This demands mediating and/or coordinating institutions to bring collaboration and negotiation among the riparian states. Dear learner; please compare your points to the explanations that follow for more understanding.



Why is regional cooperation required over the use of shared rivers?

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 covenant must be considered between the riparian states of the basin. In addition to this, some form of harmonizing device 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 the alleviation of potential disputes arising from the use of shared watercourses.



Dear learner; what explicit roles shall institutions and countries assume related to the use of common river courses in your view? Your reflection prepares you for the next lesson.

3.5.2 Typical Regional Organizations Connected to Shared River Basins

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.



Can you enumerate the well-known river based organizations operating over the Globe?

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 NBI in 1999 at Waterbury in 2002; with Ethiopia joining as a full member.



What is the NBI? When it was established? Please think about it and make connection to the notes provided.

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 socio-economic 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.



Can you name some river based organizations other than the NBI? Dear learner; could you please relate your imagination with the text you read about the NBI and the river basin institutions given below?

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; and
- ◆ 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.

Landcare: was established in 1989 as a response to the problem of land water management in Australia. It was mainly created to support voluntary land conservation groups.

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.

OEGS: Organization of Eastern Caribbean States was created to control the quality of the maritime environment of the Caribbean Sea for it was polluted by wastes disposed on land (solid waste) from land-based sources and at the Sea from marine ships.

CEC: Commission for Environmental Cooperation: is an environmental institution created in 1994 in Montreal (Canada) by the North American Agreement on Environmental Cooperation (NAAEC) to support the protection of habitats and species.



Dear learner; NBI, LHDA, JPTC, ZRA, KBO, SAPP, SARCCUS, Landcare, IJC, and OECS, CEC are some of the river based regional institutions working on the use, development and management of river basin resources.



Dear learner; can you make a generalizing comprehension about the river based institutions you learned so far which will help you to validate the information you got about this topic.

Activity 3.5

Dear learner; try to address the following questions critically so that you will be curious to read the consecutive sections of the unit

1. What does regional cooperation on the sustainable use of shared rivers imply?
2. Why cooperation is required between nations sharing similar watercourses?
3. Name the regional organization working on the sustainable use and development of the Nile River?

Feedback to Activity 3.5

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions. Please compare your answers with the feedback given below.

1. Regional cooperation on sustainable use of shared rivers implies:
 - the need for binding agreements and treaties on the use and management of shared waters;
 - avoiding conflicts through achieving mutual benefits;
 - fair use and equitable sharing of river basin resources;
 - collaboration on basin-based developments and projects;
 - avoidance of harm to others and peaceful settlement of conflicts; and
 - collaboration among riparian states related to socioeconomic development, political and security matters, and many others.
2. Most nations sharing similar River basins are often contending with each other during water-sharing actions. This demands mediating and/or coordinating institutions to bring collaboration and negotiation among the riparian states.
3. The regional organization working on the development and sustainable use of the Nile River is the Nile Basin Initiative (NBI).

Section Summary

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 covenant must be considered between the riparian states of the basin. In addition to this, some form of harmonizing device 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. Owing to this, several river-based organizations are operating over the Globe. Some of these organizations include the:

- ◆ Nile Basin Initiative (NBI);
- ◆ Kagera Basin Organization (KBO);
- ◆ Zambezi River Authority (ZRA);
- ◆ The Southern African Power Pool (SAPP);
- ◆ The US-Canada International Joint Commission (IJC) is devoted to water management in the Great Lakes Region of North America;
- ◆ Organization of Eastern Caribbean States (OECS) was created to control the quality of the maritime environment of the Caribbean Sea; etc.



Checklist 3.5

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you understand the role of river-based organizations?		
2	Can you name some river-based organizations other than the NBI?		
3	Do river-based organizations facilitate the use of shared watercourses?		
4	Can you make a generalizing comprehension about the river-based institutions you learned so far?		
5	Do you know the NBI?		

Self-test Exercise 3.5

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

Instruction:

Multiple Choices: choose the best answer from the given alternatives

- Why are river-based organizations required?
 - For effective water use and management over the shared watercourses
 - To harmonize relations between riparian countries
 - To maximize human welfare and safeguard the environment
 - All of the above
- Which of the following river organizations is not belonging to Africa?
 - NBI
 - ZRA
 - OECS
 - SAPP
- The Kagera Basin Organization (KBO) was established by:
 - Burundi, Rwanda, and Tanzania
 - The USA and Canada
 - RSA, DRC and Angola
 - Ethiopia, Sudan, and Egypt
- Which of the following water-based institutions was established in 1989 as a response to the problem of land water management in Australia to support voluntary land conservation groups?
 - SAPP
 - Landcare
 - SARCCUS
 - IJC
- The LHDA was created in 1986 by signing a treaty between:
 - Egypt and the Sudan
 - Zimbabwe and RSA
 - Australia
 - Lesotho and the RSA

Answer Key to Self-test Exercise 3.5

Dear learner; we hope you did well in the self-testing. You are now at the stage of completion of the 5th section of module three. Please compare your answers with the feedback given and make corrections if there are errors in your answers.

1.D 2.C 3. A 4. B 5. D

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. Review and check the extent to which you have achieved the intended lesson objectives of the section. If you did well, then you should go on to the next section. What do you think?

SECTION SIX

POTENTIAL AND ACTUAL USE OF WATER IN ETHIOPIA, EGYPT, AND SUDAN (2 Hours)



Section Overview

Ethiopia, Egypt, and Sudan are African countries sharing several socioeconomic, cultural, and natural resources. These three countries have been experiencing similar cultures, religions, and even economic characteristics throughout their long history. Ethiopia and Egypt were exchanging Pops 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. Dear learner; this topic thus focuses on the evaluation of the potential and actual uses of water among these neighboring countries.

Section Learning Outcomes

Dear learner; at the end of this section, you will be able to:

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

Keywords:

- Actual water use;
- Conventions;
- Egypt; Ethiopia;
- Potential water use;
- Sudan.

3.6.1 Water Resource Potential of Ethiopia, Egypt, and Sudan

Ethiopia, Egypt, and Sudan have both surface and groundwater potentials. Nevertheless, the mentioned water reserves and potentials in the three countries seem to vary due to the variation in their geographic location, geomorphic structure, and geological formation. The three countries appear also to share the Nile waters and related resources.



How is the water potential of Ethiopia, Egypt and Sudan? Explain?
Dear learner; please make the explanation for yourself then relate and compare to the message of the content.

Ethiopia has 194.4 billion cubic meters (BCM) surface and 30 BCM groundwater potentials. Sudan has a share of 18.5 BCM water from the Nile flow based on the 1959 agreement signed with Egypt. The rainfall potential for this country is estimated at 400 million cubic meters per year. Its water potential from underground aquifers is enormous; estimated to reach 16,756 BCM.

Egypt is a country more dependent on the Nile for freshwater. Its total water potential is merely 88 BCM per year. Of this total potential water, nearly 56 BCM (66%) originate from the Nile. Like Sudan; the groundwater potential of Egypt is so great. Underground aquifers from the alluvial plains and coastal areas provide over 150,000 BCM water potential for Egyptians. Yet, much of this water is affected by complex chemicals and may demand much money to develop. So currently, Egypt appears to insist on the use of the Nile waters.

3.6.2 Water Use in Ethiopia, Egypt, and Sudan

Similar to the water potential, the actual per capita water use in Ethiopia, Egypt, and the Sudan is also different.



Dear learner; how is the per capita water use in the three countries? Explain? Could you please relate your understanding with the notes given below?

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 6.1 Notable conventions and treaties of Nile basin countries for additional information

Year	Parties	Name of treaty	Treaty objectives/contents
Dec. 1925	UK & Italy	Formation of 'Nile Waters Commission' & 'Exchange of notes' (Re-Concessions for Barrage at Lake Tana)	A new water Commission was named; Italy recognized the 'prior hydraulic rights' of Egypt & 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 the Owen Falls Dam & Aswan High Dam Proposal	Aswan High Dam with 156 BCM/year storage capacities proposed by Egypt.
Own Falls Dam proposed			
Sept.- Dec. 1954	Egypt & Sudan	Negotiations over the proposed High Aswan Dam	Sudan was outside of the negotiations until 1954

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 & Sudan (Egypt granted 55.5 BCM while Sudan 18.5 BCM). A Permanent Joint Technical Commission was 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
05 August 1994	Kenya, Tanzania & Uganda	Lake Victoria Environment Management Programme (LVEMP) formation agreement	LVEMP established
1994	Kenya, Tanzania & Uganda	Lake Victoria Fisheries Organization (LVFO) formation agreement	LVFO created
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 the 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



Dear learner; in addition to water developed from underground and rainfall sources, Ethiopia, Egypt and Sudan share the waters of the Nile River. Nonetheless, 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 6.1.

Activity 3.6

1. How do you evaluate the water resource potentials of Ethiopia, Egypt, and 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?
4. How do the relations impact the local people in the three countries?

Dear learner; please analyse and use these questions to assess your experience and build-up the next understanding on the subject.

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions.

Feedback to Activity 3.6

Please compare your answers with the feedback given below.

1. Ethiopia has 194.4 BCM surface and 30 BCM groundwater potentials. Sudan has a share of 18.5 BCM water from the Nile flow based on the 1959 agreement signed with Egypt. The rainfall potential for this country is estimated at 400 million cubic meters per year. Its water potential from underground aquifers is enormous; estimated to reach 16,756 BCM. Egypt is a country more dependent on the Nile for freshwater. Its total water potential is merely 88 BCM per year. Of this total potential water, nearly 56 BCM (66%) originate from the Nile. Like Sudan; the groundwater potential of Egypt is so great. Underground aquifers from the alluvial plains and coastal areas provide over 150,000 BCM water potential for Egyptians. Yet, much of this water is affected by complex chemicals and may demand much money to develop. So currently, Egypt appears to insist on the use of the Nile waters.

2. 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).
3. Ethiopia, Sudan, and Egypt share several socioeconomic, cultural, and natural resource benefits. They have been experiencing similar cultures, religions, and even economic characteristics throughout their long history. Ethiopia and Egypt were exchanging Pops for their Orthodox Churches during their past long history. Ethiopia and Sudan also share a long land border in addition to their strong economic ties. These three countries again together share the Nile waters and related resources. Nevertheless, these three countries sometimes appear to experience conflicts among themselves. The sources of conflict among these countries originate from the 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.
4. Based on the 1959 covenant, Sudan and Egypt exclusively shared the Nile water (55.5 MCM for Egypt and 18.5 MCM for Sudan). This indicates that the use of the Nile waters for hydropower generation and irrigation was in the past wholly dominated by Egypt and Sudan. Conversely, widespread poverty and lingering political instability hindered upstream countries like Ethiopia from effectively using the potential of the Nile water. This implies that the water-sharing contention of the three countries mainly affected the people of Ethiopia although the actual impact on the local people of Sudan and Egypt is not identified. If these neighboring countries run into conflict, the local people in both countries could be victimized.

Section Summary

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 allocate water to Ethiopia. 55.5 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.



Checklist 3.6

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you understand the water potential of Ethiopia, Egypt, and Sudan?		
2	Egypt is a country more dependent on the Nile for freshwater.		
3	Can you explain the per capita water use in Ethiopia, Sudan, and Egypt?		
4	In the 1959 convention, all the Nile water was shared between Egypt and Su-dan.		

No	Questions	Yes	No
5	On 23 March 2015, Ethiopia, Egypt, and Sudan signed the Declaration of Principles on the Grand Ethiopian Renaissance Dam Project (GERDP); i.e. to cooperate based on common understanding, mutual benefit, good faith, win-win, and principles of international law.		

Self-test Exercise 3.6

Dear learner; we hope you enjoyed reading the notes and doing the activities. We think you found them interesting and relevant. Now, attempt the questions given below to evaluate how far you have understood the lesson you studied.

Instruction: Multiple Choices: choose the best answer from the given alternatives

- Which one of the following is true about the relations existing between Ethiopia, Egypt, and Sudan?
 - The three countries have long-established historical and cultural ties
 - Egypt shares a long borderline with Ethiopia
 - There are no contentions or conflicts between the three countries
 - All of Ethiopia, Egypt, and Sudan have no right over the use of the Nile water
- Which of the three countries (Ethiopia, Egypt, and Sudan) more depend on the Nile water?
 - Ethiopia
 - Sudan
 - Egypt
 - None
- Which one of the following is not true about the 1959 bilateral treaty held by Egypt and Sudan over the distribution of the Nile water?
 - Egypt and Sudan secured an equal share of the Nile water
 - All Nile water was allotted to Egypt
 - Ethiopia granted 50% of the Nile water
 - About 70% of the Nile water was allocated to Egypt
- When did Ethiopia, Egypt, and Sudan sign the 'Declaration of Principles' over the Grand Ethiopian Renaissance Dam Project (GERDP) to cooperate based on common understanding, mutual benefit, good faith, win-win, and principles of international law?
 - On 08 Nov. 2010
 - On 23 March 2015
 - On 23 March 2003
 - On 05 August 1994
- What happened during the formation of the 'Nile Waters Commission' by the UK and Italy in Dec. 1925?
 - UK and Egypt exchanged Notes over the re-use of the waters of the Nile for irrigation
 - Italy recognized the 'prior hydraulic rights' of Egypt and Sudan
 - Ethiopia and Egypt signed a Framework for General Cooperation
 - Creation of the permanent Nile River Basin Commission

Answer Key to Self-test Exercise 3.6

Dear learner; we hope you did well in the self-testing. Now, you are at the stage of completion of the 6th section of the module. Please compare your answers with the feedback given and make corrections if there are errors in your answers.

1.A 2.C 3.D 4.B 5.B

Dear learner; how did you find the lesson? We think you enjoyed it and found it very interesting and exciting. We hope you did well in the self-testing. Review and check the extent to which you have achieved the intended lesson objectives of the section. If you did well, then you should go on to the next section. What do you think?

SECTION SEVEN

CONFLICTS OVER RESOURCES (2 Hours)



Section Overview

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’. Dear learner; this topic thus focuses on conflicts arising from resources.

Section Learning Outcomes

Dear learner; at the end of this section, you will be able to:

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

Keywords:

- Arbitration;
- Resource conflict;
- Negotiation.

3.7.1 The Concepts and Sources of Resource Conflict

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 administrations, 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.



Dear learner; what are really resource conflicts and how they are arising?

What did you say about conflicts over resources and how they are caused, dear learner? Additional details are provided in the forth-coming paragraph. 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.



What are the main areas and sources 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, or freshwater.



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; distribution of resource revenues; and environmental and social damage caused by extracting of the resource.



Dear learner; can you identify typical conflicts arising from the seizure and use of resources?

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: in Ethiopia (between Somali and Afar pastoralists),
- ◆ In Afghanistan, the main causes of 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. Such water bodies could also be sources of conflict if not handled wisely. Examples:

- ◆ Fishing disputes led to “cold 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,



Dear learner; could you please identify additional areas and sources of resource conflict between countries?

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.



Dear learner; where do you think the use of timber frequently emerging as source of conflict among people?

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.



Dear learner; do you think that energy (fuel) could cause conflict among countries of the world?

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.



Dear learner; why and where do you think precious stones trigger conflict among people and between countries?

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.



Dear learner; does resource scarcity alone cause conflict? From availability and scarcity, which one causes conflict among people and nations?

Dear learner; there are two contrasting views concerning the causes of resource conflict (i.e. too much or too little?) among scholars (e.g. between Cornucopian and Neo-Malthusian scholars). For this please read books or internet sources about the diverging views of scholars to widen your knowledge.



Dear learner; when do you think resource conflicts arise among people, and between community groups and countries?

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.



Dear learner; could you please analyse and integrate the concepts and ideas presented in this section?

3.7.2 The Forms of Resource Conflict Expressions and Handling Mechanisms

The form and intensity of conflicts vary widely with the place and over time within any community. The ways how people respond to natural resource conflicts also 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.



Dear learner; in what forms do resource conflicts manifest themselves? Explain

As you might have guessed; 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
- through peer pressure, etc.



Dear learner; who are the actors of resource conflict?

Dear learner; natural resource conflicts occur at various levels and involve a variety of actors; the following are major ones among others:

- 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.



What strategies do people employ to handle conflicts arising over the control and use of resources?

Dear learner; most people use the following strategies to handle resource conflicts:

- 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 (for instance, developing bylaws and regulations).

Dear learner; thank you for attempting the activity questions. We hope you have written the answers to the questions

Activity 3.7

Dear learner; please try to find answers to the following questions and compare them to the notes that follow.

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

Feedback to Activity 3.7

Please compare your answers with the feedback given below.

1. Resource conflicts are disputes arising over accessing, controlling, and using land resources such as forests, water, pastures, land, energy sources, and minerals. At times disputes may arise when the interests and needs of users are not met or when the priorities of some user groups are not considered by governments.
2. The causes and areas of resource conflict are broad; emanating from various areas and interests. The general sources could be:
 - ◇ the control and use of resources,
 - ◇ secessionist interests,
 - ◇ complaints about standalone projects such as mines and hydroelectric dams,
 - ◇ cumulative impacts of multiple small-scale clashes.

Examples of resource conflict consequences:

- ◇ loss of property and human lives,
- ◇ environmental degradation,
- ◇ deterioration of livelihoods,
- ◇ development retardation,
- ◇ spoil human relations, etc.,

Section Summary

Natural resources are useable assets essential for human livelihoods. They are crucial for both people and animals. Access to natural resources partly decides the wealth and prestige of people and even the position of countries in the international economic system. But, 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’.

Secessionist tendencies, disputes over laws and conventions, grievances over standalone projects (such as mines and hydroelectric dams); and small-scale clashes over the seizure and use of land resources (e.g. land, livestock, pasture, freshwater, energy sources, and minerals) could be areas of conflicts. Controlling vast areas of land and water (Sea coasts, ports, rivers, lake shores, borderlands, forests, and even oceanic resources) can pose conflict among countries. Conflicts may arise also when user groups are excluded from participating in natural resource management; and when natural resources are poorly managed and inequitably shared. Paradoxes arising between local and introduced management systems and confusion occurring among users due to the absence of information about government policy and program objectives could likewise lead to

conflicts. Conflicts may again arise when a lack of clarity occurs on laws and policies. Absence of equity in resource distribution; poor policy and unsuccessful program implementations perhaps equally trigger conflict among user groups.

The forms and intensity of conflicts vary widely with the place and over time within any community. The ways how people respond to natural resource conflicts also 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. For instance, some of the forms of how resource conflicts manifest themselves involve breaking rules, sabotaging activities and violence, and showing distrust and peer pressure.

Natural resource conflicts occur at various levels and involve a variety of actors. Local people in the homesteads; communities; villages; organizations; domestic and multinational businesses; governments; international development agencies; and NGOs can seldom emerge as actors in natural resource conflicts. Avoidance; coercion; negotiation; arbitration; mediation; and adjudication are among the strategies followed to manage conflicts among conflicting groups.



Checklist 3.7

Dear learner, please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you understand the sources and forms of resource conflict?		
2	Natural resource conflicts have always been with us due to multiple competing demands.		
3	Disputes over the control, ownership, and use of natural resources exist all over the world.		
4	Natural resource conflicts cannot be managed and resolved.		
5	Some 40–60 % of the civil wars during the past six decades have been instigated by the control and use of natural resources.		
6	Disputes can arise when the interests and needs of users are not met or when the priorities of some user groups are not considered by governments.		
7	Can you identify typical examples of conflicts that originated from the seizure and use of natural resources?		
8	Oceans, Seas, Lakes, and Rivers could be sources of conflict.		
9	Can you identify some of the wars fought between countries over the control of land?		
10	Can you identify some of the strategies used by people to handle resource conflicts?		

Self-test Exercise 3.7

Dear learner; we hope you enjoyed reading the notes about resource conflicts and thereby engaged in learning by doing the respective activities. We think you found everything interesting and relevant. Now, do the questions given below evaluate how far you understood the lesson you studied.?

Instruction: Multiple Choices: choose the best answer from the given alternatives (5 points)

1. What does not cause conflict among people and governments?
 - A) Prevalence of Good governance, transparency, accountability, and tolerance
 - B) User confusion due to the absence of information about government policy & programs
 - C) Question of secession by small groups due to dissatisfaction with government actions
 - D) Lack of transparency on management and distribution of communal resources
2. Which of the following is true?
 - A) The form and intensity of resource conflict never differ with place and time
 - B) Conflict handling strategies could be formal or informal, violent or peaceful
 - C) People do not follow common and basic procedural principles to handle conflict
 - D) Resource conflicts often arise in only rural areas
3. Which of the given is not an expression/manifestation of conflict?
 - A) Breakage of working rules and laws
 - B) Sabotage activities and violence
 - C) Trustfulness and Good faith
 - D) Showing distrust and peer pressure
4. Who do you think are the actors of resource conflict?
 - A) Development agencies and NGOs
 - B) Individuals and communities
 - C) State governments and countries
 - D) All are actors
5. Which of the following cannot be used as a strategy for handling conflict?
 - A) Coercion
 - B) Adjudication
 - C) Avoidance
 - D) None

Answer Key to Self-test Exercise 3.7

Dear learner; we hope you did well in the self-testing. You are now at the stage of completion of the 7th section of module three. Now, please compare your answers with the feedback given and make corrections for any errors, if available.

1.A 2.B 3.C 4.D 5.D



Dear learner; could you please analyse and integrate the concepts and ideas presented per section throughout the module in your study? This will help you internalize and validate the information you got from the whole reading.

UNIT SUMMARY

Dear learner; 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. 55.5 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

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UNIT FOUR

GLOBAL POPULATION DYNAMICS AND CHALLENGES (14 Hours)

UNIT INTRODUCTION

Dear learner, Welcome to unit four, which focuses on global population dynamics and challenges. The population is one of the topics covered by Geographic Education in schools, colleges, and universities. Population geography is the branch of geography concerned with population issues such as population size, composition, spatial distribution, and changes over time. The pattern of population growth is defined by three critical processes: fertility, mortality, and migration. The modern world appears to be characterized by exponential population growth. As a result, food is scarce, nonrenewable resources are scarce, renewable resources are overexploited, and the environment is deteriorating. In response to the unbalanced relationship between the rate of population expansion and socioeconomic progress, population geographers have focused their attention on the study of population growth patterns and international migration. As a result, dear learner, this unit will deal with population growth trends in both developing and developed countries in the first unit. The second, third, and fourth sections, cover elements influencing population growth, international migration, and population policies, respectively.

Expected learning outcomes of the unit

Dear learner, at the end of this unit, you will be able to:

-  illustrate the trend of world population growth;
-  recognize the key factors behind major population problems;
-  distinguish the population growth trends of least developing countries (LDCs) and more developing countries (MDCs); and
-  assess the factors underlying international migration.

SECTION ONE

THE GROWTH OF THE WORLD POPULATION

(6 Hours)



Section Overview

Dear learner, agrarian, industrial, and medical advancements all contributed to rapid population growth. Two-thirds of developing countries are expected to see population growth between 2019 and 2050 as a result of the sustained high rate of fertility. In contrast to less developed countries, the most pressing concern in more developed countries is population stagnation, which is accompanied by aging and results in a decrease in the number of working-age populations. Dear learner, it is critical to start the discussion with questions that allow you to think critically about the topic.

Section learning outcomes

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

-  illustrate the global population growth trend; and
-  differentiate the population growth trends in MDCs and LDCs.

Keywords:

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

4.1.1. World Population Trends



Dear learner, how do you explain the demographic transition model in Figure 4.1 illustration?

The Demographic Transition Model (DTM) illustrates how the relationship between birth and death rates, as well as overall population change, varies over time. According to Figure 4.1, in the first stage countries normally exhibit 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 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 that is significantly bigger than before the transition. In the fifth stage, the birth rate rose again but the death rate remained low bringing stable or low population growth.

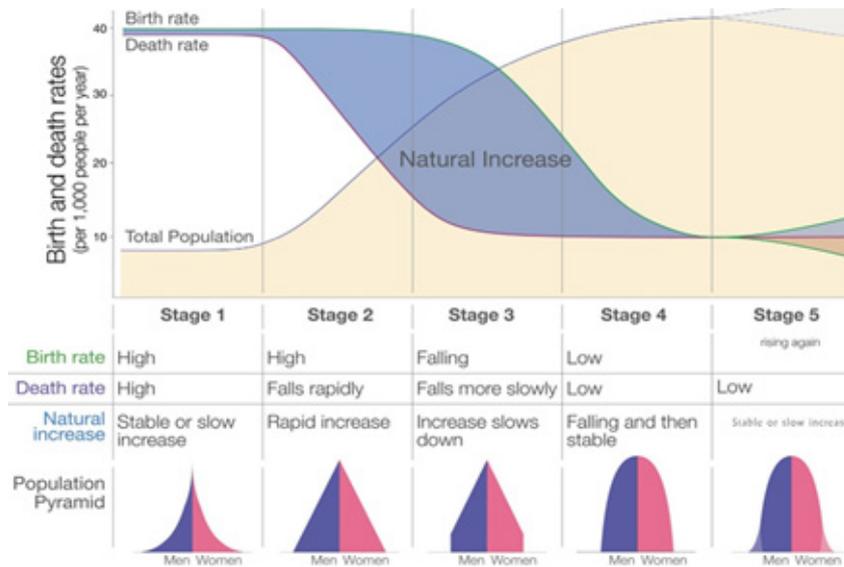


Figure-4.1. Demographic transitional model in five stages: Presenting natural increase and population pyramid



Dear learner, please attempt to comprehend the connection between population growth rate (Figure. 4.2) and population trends (Figure 4.1).

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 (Figure 4.2).

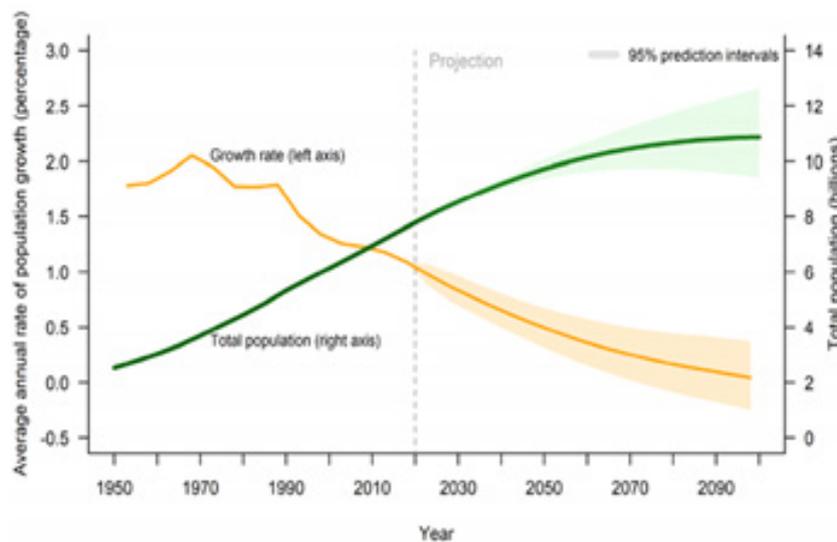


Figure.4.2. Population size and annual growth rate for the world.
Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

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 twentieth century in the first stage, progressed to the second stage by the middle of the century, and by the last few decades had entered a period of declining fertility.

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. Figure 4.2 depicts that 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 (a 42 % increase). 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.



Dear learner, based on the concepts of population growth you acquired, tries to identify and interpret the population data presented in Figure 4.3.

Between 1950 and 2020, the average number of live births per woman decreased significantly in various locations (Figure 4.3). 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.

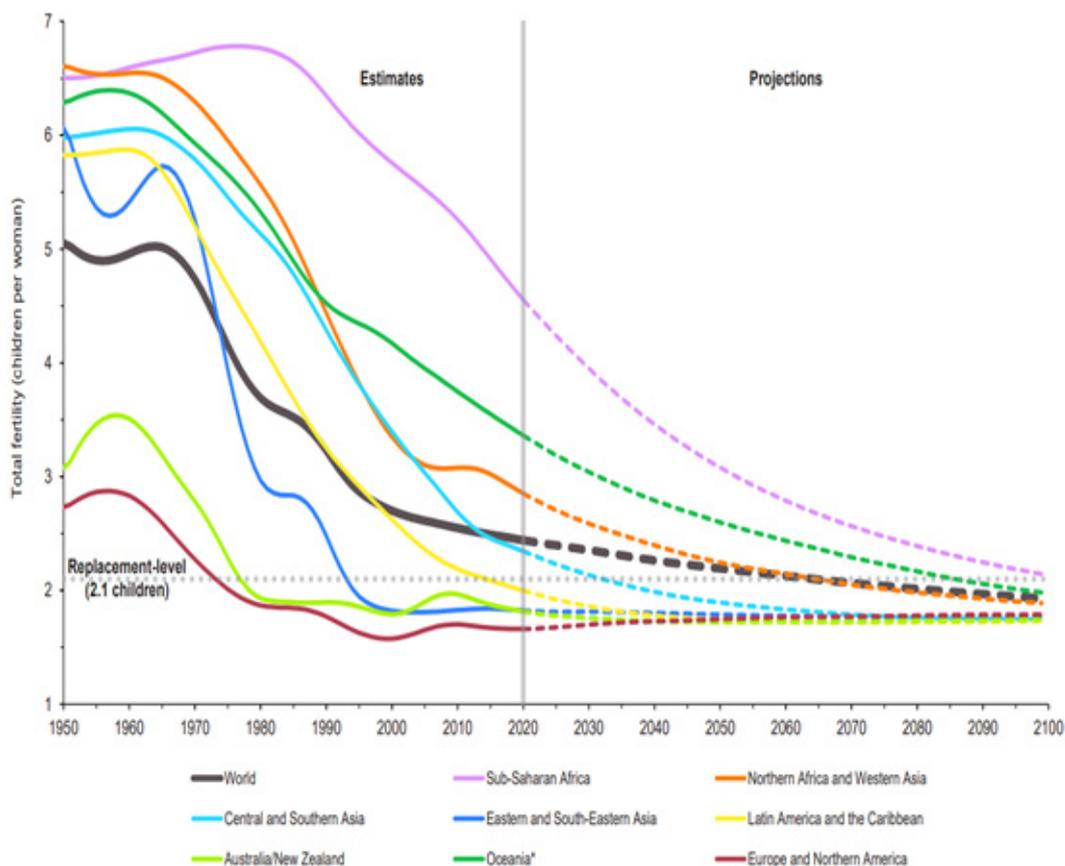


Figure 4.3. Total fertility (births per woman) by SDG region, estimates, 1950-2020, and medium-variant projections, 2020-2100.

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

Close to half of the global population lives in Europe and North America, Latin America, the Caribbean, Australia/New Zealand, and eastern and southeastern Asia, where lifetime fertility is below 2.1 births per woman. Fertility remained above the global average in 2019, primarily in Sub-Saharan Africa (4.6), Oceania (3.4), Northern Africa and Western Asia (2.9), and Central and Southern Asia (2.4). 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. 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.



Dear learner, which countries will be responsible for the largest increase in population between 2019 and 2050 (see Figure. 4.4)?

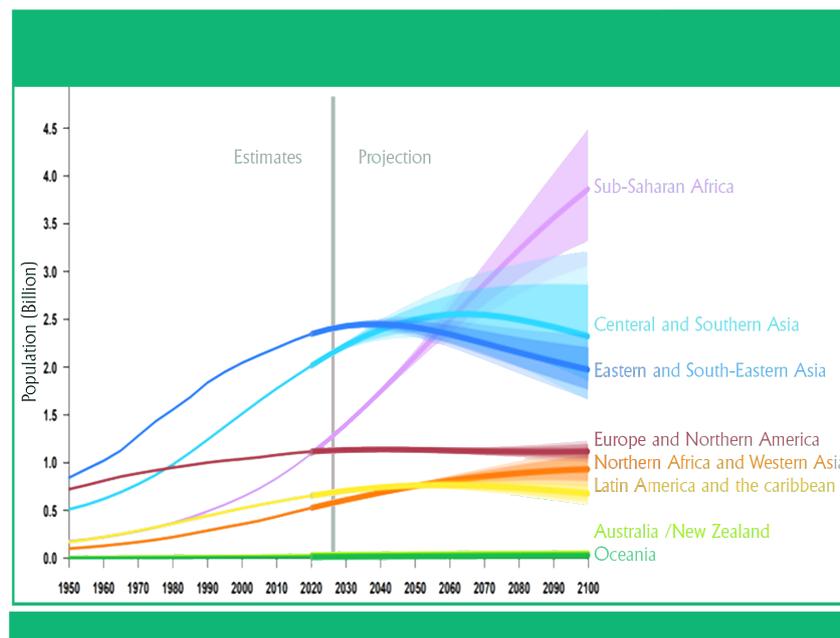


Figure 4.4. Population by SDG region: Estimates, 1950-2020, medium-variant projections, 2020-2100, with 80- and 95-percent prediction intervals

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 (Figure. 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.

Adolescent fertility (births to mothers aged 15-19 years) remains high in some countries (colored in darker blue on the map), 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.

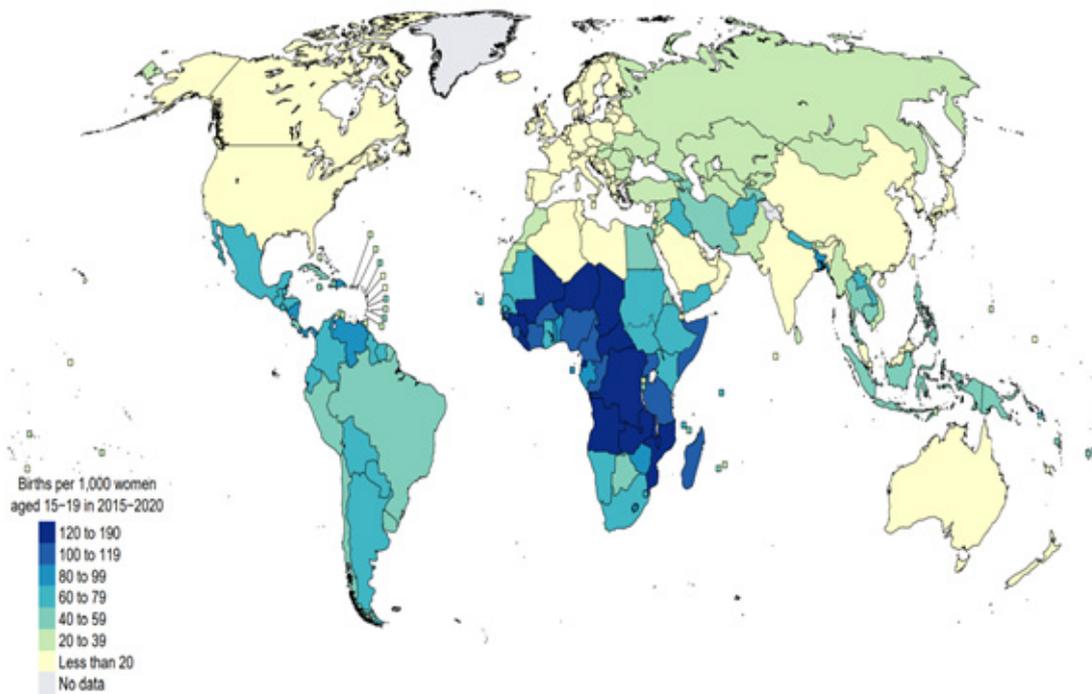


Figure 4.5. Adolescent birth rate (births per 1000 women aged 15-19 years), 2015-2020
Source: United Nations, Department of Economic and Social Affairs, Population Division (2019).
World Population Prospects 2019.

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. Dear learner, please, try to answer questions in activity 4.1.1 to see how well you understand this section.

Activity 4.1.1

Dear learner, attempt the following questions provided below.

1. Why has the largest increase (growth rate) in the world population, in history, occurred when nations began to lower their fertility rates?
2. Which countries are predicted to contribute the most to global population growth over the next 50 years?
3. Which group is expected to have zero population growth by 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.

Dear learner, have you completed activity 4.1.1's questions? If you answered no, please reread this section and attempt to answer the questions. If you answered yes, proceed to the next unit.

4.1.2. Population Trends in Less Developed Countries (LDCs)

Dear learners, you may recall that global population growth has followed a cyclical pattern. As a result, in the mid-eighteenth century, population growth rates in less developed countries were relatively low. Since the 1920s, natural growth rates in LDCs have been approaching those in more developed countries,

and in the 1930s and 1940s, they began to exceed them. LDCs began their demographic transition from high to low birth and death rates later in the twentieth century.



Dear learner, what are the key factors that explain the fast growth of the population in LDCs?

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 (indicated in pink colors on the map, Figure 4.6), 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.

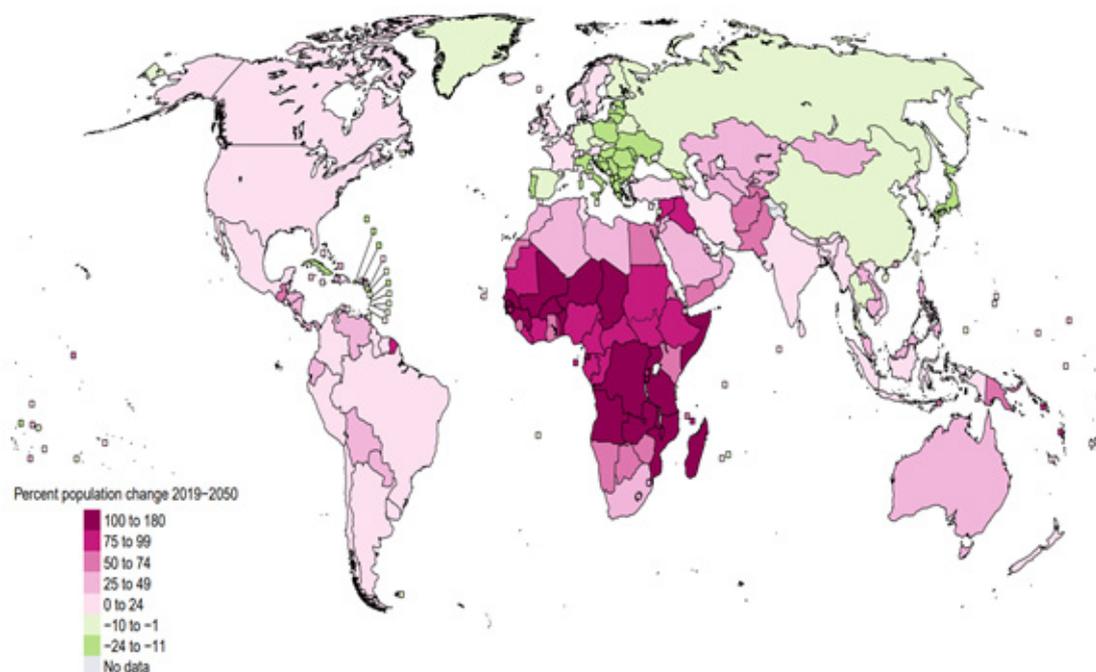


Figure 4.6. Changes in total population between 2019 and 2050 based on the medium-variant projection

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



Dear learner, what are the possible implications of population growth in LDCs?

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 will all be 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%. Dear learner, please, try to answer questions in activity 4.1.2 to see how well you understand this section.

Activity 4.12

Dear learner, please attempt the question set below

1. When and how do populations become a problem for countries?
2. How would a high population increase in some of the world's poorest countries constitute a threat to long-term development?

Dear learner, please summarize your comprehension of the world population growth trend, actual population structure differences among more developed countries and developing countries, and association implications before moving to the next subcontinent.

4.1.3. Population Trends in More Developed Countries (MDCs)



Dear learners, what are the consequences of population stagnation in 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.

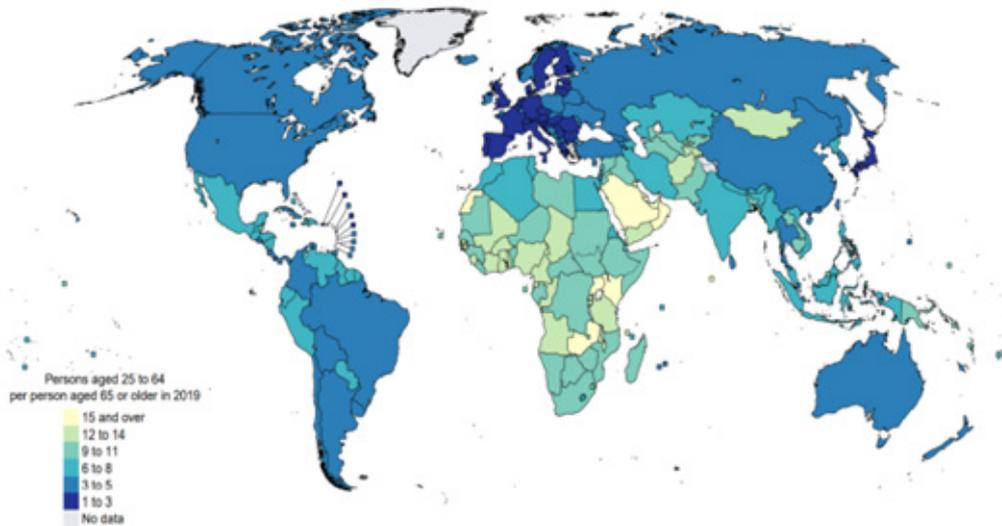


Figure 4.7. The old-age potential support ratio

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

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 blue on the map, 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. In this connection what did you learn student, about population size, and growth rate and its resultant consequences? Thus, based on your reflective observation, attempt to broaden your understanding in this direction and imagine what societal agencies should do to regulate their respective population.? Have you attempted to answer the question in Activity 4.1.1? If you answered no, please read the note again and attempt to answer the questions. If your answer is yes, great! Write it down on a piece of paper and try to relate it to the following feedback.

Feedback to Activity 4.1.1

1. The model's third and fourth stages (slow natural increase) began in most industrialized countries, while the second stage began in less developed ones (high birth rate minus low death rate). As a result, the combined effects of both more developed and less developed countries' population growth stages may result in the world's population increasing at the fastest rate.
2. With a population growth rate of 2.8 % per year, African LDCs outperformed the worldwide LDC average of 2.5 %. Because of the sustained high rate of fertility, two-thirds of less developed nations are forecast to see population growth between 2019 and 2050 (indicated in pink colors on the globe, Figure 4.5), with 40 of them expected to expand by more than 50% and 19 likely to quadruple their population.
3. Before the end of the century, Eastern and South-Eastern Asia, Central and Southern Asia, Latin America and the Caribbean, and Europe and Northern America are expected to achieve peak population size and begin shedding population.

4. 4. 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).
5. 5. Sub-Saharan Africa, Latin America, and the Caribbean

Have you attempted to answer these questions in activity 4.1.2? If you answered no, please read the note again and attempt to answer the questions. If your answer is yes, great! Write it down on a piece of paper and try to relate it to the following feedback.

Feedback to Activity 4.1.2

1. The High birth and death rates, increasing population size and density, rapid population growth, and increasing dependency burdens all result in increased demands on developing countries, particularly African governments, in productive activities, exacerbating unemployment, underemployment, and persistent poverty, urban slums, crime, and political unrest. The rapid growth of the population adds to the challenges of eradicating poverty, improving quality of life, combating hunger and malnutrition, and improving the quality and coverage of the health and education systems.
2. The rapidly rising population adds to the challenges of eradicating poverty, improving quality of life, combating hunger and malnutrition, and improving the quality and coverage of the health and education systems. Rapid urbanization has led to overcrowding, traffic congestion, poor sanitation and education facilities, and the emergence of antisocial behavior in many emerging world cities. Another effect is the growth of informal communities with no infrastructure or amenities.

Section Summary

Dear learners, please sum up the following section's essential points. Until the mid-nineteenth century, the human population grew slowly since birth rates were only slightly greater than death rates; in the first stage, countries often have high fertility and mortality rates. The twentieth century has seen extraordinary growth in the human population. Less developed countries began the century in the first stage; in the second stage, death rates decline, notably among children aged 0 to 5, but birth rates remain high, indicating strong population growth. The third stage is marked by a lowering birth rate, owing primarily to the widespread use of contraception, but continued population expansion of reduced size. The majority of industrialized countries were already in the third stage of the model when the twentieth century began. In the last stage, birth rates fall to a level where they equal mortality rates, putting a stop to population increase. Between 1950 and 2020, the average number of live births per woman fell dramatically in several countries, and the trend persisted in 2100. It is well known that significant advancements in the delivery of healthcare services, the control of diseases, the installation of water pipes, the improvement of housing, and the dissemination of education have caused a decline in mortality rates and an increase in population growth in the less developed nations. The attempts to alleviate poverty, improve quality of life, combat hunger and malnutrition, and expand the quality and coverage of the health and education systems face new obstacles as the population grows. In more developed countries, population stagnation combined with aging results in a decrease in the number of working-age people, resulting in a reduced potential support ratio.



Checklist 3.7

Dear learner; please check how far you understand the given lesson by answering the following questions by writing ‘√’.

No	Questions	Yes	No
1	Did you comprehend and show the worldwide population growth trend?		
2	Did you distinguish between the MDC and LDC population growth trends?		

Self-test Exercise 4.1

Part one: Multiple-Choice Item

Instruction: Choose the Best Answer from the given alternatives

- The first stage of the demographic transition model exhibits
 - high level of fertility and mortality
 - death rates decrease
 - decrease in the birth rate
 - all
- Which one is wrong?
 - The eighteenth century saw a demographic change in more developed nations
 - In the fourth stage, in a population that is steadily growing and is significantly larger than it was before the transition
 - Human population growth was modest until the middle of the 20th century
 - None
- Which region could account for more than half of the world’s population growth and is expected to continue rising through the end of the twentieth century
 - Central and Southern Asia
 - Eastern and Southeastern Asia
 - Sub-Saharan Africa
 - D/ all
- Which of the following does not fall under the category of a result of the high population expansion in developing nations?
 - ever-increasing rural-to-urban movement
 - eradicating poverty
 - inadequate sanitation and education facilities
 - D/ A & B

Part Two: True/false Item

Instruction: If the Sentence is “Correct” Say “True” and if the Sentence is “Incorrect” Say “False”

- The ninetieth century has seen extraordinary growth in the human population
- In the second stage of the 20th century, less developed countries showed significant population growth.
- Population stagnation and aging in less developed nations lead to a lower potential support ratio.

Answer Key to Self-test Exercise 4.1

Choice Item: 1. A 2. C 3. C 4. B

True/False Item: 1. False 2. True 3. False

SECTION TWO

FACTORS RESPONSIBLE FOR ACCELERATED WORLD POPULATION GROWTH

(3 Hours)



Section Overview

Dear learner, how does a socioeconomic change affect world population growth? The advancements in agriculture 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 period 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). Dear learners, how does the quality of education affect the rapid population growth in developing nations? It is more challenging for people with higher degrees of illiteracy to understand the negative effects of rapid population growth and to take action to slow it down (e.g. use of contraceptives). Due to a lack of knowledge, the majority of rural societies are against utilizing family planning methods. More of the highlighted issues will deal with in this section.

Section Learning Outcomes

Dear learner, at the end of this section, you will be able to:

-  explain the key factors attributed to population growth in developing countries,
-  estimate fertility and mortality rates of a given country's population

Keywords:

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

4.2.1. Measures of Fertility



Dear learners, how do you define fertility? What factors affect the fertility rate?

Interrelate to the following note and internalize more. 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 contemporary 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. For example, breastfeeding lowers (but does not eliminate) the risk of pregnancy for up to 21 months following 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 the 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 defined 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). Please refer to the case examples given below.

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:
 $CBR = (295,500) / 90,898,000 \times 1,000 = 3.25$ birth per 1,000 per year

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:

$TFR = \sum(Bx/Px) \times 5$, 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 groups represented by Bx are 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 4.2.2. The total fertility rate of a given area

Age groups	2020 Births	2020 women population	Age-specific birth rate	2020 Female Birth
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

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

II. 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:

$$GRR = TFR \times (\sum FB) / (\sum Bx)$$

Based on the previous example, $TFR = 2$. Therefore, $GRR = 2 \times (\sum FB) / (\sum Bx)$ where $\sum Bx = 78,500$, total birth in 2020, $\sum FB = 42,300$, total female birth in 2020.

$$GRR = 2 \times 42,300 / 78,500 = 1.077$$

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.

iv. General Fertility Rate (GFR): this 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:

$GFR = B/P1 \times 1,000$, where B is the total number of live births during a year, and P1 is the mid-year population of women between 15 and 49 years of 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 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 of their reproductive age was one-fifth of the total population = $(1/5) \times 60,000,000 = 12,000,000$, then $GFR = (600,000 / 12,000,000) \times 1,000 = 50$ 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. Dear learner, please try to answer the questions in activity 4.2.1 to see how well you understand this unit.

Activity 4.2.1

Dear learner, please 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 do you explain the rapid growth of the world population?
4. What are the factors responsible for population distribution across different geographical areas?

5. Calculate the TFR and GRR based on the data given below

Age groups	2022 Births	2022 female population	2022 Female Birth
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

4.2.2. Measures of Mortality



Dear learner, how do you define and measure mortality? What are the key factors determining the mortality rate?

Mortality is the state of being mortal. Mortality (the occurrence of death) can be measured using the 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: $=D/P \times 1,000$, where CDR is Crude Death Rate, D stands for total observed deaths, and P is the total mid-year population.

Case Example 4.4. In a given region, the total number of deaths observed in 2017 was 80,000, and the total mid-year population was 16,000,000. Therefore, the result of CDR was:
 $CDR = 80,000 / 16,000,000 \times 1,000 = 5 / 1000$

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

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

Case Example 4.2.5.

A total of 600,000 babies were born in a certain region in 2017. 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

$IMR = 140,000 / 600,000 \times 1,000 = 233.3 / 1000$

Dear learner, please attempt to answer the questions in activity 4.2.2 to assess your understanding of this unit.

Activity 4.2.2

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 the region "A" in 2021. Of these newborns, 360,000 babies survived their first year of life. Calculate the IMR of this region.

Dear learner, have you tried to answer questions in activities 4.2.1 and 4.2.2.? If your answer is no, please reread the note and try to answer the questions. If your answer is yes, excellent, write your answer on a rough paper and try to relate it with the following feedback to activities 4.2.1 and 4.2.2.

Feedback activity 4.2.1

1. Agriculture development, market economy development, urban-oriented societies, increased living conditions, and migration implications affecting birth and mortality rates altered throughout the industrial age, resulting in a substantial increase in the world's population. Agriculture mechanization was a key factor in enabling cultures to produce more food with fewer resources. Over successive generations, as food sources increased, average levels of nourishment increased, and vulnerability to chronic and communicable diseases decreased. Improvements in medical care and public health services, which occurred more frequently in cities than in rural regions, helped people live longer, resulting in lower death rates. People understood that they didn't need as many children to attain their desired family size after several decades of decreasing mortality, therefore birth rates began to decline as well. Rapid population increase came from lower mortality rates and a large newborn young population. The demographic transition is a process that adjusts population growth rates in multiple stages by lowering mortality and birth rates.
2. Net migration is also crucial in some countries in this regard. In Europe, Northern America, and Australia/New Zealand, net international migration has become a key component of population change.
3. Exponential population growth is defined as population expansion that is driven by a steady increase in birth rate and is not constrained by food or sickness. The birth rate alone controls population increase. This means that throughout the transition from pre-industrial to industrial economic stages, a high birth rate minus a lower mortality rate leads to rapid population expansion. Exponential expansion is the term for this rapid pattern of population growth. Exponential growth occurs when the per capita (per individual) growth rate of a population remains constant regardless of population size, causing the population to increase faster and quicker as it grows larger. Because populations can grow exponentially, resource depletion can happen quickly, causing environmental issues including global warming, deforestation, and biodiversity loss. Rapid population growth could lead to food shortages and an increase in the dependence ratio.
4. The arrangement of people throughout space, or the population's relative geographic location, is referred to as "population distribution." It describes how humans are distributed across the earth's surface. Climate, landforms, topography, soil and water resources, transportation and communication accessibility, energy and mineral resources, navigable rivers or canals, cultural factors, political boundaries, migration and trade controls, government policies, types of economic activities, technology, including farming and transportation facilities, and social organization are all factors that influence population distribution across geographical regions. The following examples demonstrate the environmental consequences of population distribution:

(1) The growing demand for overburdened resources in many less developed countries as a result of rising population densities, and

2) The ecological effects of urbanization, such as pollution concentration and land-use conversion.

5. Dear learners, here is how the TFR and GRR are presented.

Age groups	2017 Births	2017 female population	Age-specific birth rate
15 - 19	10,000	190,000	52.6
20 - 24	18,000	120,000	150
25 - 29	20,000	250,000	80
30 - 34	18,000	182,000	98.9
35 - 39	9,000	195,000	46.15
40 - 44	3,500	250,000	14
45 - 49	1500	170,000	8.82
	80,000		450.47
450.47 x 5 = 2252.35			

$GRR = 2252.35 \times 100 / 80,000 = 2.8$, implying that the current generation will more than replace themselves.

Feedback to Activity 4.2.2

1. The crude death rate of the “A” region is:

$CDR = 100,000 / 26,000,000 \times 1,000 = 3.8 / 1000$, implying that 3.8 people die per 1000 mid-year populations, in a specified year.

2. The IMR of this region “A” in 2021 is:

$IMR = (400,000 - 360,000) / (400,000) \times 1,000$

$IMR = (40,000) / (400,000) \times 1,000 = 100 / 1000$, implying that 100 infants die under the age of one year for every 1000 live births in a given year.

Section summary

Dear learners, please include the following key points while summarizing this section. The development of agriculture was the primary factor ensuring the security and continuity of human existence. The second major factor was the increased specialization of labor, which was followed by the development of market economies and urban-centered societies, which significantly increased the population living in those societies. The third factor was increased economic productivity was made possible by the revolution in agriculture and manufacturing, which was accompanied by a swift and steadily accelerating rise in population. Over consecutive generations, as the average level of nutrition rose, the susceptibility to infectious and chronic diseases declined, medical knowledge expanded, and public health measures to combat various illnesses were strengthened, the general death rate also reduced. The frequency of live births, or fertility, represents a population’s real reproductive efficiency. The crude birth rate (CBR), the general fertility rate (GFR), and the total fertility rate are the three most popular methods of determining fertility (TFR). There are many ways to assess mortality (death), including by utilizing the crude death rate and the infant mortality rate.



Checklist 4.2

Dear learner; please check how far you understand the given lesson by answering the following questions by writing ‘√’.

No	Questions	Yes	No
1	Did you attempt fertility measures, such as the crude birth rate (CBR), the general fertility rate (GFR), and the total fertility rate (TFR) of a specific country’s popula-tion?		
2	Are you familiar with the main causes of population increase in developing coun-tries?		
3	Can you name the elements affecting a country’s fertility rates?		
4	Did you attempt to calculate the population’s mortality rates, such as the crude death rate and infant mortality rates?		
5	Can you identify the factors affecting a country’s death rates?		

Self-test exercise 4.2

Part One: Multiple-Choice Item

Instruction: Choose the best answer from the given alternatives

- Which one was the primary factor ensuring the security and continuity of human existence
 - the increased specialization of labor
 - The development of agriculture
 - The increased economic productivity
 - D/ all
- Which one doesn’t determine the mortality rate
 - standards of living,
 - environmental sanitation
 - Contraception
 - D/ all

Part Two: True/false Item

Instruction: If the Sentence is “Correct” Say “True” and if the Sentence is “Incorrect” Say “False”

- Only female births, not all births, are included in the Gross Reproductive Rate (GRR).
- To compare fertility rates across different regions and to describe fertility patterns, the total fertility rate is frequently utilized.
- The GFR accounts for the difference in age groups



Answer Key to Self-test Exercise 4.2

Choice Item: 1. B 2. C

4. True/False Item: 1. True 2. True 3. False

Learner, how did you find the lesson? I think it was thrilling and engaging for you. Did your self-test go well? If you selected yes, move on to the following section

SECTION THREE

INTERNATIONAL MIGRATION (3 Hours)



Section Overview

Dear learner, the current highly irregular spatial distribution of the 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. People with archaic technologies have historically been forced to migrate due to environmental factors such as dwindling resources or overutilization of agricultural land. Furthermore, people migrate in groups (clans, tribes) to obtain seasonal food and rear livestock. 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. Migration, like fertility and mortality, has an impact on population growth rates in sending and receiving countries. The negative natural increases may worsen population shrinkage induced by net migration. 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. Hence, you will be more familiarized with the details of issues of international migration in this section.

Section Learning outcomes

Dear learner at the end of this section, you will be able to:

-  identify the countries that constitute the main targets or destinations of international migration and those that are the main senders of international migrants; and
-  measure the international and national migration rate.

Keywords:

- International;
- Measurements;
- Migration



Dear learner, how do you understand international migration?

It is hoped that you have reacted to the above questions and made points; then continue to the next lesson note. 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.

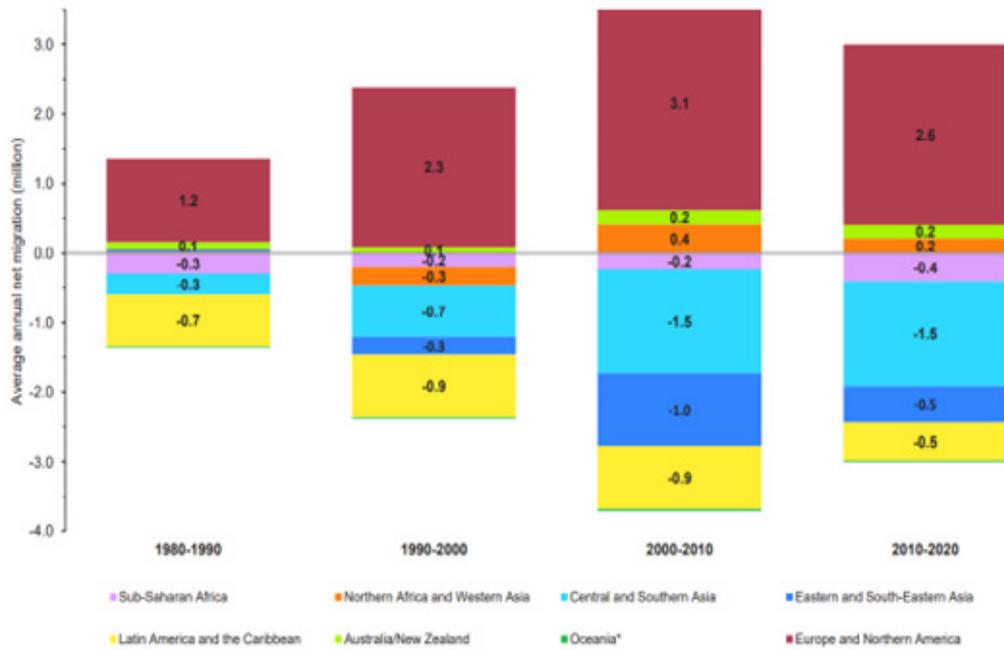


Figure 4.8. The average annual net international migration by SDG region and decade, 1980-2020

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

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).

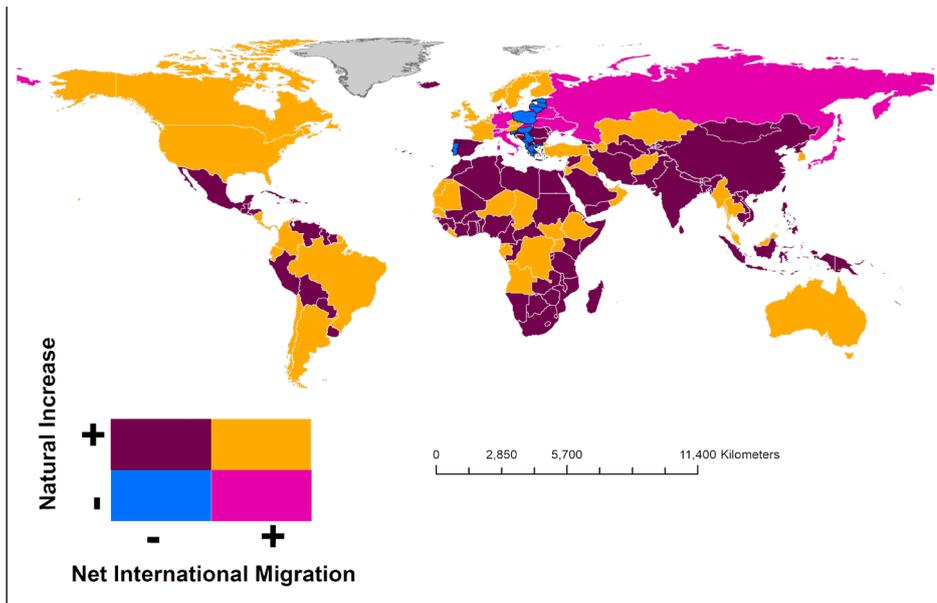


Figure 4.9. Net international migration and natural population increase, 2010-2020.

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

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 dark blue). 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.

Measures of Migration

The annual change in population for every country is equal to birth minus death plus immigrants minus emigrants $(B-D) + (I-E)$. 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.

Immigrant rate = $(\text{number of immigrants}) / (\text{total population at destination}) \times 1,000$

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.

Emigration rate = $(\text{number of emigrants}) / (\text{total population at origin}) \times 1,000$

The 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 a given year.

Net migration rate = $(\text{Number of immigrants} - \text{Number of emigrants}) / (\text{Total population}) \times 1,000$

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'?

$\text{NMR} = (350,000 - 60,000) / 110,000,000 \times 1,000 = 2.6$, implying that the net migration rate is 2.6 per 1000 people

Dear learner, please attempt to answer the questions in activity 4.3 to assess your understanding of this section.

Activity 4.3

Dear learner, please attempt the questions below about the migration of the population and its impacts.

1. How do you assess the impacts of migration from one country to another on the growth of the world population?
2. Which countries of the world are the highest senders of migrants?
3. Explain why the world's population distribution is asymmetric, with some areas becoming densely populated while others become sparsely densely populated.
4. Discuss the opportunities and challenges of international migration.
5. What are the impacts of international migration? Finally, compare your responses to the related lesson note discussion and mainly to the respective feedback given at the end of section(s).

Dear learner, have you attempted to answer the questions in activity 4.3? If you answered no, please read the note again and attempt to answer the questions. If your answer is yes, great! Write it down on a piece of paper and try to relate it to the following feedback.

Feedback to Activity 4.3

1. Because one country's loss is another's gain, international migration has no direct impact on the global population.
2. Net senders include 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).
3. Because population distribution can be explained in terms of human ability to adjust to spatial relationships and accessibility; relief, climate, vegetation, soils, water supplies, and mineral deposits; the influence of birth and death rates, age structure, population migration flows; social attitudes and institutions; economic development; and historical factors throughout human history.

4. International migration allows immigrants to be financially better off in their host country than they were in their home country. Due to direct competition with better competent immigrants in the job market, less-skilled natives may lose out in terms of income and labor prospects, showing the difficulty of international migration.
5. International migration has an impact on global population distribution, cultural dissemination, and resource exploitation. Migration, like fertility and mortality, has an impact on population growth rates in sending and receiving countries. Due to direct competition with more competent immigrants in the job market, less-skilled natives may lose out in terms of income and labor prospects.

Section summary

Dear learner, you can summarize the main points and concepts of the lesson focusing on:

Migration, like fertility and mortality, has an effect on population growth rates in both sending and receiving countries. For nearly five decades, global migration has been increasing from less developed to more developed regions for economic (seeking better jobs) and political (seeking asylum or refugee) reasons. International immigration is a business process that is fueled by a variety of 'push' factors in the source country, such as a lack of job opportunities, a large population, and low wages. Immigration now contributes more to population growth than natural growth in increasingly developed countries. Immigration and emigration rates are two of the most common migration indicators that may influence population growth. The net migration rate demonstrates the net effect (balancing) of immigration and emigration in a given area (NMR).



Checklist 4.3

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Did you identify the principal sending and receiving nations for international mi-grants?		
2	Have you tried calculating the rates of international and domestic migration?		
3	Are you aware of the causes of both international and domestic migration?		

Self-test exercise 4.3

Part One: Multiple-Choice Item

Instruction: Choose the best answer from the given alternatives

1. Which of the following has remained the world's most popular destination for migrants for the past five decades
A. The United States B/ Sub-Saharan Africa C/ Western Europe D/ all
2. Which one of the following is not sender to international migrants for decades
A. Africa B/ Latin America, C/ the Caribbean D/ New Zealand

Part Two: True/False Item

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

1. The distribution of the population, the spread of culture, and the exploitation of resources are all unaffected by individuals moving from one location to another.
2. Migration, like fertility and mortality, has an impact on world population growth rates
3. In more developed nations, immigration has increased population growth more than fertility has.

Answer Key to Self-test Exercise 4.3

Choice Item: 1. A 2. D

True/False Item: 1. False 2. False 3. True

Dear learner, how did you like the lesson? I believe it was exciting and engaging for you. How did your self-test go? If you answered yes, proceed to the next section.

SECTION FOUR

POPULATION POLICIES (2 Hours)



Section Overview

Dear learner, 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.

Dear learner, at the end of this section, you will be able to:

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

Keywords:

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

4.4.1 Types of population policies

Unbalances between demographic changes and social, economic, and political goals could be avoided through explicit or implicit population strategies.

Types of population policies	
Direct or explicit	Indirect or implicit
<p>Government actions are taken for affecting the demographic outcome. Example:</p> <ul style="list-style-type: none"> ◇ Provide free family planning ◇ Increase taxes for each additional child ◇ Migration law: Restrict immigration ◇ Raise the age of marriage 	<p>Decisions and actions of the government indirectly have some demographic effects. Example:</p> <ul style="list-style-type: none"> ◇ Compulsory secondary education ◇ Restrict child labor ◇ promoting female education and raising the status of women ◇ Provide old-age security

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

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. 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 has taken 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, and
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 the population out of environmentally fragile or threatened areas.

Dear learner, please try to answer the questions in activity 4.4 to see how well you comprehend this section.

Activity 4.4:

Dear learner, please try to answer the following questions.

1. explain how demographic problems need to be addressed by major population policies at the national level in the developing world.
2. differentiate pro-natalist and anti-natalist policies on population change.

Dear learner, have you tried to respond to this question? If you answered no, please reread the note and try to answer the questions again. If you answered yes, congratulations! Write it down on paper and endeavor to relate it to the following feedback on activity 4.4.

Feedback on activity 4.4

1. The following areas could be the focus of policies advised to the developing world to achieve the demographic problems.

- Make birth control legal.
- Establish a special institution for demographic and policy planning.
- Establish service delivery and outreach for family planning.
- Make investments in public health and illness prevention.
- Provide free general education.
- Make financial services accessible to everyone.

2. The idea that human reproduction is desirable for societal reasons and to preserve national continuity is known as natalism or pronatalism. Typically, public policy aims to provide social and financial incentives for populations to reproduce, such as tax breaks for having and raising children. Sweden, for instance, has implemented pronatalist measures. Conversely, anti-natalist policies work against human reproduction to address issues with population growth, hunger, and the depletion of energy sources. By releasing more resources for investment in activities that boost productivity, a lower birth rate could hasten economic development. For instance, China's one-child policy was implemented to control population growth.

Section Summary

Through explicit or implicit population policies, imbalances between demographic changes and social, economic, and political goals could be avoided. Population policies need to address both internal migration and urbanization challenges. Pro-natalist policies are those that are intended to raise the birth rate in nations that are experiencing either a very sluggish natural increase or natural drop, as well as in regions where the population is aging. Conversely, In particularly developing countries, where rapid population growth has been recorded, anti-natalist programs attempt to solve difficulties with population growth, malnutrition, and the depletion of natural resources.



Checklist 4.4

Dear learner; please check how far you understand the given lesson by answering the following questions by writing '✓'.

No	Questions	Yes	No
1	Have you identified the different sorts of population policies?		
2	Do you comprehend population migration and distribution policies?		
3	Did you make an effort to evaluate the main national population policies in tack-ling the main demographic and socioeconomic issues in the developing world?		

Self-test exercise 4.4

Part One: Multiple-Choice Item

Instruction: Choose the best answer from the given alternatives

1. Which one is wrong about Pro-natalist policies?
 - A. human reproduction is desirable for societal reasons
 - B. restricting emigration and stimulating immigration
 - C. a lower birth rate could hasten economic development

D/ A& B
2. Which one does not belong to explicit population policies?
 - A. Provide free family planning
 - B. Restrict immigration
 - C. Compulsory secondary education

D/ all

Part two: True/ False Item

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

1. Anti-natalist policies seem to be ineffective in addressing the problems of population increase and mal-nutrition.
2. Urbanization and geographic distribution policies have significant effects on a nation's long-term growth

Answer Key to Self-test Exercise 4.4

Multiple Choice Item: 1. C 2. C

True/False Item: 1. False 2. True

UNIT SUMMARY

As a result of agrarian, industrial, and medical improvements, the 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.

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MODULE ONE GLOSSARY

Absolute age: refers to the actual age of rocks given in numerical values through the analysis of the spontaneous decay of radioactive isotopes.

Abiotic resources: are nonliving natural materials or components of the ecosystem

Accelerated population growth: The fast rise in the number of people on Earth

Actual use: this text implies the current total development, extraction, and utilization of water in Egypt and Ethiopia.

Afforestation: is the process of planting trees on lands that were not previously covered with forests.

Arbitration: 'is a procedure in which a dispute is submitted, by agreement of the parties, to one or more arbitrators who make a binding decision on the dispute. In choosing arbitration, the parties opt for a private dispute resolution procedure instead of going to court.

Big Bang: the theory says that the universe originated 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.

Continental drift: is the theory proposed by Alfred Wegener that says the Earth's continents were once joined together forming a big continent named Pangaea and then splitting by moving apart one from the other.

Cratons: are rocks occupying continental interiors and have been physically inactive for a long period (for hundreds of millions or longer years).

Climate classification: The classification of the world's climates into a system of connected regions, each of which is identified by a degree of climatic homogeneity

Continents: are larger landmasses created by the drifting of Pangaea. They are seven in number at present time.

Convention: This text refers to an agreement or treaty deliberated by countries regarding the sharing of shared water resources.

Deforestation: 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 purposes.

Daughter elements: are products created after parent elements undergo radioactive decay

Eons: are the largest time units in the geological timescale of the Earth.

Epoch: is the smallest subdivision of the geologic timescale.

Erosion: is the removal of Earth materials by moving water, wind, or glacial ice

Fossils: are the traces of plant or animal remains imprinted in sedimentary rocks

Forest: is the type of vegetation where trees make the dominant species.

Geological timescale: the timeframe (timetable) showing the possible age of the Earth and its associated life forms.

Geological eras: are the second largest time units (divisions) of the geological history of the Earth. They are subdivided into two or more periods.

Gondwanaland: is the Supercontinent (Paleocontinent) that consisted of landmasses that are now called Africa, Antarctica, Australia, India, and South America.

Half-life: the time taken to convert from the Parent element to the Daughter element.

Holocene: is 'the most recent time interval of warm, relatively stable climate that began with the retreat of major glaciers about 10,000 years ago'.

Ice-age: this is the time in the Earth's history when much of its surface was covered with immense continental ice sheets. The latest ice age is the Pleistocene Epoch.

Isotope: refers to the existence of an element in different forms

Land: is an area of the earth's surface...; the characteristics of which embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area...including those of the atmosphere, the soil, and underlying geology, the hydrology, the plant and animal populations...; and the results of past and present human activity, to the extent that these attributes exert a significant influence on present and future uses of the land by humans (FAO, 1985).

Land degradation: is the process in which land resources are biologically, physically, and chemically damaged and diminish the quality and quantity of the resources. In this case, the entire health of land resources is upsetting and declining.

Laurasia: is the Supercontinent (Paleocontinent) that once comprised the continents of Eurasia (Europe & Asia) and North America.

Oceans: are large water bodies created through the rifting of Pangaea synonymous with the occurrence of the Earth's continents. They are five in number at present times.

Mid-oceanic ridges: are under-water Mountains occurring in the middle parts of the Oceans through upwelling magma by sea-floor spreading processes.

Migration: the movement of a person or individuals to settle in another country, area, place of residence, etc

Natural Resources: these are useable materials that are occurring naturally in the environment.

Natural vegetation: is naturally growing plant association free of human interference and modification.

Negotiation: arbitration (strategic discussion) undertaken by conflicting groups to reach peaceful conflict settlements. It is often made to reach some form of compromise by discussing conflicting issues.

Non-renewable resources: are resources with finite supplies that reduce in size and quality with use. They are resources that they do not replace themselves after use or do not come back after use or would take a very long time to regenerate.

Oceanic trench: a narrow deep trough forming the deepest part of oceans. It is created by the conversion of two oceanic plates at the subduction zone parallel to the edge of a continent or island arc.

Pangaea: is the single Supercontinent that comprised all of the Earth and then rifted to form the present-day continental landmasses.

Parent element: is the unstable original element from which daughter elements are created through radioactive decay.

Period: refers to the third largest subdivision of the geologic time which is often subdivided into many epochs.

Plate: a mobile (or relatively rigid) large block/segment of the Earth's crust bounded by fault lines and often 'moving in response to internal forces'.

Radioactive decay: is the spontaneous breakdown of unstable parent elements into stable daughter elements

Relative age: refers to the dating of rocks or geologic events based on the sequence of their occurrences with the use of established rules and principles.

Rodinia: is the earliest continent (Earth) created from the solidification of cosmic rocks at about 4500 to 3900 Ma.

Sea-floor spreading: the expansion of the sea floor by heat generated from the mantle through convection currents. It results in the formation of new basaltic oceanic crusts (mid-oceanic-ridges) at the mid-oceanic locations.

Simplified Köppen: The Köppen climate classification classifies climates into five main groups, with categories within each group determined by seasonal patterns of temperature and precipitation.

Solar System: is the Sun's system that comprises the Sun, Planets, stars, and other satellites

The modified Köppen method is simple and effective in classifying both global and local climates. The first letter, which is always capitalized, stands for the main type of climate. The second, lower-case letter designates the location's precipitation patterns.

Political disadvantages: are challenges posed by unresponsive, volatile, and non-secured political conditions in a region or a country.

Potential use: this text implies the quantity of water (resource) that can be developed and used in the future.

Proximate causes: are those forces directly initiating the alteration of natural resources. They are secondary issues initiated by the primary (underlying) agents but immediately attack the resources (e.g. repeated tillage, burning vegetation; overgrazing, etc).

Reforestation: is the process of planting trees in deforested areas or on lands that were under forest cover previously but that have been converted to some other use in the latter periods.

Regional institutions: are geopolitical organizations established by nation-states to deal with the sustainable management and mutual use of shared watercourses.

Renewable resources: are resources that can regenerate themselves after use

Resource conflicts: are disputes arising over accessing, controlling, and using materials found in nature.

Resource degradation: is the alteration of environmental resources through the exhaustion of water, air, and soil, the desolation of ecosystems, and the disappearance of wildlife resources.

Resource management: refers to the proper use of material and human resources for the beneficial service of human beings. All resources including human labor, national finance, and technological and material resources are interactively put into use for human benefit and societal development.

Riparian countries: are countries crossed by and/or claiming ownership rights on watercourses crossing their territories.

Shared watercourses: are water bodies used and shared by two or more nations.

Soil conservation: is the process of controlling soil resources from damage by constructing structural measures (e.g. terraces, check-dams). It includes the restoration and maintenance of lost soil nutrients and properties through the addition of manure and compost.

Soil degradation: is the process where 'potential ecological functions of the soil are' damaged or demolished. It is the physical and chemical destruction of soil resources that diminishes the current and potential 'capacity of the soil to produce goods and services'.

Soil erosion: is the removal of soil particles by agents like running water, wind, and glaciers.

Sustainable land management: refers to the proper use of land resources (soils, water, animals & plants) with concurrently ensuring or preserving their long-term productive potential and environmental functions.

Transboundary waters: are watercourses crossing national boundaries and shared by two or more countries.

Watershed management: is the process of making resource development and land use practices (including soil and water conservation) 'to protect and improve the quality of the water and other natural resources within a watershed by managing the use of those land and water resources comprehensively'.

Water stress: is the situation where 'the water demand exceeds the available amount during a certain period or when poor quality restricts its use'. 'Water stress causes deterioration of freshwater resources in terms of quantity'.

SAMPLE ASSIGNMENT OF MODULE ONE

Dear learner; we hope you enjoyed reading the module and doing the self-test questions. Now you are at the stage of completion of Module One. But, before moving to module two, you are required to do 'sample Assignment of module one. Hence, please try to do it carefully and properly. General Direction: The assignment comprises short answer writing and project-based activity items. Hence, read each item carefully and answer/complete all the questions according to their respective instruction.

1. The earth's continents are dynamic and continuously moving. Thus, what causes the movement or drifting of the continents?
2. The geological timescale of the earth is divided into larger and smaller time units named Eons, Eras, Periods, and epochs. Then, list down the four geological eras of the Earth.
3. The earth is made up of seven continents and five oceans. Then, can you write the name of the continent you are living in and the name of the major oceans found adjacent to your continent?
4. Why are genetic schemes more difficult to implement and less successful overall even though they are scientifically more desirable?
5. Why is Koppen's scheme commonly used for classifying world climate although it has some major limitations?
6. What are the climatic factors not considered by Koppen's climatic classification system?
7. Explain the characteristic features of the dry climate.
8. Which of the climatic regions are influenced most by the migration of the intertropical convergence zone?
9. Which of the climatic regions is most influenced by upper air stability and subsidence?
10. Why does solar energy insolation on a given day strikes the surface at a decreasing angle from 90° to 0°?
11. How does the Earth-Sun relationship affect the spatial and temporal distribution of energy?
12. In what ways does insolation at the water or land surface contribute to the variation of temperature?
13. Compare and contrast the maritime effect and continentality by examining the climate of selected cities located along the same line of latitude
14. Natural resources are useable materials that can be divided into different groups based on their formation, use, renewability, mode of distribution, and stage of development. Then, based on renewability, natural resources are classified into two groups _____ and _____.
15. There are numerous resources provided by the environment for human use and ecosystem services. Nevertheless, most of them are at severe risk of degradation. Hence, can you identify the resources facing intense pressure of degradation? Explain why the resources you mentioned face severe degradation.
16. Natural resource degradation is instigated by direct and indirect causes. Then, list down the direct and indirect causes of resource degradation.
17. Transboundary Rivers are among the earth's resources providing service to humans. So, what are Transboundary Rivers? Please explain by giving examples from Eastern Africa. Natural resources appear to be sources of conflict among individuals, communities, and countries. Then, enumerate the causes and consequences of resource conflicts.

18. Reason out why the death rate declines before the birth rate in the second stage of the demographic transition model
19. 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? How could the rising population growth be a challenge for less developed countries? How could the growth of the working-age population create opportunities for economic growth in less developed countries?
20. Dear learners, please find out 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.
21. Please go to the Woreda statistical office and get population data, and try to characterize the population composition in Woreda. 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?



GEOGRAPHY

GRADE 11

DISTANCE LEARNING MATERIAL

MODULE

1



FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF EDUCATION

