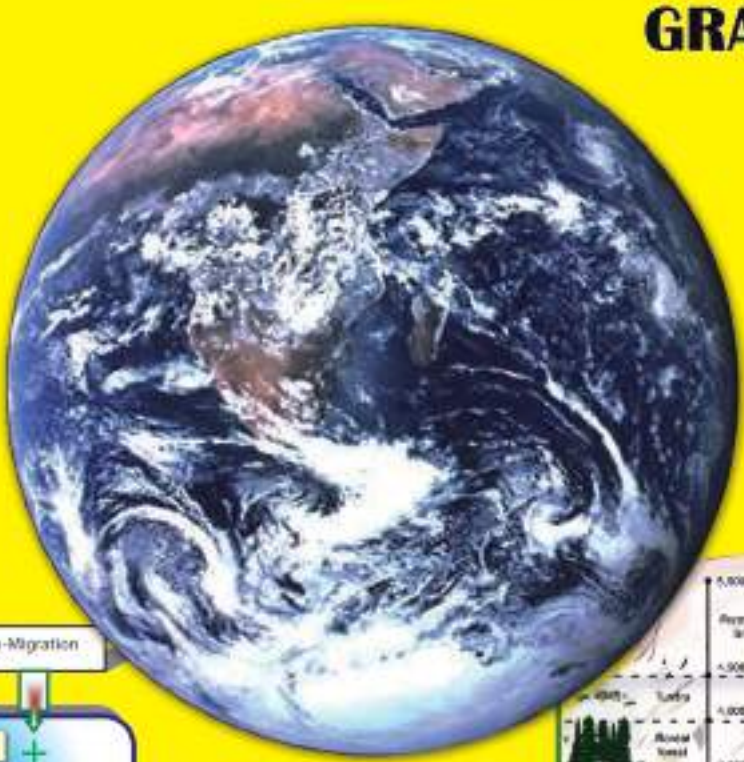
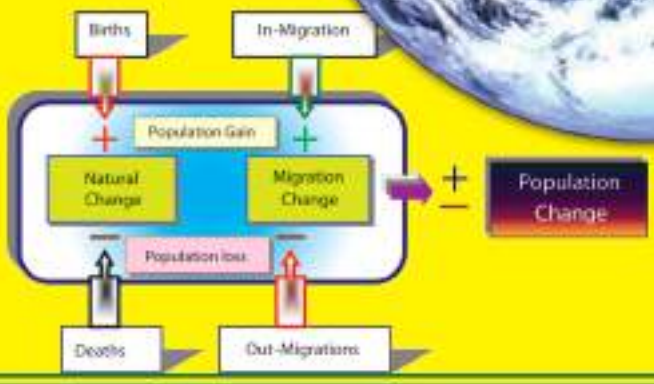
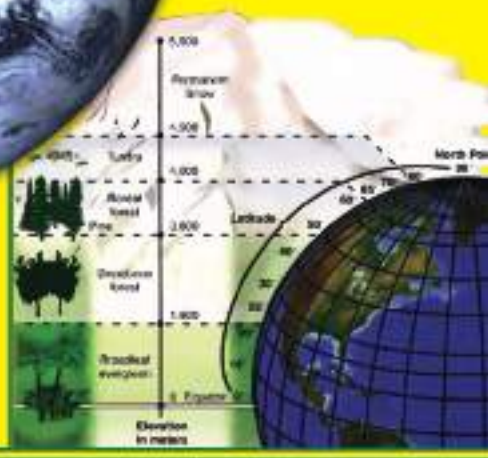
GEOGRAPHY

STUDENT TEXTBOOK
GRADE 10







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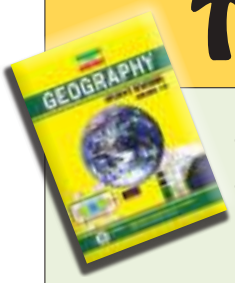

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STUDENT TEXTBOOK

GRADE 10

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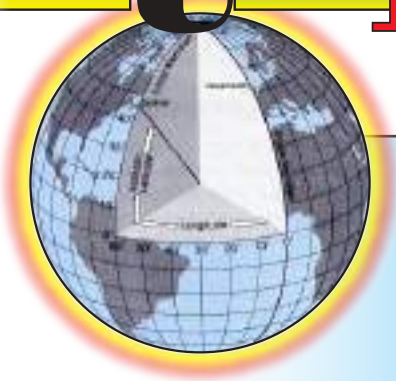

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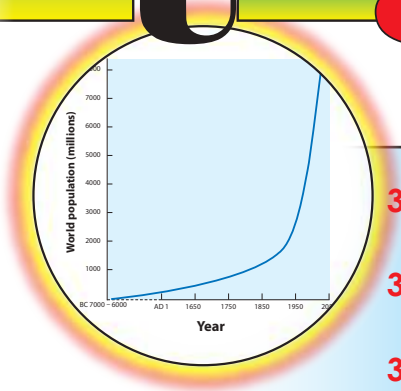

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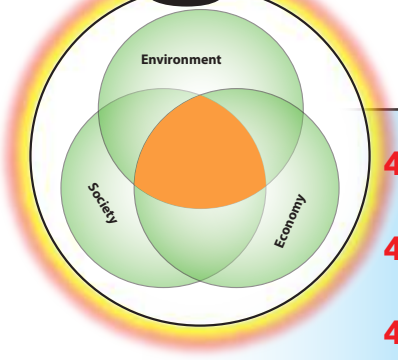


ECONOMIC SYSTEM AND DEVELOPMENT 181

Unit 1

MAP READING

Unit Outcome

After completing this unit, you will be able to:

- Develop the skill of identifying direction;
- Measure distances on a map;
- Practice map enlargement and reduction;
- Acquire basic skills of locating places and objects on maps using different methods;
- Understand the different ways of representing relief on maps.

Main Contents

INTRODUCTION

Maps are graphical representations of the earth's surface. They give a bird's eye-view of features of the earth's surface. As you learned in Grade 9, they are used for many purposes, and are especially effective devices for recording and communicating information about our environment. This unit focuses on maps that present physical features of the world. You will learn how to read maps that

- *Show where places and things are located*
- *Indicate heights and depths of features on the earth*

What do we need to know in order to use maps?

To use maps effectively, you must be able to read them easily. In other words, you must be map-'literate.' This unit will teach you many skills you need to read maps.

For example, you will learn how to use the following information that maps present:

- *Location*
- *Distance and direction between locations*
- *Relief (elevation), which indicates the third dimension on a two-dimensional plane*

As you learn to read maps, you will also learn more about *scale*. As you learned in Grade 9, scale is the ratio between distance or area on a map and the corresponding measurements on the surface of the earth.

You will also learn how to reduce and enlarge maps accurately.

1.1 DIRECTION ON MAPS

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

- Acquire the skill of finding direction on a map;
- Show direction of a given place on a map by means of compass direction and bearings;
- Explain the use of magnetic compass;
- Practice, how to find direction and bearings of points on maps.

Key Terms

- Cardinal points
- Bearing
- True north
- Grid north
- Intermidate direction
- Land mark

1.1.1 Identification of Direction

How do we identify direction? Do you know places in your locality that got their names from winds? Do you know some local expressions related to direction?

The science of direction goes back to human's earliest observations of nature, especially stars and winds. For example, imagine an Ethiopian farmer of those days waiting for a wind to blow off the fine chaff of grains during harvesting. The farmer looked in the direction from which he or she hoped the wind would come. When the wind came, the farmer gratefully named it after its source, like 'ye Dega Nefas', 'ye Kola Nefas' etc.

Sometimes place names are associated with winds. For example the provincial capital city of Gayent in southern Gonder is known as 'Nefas Mewicha' or Source of Wind.

Landmarks are important aids to people who are travelling in a new environment. A landmark is an object that is easily seen from a distance. We use landmarks to help us remember where things are, and we try to remember their appearance and locations in order to avoid getting lost.

When we travel in familiar surroundings, we often relate to landmarks without being aware that we are doing so. But when we are in a new or not well- known area, we make a conscious effort to notice them. We might also use tools such as maps and compasses to help us find our way around.

Many of us are familiar with the four *cardinal* points of the compass–North, East, South and West. There are *thirty-two* points of the compass, but only sixteen are used to describe direction. The points midway between the cardinal points are known as North-East (NE), South-East (SE), etc. The others, North-North-East (NNE), East-North-East (ENE), etc. relate to further sub-divisions.

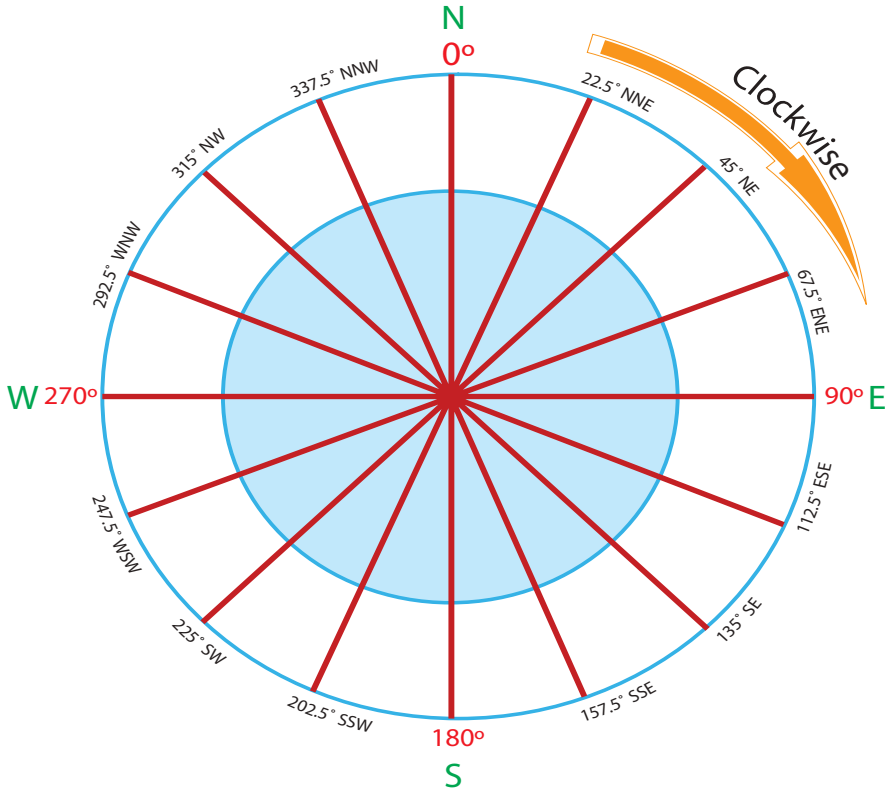


Figure 1.1: **Compass Points**

Compasses are marked with degrees as well as with the direction points we described earlier. As shown in Figure 1.1, the degrees start at the north from 0°, and increase in the clockwise direction. The direction points coincide with degree points. For example, 0° coincides with N, and 180° coincides with S. You can express direction more precisely in degrees than in direction points.

Activity 1.1

1. Draw a figure that shows comapss points and bearings respectively?
2. Identify the four cardinal points?
3. What is a landmark?
4. How many points do we have on a compass?
5. Which points of the compass coincide with 0°, 180°, 225° and 315°?

1.1.2 Measurement of Direction and Bearing

How do we measure direction and bearing?

In order to determine directions from one place to another out in the field or on a map, we must first select or identify one direction from which we can identify and measure other directions. This basic direction we call the cardinal direction.

The cardinal direction could be anyone but at present, internationally, we use North as the cardinal direction and measure all other bearings from this one.

When printing a map we usually arrange the cardinal direction so that it points to the top of the map. Before doing any measurements of directions, make sure that you know where true north is.

Directions from one point to another or the bearing of one point from another can be given using two different sets of units. The traditional system uses the cardinal compass points north, east, south, west and subdivisions of them. A modern, and more accurate, method gives the directions in degrees and fractions of degrees clockwise from north. The relationship between the two ways of giving directions is shown in Figure 1.1.

Figure 1.2 shows you how to determine directions and bearings on maps.

The procedure involves the following steps.

Example:

To find the direction from point A to point B on the map Figure 1.2.

1. Draw a line with a pencil joining points A and B on the map.
2. Through the point from which the bearing is required draw a pencil line parallel to true north as indicated by the meridians or the arrow indicating true north.
3. Using these two lines, set your protractor so that its centre is in point A and measure the angle between the true north line and the line A - B reading clock wise from north = 0^{o}.
4. State the bearing either in compass directions or degrees clockwise from north.

Answer:

i The direction from A to B is 135° or point B bears 135° from A.

ii Point B is roughly South East of A or point B bears South East from A.

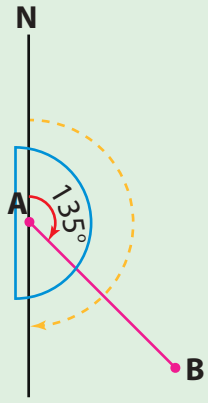


Figure 1.2: **The Measurement of directions**

The direction of a line from one point to another can be given in terms of compass direction. In Figure 1.3, for example, B lies north-east of A, and conversely A lies south-west of B.

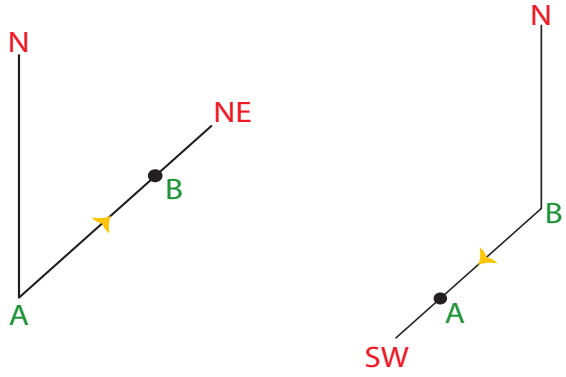


Figure 1.3: **Compass directions**

We may also describe wind direction in terms of compass direction. Look at Figure 1.4. B lies north-east of A. Therefore a wind blowing from B to A is called a north-east wind. Note carefully that wind direction is named after the direction from which the wind blows.

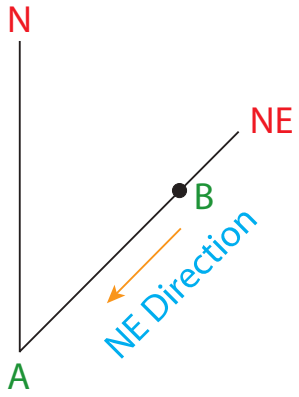
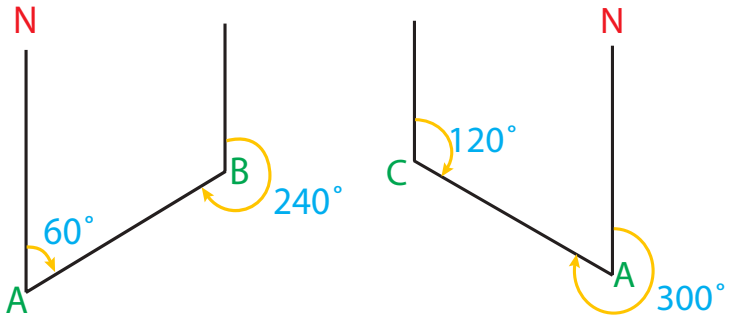


Figure 1.4: **Wind directions**

A direction indicated in degrees is called a **bearing**. The bearing of an object refers to its direction and a *clockwise* measurement in degrees from the zero line (0° or N), which is the north direction.



a) *Bearing of B from A is 60°*
Bearing of A from B is 240°

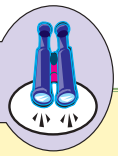
b) *Bearing of C from A is 300°*
Bearing of A from C is 120°

Figure 1.5: **Forward and back bearings**

In Figure 1.5, the bearing of B from A is 60°, which is angle NAB. The bearing of C from A is 300°, which is reflex angle NAC. Note that the bearing of C from A is not the smaller acute angle NAC, since bearings are always measured clockwise from north.

The directions of A from B and from C, respectively, are called back bearings. A back bearing is obtained by adding or subtracting 180° to or from a forward bearing.

Focus



1 If a forward bearing is less than 180°, add 180° to obtain the back bearing.
2 If a forward bearing is more than 180°, subtract 180° to obtain the back bearing.

Activity 1.2

Part I

Take an ordinary compass and try to obtain the bearing of an object in your school compound that is some distance away from you.

Hold the compass horizontally and face in the direction of the object. Turn the compass case gently until N (north) on the card lies under the north end of the needle. Now read the bearing of the object.

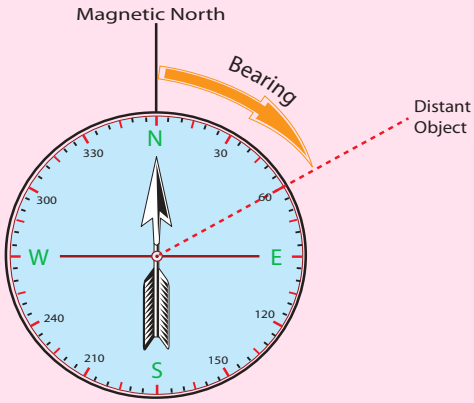


Figure 1.6: **Taking a bearing with an ordinary compass**

Part II

1 From where do we start measuring directions?
2 What would be the direction of wind blowing from A to B in Figure 1.3.
3 Which point of the compass is opposite in direction to each of the following?
E NW SSW ESE
4 What compass points do these bearings indicate?
a 135° d 67.5°
b 315° e 292.5°
c 112.5°

1.2 POSITION ON MAPS

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

- Define what the geographic grid system means;
- Demonstrate the position of a given place by means of geographic grid system;
- Define what the national grid system means;
- Show the position of places on maps by using national grid reference (four and six digit grid reference);
- Demonstrate the national grid origin of Ethiopia;
- Enlarge and reduce maps using a square or pantograph method;
- Compute the scale of enlarged or reduced map.

Key Terms

- Latitude
- Longitude
- Equator
- Meridians
- Parallels
- Grid origin
- Easting
- Northing
- Prime meridian
- Grid

How do we know the exact position of a place on the earth's surface?

The position of places on the earth's surface and upon maps can be given in a number of different ways. The most important are through the use of:

- *Latitude and longitude (international grid references)*
- *National Grid References (eastings and northings)*

1.2.1 Position by the Geographic Grid

Why do we prefer to use geographic grid system to locate the position of a place on a map?

This is a method by which the position of a place can be given accurately with the help of a grid composed of a network of lines known as parallels and the meridians.

If you study a globe carefully you will find that two sets of lines form a network on the surface of it. One set of lines run from the North pole to the South pole. These lines are known as *Merdians*.

The other set of lines are running around the globe parallel to the equator. They are known as *parallels*.

Using this grid we can now give the accurate position of any place on the earth's surface. The parallels give the position in degrees, minutes and seconds north or south of the equator. This is the Latitude of the place. The other set of lines, the meridians, give the position of the point in degrees, minutes and seconds to the east or west of the zero degree meridian. This is the longitude of the place.

Focus

On the huge earth-globe, a net of lines only 1° apart would be far too open a mesh (the spaces of a certain size in a network) for particular use. Some spaces would be as large as 100 kilometers each way. And in navigation the position of an airplane must be precise to the fraction of kilometers.

For that reason the degree is divided by 60. Each of these 60ths is a minute. (symbol:'). Not a clock-minute: "minute" also means "little". Even this little is not small enough for scientific locating. We must divide the degree a second time, and each of these divisions is a second. (Symbol:") A second is a 60th of a minute. That makes a network of so small a mesh with which to cover the earth that no place can slip through.

Study the following diagram in Figure 1.7

Latitude: The latitude of point p on the surface of the earth is equal to the angle between the radius through the point and equatorial plane. (i.e., the plane limited by the equator.)

Longitude: The longitude of point p on the surface of the earth is equal to the angle between the radius through the point and the 0° and 180° plane. (i.e., the plane limited by the zero meridian and the 180° meridian.)

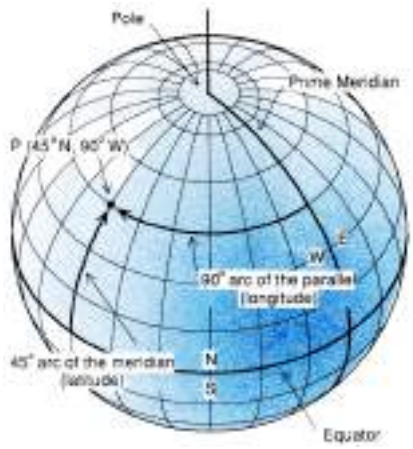


Figure 1.7: **The Complete Geographic Grid**

Therefore, the geographic grid of point P is 45°N, 90°W

Latitude and longitude sometimes are confused with two other terms: *parallel* and *Meridian*.

Parallel: an imaginary *line* joining all points with the same latitude.

Meridian: An imaginary *line* joining all points with the same longitude.

Note that the first set of terms (latitude and longitude) deal with angles the second set (Parallel and Meridians) with lines.

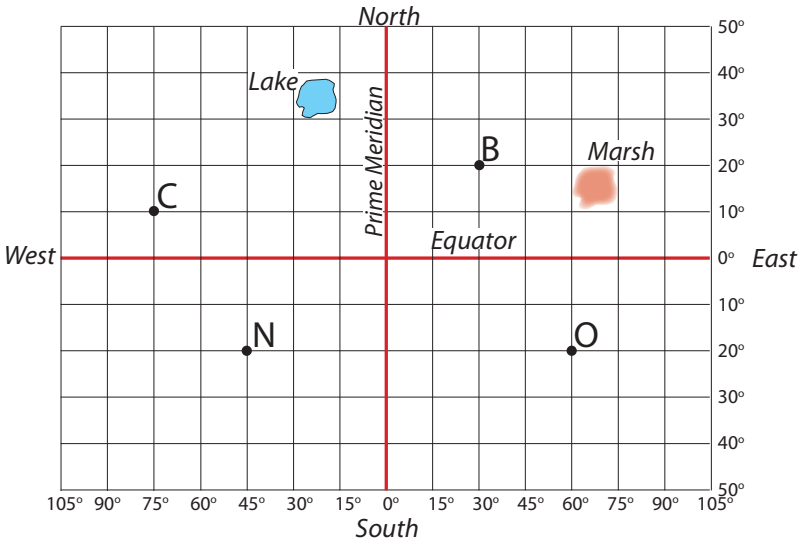


Figure 1.8: **Geographic Grid**

How do we locate the position of a place on a map?

Example 1:

Find the geographic grid of point B on Figure 1.8. Follow the following steps

1 Identify whether point B is North or South of Equator.

2 Read the latitudes of B, North of the equator i.e., 20°N.

3 Read the longitude of B, East of the prime meridian i.e., 30°E.

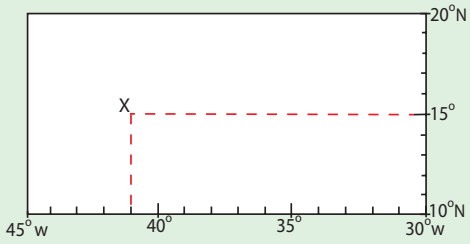
4 The complete geographic grid of point B is 20°N 30°E.

Example 2:

Find the geographic grid of point X, A and Y on Figure 1.8. In order to find the locations of X, A and Y, you have to follow the following procedures:

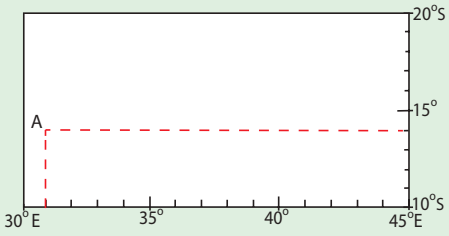
- *From Figure 1.8 identify the quadrants (boxes) where X, A and Y are found and divide the vertical and horizontal lines into 10 and 15 equal parts respectively with an interval of 1° (for X and Y points), and 1' for point Y.*
- *Identify whether X, A and Y are North or South of the equator.*
- *From point X, A and Y draw the perpendicular (using broken lines) to the two borders of the quadrants.*
- *Finally read the latitude and longitude from the vertical and horizontal borders accordingly.*

Points X (found North of the equator)



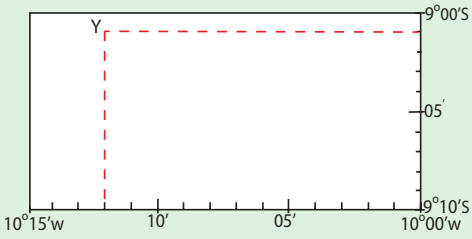
The location of point X is 15°N 41° W

Point A (found South of the equator)



The location of point A is 14°S 31° E

Point Y (found South of the equator)



The location of point Y is 9°01'S 10°12'W

Example 3:

Find the geographic grid of the Marsh area on Figure 1.8. Follow the following steps.

1 Identify whether the Marsh area is North or South of Equator.

2 Read the latitudinal extent of the Marsh area, North of the equator i.e. 10°N - 20°N.

3 Read the longitudinal extent of the Marsh area, East of the prime Meridian i.e., 60°E - 70°E.

4 The complete grid of the Marsh area is 10°N - 20°N and 60°E - 70°E.

Activity 1.3

1 Use a world map or atlas and identify places that are in the following positions:

a 9° 2'N 38°42'E

b 31° 47'N 35°10'E

c 40° 45'N 74°0'W

d 13° 15'N, 38°27'E

2 Based on Figure 1.9 find the geographic grid of the following points.

a O

b N

c C

d Lake

1.2.2 National Grid Reference System

What is a National Grid system? How can a national grid system help us to identify the position of a place on a map?

A National *grid* is a network of horizontal and vertical lines printed on the face of a map. The network of grid lines border squares. These squares may be divided into smaller and smaller squares.

The size of a map's grid squares depends on the scale of the map. For example, the sides of the squares on a large-scale or medium-scale national or regional

topographic map might represent 100 km, 10 km or 1 km. Each line is given a number. This numbering begins at a particular point. This point is the south-western corner of the whole grid for the country and it is called the grid origin or the National grid origin.

- *The grid origin of Ethiopia lies in south-west most corner, is at the point in SW Kenya where the 34°30'E meridian crosses the equator (0°). (See Figure 1.9).*
- *Such a grid system provides the position of any point, in kilometers and fractions of kilometers east and north of the grid origin.*
- *From the origin, all vertical lines are numbered eastwards. They are called eastings.*
- *All horizontal lines are numbered northwards. They are called northings.*
- *In contrast to meridians, eastings (verticals) do not indicate true north.*

Focus

The grid origin of Ethiopia is located at a point where the 34°30'E meridian and the equator cross each other.

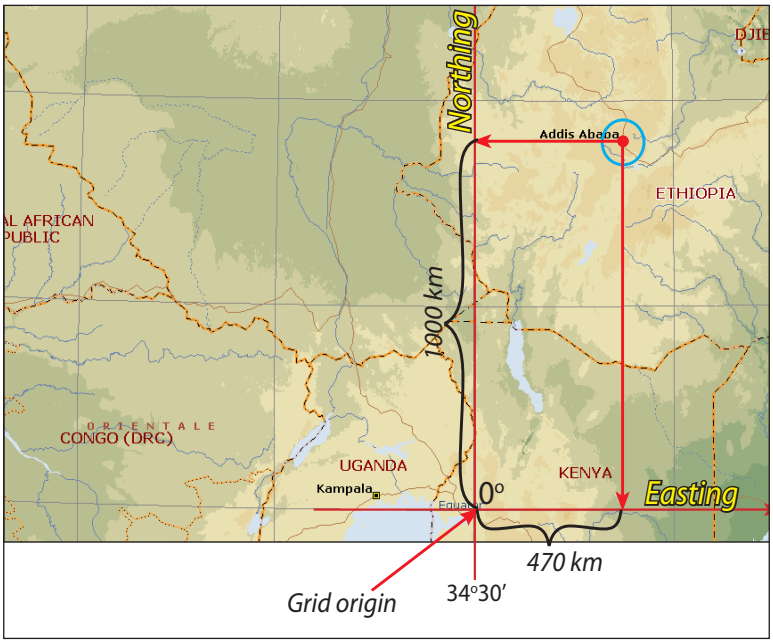


Figure 1.9: **The grid origin of Ethiopia**

The Four Digit Grid Reference

Find the four digit grid reference for point F using Figure 1.110.

Figure 1.11 shows part of Addis Ababa and its surroundings on a 1:250,000 topographic map.

Proceedings		Easting (Vertical)	Northing (Horizontal)
1	Locate the vertical grid line to the left of the point F and read the large number.	5	
2	Divide the square into ten equal divisions and pick the tenth of the point.	5	
3	Locate the horizontal grid line below the point F and read the large number.		2
4	Again divide the square into ten equal divisions and pick the tenth.		5
The grid references for point F:		55	25
The 4-digit grid reference for point F: 5525			

Activity 1.4

Find the 4-digit grid references for the farmlands marked B and N on the map (Figure 1.10).

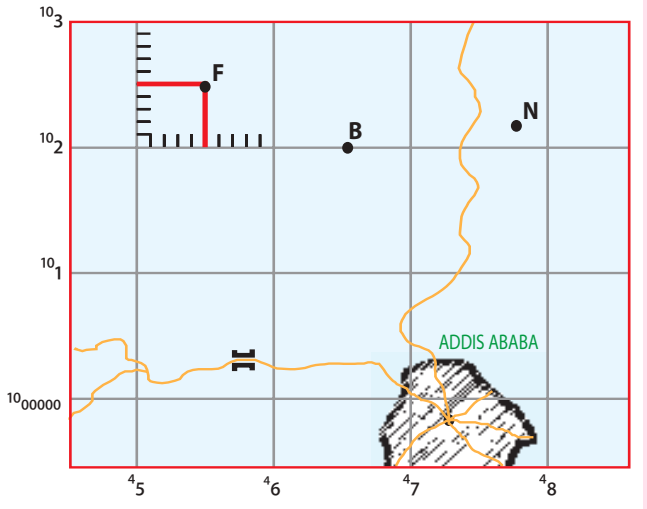


Figure 1.10: **4-Digit grid reference** Scale 1:250,000

The Six Digit Grid Reference

The six digit grid reference is appropriate on a map drawn in a larger scale so that a greater accuracy in position can be obtained.

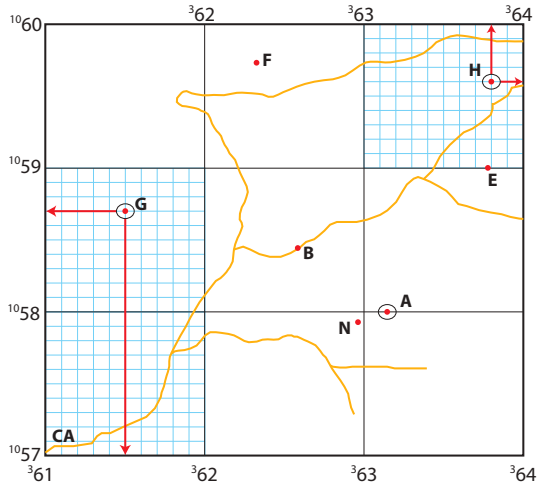


Figure 1.11: **6-Digit grid reference**

In Figure 1.11 the grid of a map drawn in the scale 1:20,000 is shown. Each square has a side of one kilometer.

Exercise: Find the national 6 digit grid reference for the points B, F and N on the map (Figure 1.11).

Procedure	Point B	Point F	Point N
1 All points are in the 100 km square marked CA.	CA	CA	CA
2 Locate vertical grid line nearest to the left of the point and write large digits only	62	62	62
3 Measure tenths from grid line to point	6	3	9
4 Locate horizontal grid line nearest below point and write large digits only	58	59	57
5 Measure tenths from grid line to point	5	8	9
6 Full National Grid Reference	CA 626584	CA 623598	CA 629579

Note that the three first digits in the grid reference always refer to the eastings and the three last digits to the northings. Find the eastings reference and the northings

reference in the margin of the map. Then draw perpendiculars from these points as shown on Figure 1.11. Where the two lines cross one another you will have the point you are looking for.

The accuracy obtained with six figure grid reference as far as position is concerned is to the nearest 100 meters. This accuracy is made possible by the larger scale of the map. The actual difference between a four figure and six figure grid reference is therefore one of accuracy. Four figure grid reference should therefore be used only in connection with maps that have a scale so small that it is impossible to get a greater accuracy than to the nearest kilometer.

Remember always that a grid reference NEVER can be used to indicate an area. The reference always stands for a POINT, that is the intersection of two lines.

Activity 1.5

1 Mark the following grid references on the map Figure 1.12

a 615587 b 638596

Mark a with G and b with H.

2 Mark points E and A and find their grid references respectively

3 Mark the following grid references on map Figure 1.12

a 615577 c 630590

b 622594 d 611599

Mark a with T, b with K,

c with Z and d with L

N.B: Do not write or mark on the book. Trace the map on a separate sheet of paper and practice to find the position of point T, K, Z and C. Follow the procedure indicated in to the previous page.

1.3 MAP ENLARGEMENT AND REDUCTION

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

- develop the skill to enlarge and reduce a map using a square method and pantograph;
- compute the scale of an enlarged or reduced map;

- appreciate the need for map enlargement and reduction in certain circumstances.

Key Terms

- Enlargement
- Reduction
- Scale
- Square method
- Pantograph

Why do we enlarge a map?

We enlarge and reduce maps for different reasons.

Enlargement: We enlarge a map when we need to show more details (features) about the area it shows. Often, enlarged maps are produced in order to support detailed study of the area that the map presents.

We enlarge a map by enlarging its scale. The size of the paper on which the new map is printed increases in proportion to the new scale.

Example:

- *city maps are often enlarged maps.*
- *An enlarged map would be quite helpful for demonstrating the required area for a class room.*

Why do we reduce a map?

Reduction: We reduce maps when we need to be selective and to generalize the information that the map presents.

When the scale of the map decreases, the size of the map also decreases accordingly.

When you enlarge or reduce a map, consider these principles: if a map is to be enlarged x times, the new map will be x times the scale of the old map. If you reduce a map by 1/x, the scale of the new map will be 1/x times the scale of the old map.

Example 1

If we enlarge a map with a scale 1:200,000 two times, what will be the scale of the new map?

Solution:

Previous scale = 1: 200,000 or 1/200,000

The scale of the new map = 1/200,000 × 2 = 1/100,000 or 1:100,000

The scale of the new map (1:100, 000) is two times larger than the scale of the old map, (1: 200,000)

Example 2

If we reduce a map with a scale 1:50,000 by half, what will be the scale of the new map?

Solution:

Previous scale = 1:50,000

The scale of the new map = 1/50,000 × 1/2 = 1/100,000 or 1:100,000

The scale of the new map (1:100,000) is half of the scale of the old map (1:50,000).

The amount of increase or reduction of scale can be obtained by applying the following formulae:

1 $$\text{Amount of enlargement} = \frac{\text{The denominator of the small scale}}{\text{The denominator of the large scale}}$$

Example 3

A map at 1: 200,000 is to be enlarged to a map at 1:100,000. By how many times is the scale increased?

Amount of increase = 200,000/100,000 = 2 times

2 $$\text{The amount of reduction} = \frac{\text{Denominator of large scale}}{\text{Denominator of small scale}}$$

Example 4

A map with a scale of 1: 50,000 is reduced to 1:1000,000. How many times is the scale reduced?

Amount of reduction = 50,000/100,000 = 1/2 times

Activity 1.6

Answer the following questions.

1 Enlarge the following map scales as indicated:
   a 1: 50,000 (twice)
   b 1: 100,000 (4 times)
   c 1: 50,000,000 (5 times)
   d 1: 10,000,000 (4 times)
2 A map with a scale of 1:400,000 is enlarged to 1: 100,000. How many times is the scale increased?
3 Reduce the following map scales as indicated:
   a 1: 250,000 (2 times)
   b 1: 500,000 (5 times)
   c 1: 800,000 (4 times)
4 A map with a scale of 1:25,000 is reduced to 1:75,000. How many times is the scale reduced?

Methods of Map Enlargement and Reduction

How do we enlarge and reduce maps?

A Square method (free-hand)

B Pantograph method (uses an instrument)

Figure 1.13 is a map of a lake's area drawn to a scale of 1: 20,000,000.

How do we redraw this map to a scale of 1:10,000,000? In other words, how do we double the original scale?

A *Using Square Method*

On the basis of the given scale, you can enlarge or reduce the map by drawing as many squares as needed. The squares should cover the whole map.

For illustration refer to Figure 1.13.

Exercise: Increase the map scale 1:20,000,000 twice.

The steps involved are the following:

1 Find the size of the original map through measurement and make up your mind about how big you want your new map to be. This will give you the scale of the new map that you want to construct.

2 Draw the frame of your map to be in such a way that the sides are double as long as the sides of the original map.

3 Cover the original map with a grid of half centimetre by half centimetre squares.

4 Cover your map under construction with a similar grid now using one centimetre by one centimeter squares.

5 In order to cross check the squares on both maps, write numbers on the horizontal margin and alphabets on the vertical margin.

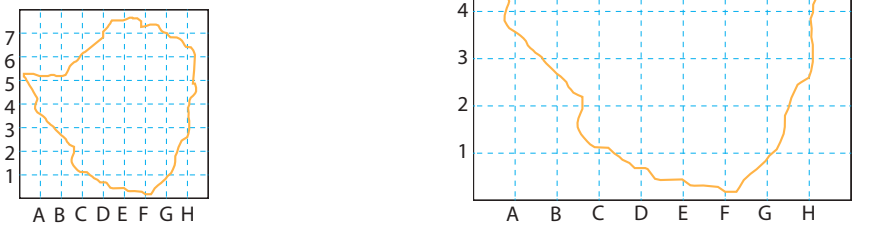
6 Using the grid as a guide, trace the major features that you want to show on your enlarged map carefully in pencil.

7 Finalize your map using color pencils for the different features that you wanted to show, then remove the grid lines from both maps.

This method of enlargement, or reduction, of scale can be used for any kind of drawing and the result is relatively accurate if your measurements and tracings are carefully done.

Note: that the scale for your map is arrived at multiplying the old scale with the number of times that you have increased the original scale or diving the original scale with the number of times that you have decreased that scale.

Note also that when you reduce the scale you usually have to leave out certain details present on the original map.



Scale 1: 20,000,000 Scale 1: 10,000,000

a) orginal b) New

Figure 1.12: **Lake area**

Activity 1.7

1 Following the above method, enlarge the map of Ethiopia (Figure 1.13) Convert the current scale of 1: 20,000,000 into a new scale of 1:10,000,000 in order to create the new map.

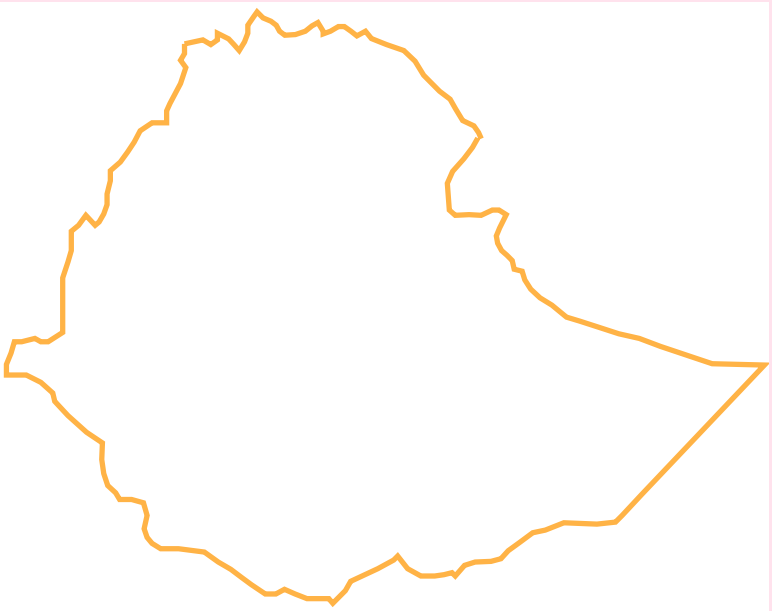


Figure 1.13: **Map of Ethiopia**

Scale 1:20,000,000

2 Following the above procedure, reduce the map in Figure 1.13 by half of its size.

NB: Do not write or mark on the book. Trace the map on a separate sheet of paper.

B *Using the Pantograph Method*

A pantograph is a mechanical device used for reproducing maps, drawings etc. at the same or different scales. Maps that are enlarged or reduced using the pantograph are more accurate than ones done using the square method.

A pantograph is made of four pieces of wood, metal or plastic.

A pantograph has three operational points: the pivot, (noted as marked in red) the tracer and the pencil holder (marked in blue). The pivot is fixed on the table.

'Panto' means 'all' or 'every'. The device works in combination of all its parts.

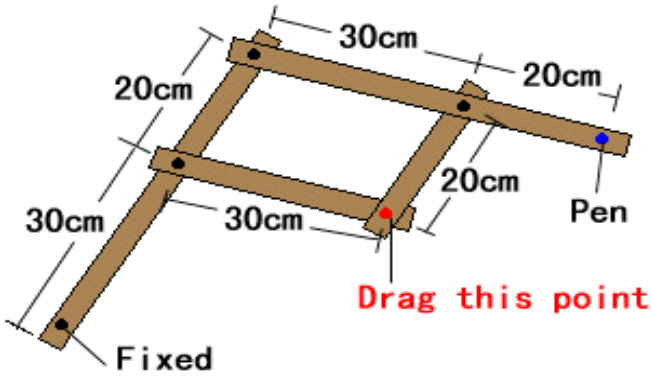


Figure 1.14: **Pantograph**
It is a drawing instrument to magnify figures. Tracing the original figure by moving the red point, we can automatically obtain the magnified figure with the pen at the blue point.

Procedure:

1 Arrange the pantograph either to do enlargement or reduction. the arrangement in Figure 1.14 is for enlargement.

2 Fix the map to be enlarged (original) at red point (traces). Fix a clean paper at the location of the "Pen".

3 Then, when you start tracing on the original map with a tracer at the red point, the pen starts drawing on the paper at the location of the "pen". The drawing will appear larger.

4 To do reduction you have to reverse the position of the tracer and the pen. The original map should be fixed at the position of the "Pen" and the new map to be drawn at the position of red point.

1.4 RELIEF ON MAPS

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

- describe methods of showing relief on maps;
- define the term contour lines;
- discuss the properties of contour lines;
- identify the different ways of showing specific height on a contour map;
- compute the altitude of points between contour lines;
- explain the term slope;
- demonstrate types of slope;
- compute gradients of slope;

- describe the term gradient of slope;
- express gradient in different ways;
- calculate field distance.

Key Terms

- Relief
- Hachures
- Physiographic diagram
- Hill shading
- Benchmark
- Trigonometric point
- Altitude
- Layer coloring
- Form lines
- Contours
- Spot heights
- Slope
- Gradient
- Field distance

What do you understand by the term relief?

What kinds of landforms are found in your locality?

Relief refers to the difference in altitude between the highest and lowest points in an area or surface structure of any part of the earth. It relates to land features like plains, hills, plateaus, valleys, ridges, etc. These relief features have three dimensions (length, breadth and height), but a map on which they are represented has only two dimensions, (length and breadth).

1.4.1 Methods of Showing Relief on a Map

How can we represent relief on maps?

In order to read relief features from maps, you should first know how map -makers represent the uneven surface of the earth on a plane sheet of paper, i.e., on a map.

There are different ways of showing relief on maps. These include:

- *Physiographic diagrams*
- *Hachures*
- *Layer coloring*
- *Hill shading*
- *Form lines*
- *Contour*

Traditional Methods

A *Physiographic Diagrams*

What is a physiographic diagram?

Early map makers used to represent relief features by diagrammatic pictures known as physiographic diagrams. They show three-dimensional pictures of landscapes as viewed from the side or oblique direction (see Figure 1.15).

This method of showing relief is simple and easy to understand. However, it has the following disadvantages:

- *It shows the side and oblique view of the landscape, unlike the modern relief map that gives you an overhead view of an area.*
- *Some geographic details of an area would be hidden from view behind the "backs" of the pictures of hills or mountains.*
- *Exact heights and slopes of the land forms are not indicated.*
- *It lacks accuracy because it is drawn without scale.*

Figure 1.15: **Physiographic diagram**

Activity 1.8

1 Carefully look at the physiographic drawings on Figure 1.15.

   a In which direction are the shadows of hills cast?

   b What is the direction of illumination (sunshine)?

2 With the help of a physiographic diagram, draw a sketch map representing the major landforms of your locality and evaluate its shortcomings with your friends in the class.

B *Hachures*

What are hachures?

Hachures are short disconnected lines that represent slopes. For example, Figure 1.16. They are drawn in the direction in which water flows. Originally they were used to represent mountains and valleys on simple sketch maps.

Basically, hachures show the steepness of slopes. When slopes are steep, hachures are put close together. For gentle slopes, the hachures are spaced wide apart. In addition, hachures representing steep slopes are shorter than those representing gentle slopes.

Can you describe the major relief features represented in Figure 1.16?

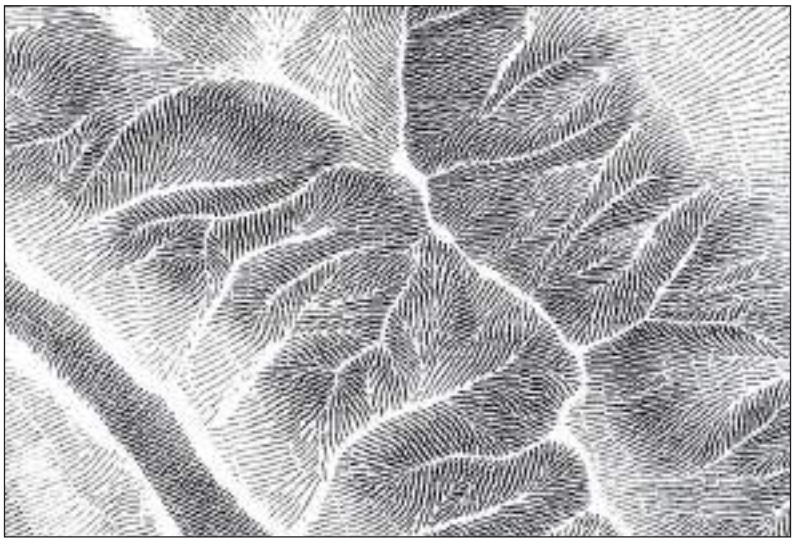


Figure 1.16: **Hachured map**

This approach has significant limitations, such as:

- *Flat areas are unshaded. Therefore, plateaus and plains can be confused.*
- *Hachures do not indicate height and exact gradients. They give only qualitative information.*
- *Hachures are laborious to draw and can be difficult to read and interpret.*

Nowadays, hachures are not used alone. Instead, they are used in combination with contour lines to show landforms like escarpments, depressions and craters. (contour lines are described in a later section of this unit).

Activity 1.9

Study Figure 1.16 and then briefly describe how hachures differ from and are superior to physiographic diagrams for representing relief.

C *Hill shading*

What is hill shading? What are some of the limitations of hill shading?

Hill shading is also known as oblique illumination. It is a method of showing relief on a map, assuming an oblique light that illuminates the landscape from the northwest corner of the map. Hence the northwest-facing slopes are shaded lighter than are the east-facing and south-facing slopes. The steeper the slope is, the darker it is shaded.

Hill shading offers a quick general impression of the land configuration that it represents. But still it has some limitations such as:

- *It does not give absolute altitude.*
- *It fails to indicate clearly whether the ground is sloping upward or downward.*
- *It fails to indicate whether the unshaded areas are low or high-level areas. Hence, plateaus and plains can be confused.*
- *Detailed map information can be obscured by shading.*

In general, hill shading is now used in combination with spot heights and contours to overcome some of its drawbacks.

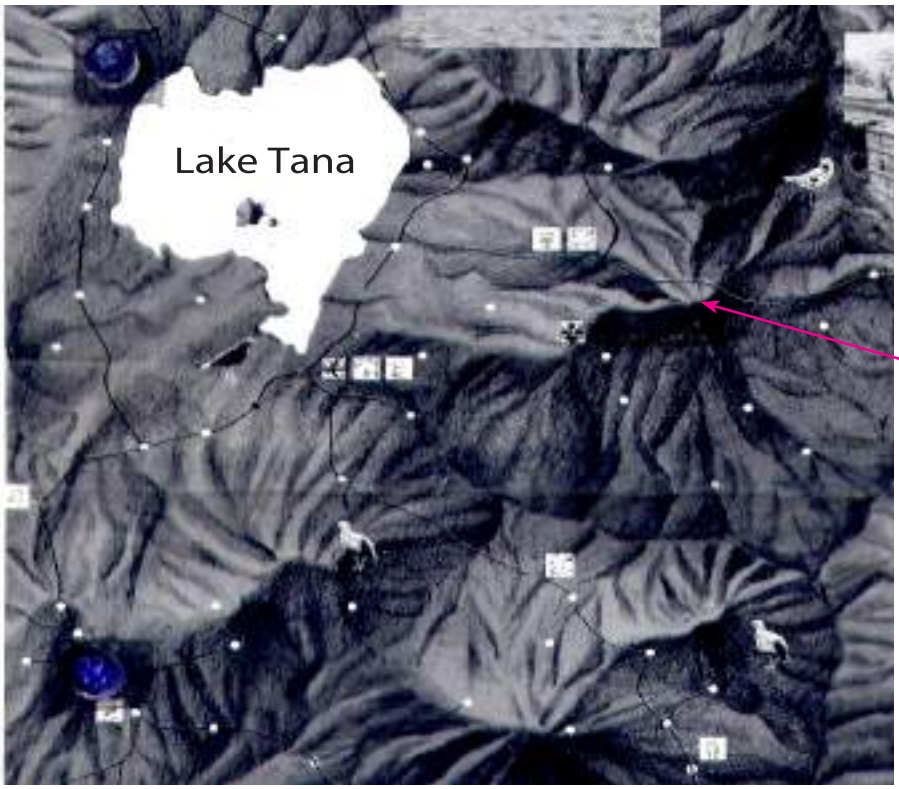


Figure 1.17: **Hill shading on a map of Northwestern Ethiopia**

Activity 1.10

Compare Figure 1.16 and Figure 1.17. What improvements do you see in Figure 1.17? Discuss your observations with your classmates or friends.

D *Layer Coloring (Layer Tinting)*

What is layer coloring?

It is a method of showing relief by using colors. The series of colors for showing different altitudes starts from sea level (see Figure 1.18).

Identify the types of colors used to represent the different elevation zones in Figure 1.18.

Elevation Zones	
	Above 3000 m
	2501 - 3000 m
	1001 - 2500 m
	501 - 1000 m
	0 - 500 m
	Water body

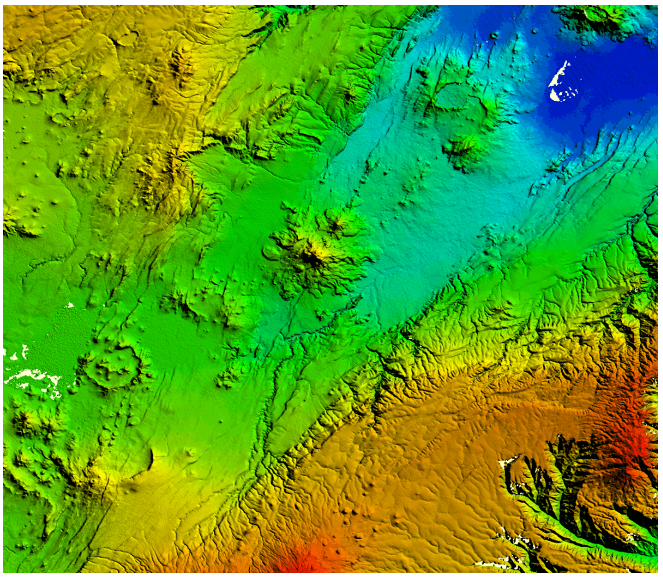


Figure 1.18: **Map with layer coloring**

Layer coloring has the following disadvantages:

- *Color shading does not indicate gradual changes in slopes.*
- *The edges of the areas of different colors can suggest nonexistent physical boundaries.*
- *Dark colors can obscure details in the areas that they overlie.*
- *Some colors can create false impressions in the map reader's mind. For example, green might suggest vegetation or a fertile area.*

Activity 1.11

By referring to the Ethiopian Atlas from your library, describe to the class how layer coloring is used to identify different altitudinal zones in Ethiopia. If possible try to cite some of the names of specific areas in each elevation zone.

E *Formlines*

What are formlines?

A formline is imaginary pecked or broken line joining points with the same approximate height on a map. Usually they are drawn on topographic maps to show where survey work is incomplete or poorly accomplished. Also, these lines are useful for showing sea depths.

What are the limitations of formlines?

Formlines have the following limitations:

- ⇨ *They are not drawn on a map at a fixed interval of altitude.*
- ⇨ *Although they represent the relief of an area, they provide little or no reference to sea level.*
- ⇨ *In many cases they are unnumbered.*
- ⇨ *They are usually drawn with broken lines.*

Activity 1.12

Discuss the following in your group and present the result of your discussion to the class.

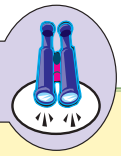
1. Briefly describe some of the common problems of traditional methods of showing relief on maps.
2. Some of the traditional methods are still being used in combination with contour lines in order to show some landforms. Mention some of their current uses.

Modern Methods

F *Contour Lines or Isohypses*

What are contour lines? How do contour lines differ from traditional methods of showing relief on maps?

Contour lines are the most common and accurate way of showing relief on modern maps. A shoreline is a good example of a contour line.

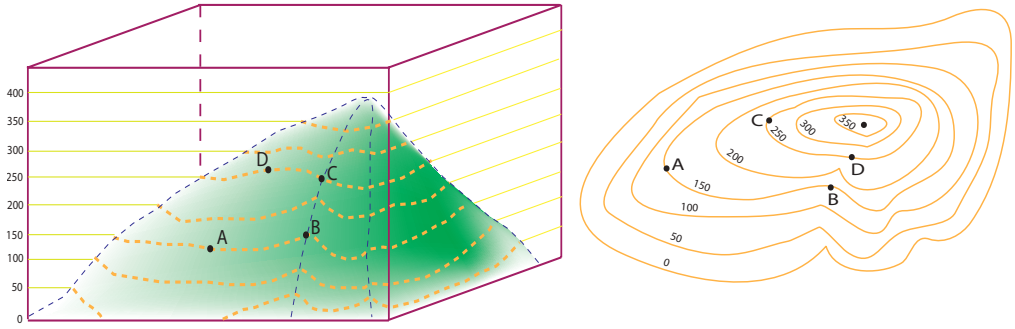


Focus

Contour lines are lines drawn on a map joining places of the same elevation above mean sea level. They give almost true altitudes. They also indicate different slopes and land forms.

How are contour lines drawn?

The drawing of contour lines is illustrated in the diagram below. Study it carefully.



a) *Side view of a hill* b) *Top view of the same hill*

Figure 1.19: **Sketches of a hill with contour lines**

As indicated in Figure 1.19, a contour line joins all points on the hill that are at the same height. For example, contour line 150 m passes through points A and B, while contour line 250 m runs through points C and D. All of the points on contour line 150 m are 150 m high and those on the 250 m line are all 250 m high.

To give clearer impressions of the relief on contour maps, contour lines are sometimes used in combination with hachures, hill-shading, layer-coloring and spot heights.

Properties of Contour Lines

What are the main properties of contour lines? Why are contour lines more accurate than the traditional methods of showing relief on maps?

General properties of contour lines.

Here are some important points about contour lines:

i Contour lines are imaginary lines used on a map to represent relief. Unlike the lines that represent rivers, boundaries or coast lines, contours do not really exist on the earth's surface. The only contour line that exists both on the map and in the field is the sea level.

Focus

Mean sea level (m.s.l.) is the average level of the sea, as calculated from a large number of observations taken at equal intervals of time. It is the most common standard level from which all heights are measured.

ii A set of contour lines is drawn at a fixed height interval. For example in the Figure 1.19, contour lines are drawn at 50-meter intervals. The difference in altitude between two successive contour lines is known as vertical interval (V. I.) or contour interval (C. I.). The V. I. helps us to find out the heights of unnumbered contour lines.

iii Contour lines cannot merge or cross one another on maps except at vertical cliffs, waterfalls or over hanging cliffs.

For example, two or more contour lines run together and then separate to represent the cliff shown in the figure below.

Figure 1.20: **Contour lines showing a cliff**

The cliff in the preceding diagram is a vertical mountain wall. It rises from 100 meters to 150 meters.

The crossing of contours occurs only in the case of an overhanging cliff. Usually contours representing a cave under an overhanging cliff are shown with pecked lines.

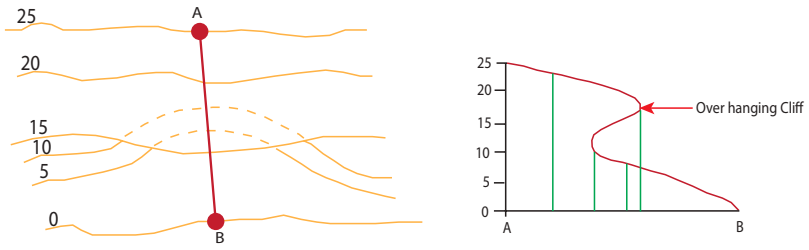


Figure 1.21: **An overhanging cliff**

iv Contour lines never branch. If you see branching lines on a map, they represent features such as rivers, roads, boundaries, etc.

v A contour line joins all points of the same altitude. For example, an altitude of 250 m will be on the 250 m contour line. The altitude of any point outside this line will be either greater or less than 250 meters (see Figure 1.22).

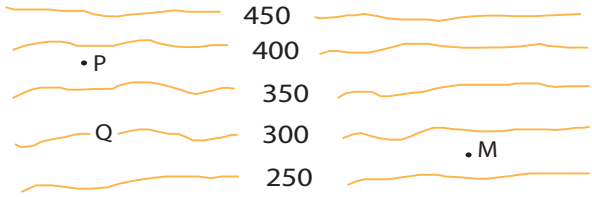


Figure 1.22: **Heights shown by contour lines**

What are the heights of points P, Q and M on the above figure?

vi Contour lines are always numbered in the direction towards which altitude increases. These numbers can be shown with or without breaking contour lines (see Figure 1.23).

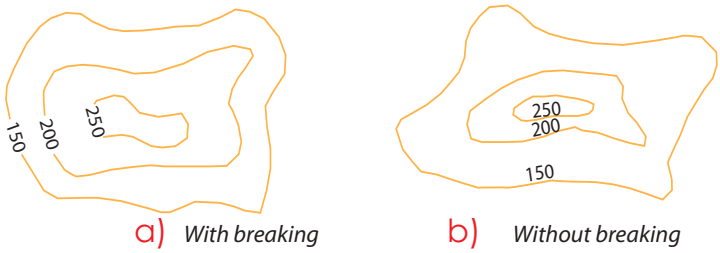


Figure 1.23: **Numbering of contours**

vii Contour lines indicate the nature of slopes. When contour lines are far apart, they show gentle slopes. But when contour lines are close together, they show steep slopes (See Figure 1.24).

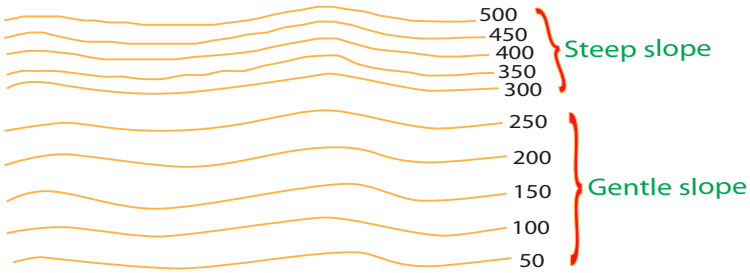


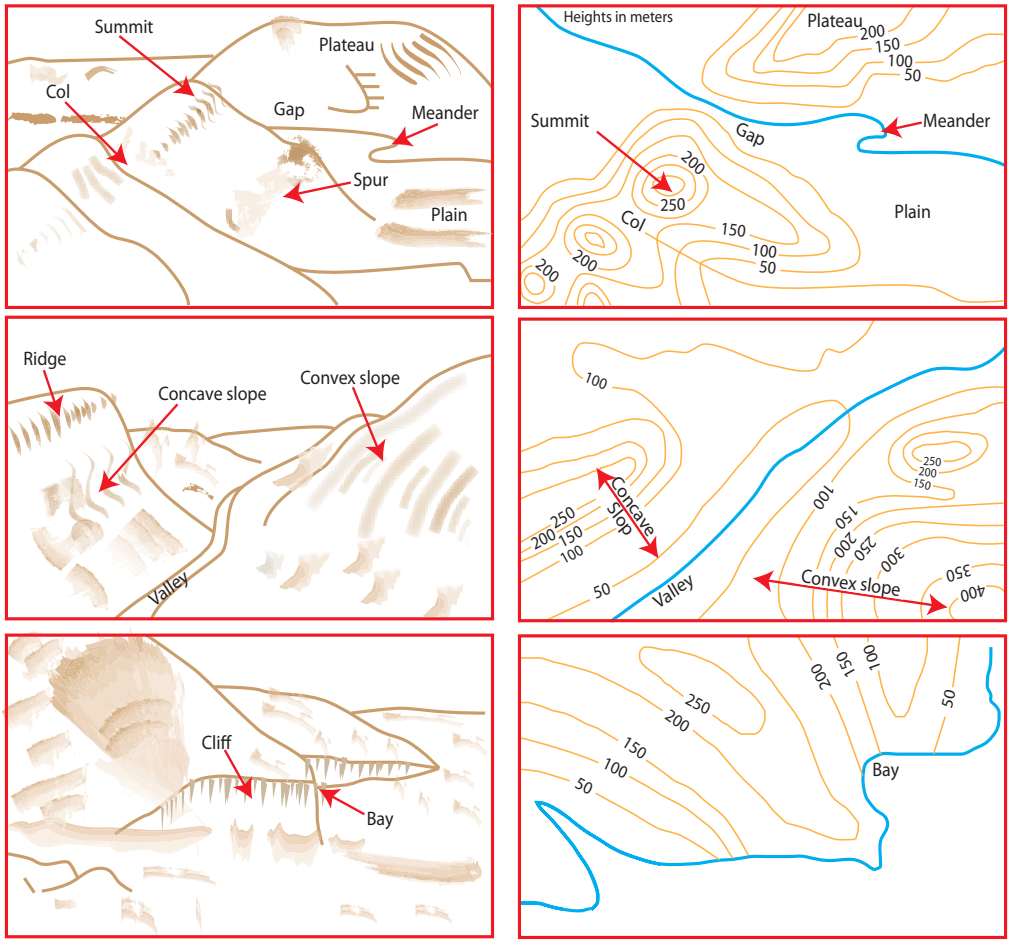
Figure 1.24: **Contour-line spacing indicating slope steepness**

viii Contour lines can be printed with different thicknesses on a map. This is especially helpful in mountainous areas where altitudes may vary considerably from summits to valley floors. In order to make the reading of contour maps easier, every fifth or tenth contour line is printed thicker than the rest. Such contour lines are called index contour lines, while the rest are called regular contour lines.

Figure 1.25: **Contour lines with a difference in thickness**

ix Contour lines can show different types of landforms, such as mountains, hills, plateaus, depressions, valleys, spurs, ridges, gorges, passes, plains, etc. Many of these relief features are readily recognized from the shapes of their contour lines.

Figure 1.26 gives pairs of representations of various land forms. Each pair has a diagrammatic view and a contour view. Study it carefully.



a) Diagrammatic views b) Contour views

Figure 1.26: **Landforms represented both diagrammaticaly and by contour lines**

Activity 1.13

1 By referring to relevant source materials, attempt to define or explain the relief features shown in Figure 1.26.

2 Trace Figure 1.27 on a separate sheet of paper and then follow these instructions:

- a Mark all roads using a red color.
- b Color all rivers and the lake blue.
- c Color areas below 1500 m green.
- d Color all areas between 1500 m and 2100 m yellow.
- e Color all areas between 2100 m and 2700 m light brown.
- f Color areas above 2700 m dark brown.
- g Find the V.I. of the map.
- h Where is the lowest and highest point of the area shown on the map?
  - i How high is Debre Tabor?
  - ii What about altitude of Bahir Dar?

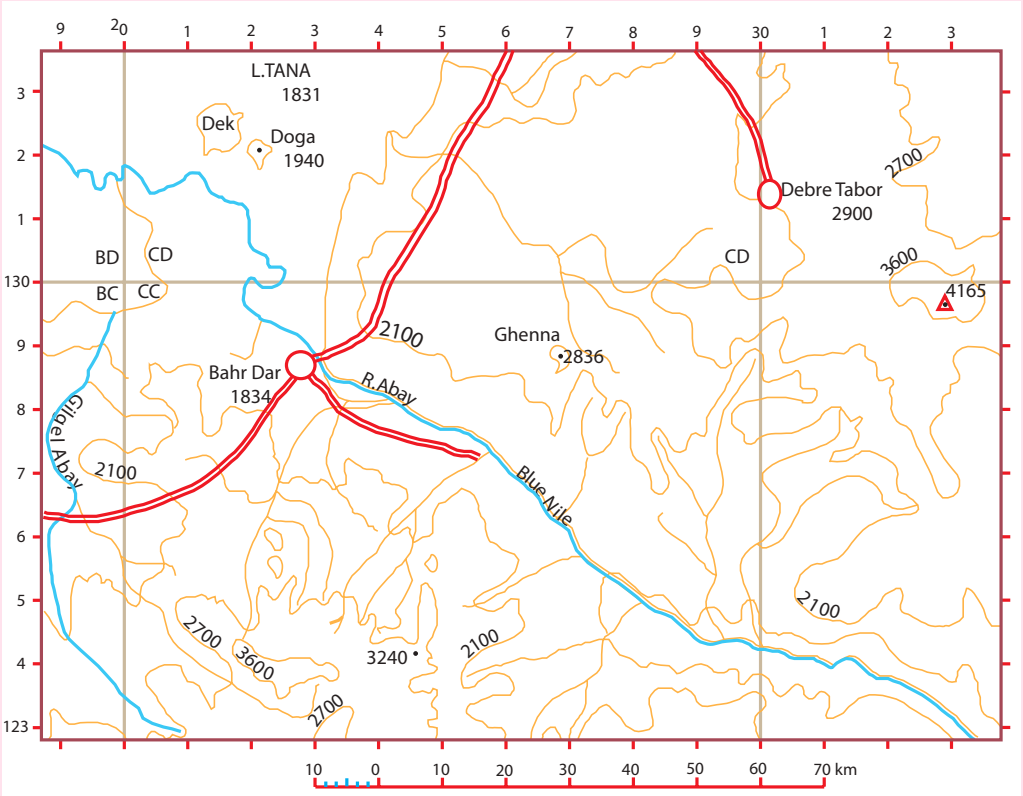


Figure 1.27: **Sample contour map**

G Different Methods of Showing Altitudes on Contour Maps

What are the shortcomings of contour lines?

How do you indicate the specific heights of hilltops, roads, railways, and towns?

Contour lines show altitude and relief on modern maps. However, they do not show the specific heights of individual features such as mountain peaks, hilltops, valley floors, towers, towns, roads or railways. Such heights are indicated on maps, using the following methods:

a Spot heights

- *They are marked on the map with a dot followed by an altitude number:*

Example:

  - *• 1940 meter (see Figure 1.27).*
- *They provide accurate altitudes for individual points, such as those along a road, on a mountain top, or between contour lines.*
- *Unlike contour lines, spot heights do not give a good visual impression of the general relief.*
- *They exist only on maps.*

b Trigonometrical points

- *They exist both on maps and in the field.*
- *They mostly mark features such as hilltops and mountain peaks.*
  - *On the ground, the relevant feature is permanently marked with a pillar (concrete).*
  - *On maps, they are shown with a small triangle enclosing a dot, followed by the exact altitude in meters (see Figure 1.27).*

Example:

The top of Mt. Ras Dashen can be shown as  4620 meters on a topographic map. Mt. Gunna is  4165 meters (see *Figure 1.27*)

c Benchmarks

- *They indicate precise heights along highways or railways.*
- *They are shown on stones, bricks or bronze plates on walls of buildings and other convenient places.*

⇨ *They are useful for road construction engineers and others who wish to know the precise altitude of a main transport network.*

Example:

• BM 1850 (where the point is marked on the ground, the height above mean sea level is 1850 meters).

d *Calculating Altitude:*

When the altitude of a point on a contour map is not shown by any of the above methods, it can be obtained by measurement and calculation, using the interpolation method. This can be done only if the given point is located between two contour lines. In order to find the altitude of point A in Figure 1.28, follow the procedures given below.

i Draw the shortest possible straight line that passes through point (A) and join the two contour lines adjacent to it.

ii Measure the length of this line: = 11 mm.

iii Measure the distance on the map between the lower and upper contours up to point (A). They are 6 mm and 5 mm respectively.

iv Find the vertical interval between the two contour lines: = 100 m.

v Then determine the altitude of the point using the following formula:

$$\text{Altitude (A)} = \text{LC} + \left(\frac{d_1 \times \text{VI}}{\text{D}}\right) \quad \text{or} \quad \text{HC} - \left(\frac{d_2 \times \text{VI}}{\text{D}}\right)$$

Where: d_1 is distance of point A from the lower contour,

d_2 is distance of point A from the upper contour,

D is distance between the upper and lower contours,

VI is vertical interval,

LC is the lower contour and,

HC is the higher contour.

$$\text{Altitude of point A} = 700 + \left(\frac{6 \times 100}{11}\right) = 754.55 \text{ meters or,}$$

$$\text{Altitude of point A} = 800 - \left(\frac{5 \times 100}{11}\right) = 754.55 \text{ meters}$$

Therefore, the altitude of point A is 754.55 meters.

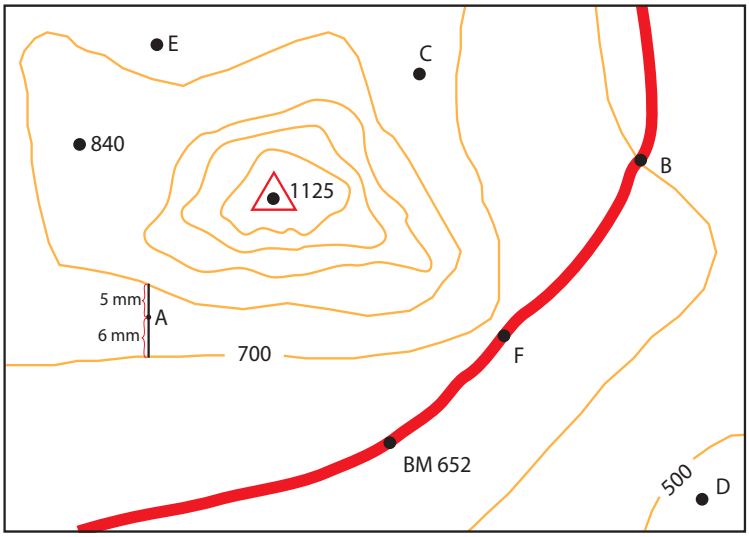


Figure 1.28: **Altitudes shown on a contour map in different ways** Scale 1:50, 000

Activity 1.14

Answer the following questions by referring Figure 1.28.

1. What are used to show altitudes on the map?
2. Calculate, using the interpolation method, the altitude of points F, B and C.
3. Where are the highest and lowest altitudes?
4. Measure the road distance between villages F and B.
5. Calculate the ground area of the map.
6. Draw a graphic scale for the map.

1.4.2 Slopes and Gradients

A *Slopes on Contour Maps*

What is slope? How can we determine the steepness of slopes on contour maps? What kind of relations exist between V.I. and slope?

Slope is the upward or downward inclination of a natural or artificial surface. It is a deviation of the surface from the horizontal.

On a map, steepness of a slope depends on:

- ⇨ *The distance between the contours drawn on the map. The closer the contours are, the steeper is the slope representation and vice versa (see Figure 1.24).*

➪ *The vertical interval (V.I.) between two successive contours. The bigger the V.I, the steeper is the slope representation and vice versa.*

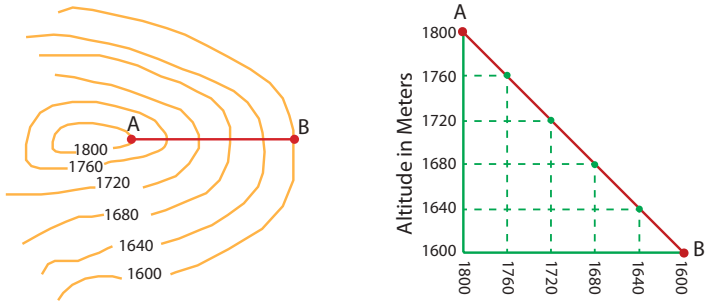
Types of Slopes

How many types of slope do you know? Mention some of them and describe how you can identify them from contour maps.

There are different types of slopes, which include:

i *Even slope*

An even slope has a constant gradient from the bottom to the top. Gradient is the degree or rate of a slope. You will learn more about gradient later in this unit. On a map of an even slope, the contour lines are evenly spaced throughout. For example, study the slope represented in Figure 1.29.

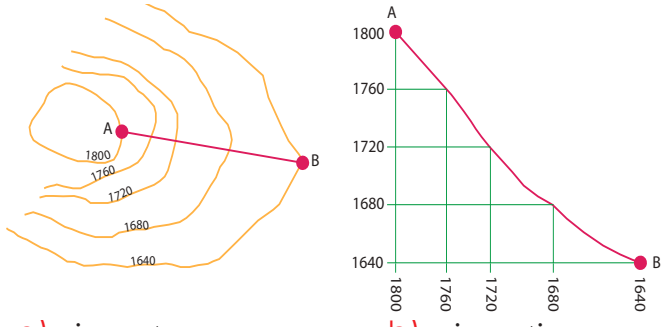


a) in contour map b) in section

Figure 1.29: **Even slope**

ii *Concave Slope*

In a concave slope; the contour lines are widely spaced at the base and are close together at the top. In other words, a concave slope has a steep gradient at the top. The gradient becomes gentler towards the bottom (see Figure 1.30).

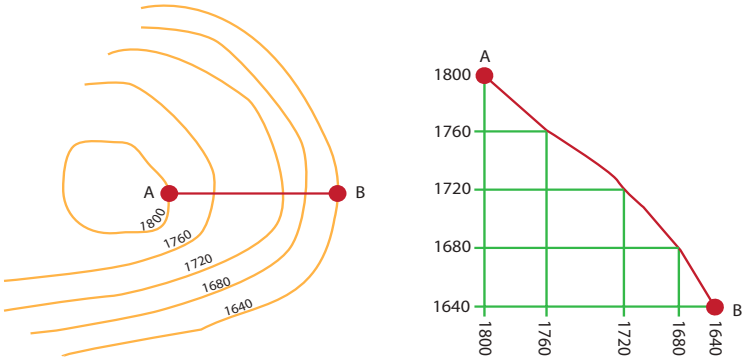


a) in contour map b) in section

Figure 1.30: **Concave slope**

iii *Convex Slope*

In a convex slope, the contour lines are close together at the base and widely spaced at the top. The slope has a steep gradient at the bottom that becomes gentler towards the top. (See Figure 1.31).

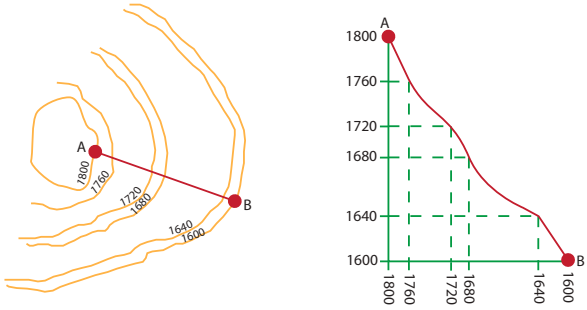


a) in contour map b) in section

Figure 1.31: **Convex slope**

iv *Terraced or Stepped Slope*

In a terraced or stepped slope, the contour lines are alternatively close together and far apart in a regular pattern. This means the gradient changes several times between the bottom and the top of the slope (see Figure 1.32).

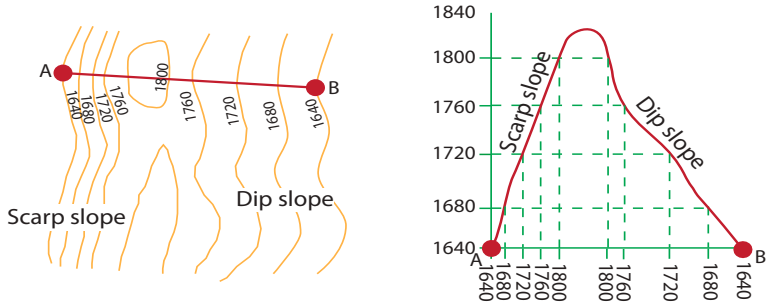


a) in contour map b) in section

Figure 1.32: **Terraced slope**

v *Escarpment*

An escarpment is the steep slope of a plateau, especially one where the plateau ends and the lowland starts. You can also identify other two more slopes on either side of a mountain ridge. One slope is steep and the other is gentle. The steep slope is called the scarp slope. The gentler slope is called the dip slope (see Figure 1.33).



a) in contour map b) in section

Figure 1.33: **Dip and scarp slopes**

Activity 1.15

Perform the following activity.

1 Draw the following relief features, representing them with contour lines only:
- a Cliff
- b Convex slope
- c Concave slope
- d Even slope
- e Stepped slope

2 Refer to Figure 1.34, and describe the types of slope between:
- a D and E
- b A and G
- c D and F

B *Gradient on Contour Maps*

What is gradient? What are the three common ways of expressing gradient?

How do you determine the rate of change of slope between two points?

Gradient (GR) is the degree or rate of change of slope or elevation between two points.

It is calculated using altitude difference (vertical distance) and map distance (horizontal distance) between two points. Both AD and MD must be in the same unit of measurement.

It can be expressed in any of these three different ways:

1 As a simple ratio: $GR = \frac{AD}{MD}$

2 As a percent: $GR = \frac{AD}{MD} \times 100$

3 In degrees: $GR = \frac{AD}{MD} \times 60^{o}$

Where: GR = gradient, AD = altitude difference,

MD = map distance.

Usually we express gradient as a percentage. This expression is the simplest to use, and it is relatively easy to calculate.

Activity 1.16

Calculate the following:

The distance on the map between Addis Ababa and Adama is about 10 cm with the scale of 1: 1,000,000 on a certain map of Ethiopia . The average elevations of the two are about 2400 and 1700 meters, respectively. Determine the gradient in ratio, in percent and in degree.

Here are some examples of the three methods:

a ***Ratio:*** This expression of gradient gives a relationship between the vertical and horizontal dimensions of the slope.

Example:

The gradient ratio 1:20 means there is 1 unit of rise of altitude for every 20 units of horizontal distance.

b ***Percent:*** We use the ratio expression of gradient to obtain the expression as a percent. Multiply the ratio by 100.

Example:

$\frac{1}{20} \times 100 = 5\%$. In other words, on average, there is a vertical rise of 5 units for every 100 units of horizontal distance.

c ***Degree:*** We also use the ratio expression to obtain the expression as a degree. Multiply the ratio by 60^{o}.

Example:

$\frac{1}{20} \times 60^{o} = 3^{o}$. In other words, on average, the slope between the two points is roughly 3^{o}.

Use the following Table 1.1 to see how individual gradients are given by the three different expressions:

Table 1.1: **Expressing gradients in three ways**

Type of expression			Type of gradient
Ratio	Percent	Degree (Approximate)	
1: 100	1%	0.6°	Gentle
1:60	1.7%	1°	Gentle
1:20	5%	3°	Moderately steep
1:10	10%	6°	Moderately steep
1:5	20%	12°	steep
1:2	50%	30°	Very steep

Example:

Find the gradient between A and F on the Figure 1.34.

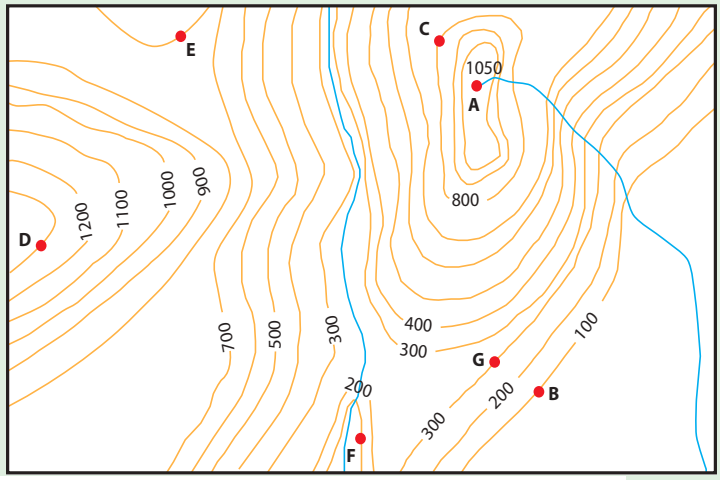


Figure 1.34: **A contour map for gradient calculation** Scale 1:50,000

Solution

Procedure:

i Find the difference in altitude between A and F.
That is, 1050 m – 100 m = 950 m = 0.95 km.

ii Measure the distance (on the map) between A and F with reference to the map scale.

Map scale = 1:50,000

The distance on the map from A to F = 5.5 cm which equal to

$$2.75 \text{ km} = \frac{5.5 \text{ cm} \times 50{,}000}{100{,}000}$$

iii Calculate the gradient between A and F.

$$\text{GR in ratio} = \frac{AD}{MD} = \frac{0.95 \text{ km}}{2.75 \text{ km}} = 1 : 2.9 \approx 1{:}3 \text{ approximately}$$

$$\text{GR in percent} = \frac{1}{3} \times 100 = 33.3\%$$

$$\text{GR in degree} = \frac{1}{3} \times 60^{o} = 20^{o}$$

Activity 1.17

1 Using the above map (Figure 1.34), calculate the gradient between A and D in ratio, in percent and in degree.

2 Change the following gradients given in ratios into percentages and degrees.

i 1:100 ii 1:25 iii 1:50

3 Change the following gradients given in percentages into ratios and degrees.

i 35% ii 75% iii 12%

1.4.3 Field Distances (FD)

Do you remember how to find or calculate the different types of distances on a map?

In any map exercise, you may need to find three different types of distances. Straight line distance, bending distance and field distance. Here we consider field distance.

What is field distance?

Field distance is the actual distance, which takes into account the effect of relief. It is the actual distance measured on the ground.

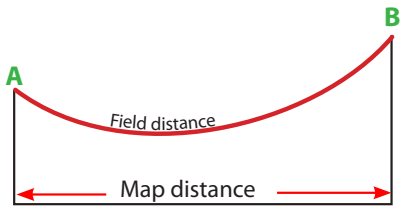


Figure 1.35: **Field distance and map distance**

To obtain field distance, a map user needs to know:

- *the map distance between the two points given*
- *the difference in altitude between the two points*
- *mathematically it can be expressed as:*

$$FD^2 = MD^2 + AD^2$$

The map distance between two points can be obtained from the map. However, the difference in altitudes between the same two points can be obtained from the contours on the map. The following example will illustrate this briefly.

Example:

a What is the actual distance in the field between point A and point B in the map shown below?

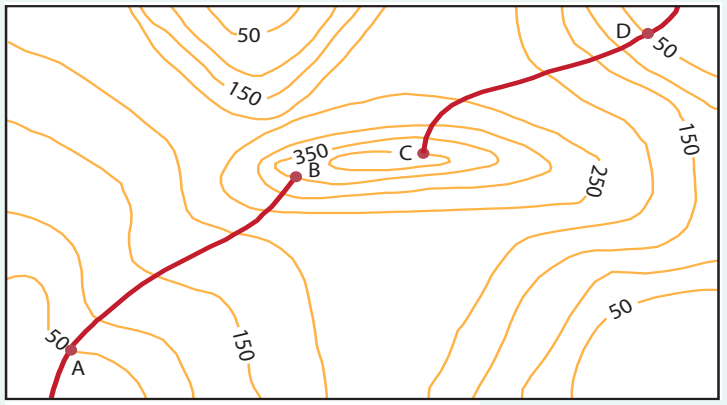


Figure 1.36: **Field distance between A and B on map**

Scale 1:25,000

Solution

Procedure:

- *Measure the distance on the map between the two points using a ruler. It is equal to 4 cm.*

➪ *The scale of the map = 1:25,000.*

b If 1 cm on the map represents 25,000 cm on the ground, how much is 4 cm on the ground?

Solution:

$$\text{Scale} = \frac{\text{Distance on the Map}}{\text{Ground distance (GD)}} \Rightarrow \frac{1}{25{,}000} = \frac{4\text{ cm}}{\text{GD}}$$

$$\text{GD} = 25{,}000 \times 4\text{ cm} = 100{,}000\text{ cm}$$

To convert the distance into kilometers

$$\Rightarrow \frac{100{,}000\text{ cm}}{100{,}000\text{ cm}} = 1\text{ km}$$

The difference in altitude between point A and point B can be obtained from the contour map.

The difference in altitude (AD) = (350 – 50) meters
= 300 meters = 0.3 kilometers

Then, FD can be calculated with the help of the Pythagorean theorem.

$$\therefore FD^2 = MD^2 + AD^2$$

$$\Rightarrow FD = \sqrt{(MD)^2 + (AD)^2} = \sqrt{(1km)^2 + (0.3km)^2} = \sqrt{1.09km^2} = 1.04km$$

Thus, the field distance = 1.04 km.

Activity 1.18

1 Find the field distance between C and D from the above map (Figure 1.36).

2 Compute the field distance for the pairs of places, based on the information given in the following table. Copy and complete the table.

Table 1.2:

Number	AD	Measured distance on the Map	Map scale	FD
1	6000 m	20 cm	1 cm to 1.5 km	?
2	1500 m	5 cm	1: 50,000	?

Unit Review

UNIT SUMMARY

- Direction is always measured clock wise starting from north. Direction can be expressed in compass points (N, E, S, W) or in degree (bearings)
- Position of a place can be described from maps by using latitude and longitude and national grid reference. The most accurate and international method used for locating places on maps is the geographic grid reference (latitude and longitude).
- Map enlargement and reduction can be done using a pantograph and graphic method. Patograph is an instrument which can be set-up for enlarging or reducing maps. Besides maps can be enlarged or reduced by using proportional grid squares. Note that whenever any map is enlarged or reduced, the scale of that map is also changed proportinally.
- Scale plays a significant role when we enlarge or reduce a map. We can perform these procedures accurately by using the grid-square method or the instrumental method.
- Relief refers to the ups and downs of the earth's surface. Since ancient times, map makers have used different methods to represent relief on maps. These days, the most common and accurate way of showing relief on modern maps is by contour lines.
- Contourlines are lines drawn on a map joining places of the same elevation above sea level. They give almost true altitude.
- Some of the properties of contour lines may include; they are imaginary lines and joining points of the same altitude on a map, they are drawn at a fixed V.I, they are never cross one another (except in the case of overhanging cliff), they are not branch, etc.
- Spot heights, trigonometrical points and benchmarks, are additinal methods, which are used to indicate specific heights that are found between consecutive contourlines, etc.
- Slope is a deviation of the land surface from the horizontal. The spacing between contour lines indicate the types of slopes (like even, concave, convex, terraced, etc) on contour maps.

- Gradient is the degree or rate of change of slope between two points. It can be expressed in the form of ratio, percent and degree.
- Field distance takes into account the ups and downs of the earth's surface. It can be obtained by combining the map distance (horizontal or straight line distance) between two points and the altitude difference between the same points.

REVIEW EXERCISE FOR UNIT 1

I ***True or False: Write True if the statement is correct and write False if it is incorrect.***

1 Grid North is the direction in which grid lines point towards the top of the map.

2 Usually direction is measured clockwise, starting from Magnetic North.

3 The grid-square method is the best method for enlarging or reducing a map without any errors.

4 The contour method uses pecked or broken lines to represent different types of landforms.

5 Field distance is usually calculated in reference to the formula for right-angle triangles.

II ***Matching: Match the items in column "A" with items in "B".***

A		B	
6	Magnetic variation	A	Position by geographic grid
7	Absolute location	B	Side and oblique view of the landscape
8	Four-digit grid reference	C	Magnetic declination
9	Physiographic diagram	D	Refers to the location of a point
10	Hill shading	E	Form line
		F	Oblique illumination

III ***Multiple Choices: Choose the correct answer from the given options.***

11 A method of finding the position of a place in relation to directions and distances from well-known places is:

A Position by the use of bearing and distance.
B Position by the use of geographical grid.
C Position by the use of place names.
D Position by national grid reference.

12 If the angular bearing of point A to point B is 135°, then the cardinal direction will be:

A Northwest
B Southwest
C Northeast
D Southeast

13 Which of the following is not true about contour lines?

A They are drawn at a fixed-height interval
B They can merge or cross one another in the case of overhanging cliffs or waterfalls.
C They are continuous lines
D They are always numbered in the direction towards which altitude decreases.

14 The one that exist both on maps and in the field is _____.

A Spot heights
B Trigonometrical points
C Benchmarks
D B and C

15 In _____ slopes, the contour lines are widely spaced at the base and are close together at the top.

A Even
B Concave
C Convex
D Terraced

IV ***Fill in the blank: Fill the following blanks with appropriate word(s).***

16 Direction can be expressed in either _____ or _____.

17 The steeper slope of an escarpment is known as _____.

18 An instrument used to enlarge or reduce a map is known as _____, _____.

19 A steep slope of a plateau which begins to descend gradually on the other side is _____.

V ***Short Answers: Give short answers to the following questions.***

20 What is the basic difference between a contour line and a formline?

21 Indicate three shortcoming of hachures.

22 Define the term "cliff".

23 Explain briefly the difference between spot heights and trigonometrical stations or points.

VI ***Things to Do: Answer the following questions by referring to*** *Figure 1.37.*

24 Find the approximate R.F. of the map _____.

25 Measure the direction (bearing) of:

i A from B ii B from D iii D from A

26 Between points C and E, calculate

a The field distance

b The gradient in;

i ratio ii percent iii degree

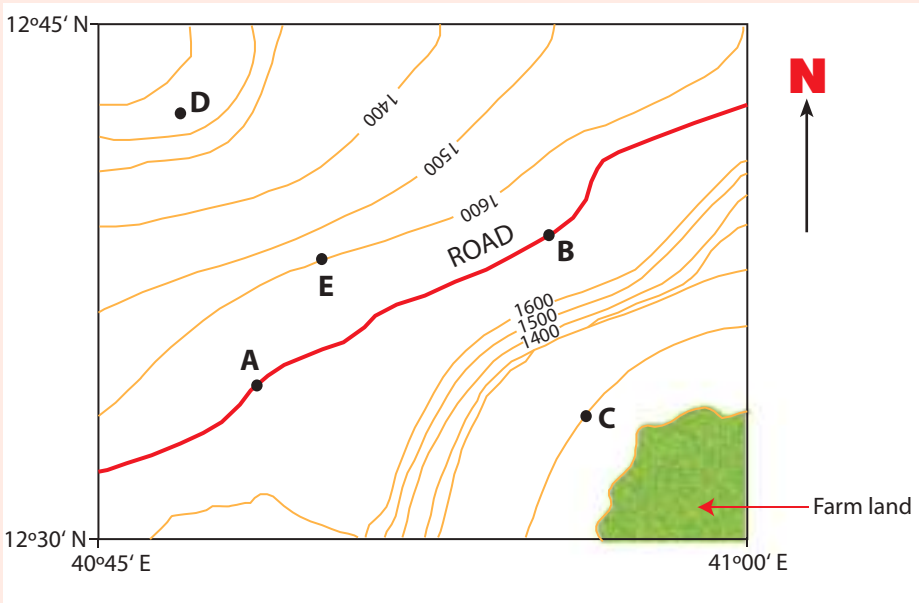


Figure 1.37: **Contour map of place 'x'**

27 Copy Figure 1.37 and then indicate a cliff, an escarpment, a convex slope, a terraced slope and an even slope.

Unit 2

THE PHYSICAL ENVIRONMENT OF THE WORLD AND ETHIOPIA

Unit Outcomes

After completing this unit, you will be able to:

- understand the origin of the earth and its tectonic movements.
- describe the movement, composition of the earth and components of its physical environment.
- discuss climate classification, change and climate of Ethiopia.
- Explain factors that affect the diversity of Fauna and Flora and soil in the ecosystem.

Main Contents

2.1 THE EARTH IN THE UNIVERSE

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

- discuss the concept of universe
- identify the position of the earth in the solar system
- explain the origin of the earth
- demonstrate the structure of the earth
- describe the geological time scale and major geological events
- realize the major geological events of Ethiopia
- describe the concept of continental drift theory.
- describe the characteristics of each type of rocks.
- demonstrate major rock distribution in Ethiopia
- state causes and impacts of soil degradation in Ethiopia.

Key Terms

- Universe
- Solar system
- Era
- Galaxy
- Geological time scale
- Plate tectonics
- Period
- Lithosphere
- Plate boundary
- Continental drift
- Plate

Start-up Activity

Discuss the following questions.

1. What do you understand about the universe and solar system?
2. What is the solar system?
3. In which galaxy is the earth located?

The universe is the totality of space and cosmos, in which everything is found. All heavenly bodies, including all stars, together with the sun, comets, meteors, planets and their satellites are found in the very vast space called the **universe**.

A **galaxy** is a large group of stars. The universe contains many galaxies. The Milky Way is our galaxy. Within the Milky Way is our solar system. A **solar system,** is a smaller group of heavenly bodies, which includes the sun at the center and the nine planets and their satellites and asteroids.

Activity 2.1

Fill in the blank spaces with the appropriate words or phrases.

1 The star from which we get light and heat is the _____.

2 The galaxy, of which our solar system is part, is _____.

2.1.1 The Origin and Structure of the Earth

The Origin of the Earth

Why is earth special?

The earth's origin is related to the process of formation of the solar system. Some scientists believe that the solar system, of which the earth is part, formed from a large flammable of hot whirling gases. The flammable was loosely packed gases, largely hydrogen and helium, and dust particles about 4.6 billion years before the present. The gases and dust particles gradually drew together because of gravitational pull and formed a thin disc. The disc, in due course, split into rings and kept spinning. The spinning rings at the center formed the sun, while the outer rings resulted in the formation of the nine planets, including the earth.

The earth is one of the nine planets that, along with the others, revolves around the sun. The orderly nature of our solar systems leads most researchers to conclude that the earth and the other planets formed at the same time and from the same material as the sun.

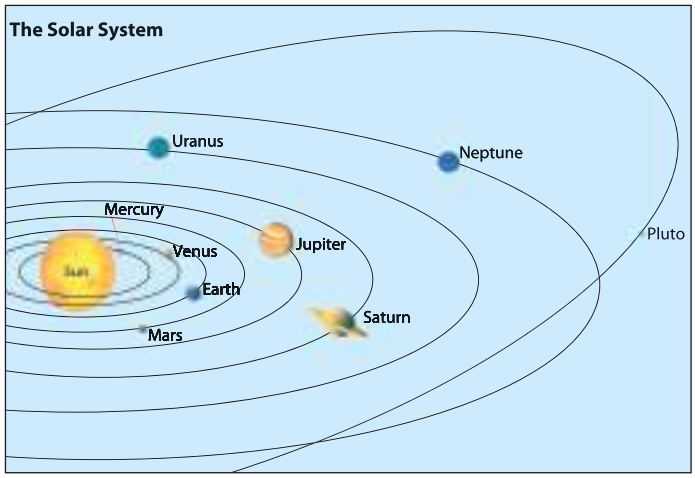


Figure 2.1: **The Solar System**

The solar system is the sun and the objects that are traveling around it. The objects around the sun include nine planets. Planets are objects that travel around a star in a path. That path is called an orbit.

The Structure of the Earth

Is the Earth a solid planet? Liquid? Gas?

Human lives on the surface of a globe that has a radius of nearly 6500 km, yet no one has ever penetrated more than a few kilometers below the solid earth. Geophysicists have inferred that the earth is composed of a great central core and a series of surrounding layers, known collectively as the mantle, and the crust (Figure 2.2).

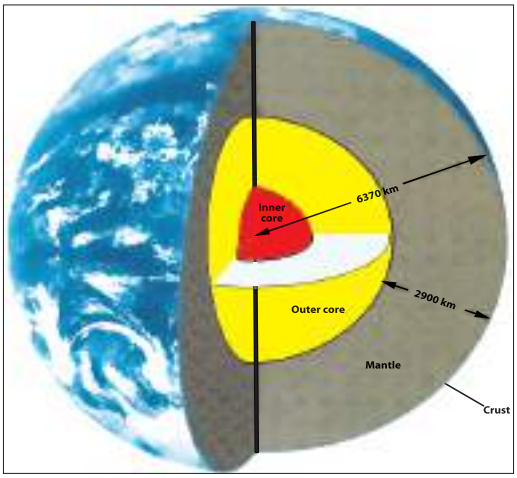


Figure 2.2: **Different layers of the earth's interior (***after Tarbuck Lutgens, 2005***)**

The Earth's Crust

The crust is the outermost and thinnest layer. Because it is relatively cool, the crust consists of hard, strong rock. Crust beneath the oceans differs from that of continents. Oceanic crust is between 4 and 7 kilometers thick and is composed mostly of dark, dense basalt. In contrast, the average thickness of continental crust is about 20 to 40 kilometers, although under mountain ranges it can be as much as 70 kilometers thick. Continents are composed primarily of light-colored, less dense granite. Relative to its size, Earth’s crust is about as thin as an apples skin about 0.01 percent in volume.

The Mantle

The mantle lies directly below the crust. It is almost 2900 kilometers thick and makes up 80 - 84 percent of the earth’s volume. Although the chemical composition is similar throughout the mantle, the earth’s temperature and pressure increase with depth. These changes cause the strength of mantle rock to vary with depth, and thus they create layering within the mantle.

The Core

The core is the innermost layer of the earth. It is a sphere with a radius of about 3470 kilometers, and is composed largely of *iron and nickel*. The outer core is molten because of the high temperature at the center of the core. The core's temperature is about 6000°C, which is as hot as the sun's surface. The pressure is more than 1 million times that of the earth's atmosphere at sea level. The extreme pressure compresses the inner core into a solid, despite the fact that it is even hotter than the molten outer core. About 15 percent of Earth's volume is an iron - nickel core the size of Mars.

Activity 2.2

I Match the items in column A with items in column B.

	A		B
1	Crust	a	Continental crust
2	Mantle	b	2900 kilometers
3	Molten	c	Largely iron and nickel
4	Basalt	d	Magma
5	Core	e	the thinnest layer
6	Granite	f	Oceanic crust

II Answer the following questions:

7 Which layer constitutes about 80 percent of the volume of the earth?
8 In which part of the earth are you living?
9 Which layer of the earth account about 15% of the earth's volume?
10 What makes the mantel develop different layers?
11 What is the solar system?
12 How many degree Celsius the core temperature measured?

2.1.2 The Geological Time Scale and Major Geological Events

What is the geological time scale? How old is the earth? When did life first evolve?

The geological time scale is a record of earth's history, starting with earth's formation about 4.5 billion years before the present. Numbers on the time scale represent time in millions of years before the present.

Geologists have divided the earth's history into four major **eras** and each era into a number of **periods,** to which specific names have been assigned. The periods are further divided into **epochs**. The scheme of subdivisions is based upon various aspects and events of the earth's history, such as widespread occurrences of strong tectonic activity, the appearance or disappearance of particular forms of life, or extensive changes in environmental conditions. The eras are major divisions of the geological time scale. They are defined based on differences in the life forms that existed.

There are four eras:

- *The Precambrian*
- *The Paleozoic, whose name means ancient life*
- *The Mesozoic, or middle life*
- *The Cenozoic, or recent life*

The *periods*, which are subdivisions of eras, are defined in the same manner, based on differences in the life forms that existed. The periods of the Cenozoic are divided into *epochs*.

The Precambrian Era

When did the Precambrian era take place?

The Precambrian era is the longest geological time unit of Earth's history. It comprises 88% of the geological time scale. It lasted from 4.5 billion to about 600 million years before the present.

Little is known about the earth and the organisms that lived during this era. Rocks have been buried deeply and changed by heat and pressure. The Precambrian rocks formed foundation rocks in many parts of the world. Because of great pressure and heat, they transformed from either sedimentary deposits or volcanic origin rock types to metamorphic type rock, which is crystalline in nature.

The Paleozoic Era

What is the major event of the paleozoic era?

The beginning of the Paleozoic era is marked by the presence of the first organisms, ancient life with hard parts. This era began about 600 million years ago. Warm shallow seas covered much of earth's surface during the early Paleozoic era. Because of this, most of the life forms were of marine origin (lived in oceans).

The Mesozoic Era

Which animal species was dominant in the Mesozoic era?

The Mesozoic era, the era of "middle" life, began about 250 million years before the present. At the beginning, all continents were joined as a single land mass that we call **Pangaea**. It separated into two large land masses during the Triassic period. The northern mass and southern mass, respectively, were **Laurasia** and **Gondwanaland**. Reptiles were the dominant animal life form in the Jurassic period.

Figure 2.3: **The breakup of Pangaea over 200 million years (***After Tarbuck and Lutgens, 2005***)**

The Cenozoic Era

What is unique about the Cenozoic era?

The Cenozoic era is the era of recent life, which began about 70 million years ago, when dinosaurs and many other life forms became extinct. Many of the mountain ranges began to form. The climate became cooler, and ice ages occurred.

The present-day period is the Quaternary. We live in the Holocene epoch, which began after the last ice age. Our species, *Homo Sapiens*, probably appeared about 500,000 years ago, but became a dominant animal only about 10,000 years ago.

2.1.3 Geological events in Ethiopia

What do you know about geological events in Ethiopia? What happened during the cenozoic era in Ethiopia?

The whole of Africa essentially consists of a basement of ancient crystalline rock. During the Precambrian era, Ethiopia was made up of huge mountains which were folded and faulted. During the Paleozoic era, the land was greatly affected by persistent denudation (erosion) and peneplanation. In many parts of Ethiopia, there was no significant rock formation in this era.

At the beginning of the Mesozoic era, the land surface sank, very slowly. As a result, the sea invaded the land from the southeast towards the northwest. In this process, layers of sandstone and limestone were deposited, one over the other. The layers of sandstone, referred to as **Adigrat sandstone,** were formed first, followed by deposition of layers of limestone called **Hintalo limestone**. Gradually, the landmass which was under the sea started uplifting, and the land emerged out of the sea toward the end of Mesozoic era. Following this, the sea started to retreat in the southeast direction, and it deposited other layers of sandstone called **Upper sandstone.** Hence, by the end of the Mesozoic era, many parts of Ethiopia were covered by the three layers of Mesozoic marine sediment.

During the *Cenozoic era,* Ethiopia experienced two major geological events:

i. The uplift of the Ethiopian landmass, followed by crustal deformations and the emission of an immense lava flow, Trapean (old) lava series, to the surface. This process produced the Ethiopian highlands.
ii. During the middle tertiary, the land was subjected to major vertical displacements, which produced the formation of the Ethiopian Rift Valley. This divided the Ethiopian highlands into the Western Highlands and the Southeastern Highlands.

In the quaternary period, the earth experienced a marked climatic change resulting in rains known as the Pluvian Rains in Africa. During this period the Ethiopian plateaus were affected by heavy erosion.

Later on, the heavy rains were replaced by a dry climate which increased the rate of evaporation. As a result the rift valley lakes were reduced in size.

Within the Afar depression, there was believed to be a large lake. Due to absence of rivers flowing into the lake and a continuous rate of evaporation, it disappeared. Finally, salt, potash and pockets of saline water were left behind.

Activity 2.3

I Give short answers.

1 In which era and period did layers of sandstone form in Ethiopia? What are these layers called?

2 In which era was Ethiopia subjected to continuous erosion?

II Match the words in column B with the phrases in column A.

A		B	
3	Record of events in Earth history.	A	Cenozoic era
4	Geologic time with poorest fossil record.	B	Precambrian time
5	The geological era in which we live.	C	Mesozoic
6	Dinosaurs rose and became extinct during this era.	D	Geological time scale
7	Most of the life forms were marine origin.	E	Paleozoic era

III Critical Thinking

8 Why do we say that the Rift Valley region of Ethiopia is the most geologically unstable area in the country?

9 Identify some existing geological processes occurring along and in the Ethiopian Rift Valley System, and identify manifestations which indicate the unstable situation of the region.

10 Prepare a geographic newsletter on current developments of the Ethiopian Rift System.

2.1.4 The Movement of Continents

Continental Drift

What is continental drift? What is plates tectonics? What makes the lithosphere plate move?

The idea that continents, particularly South America and Africa, fit together like pieces of a jigsaw puzzle originated with the development of reasonably accurate world maps (Figure 2.4). Little attention was given to this idea until 1915, when Alfred Wegener, a German meteorologist, polar explorer and visionary, who lived between 1880 and 1930, published a book titled *The Origin of Continents and Oceans*. In his book, Wegener set forth the basic outline of his radical hypothesis of **continental drift**.

Figure 2.4:
The West African coastlines and eastern coastlines of South America appear to fit together like adjacent pieces of a jigsaw puzzle. The pink areas show locations of distinctive rock types in South America and Africa. (After Tarbuck and Lutgens, 2005)

Wegener suggested that once there was a single supercontinent, a huge landmass, that he called **Pangaea (***pan = all, gaea = Earth***)**. Wegener further postulated that during the Mesozoic era, about 200 million years ago, the supercontinent (Pangaea), which centered upon Africa, began to break apart into two. He called them ***Gondwanaland*** (which consisted of South America, Africa, the Arabian Peninsula, the Indian subcontinent, Australia and Antarctica) and ***Laurasia*** which included the North America and Eurasia. At a later stage, the two broke farther apart into smaller continents, which then 'drifted' to their present positions. This idea was common and remained popular until very recently.

2.1.5 Components of the Earths Physical Environment

Basically the physical environment of the earth can be divided into four major parts: the water portion of the planet, (the **hydrosphere)**, Earth's gaseous envelope, (the **atmosphere)**, and the solid Earth, (the **lithosphere)**. But it should be noted that our physical environment is highly integrated and not dominated by rocks, water, or air alone. Rather, it is characterized by continuous interactions as air comes in contact with rocks, rocks with water, and water with air.

Furthermore, the **biosphere**, which is the totality of all plant and animal life on our planet, interacts with each of the three physical realms and is an equally integral part of the planet. Thus, the earth can be thought of as consisting of four major spheres: the *hydrosphere*, the *atmosphere*, the *lithosphere* and the *biosphere*.

A *The Hydrosphere*

What percentage of the hydrosphere forms streams and lakes?

The hydrosphere includes all of the earth's water, which circulates among oceans,

continents and the atmosphere. The oceans are the most prominent features of the hydrosphere, covering nearly 71 percent of the globe, to an average depth of about 3.8 kilometers. They account for about 97 percent of Earth's water. About 1.8 percent of the earth's water is frozen in glaciers. The hydrosphere also includes the 0.63 percent of the earth's water that is found underground, saturating the rock and soil of the upper few kilometers of the geosphere. Only 0.01 percent of the hydrosphere forms streams and lakes.

B *The Atmosphere*

What do you know about the atmosphere?

What percentage of the atmosphere is concentrated within 6 km altitude?

The earth is surrounded by a life-giving gaseous envelope called the **atmosphere**. It is a mixture of gases, mostly nitrogen and oxygen, with smaller amounts of argon, carbon dioxide and other gases. One-half of the mass of the atmosphere lies below an altitude of 5.6 kilometers, and 90 percent occurs within just 16 kilometers. About 99 percent is concentrated in the first 30 kilometers above the surface of the earth.

C *Biosphere*

What are the life forms that exist in the biosphere?

The biosphere is the zone inhabited by life. It is concentrated near the surface in a zone that extends from the ocean floor upward for several kilometers into the atmosphere. It includes the uppermost lithosphere, the hydrosphere, and the lower parts of the atmosphere.

D *Lithosphere*

What makes the top of the lithosphere?

Lying beneath the atmosphere and the oceans is the *solid earth*, referred to as the **lithosphere.** The ***lithosphere*** consists of three major layers: the crust, mantle and core (see Figure 2.5). The outermost layer is a thin layer called the ***crust***. Below a layer of soil and beneath the ocean water, the crust is composed almost entirely of solid rock.

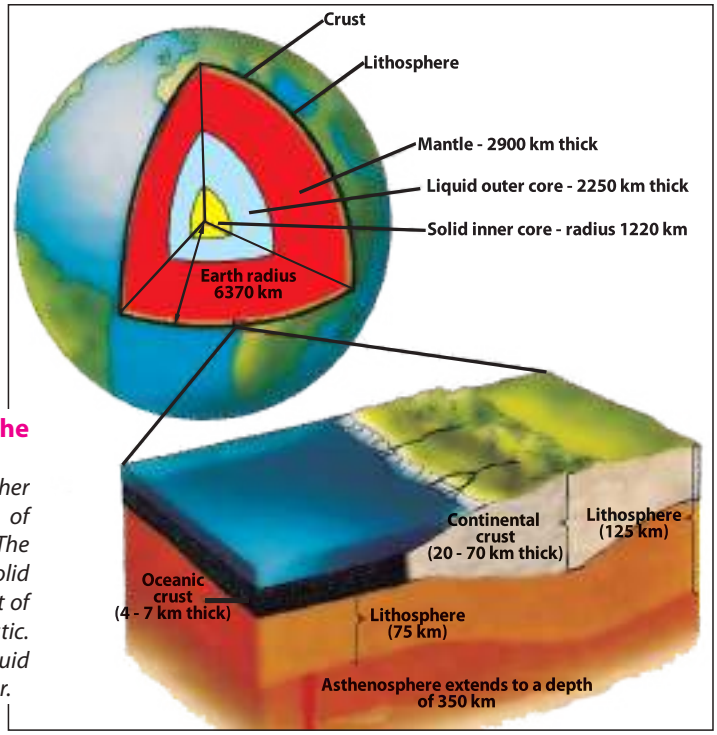


Figure 2.5: **The layers of the lithosphere**
Each of these layers is further subdivided. The crust consists of continental and oceanic crust. The uppermost mantle is hard solid rock, like the crust, while the rest of the mantle is hot, weak and plastic. The core consists of an outer liquid region surrounding a solid center.

The *mantle* lies beneath the crust. Although the mantle is mostly solid rock, it is so hot that it contains small pools of liquid rock called *magma*. The third and innermost layer is a dense, hot, partly molten *core* composed mainly of iron and nickel.

Focus

Note that the earth, which is part of the solar system, consists of four subsystems: *atmosphere*, *lithosphere*, *hydrosphere*, and *biosphere*. To these may be added the *anthroposphere*, which is that part of the earth on which humans have made their cultural imprint.

Components of the Lithosphere

Rocks

What are rocks? How are they formed?

Rocks are a naturally formed solid aggregate of one or more minerals.

Types, Formation and Characteristics

Geologists group rocks into three main categories called *igneous*, *sedimentary*, and *metamorphic rocks.*

1 *Igneous Rocks*

What is the origin of igneous rocks?

Igneous rocks (*ignis* = fire) form when the molten rock cools and solidifies, either in the crust or on the surface of the earth.

Igneous rocks come from melted rock deep in the earth, where it is very hot. The melted rock is called *magma*. The hot rock moves up through cracks in the earth's crust. Sometimes the magma cools and hardens before it gets to earth's surface. Sometimes the hot rock breaks out, or erupts, on the surface. Magma that gets to the surface is called *lava.*

Types of Igneous Rocks

There are two main groups of igneous rocks: *intrusive* and *extrusive* igneous rocks.

i **Extrusive igneous rocks:** Sometimes, when magma breaks through and erupts onto the relatively cool surface of the earth, it solidifies rapidly. Because it cools quickly when it reaches the earth's surface the molten rock, called *lava*, solidifies rapidly, and there is insufficient time for large crystals to form. As a result, many extrusive rocks have fine-grained textures, consisting of crystals too small to be seen with our eyes. An abundant and important example is *basalt* and *obsidian* (see Figure 2.6).

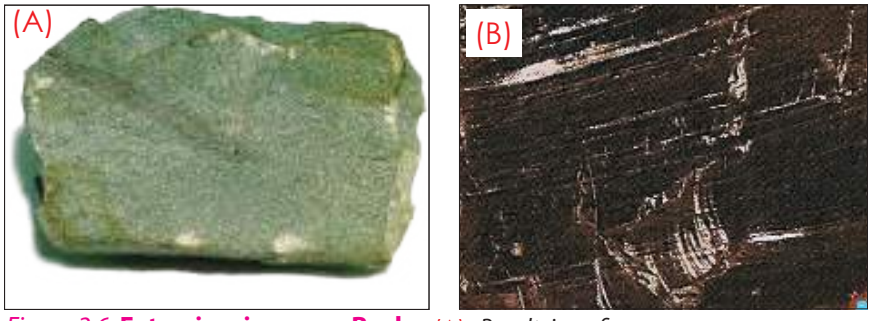


Figure 2.6: **Extrusive igneous Rocks** (A) *Basalt is a fine-grained volcanic rock and* (B) *Obsidian is natural volcanic glass. containg in no crystals.*

ii **Intrusive (plutonic) igneous rocks:** When magma solidifies within the crust, the magma cools slowly, and the crystals form over hundreds of thousands to millions of years. As a result, most plutonic rocks are coarse-grained. Granite is the most abundant rock in continental crusts. It is coarse-grained, and the crystals are clearly visible.

Figure 2.7: **Granite** *Granite is the most common coarse-grained igneous rock.*

2 *Sedimentary Rocks*

What is unique about sedimentary rocks?

Sedimentary rocks are made of small particles of matter, or sediments, of weathered rocks. They may be shells or other remains of living things. Water, wind and ice picked up sediment and transported it. Eventually they dropped the sediment in places where it collected into layers.

Most common sedimentary rocks are formed when sediment is compacted or cemented together. The weight of layer upon layer of sediment on top of each other compacts or squeezes sediment together to form sedimentary rocks.

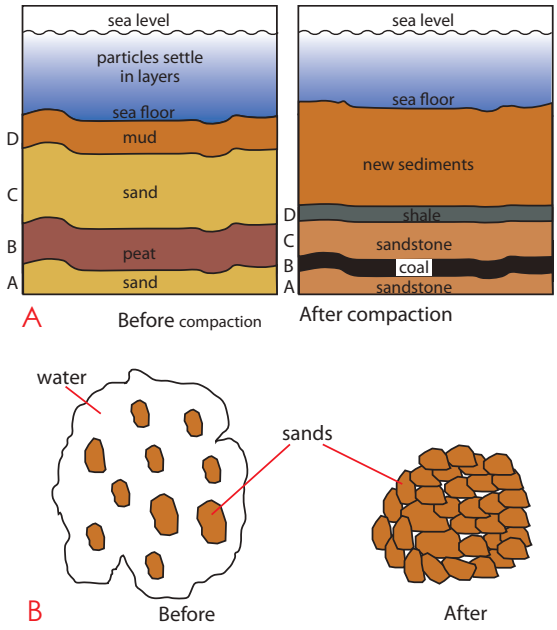


Figure 2.8: **How sediments become solid rock** *Sediments become solid rock by compaction and cementation.*

Types of Sedimentary Rocks

Which type of sedimentary rocks constitute 85 percent of all sedimentary rocks?

About 5 percent of the earth's crust is made up of sedimentary rocks. They are broadly grouped into four categories: *clastic, chemical, bioclastic* and *organic sedimentary rocks.*

i **Clastic sedimentary rocks:** They are composed of fragments of weathered rocks called *clasts*, which were transported and deposited, and then cemented. Clastic rocks make up about 85 percent of all sedimentary rock (Figure 2.9). This category includes sandstone, siltstone and shale.

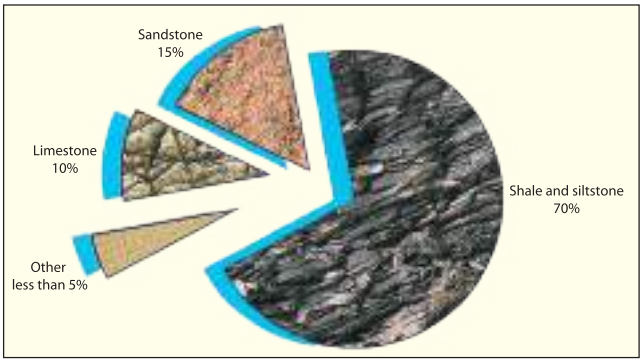


Figure 2.9: **Sandstone, siltstone and shale** *Sandstone, siltstone, and shale are clastic rocks that make up more than 85 percent of all sedimentary rock. Limestone and others make up less than 15 percent.*

ii **Chemical sedimentary rocks:** They are formed by direct precipitation from minerals in water. The water dries up, leaving layers of these minerals that turn into rock. *Gypsum* and *halite* (example: rock/table salt) are formed in this way. *Potash* is another type of chemical sedimentary rock. It is formed from solutions of certain salts.

iii **Bioclastic sedimentary rocks:** They are composed of broken shell fragments and similar remains of living organisms. The fragments are clastic, but they are, of course, of a biological origin. Limestone is a sedimentary rock which was formed from the shells of snails. A good example of limestone is chalk.

iv **Organic sedimentary rocks:** They consist of the solidified remains of plants or animals. *Coal* is an organic sedimentary rock made up of decomposed and compacted plants that died millions of years ago. When plants die, their remains usually decompose by reacting with oxygen.

3 Metamorphic Rocks

What makes metamorphic rocks hard and strong?

Metamorphic rock results from changes in other kinds of rock. Metamorphic rocks are produced from pre-existing igneous, sedimentary, and even other metamorphic rocks through heat and pressure inside the earth's crust.

Under the influence of heat, *limestone* and *sandstone* change, respectively, to *marble* and *meta-quartzite*. *Mudstone* and *shale* change to *schist* or *quartzite*, respectively, under the influence of both heat and pressure. They change to *slate* when subjected only to pressure. See Figure 2.10.

Figure 2.10: **Metamorphic rock** *Often have a banded appearance.*

Focus

Rocks are chunks of solid minerals. They are the most common and abundant materials on Earth. They consist of smaller crystals or grains called *minerals*. Basically one can identify three broad classes of rocks: igneous rocks, which are volcanic in origin, sedimentary rocks, which form by compaction and cementation of accumulated sediments under pressure, and metamorphic rocks that are transformed from volcanic or sedimentary rock, or even other metamorphic rock, under high pressure and heat.

Activity 2.4

1. In your geography work group, walk around your school compound and its surroundings. Collect samples of several types of rocks and bring them back to the classroom.
2. Work with your group to write a report about the collection of rock samples. Let the report consider each type of rock sample and present answers to the following questions. You can format some or all of the report as a chart.
   - a. What color is it?
   - b. Is it shiny?
   - c. Does it break or scratch easily? Use a coin, knife, or other hard object to test the sample for this characteristic. Is the rock hard or soft?
   - d. Is it permeable? To test for this characteristic, place the rock in water and see whether it absorbs liquid.
   - e. Is it crystalline? To test for this characteristic, examine the rock closely, looking for crystals. If you find crystals, are they large or small?

Distribution of Major Rocks in Ethiopia

Major rocks in Ethiopia include igneous, sedimentary and metamorphic rocks. These rocks are found exposed at the surface in different parts of the country. There are many other rocks underlying surface rocks.

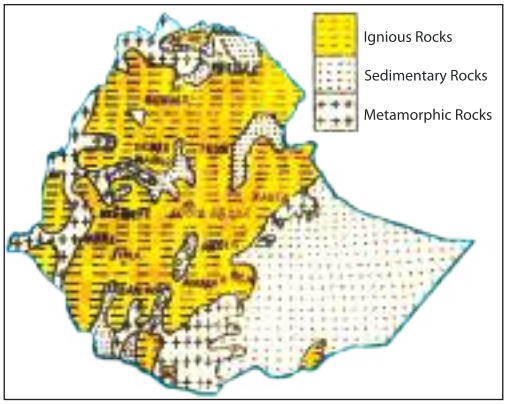


Figure 2.11: **Distribution of the major outcropping rocks in Ethiopia**

As you can see from the map igneous rocks cover large areas in the central part of the country. Eastern Ethiopia is mainly covered with sedimentary rocks. Metamorphic rocks are found in the northern, western and southern edges of the country.

Soil

Have you ever run barefoot through grass? Have you ever looked at a field of corn? Have you ever planted a flower seed in a garden?

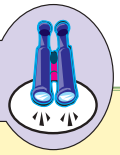
Soil is a unique and vitally important part of the terrestrial ecosystems. It is fundamental to continue human existence; without soil we can not grow the food we need. *Soil is a complex mixture of inorganic minerals, decaying organic matter, water, air and living organisms*. The earth's thin layer of soil, utmost only a metre or two thick, provides nutrients for plants, which directly or indirectly provide the food all animals need to stay alive and healthy.

Soil Composition

What is soil made of?

Although soils vary considerably in composition, they all contain the same basic components: inorganic materials (minerals), air, water and organic material. The inorganic materials in soil are tiny particles. They come from rock fragments that have been broken down very slowly over many years. They account for about 45% of the composition of good-quality soil. Water and air often complement each other, and each accounts for 25% . The organic material consists of humus, roots, and other living organisms. It represents about 5% of the total.

Focus



What kinds of things live in soil?

Soil is the loose material of the earth's surface in which terrestrial plants grow. Soil is usually formed from weathered rocks or regolith changed by chemical, physical and biological processes. Look closely at and through a large quantity of soil. It is full of living creatures. You may see earthworms, mites, millipedes, centipedes, grubs, termites, and other large and small creatures. Soil is also full of things you can only see under a microscope.

In the small world of soil, a lot is going on. Worms and other fairly large creatures eat decaying parts of plants. Bigger animals eat smaller ones. They expel waste into the soil. Microscopic life forms, called bacteria and fungi, feed on the bodies of dead animals and reduce them to simpler materials that plants can use for food. Decayed plant and animal parts create a rich, dark-colored soil called *humus*.

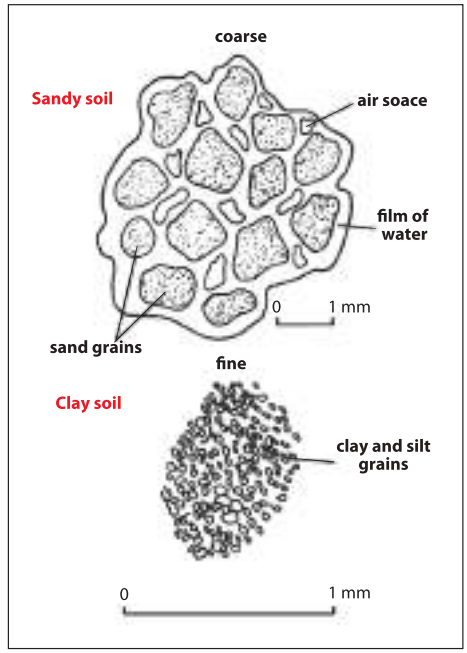


Figure 2.12: **Soil texture**
Look at these two microscopic views of sand and clay soils. Notice how much bigger the soil grains are in the sand. Large grains, as in sand, give a coarse texture. Clay and silt soils have a fine texture. A coarse, sandy soil allows water to drain through it quickly. Very little water is stored by the soil, so it quickly dries out. Clay soil is so fine that water has difficulty of passing between the grains, so these soils easily become waterlogged.

Formation of Soil

Soil formation takes a long time, which is why it is such a disaster when soil is washed away in floods: it will take hundreds or thousands of years to replace. The basic components of soil are:

- ⇨ *the inorganic components: rock particles, air, water and mineral salts.*
- ⇨ *the organic components: humus and living organisms*

Types of Soil

Which soil type is poorly drained and areated?

There are many different types of soil, which vary in their content of:

- ⇨ *Clay - very fine, microscopic particles*
- ⇨ *Silt - fine particles*
- ⇨ *Sand - coarse particles*

Soils are classified according to the proportion of these different types of particles. Porosity is the major factor controlling the amount of water and air the soil can hold and the rate at which water moves through it.

Sandy soils have relatively large pores and the particles have little tendency to clump together.

Sandy soils have good aeration and are easy to work. However, sandy soils retain little water, they dry up quickly in hot weather and useful minerals are easily washed out of them. This means they are poor in plant nutrients. They are useful for growing crops which do not require large amounts of water, such as groundnuts.

Clay soils are made of very small particles, which are easily packed together. Clay soils have low porosity, retain water and rich in nutrients. They are poorly drained, poorly aerated and difficult to cultivate. Waterlogging, when all the pores fill with water, is a common problem. Poor aeration causes the death of roots due to lack of oxygen.

Silt soils: If the particles are smaller than sand, they are called silt. Soil with silt is less gritty to the touch and some what sticky when wet. When it is dry, however, soil with much silt is usually loose and cruby. Soil with silt accepts water more slowly than sandy soil, but more quickly than clay. It also retains water longer than sandy soil, but it dries faster than clay.

The ideal soil is a ***loam***, which is a mixture of sand, clay and silt and contains a mixture of particle sizes, and plenty of humus. Such a soil is fertile, it is properly aerated and contains adequate supply of mineral and water.

Major Soil Types of Ethiopia

Which soil type has the largest coverage in Ethiopia?

FAO, on the basis of predominant chemical and physical properties derived from parent materials, has identified about *18 major soil* associations in the country. Ten of the 18 soil associations are considered in this section, which together cover more than 87.4 % of the land area of the country.

Liptosols alone cover about 29.8% of the total land area of Ethiopia. But together with ***Regosol*** cover about 30% of the area of the country. These soil groups developed on recent lava and young quaternary sediments. They are mostly found in a rugged topography and steep slopes.

Nitosols cover about 12.5% of the area of Ethiopia. The ***Nitosols*** develop on gently sloping ground. They are basically associated with high rainfall and were, probably, formed originally on forest covered areas. But they are now widely found on cultivated areas and on mountain grasslands.

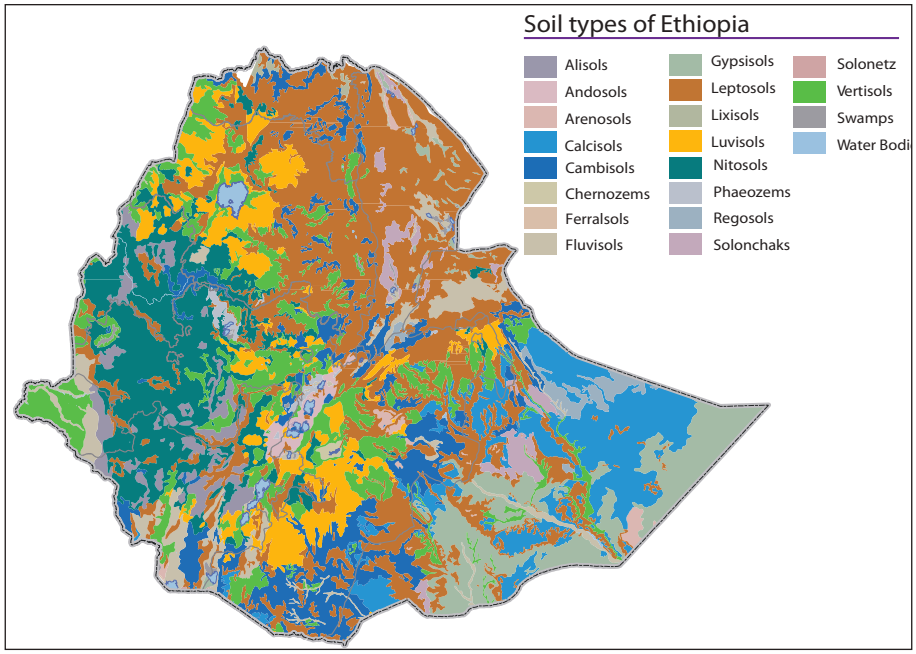


Figure 2.13: **Major Soils of Ethiopia**

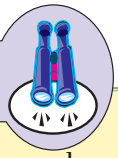
Vertisols: These soils cover about 10 % of the land area of Ethiopia. They mostly develop on volcanic plateau. They also develop on sedimentary rocks, and alluvial plains. Unlike the ***Nitosols***, which are found in humid areas, Vertisols mostly occur in moderate climatic regions and gently slopping grounds.

Luvisols: They cover about 7.8% of Ethiopia and developed mainly in areas where pronounced wet and dry seasons occur. Where leaching is not very high, they are found in association with ***Nitosols***.

Fluvisols formed through erosion from the lava plateau of Ethiopia and deposited in depressions, lower valleys and lowlands of the country. They are associated with *fluvial* (river), *marine* (sea) and *lacustrine* (lake) deposits. ***Fluvisols*** are unique because their origin depends on the deposition of alluvium (being transported from many areas) than on weathering processes.

Other soils including ***Cambisols*** and ***Calcisols*** which, respectively, cover 9.4 and 9.3 of the area of Ethiopia have relatively good physical and chemical properties for agricultural production. ***Gypsisols*** which cover about 7.6% of Ethiopia occurs in the eastern lowlands have limited agricultural potential. ***Solanchaks*** are saline soils, which develop in areas of high evaporation and capillary action.

Focus



The soils of Ethiopia were basically derived from the rocks of the basement complex, Mesozoic old sediments and rocks of Trapean and Aden volcanic-series lavas, including Quaternary sediments. Diversity in topography and climate, including biological diversity, heightened the highly fragmented (mosaic) nature of soil types in Ethiopia. On the other hand, although about 18 different soil groups have been identified in the country, 87% of the combined areas of Ethiopia is covered by 10 of them. Further, more than half of Ethiopia is covered by vertisols, nitosols, acrisols, lithosols, regosols and cambisols.

Activity 2.5

i Answer the following questions

1 Which soil is an extremely leached version of nitosols?
2 Which soil group most commonly cover sides of major river gorges, escarpments and other very steeply sloped areas?
3 Where are lacustrine deposits found most commonly?
4 If you want run a modern farm, which soil type is your choice?
5 Which soil types formed from already existing rocks?
6 How many percent of the hydrosphere water found underground?

ii Fill in the blanks with appropriate word or phrase

7 Rocks make up about 85 percent of all sedimentary rock _____.
8 Rocks are dominant in the central part of Ethiopia _____.
9 Eastern Ethiopia is largely covered by _____ rocks.

Soil Degradation and Conservation in Ethiopia

What is soil degradation? What causes soil degradation? Can you list different forms of soil erosion? What causes soil erosion and what is the impact of soil erosion in Ethiopia? List possible soil-conservation measures for Ethiopia.

A *Soil Degradation*

Degradation, in geological terms, means the wearing down of rocks by disintegration. It refers to the general lowering of the surface of land by erosive processes.

In connection with soil, *soil degradation* refers to a change in the state of soil due to increased erosion, leaching and both processes.

Erosion

Erosion is the term given to the process of the wearing away of soil by natural agents (running water, wind, ice, wave action and corrosion) and the transport of the rock debris that results. Wind, water and other agents of erosion move the eroded particles to some other location, where it is deposited as sediment. Soil erosion is a natural process that removes soil from the land. However, human activities frequently aggravate this process.

Causes of Soil Erosion in Ethiopia

The causes of soil erosion can be divided into two: physical and human.

i ***Physical causes*** involve a combination of the following physical factors: steepness of slope, the intensity, duration and seasonality of rainfall, soil type (example, texture) and vegetation cover.

ii ***Human causes*** have to do with human interference with natural processes, including *deforestation*, *overgrazing* and bad farming practices which deplete plant cover, leaving the land exposed and vulnerable to erosion. Activities that lead to deforestation include the burning of forests and the cutting down of trees faster than the forests can regenerate.

In Ethiopia, about 1.9 billion tons of topsoil is washed away from the highlands every year. The loss of topsoil has been estimated to cost billions of Ethiopian birr per year. Since topsoil production rates are so slow, the lost topsoil is essentially irreplaceable.

Badly eroded soil has lost all of its topsoil and some of its subsoil, and it is no longer productive as farmland. In Ethiopia, soil erosion has reached critical levels for farmers.

Water erosion is the main cause of soil erosion in Ethiopia. People left the soil unprotected when they removed protective plant cover by farming, burning crop residues, overgrazing and cutting trees (see Figure 2.14). Additional damage has occurred through over cultivation and by disturbing the soil, using heavy machines in road and building construction and mining activities.

In Ethiopia, soil loss occurs at a rate of between 1.5 billion and 2 billion cubic meters per year. About four million hectares of highlands is now considered irreversibly degraded.

Figure 2.14: **Soil erosion** *This badly degraded area in Kembata and Timbaro Zone in SNNPR has lost its potential for cultivation.*

Types of Soil Erosion

Soil erosion by running water are of three types: *sheet, rill, and gully erosion.*

i ***Sheet erosion*** occurs when the soil scattered by rain drops is removed more or less uniformly from every part of a slope.

ii ***Rill erosion*** occurs when the smooth surfaces of the slope develop small depressions in which water concentrates and later overflows to create many shallow channels called ***rills***.

iii ***Gully erosion*** develops when the water flowing along *rills* converges in channels that become enlarged, causing deep cuts in the ground. This process often causes considerable damage to both the topsoil and the subsoil. Running water, when concentrated, is able to pick up soil particles and move them downslope. In cases of prolonged (continuous) erosion, ***gullies*** (such as the one shown in Figure 2.15) are likely to form.

Figure 2.15: **Gully erosion** *This very deep gully developed because of the construction of the main road at Kurfa, past Nazareth (Adama), on the way to the town of Wolenchiti, Oromia Region.*

Stream Erosion

Rivers can form large concentrations of runoff that run downslope. Such river runoffs can cut the surface of the earth laterally and vertically, and transport eroded materials in the form of a solution full of mud downslope along their course (Figure 2.16). In this process, they form gorges and valleys. Ethiopian rivers are essential agents of erosion in the country. Soil erosion by runoff is serious in the highlands of Ethiopia. It occurs wherever grass, bushes, and trees are disappearing. Deforestation and desertification leave land more liable to erode.

Figure 2.16: **Stream erosion** *Amassa River is used as a border between Woliyta and Gamo zones. It carries a lot of mud in the form of a solution brought down from upslope areas of Wolyita Zone. It drains into Lake Abaya.*

Wind erosion

Wind erosion is the most common form of erosion in dry and treeless areas where the soil is exposed. The dry and unprotected topsoil from fields is blown away. Wind forces are capable of removing all of an area's topsoil and transporting it several thousand kilometers away.

Soil Conservation in Ethiopia

What is conservation?

Simply the term *conservation* means *the protection of resources from destructive influences*. The term applies to the positive work of maintenance, enhancement and wise management, of resources and to restoration by reducing and reversing rates of damage and destruction of resources. For example, conservation efforts might reduce the consumption rate of a valuable resource to prevent its irreversible depletion.

Soil Conservation Measures Needed in Ethiopia

There are several measures we can institute to reduce, minimize or eliminate soil erosion by wind and running water. They include:

- ***contour ploughing*** *– ploughing across slopes, rather than up and down them, to create barriers to runoff.*
- ***terracing*** *– installing ledges for cultivation at right angles to slopes to reduce runoff.*
- ***strip cultivation*** *– planting different crops in alternating strips to retain water and soil.*
- ***installing hedges*** *and* ***other windbreaks*** *– creating borders of closely growing bushes, shrubs or trees beside or around areas to protect them from winds, predation by animals, and so forth.*
- ***afforestation*** *and* ***reforestation*** *– planting trees, for example, on bare land that is vulnerable to erosion.*
- ***avoiding cultivation*** *– leaving land that is unsuitable for cultivation untilled.*
- ***plugging gullies*** *– for example, with brush and wood barriers.*
- ***limiting grazing*** *– keep livestock according to the carrying capacity of the land.*
- ***fallowing*** *– initiating multi-year periods of non-cultivation for the land, allowing it to regenerate its fertility.*

Here are more-detailed descriptions of some of these methods.

i **Contour ploughing:** It is ploughing across slopes rather than up and down them in order to reduce runoff. It is one of the simplest ways to prevent soil erosion. This soil-conservation practice is useful on gentle slopes. As the plough tills, it creates ridges across the slopes. They act as barriers to down-running water, preventing runoff from eroding the slope's soil.

Contour ploughing can reduce soil erosion by as much as 50 percent in drier regions, and it increases crop yields and conserves water.

Figure 2.17: **Contour plowing**
Tilling land at right angles on slopes creates a series of ridges (narrow raised areas) that slow runoff and prevent soil erosion.

ii **Strip cultivation:** It refers to the planting of different crops in alternating strips. Typically, the farmer alternates closely grown crops (such as wheat, teff, barley, and other small grains) and open-growing crops (such as corn and cotton). The closely grown crops minimize the flow of water, which reduces soil erosion and allows more water to be absorbed into the ground.

Figure 2.18: **Strip cultivation**
The strips are planted with alternating crop types.

iii **Windbreaks:** They are plantings of trees or other plants that protect bare soil from the full force of the wind (Figure 2.19 (A) and (B)). Windbreaks reduce the velocity of wind, and decrease the amount of soil that it can move away.

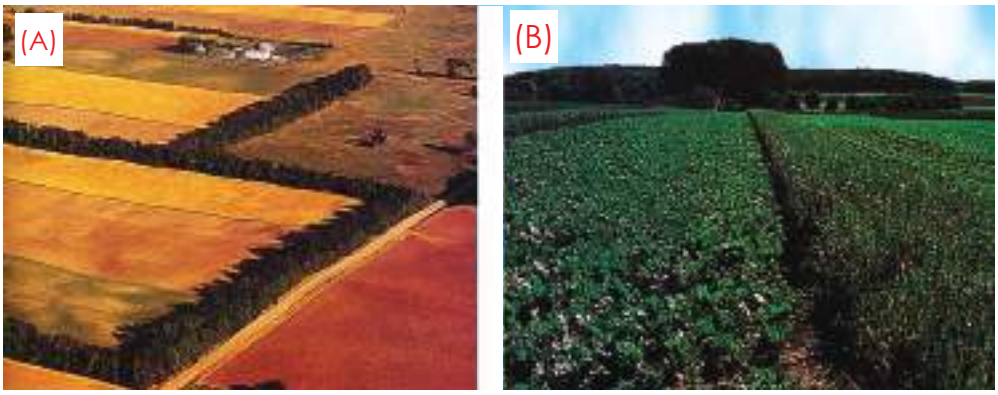


Figure 2.19: **Windbreaks** *In large plain areas, trees provide protection from wind erosion. The trees along the road protect the land from oncoming winds (A). In the other field, temporary strips of vegetation serve as windbreaks (B).*

iv **Terracing:** It involves building level surfaces at right angles to the slope to retain water and reduce the amount of erosion. It is an expensive method of controlling erosion since it requires moving of soil and stones to construct the level areas. This method of soil and water conservation has been commonly practiced by the Konso people of Ethiopia. It is also used in other steep-slope areas of Ethiopia.

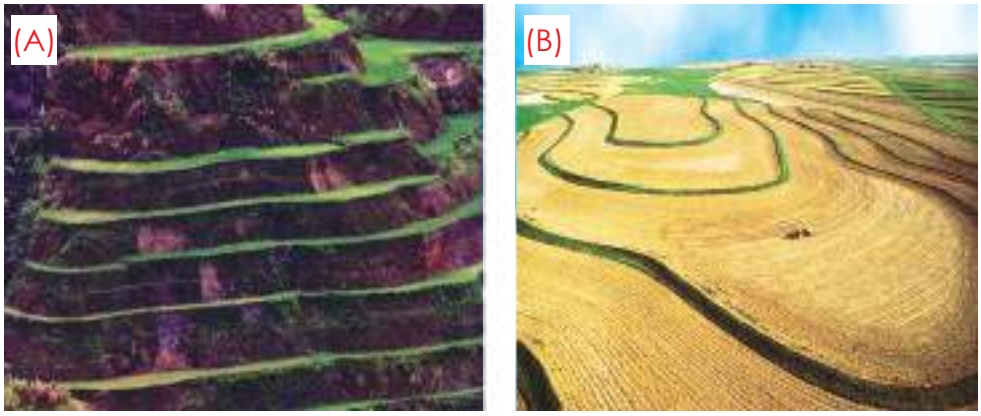


Figure 2.20: **Terraces** *Terraces are installed at right angles to the slopes in (A). They are extremely important for people who live on steep slopes, especially in countries with little available land. They require much energy and hand labor. The type of terracing shown in (B) is appropriate for gentler slopes. It is more widely spaced, and it allows the use of farm machines.*

v **Reforestation and afforestation:** Reforestation is the planting of trees on land previously forested but from which the trees have been removed by natural causes or by cutting, burning or other means (Figure 2.21). *Afforestation* refers to the planting of land, not formerly so covered, with trees to make a forest for commercial or other purposes.

Figure 2.21: **Reforestation** *The photograph shows* ***reforestation****, planting trees on hills that were once badly denuded and devoid of trees. The area in this photograph is close to Negash town (which is the site of what is probably the first and oldest mosque in Ethiopia, Negashi, Tigray).*

Focus

Soil is a renewable resource that can be replenished indefinitely by applying appropriate measures of conservation, although some of these measures are enormously expensive. *Conservation* is wise use of resources in the best possible way, so that the greatest long-term benefit is realized by society.

Activity 2.6

Part I

Give answers to the following questions.

1 What is soil/land degradation?
2 What causes soil degradation?
3 Which forces of soil erosion are most damaging in (a) the highlands and (b) the lowlands of Ethiopia?
4 What are renewable and non-renewable resources?
5 What measures of soil conservation are commonly practiced in Ethiopia?

Part II

In your group, discuss these issues.

1 The difference between reforestation and afforestation.
2 Which measure of soil conservation is the cheapest and most effective?

2.2 CLIMATE

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

- Realize the criteria used for classifying climate;
- Compare the climate classifications of the Greeks' and that of Koppen;
- Express causes of climate change;
- Explain major consequences of climate change

Key Terms

- greenhouse effect
- greenhouse gases
- ozone layer
- permafrost
- desertification

How does climate differ from weather? What are the elements of climate? What are climate controls? Why is climate classification needed? What are the major types of climate and climatic regions of the world? In which climatic region do you live?

2.2.1 Classification of the Climates of the World

How is climate classified?

There are many ways to classify climate, each with its own advantages and disadvantages, depending on the purposes for which it is used. In the following sections, we consider two systems of climate classification with their climatic regions:

- *the system of the ancient Greeks – based on temperature and sunshine within latitudinal boundaries*
- *the Koppen system – based on temperature and precipitation as reflected in vegetation zones*

Classification by Ancient Greeks

Which zone is warm year - round?

After considering worldwide temperature and sunshine distribution, the ancient

Greeks divided the world into three climatic regions. Note that they are bounded by specific latitudes:

1 ***The low-latitude tropical (or torrid) zone*:** a winterless tropical region. It is bounded by the northern and southern limit of the sun's vertical rays (23½°N and 23½°S). In this climatic region, the noon sun is always high, day and night are of nearly equal length, and it is warm year-round.

2 ***A middle-latitude temperate zone*:** sandwiched between the other two zones i.e., (23½° – 66½°N), and 23½° – 66½°S this climatic region has distinct summer and winter seasons and exhibits characteristics of both extremes, in terms of seasonal temperatures.

3 ***The high-latitude polar (or frigid) zone*:** bounded by (1) the Arctic Circle, at 66½N-90°N, and (2) the Antarctic Circle, at 66½°S-90°S. Places with this climate are considered summerless, because they are cold all year round due to long periods of winter darkness and a low summer sun.

The ancient Greeks' system is some what simplistic method of climatic classification because it does not consider precipitation, and therefore it does not differentiate between wet and dry regions.

The Kðppen System of Climate Classification

What makes Koppen classification more acceptable than the others?

This widely used classification of world climates is based on seasonal variations in the annual and monthly averages of temperature and precipitation. It was devised by the famous German scientist Waldmir K**ð**ppen (1846 – 1940). Faced with the lack of adequate observing stations throughout the world, K**ð**ppen related the various climates to the distributions and types of native vegetation in the world. In this way, where no climatological data were available, climatic boundaries could be approximated with vegetation zones.

The K**ð**ppen climate classification, is now used by climatologists throughout the world. It defines five principal climatic groups. Each type is designated by a capital letter. Note that a single climatic region can exist in multiple locations on the earth. A Koppen *climatic region* is not a spatial or areal region.

A ***Tropical moist climate:*** All months have an average temperature above 18ºC (64ºF). There is enough moisture to support abundant plant communities. Since all months are warm, there is no real winter season.

B ***Dry climates:*** precipitation is deficient most of the year. Potential evaporation and transpiration exceeds precipitation.

C ***Moist mid-latitude climates with mild winters:*** C climates have warm-to-hot summers with mild winters. The average temperature of the coldest month is below 18°C (64°F) and above -3°C (27°F).

D ***Moist mid-latitude climates with severe winters:*** D climates are similar to C climates, but have distinct summer and winter seasons. They have enough moisture to support abundant plant communities. The average temperature of the warmest month exceeds 10°C (50°F), and the coldest month average drops below -3°C (27°F).

E ***Polar climates:*** They have extremely cold winters and summers. The average temperature of the warmest month is below 10°C (50°F). Winters are extremely cold, and even the summers are cool. Since all months are cold, there is no real summer season.

H ***Highland climate:*** At low latitudes the effect of altitude can produce tundra and polar conditions. Glaciers on tropical mountain sum its attest to the cooling effects of altitude highland climates follow the pattern of Earth's mountain ranges.

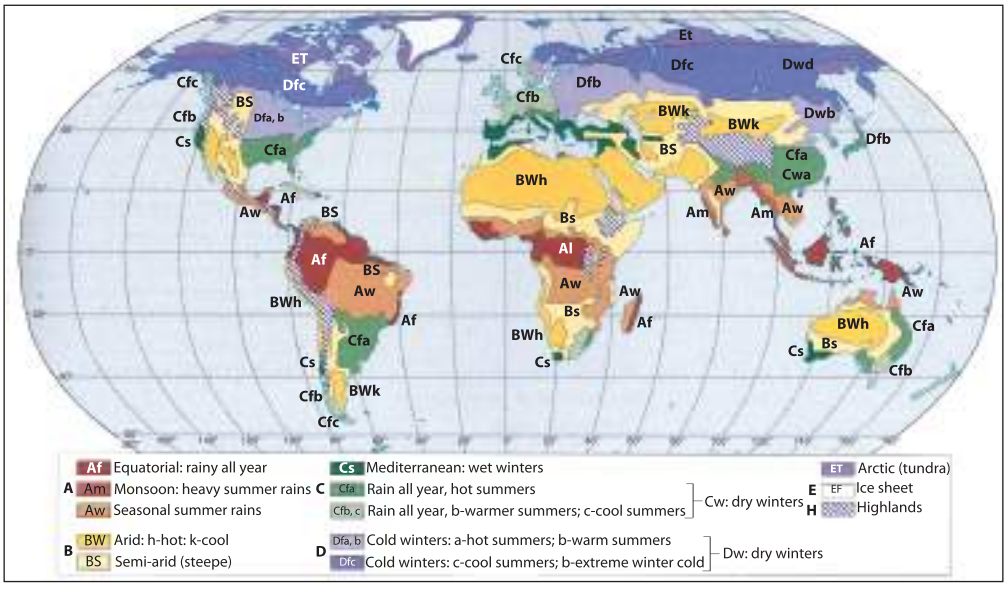


Figure 2.22: **General climate classfication**

Activity 2.7

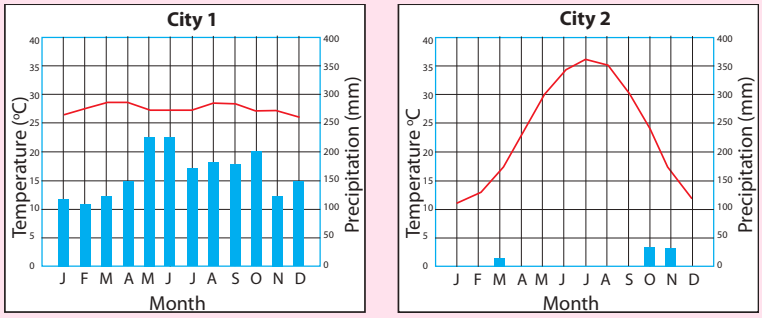


Figure 2.23: **Seasonal patterns of temperature and precipitation for meteorological stations in two different cities**

1 Study the monthly temperatures of City 1 and City 2.

2 Compare and contrast. Next study the seasonal patterns, in each city, for each of the two climate elements – temperature and precipitation. Then perform the following activities and answer the following questions:

- a Describe the pattern of rainfall and temperature distribution for each city.
- b Which city has the warmest climate?
- c Which city has the driest climate?
- d Which city is probably situated in a desert?
- e Which city is probably located in a tropical zone?
- f Which city has uniform annual precipitation distribution?

Part 2

With your teacher, visit the meteorological station found nearest to your school. Ask the experts there to give you the most recent available 12 months of data for your locality's monthly temperature and precipitation.

3 When you return to your classroom, use the data to perform these activities,

4 Draw two graphs, similar to those in Figure 2.24, that show seasonal distributions of

- a temperature
- b rainfall;

5 Identify

- a the warmest three months
- b the coldest three months
- c the driest three months
- d the wettest three months

Part 3

Work with your group to choose a group representative to present your ideas to the class.

2.2.2 Climate Change

What is climate change? Is climate change a reality? What are some of the manifestations and consequences of climate change?

Climate change is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or fewer extreme weather events. Climate change may be limited to a specific region, or may occur across the whole Earth.

Causes of Climate Change

What causes climate change?

The earth's climate is dynamic. It is always changing through a natural cycle. What the world is more worried about is that the changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world and tried to identify the causes. The causes of climate change can be divided into two categories - those that are due to natural causes and those that are caused by human factors.

A *Natural causes*

There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents etc. Let's look at them in a little detail.

Continental drift

The continents that we are familiar with today were formed when the landmass began gradually drifting apart, millions of years back. This drift also had an impact on the climate because it changed the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today; the Himalayan range is rising by about 1 mm (millimeter) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.

Volcanoes

When a volcano erupts it throws out large volumes of sulphur dioxide (SO_2), water vapour, dust, and ash into the atmosphere. Although the volcanic activity may last only a few days, the large volumes of gases and ash can influence climatic patterns for years. Millions of tones of sulphur dioxide gas can reach the upper levels of the atmosphere (called the stratosphere) from a major eruption. The gases and dust particles partially block the incoming rays of the sun, leading to cooling.

Ocean currents

What causes ocean currents?

The oceans are a major component of the climate system. Ocean currents move vast amounts of heat across the planet - roughly the same amount as the atmosphere does. But the oceans are surrounded by land masses, so heat transport through the water is in channels.

Ocean currents have known to change direction or slow down. Much of the heat that escapes from the oceans is in the form of water vapour, the most abundant greenhouse gas on earth. Yet, water vapour also contributes to the formation of clouds, which shade the surface and have a net cooling effect.

B *Human Causes*

How do human activities affect climate?

The industrial revolution in the 19th century saw the large - scale use of fossil fuels for industrial activities. These industries created jobs and over the years, people moved from rural areas to the cities. This trend is continuing even today. More and more land that was covered with vegetation has been cleared to make way for houses. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for material things) has increased by leaps and bounds, creating mountains of waste. Also, population growth has increased to an incredible extent. All this has contributed to a rise in greenhouse gases in the atmosphere.

Greenhouse gases and their sources

What are the sources of green house gases?

Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide.

Methane is another important greenhouse gas in the atmosphere. About 1/4 of all methane emissions are said to come from domesticated animals. These animals produce methane during the cud - chewing process. Methane is also released from rice or paddy fields that are flooded during the sowing and maturing periods.

A large amount of nitrous oxide emission has been attributed to fertilizer application.

Greenhouse effect

What aggravates green house effect?

The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions. Since part of this re-radiation is back towards the surface, energy is transferred to the surface and the lower atmosphere. As a result, the temperature there is higher than it would be if direct heating by solar radiation were the only warming mechanism.

This mechanism is fundamentally different from that of an actual greenhouse, which works by isolating warm air inside the structure so that heat is not lost by convection.

Global warming, a recent warming of the earth's surface and lower atmosphere, is believed to be the result of a strengthening of the greenhouse effect mostly due to human - produced increases in concentration of atmospheric greenhouse gases, CO_2 in particular.

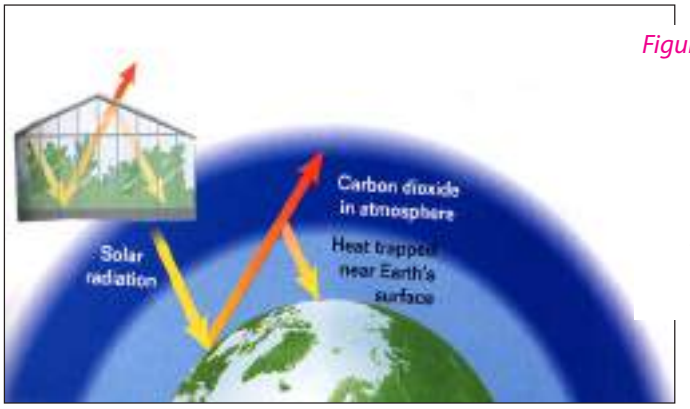


Figure 2.24: **The greenhouse effect** *The moment you step into a greenhouse, you feel the greenhouse effect. Heat trapped by the glass walls warms the air inside. Similarly, atmospheric greenhouse gases, particularly CO_2, trap heat close to Earth's surface.*

Since the beginning of the industrial revolution, the burning of fossil fuels has increased the levels of carbon dioxide in the atmosphere from 280 ppm to 390 ppm (parts per million). The emissions of carbon are directly proportional to energy consumption.

Consequences of climate change

What are the possible consequences of climate change resulting from global warming?

Global warming

Global warming is the increase in the average temperature of earth's near - surface air and oceans since the mid - 20th century and its projected continuation. According to the 2007 fourth assessment report by the Intergovernmetnal Panel on Climate Change (IPCC), global surface temperature increased by about 0.74 ± 0.18°C (1.33 ± 0.32°F) during the 20th century. Most of the observed temperature increase since the middle of the 20th century has been caused by increasing concentrations of greenhouse gases, which result to human activity such as the burning of fossil fuel and deforestation. Global dimming, a result of increasing concentrations of atmospheric aerosols that block sunlight from reaching the surface, has partially countered the effects of warming induced by greenhouse gases.

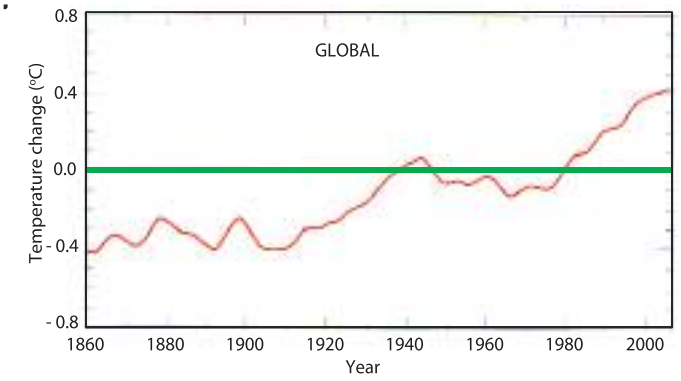


Figure 2.25: **Average global temperature variations from 1860 through 2000**
The zero line represents the average surface temperature from 1961 to 1990 (Source: P. D. Jones, et al., and Climate Change 2001: the Scientific Basis, 2001, by J.T. Houghton, et al.)

Desertification

Desert - like condition's may spread over human habitats, crop lands and wet lands. Grass land and forest areas might turn into desertified environments as a result of global warming and hence climate change.

Drought

Because of climate change which results in extensive damage to plants, crops and animals, droughts are likely to occur more frequently. Up to three billion people could suffer from increased water shortages by 2080. In Ethiopia, for example,

drought started to reoccur more frequently, at an interval of 3 to 8 years in the most drought prone regions.

A rise in the sea - level

Globally, the average sea - level could rise by 18 to 59 cm, or more, by the end of the century. Rising sea levels could swamp some small, low - lying island states and put millions of people living in low - lying areas at greater risk of flooding.

It is also possible that salt from rising sea levels may contaminate underground fresh water supplies in coastal areas. The sea expected to encroach coastal areas and cover land surfaces.

Shift of the direction of global winds

If the average global temperature increases the jet stream will weaken and global winds will shift from their "normal' position. This in turn may disturb the "normal" amount of seasonal pattern and distribution of precipitation.

Shift of Tropical Zone

The tropical zone expected to extend north and southwards by not less than one degree in the northern and southern hemisphere respectively.

Expansion of Tropical Diseases

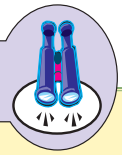
It is widely recognized that zone of mosquitos breeding and hence malaria spread farther into upper grounds, lower Woina Dega agroclimatic zones in case of Ethiopia.

Loss of Biodiversity

A global temperature rise could make some species extinct. There are already changes to the way plants and animals live.

Further changes in rainfall and temperature will affect many animal and plant species around the world. Some species might be unable to adapt quickly enough and habitats might not be available for them to move into. If global temperatures rise by two degrees celsius, 30 percent of all land-living species could be threatened by an increased risk of extinction.

Focus



The atmospheric greenhouse effect blocks the escape of some radiation to upper space. Therefore it heats the earth's atmosphere and surface. This process is due to the presence of blanketing "greenhouse gases" such as CO_2, CH_4, N_2O, CFC, and water vapor in the atmosphere. Their presence acts as a barrier to radiation and heat that would normally escape through the atmosphere. The atmosphere warms as it absorbs and then emits infrared radiation downwards, while allowing shortwave radiation to pass out, away from the earth. The most noticeable result of the greenhouse effect is global warming, which is characterized by global temperature rises ranging between 0.5°C and 0.6°C.

Activity 2.8

In your geography work group, perform the following activities.

1 Discuss climate change: what it is and how it differs from climate variability. List some of its most noticeable effects.

2 What changes do you observe in your locality in relation to climate change? Do you think any of Ethiopia's endangered plant and animal species still exist in your wereda and region? Have patterns of temperature and rainfall changed during your lifetime or that of your parents or of the elders in your family?

Ask your parents and elderly relatives about temperature and rainfall changes in your locality? Have such changes been significant within their lifetimes? Within your lifetime, so far? Have such changes affected any of your lives? If so, how?

3 Consider any other changes in your locality that you think have resulted from climate change.

Create a report of all of your findings and opinions in your science journal.

4 Have you heard about any rivers, lakes or swampy areas in your locality that have shrunk in volume or even disappeared due to climate change? If so, write about it and report your ideas in class.

5 Travel, either with the group or alone, to nearby rural area and talk with the peasants about climate change. Have they encountered the term climate change? Are they aware of climate changes in their area? If so, what are the changes, and how have they affected their work and earning capacity? For example, have climate changes led them to change their farming activities, and have those changes affected their ability to earn a living?

6 Work with your group to prepare a report on your activities findings and opinions that you developed during in Tasks 1–5 of this Activity. Then work together to choose a group representative to present the report to the class.

2.3 CLIMATE OF ETHIOPIA

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

- describe the spatio-temporal variation of temperature in Ethiopia;
- compare rainfall distribution of Ethiopia by place and time;
- discuss factors why Ethiopia experiences climate different from other tropical countries;
- differentiate climate zones of Ethiopia;
- explain the reasons that drought may not necessarily followed by famine;
- identify drought prone areas of Ethiopia;
- state drought coping mechanism in agriculture.

Key Terms

- altitude
- traditional climate zone
- insolation
- Inter tropical convergence zone
- drought prone areas
- drought
- desertification
- rainfall regime
- range

2.3.1 Distribution of Major Elements of Climate in Ethiopia

What are the two most important elements of climate? Is the distribution of rainfall and temperature uniform in Ethiopia?

Temperature Distribution

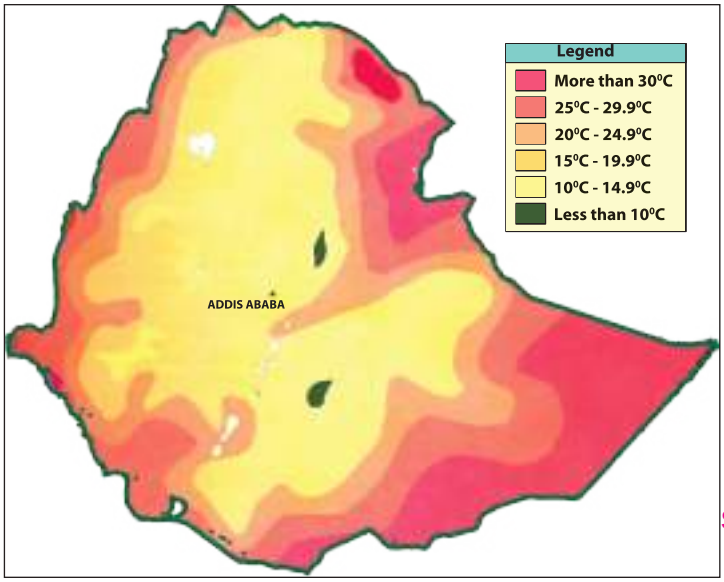
Temperature in Ethiopia is determined primarily by altitude and latitude. Ethiopia lies within the tropics, a zone of maximum insolation, where every place has overhead sun twice a year. However, considerable portions of Ethiopia are highland areas, and their altitudes give them non-tropical temperatures. Ethiopia's tropical climate occur in lowlands at the country's peripheries.

Away from the peripheral lowlands, the land begins to rise gradually and considerably, culminating in peaks in various parts of the country. The highlands form the heartland of the country. Thus temperature in most of the center of the country is affected by altitude, and temperature essentially decreases from Ethiopia's peripheries towards the interior. Ethiopia experiences both hot and cold extremes of temperature (see Figure 2.26).

Daily Temperatures: Ethiopia's daily temperatures are more extreme than its annual averages. In terms of spatial distribution, Ethiopia's daily maximum temperature varies from a high of more than 37°C over the lowlands of the northeast and of the southeast to a low of about 10°C-15°C over the highlands of Ethiopia. In terms of temporal distribution, the months of March, April and May are generally the hottest throughout the country.

Monthly Temperatures: Ethiopia's monthly temperatures also exhibit extremes. The lowest monthly minimum temperatures mostly occur over the highlands of the country. Most of the highlands experience mean minimum temperatures as low as 0°C between November and January (Bega season). The highest mean monthly minimum temperature (20°C - 30°C) is observed in the Dallol Depression. The lowest mean monthly minimum temperature (0°C or less) occurs in January in the highlands in the northwest (Gonder and Gojam), central (Shewa) and southeast (Arsi-Bale), and the highest (30°C) occurs in the lowlands of the western, southeastern and northeastern areas.

Annual temperatures: Mean annual temperature varies from a low of about 10°C, in the northwest, central and southeast highlands, to a high of about 35°C at the country's northeastern edges, which contain the Dallol (Denakil) Depression. As you can again infer, altitude is the most important temperature-controlling factor in Ethiopia.



Source: *EMA, 1988.*

Figure 2.26: **Mean annual temperature distribution Ethiopia**

Temperature Ranges

Daily (diurnal) temperature range: In the northern hemisphere, during the winter months of December, January and February, the sun apparently shifts to the southern hemisphere and Ethiopia experiences its *bega* season. During this period, the sky is clear, without blanketing cloud cover to retain heat or cold on earth. Therefore, during the day the heat from the sun is intense. But at night, because of the clear sky and relatively longer nights, temperature drops very low. Reflecting such clear-sky conditions, Ethiopia's daily temperature range is greatest during bega in most parts of the country.

Annual temperature range: Ethiopia's annual temperature range is the highest in the lowlands, and it decreases with increasing altitude.

Distribution of Rainfall

Which part of Ethiopia is the driest and wettest?

Overall, mean annual rainfall ranges from over 2200 mm in pockets of areas in the southwestern high lands to less than 400 mm over the northeast and southeastern lowlands of the country (Figure 2.27). However, the low end of the range is much less in the southeast lowlands, the Ogaden area, standing at 200 mm. In the northeast lowlands, the Afar region, it is even less than 100 mm.

The map shows that southwestern Ethiopia is the region of heaviest rainfall. It is the wettest part of the country, with only two to four dry months in a year. The mean annual rainfall for southwestern Ethiopia is about 1500 mm, but in some areas it is much higher – reaching up to 2800 mm in Mocha, southwestern parts of Gore and Arjo. Also well over the national average, mean annual rainfall can exceed 2000 mm in parts of Gimira and Kafa, Limu, Gore, Buno Bedele, Sore and Geba and the southern extreme of Gimbi. The adjoining western lowlands of Gambella and Assossa and Benishangul, which are found on the windward sides of the western highlands, receive over 1000 mm of annual rainfall.

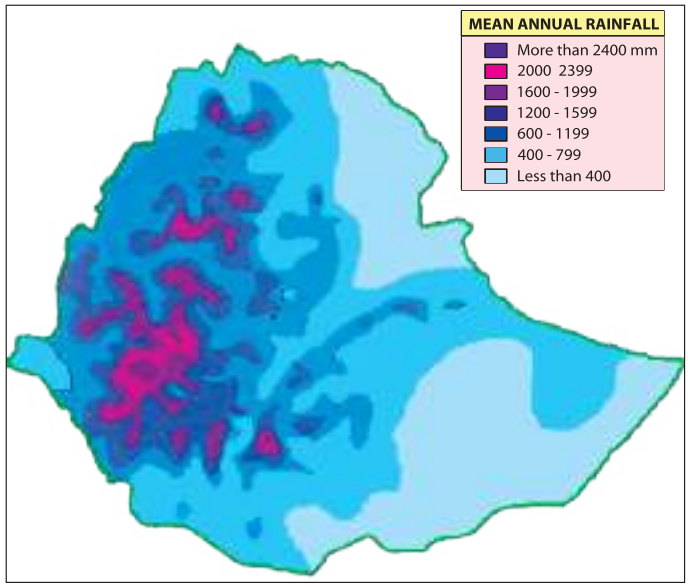


Figure 2.27: **Mean annual rainfall distribution in Ethiopia (***Adapted from the National Atlas of Ethiopia, EMA, 1988***)**

From the southwest, mean annual rainfall gradually decreases towards the northeast and east. In central and north-central Ethiopia, the annual amount is moderate, about 1100 mm. But, there are some pockets where annual rainfall reaches over 2000 mm. These include the western parts of Awi zone, and parts of Metekel and Kola Dega Damot. In parts of northern Gonder and central Wegera and central Semien, the mean annual exceeds 1600 mm.

In southeastern Ethiopia, the mean annual rainfall is about 700 mm. However, this amount varies from over 2000 mm in Jemjem, and over 1200 mm in parts of Genale and Dolo in the Bale zone and parts of Webera in Harerge, to less than 400 mm in most of the Ogaden area. In northern Ethiopia, including Tigray and Wollo, the mean annual rainfall is about 500 mm, but in some areas it rises to over 1200 mm.

Seasonal Pattern of Rainfall

Which part of Ethiopia is all - year rainfall region?

Summer Rainfall

As the ITCZ (Inter - Tropiacal convergence zone, zone of convergence of north east and south east trade winds) drifts towards the north in northern hemisphere summer (Keremt), the equatorial westerly winds from the South Atlantic Ocean invade most parts of Ethiopia, while the trade winds from the north retreat from the country. The ITCZ's southward drift marks the onset of the trade winds from the north, which causes the retreat of the equatorial monsoons. Such periodical shifts in the flow pattern of winds causes rainfall to be variable and seasonal in Ethiopia.

Rainfall in Ethiopia is seasonal, varying in amount over space and time. There is the long and heavy summer rain, which is normally referred to as "the big rain" or *keremt*. There are also short and moderate rains in autumn *(Tebi)*, winter *(Bega)* and spring *(Belg)*. They are collectively called "the little rains".

In contrast to the rest of Ethiopia, southwestern Ethiopia gets rain for a long period that stretches usually for more than eight to ten months.

Other regions, for instance the southeastern lowlands, receive rain twice a year. These rainy seasons do not correspond with *keremt* or *bega*.

In most of highland Ethiopia, the main rainy season is in summer (June to September), when the ITCZ is to the north of Ethiopia. During this season, the whole country with the exception of a few places is under the influence of the southwest equatorial westerly winds from the South Atlantic Ocean or of the south easterly winds from the Indian Ocean.

Effects of the southwest equatorial westerly winds: The southwest equatorial westerly winds originate from the South Atlantic Ocean, and they blow over the humid regions of the Gulf of Guinea, the Congo basin and Central Africa on their way to Ethiopia. When these winds approach Ethiopia they encounter highlands. When they start ascending over the highlands, they cause heavy rain in southwestern Ethiopia because they are moisture - laden. However, the amount of rainfall gradually decreases as the winds move north and northeastwards.

Highland Ethiopia receives the widest coverage of these *keremt* rains, though the amount that falls in different areas varies. The southwest experiences the longest *Keremt* rain. *Keremt* lasts for only two to three months in the extreme northeast highlands.

The eastern escarpments of the northeastern highlands and associated lowlands (the Afar region) remain dry, because they are in what is called a rain shadow.

Effects of the southeasterly winds: The southeasterly winds that originate from the Indian Ocean blow over Ethiopia's southeastern highlands and associated lowlands. However, these winds lose their moisture over the East African highlands before they reach Ethiopia. Therefore, the country's southeastern highlands and associated lowlands that receive the winds remain relatively dry.

Winter Rainfall

In winter the ITCZ shifts farthest south. Most of Ethiopia comes under the influence of North East Trade winds, which originate from west Asian high pressure centers.

These winds are cold and dry, and they carry little or no moisture, giving most of the country a dry winter. Only the Red Sea coastal plains, including parts of the Afar region, receive rain. This rain is little in amount, and is due to the area's proximity to the Red Sea.

Another exception to this lack of rain is southwestern Ethiopia. In winter this region is still under the influence of the equatorial westerly winds, although they are now weak. The moderate rain they supply to the region at this time is the area's smallest annual amount.

Spring and Autumn Rainfall

In spring the ITCZ drifts to the north and lies across Ethiopia. At this time, a strong low-pressure cell develops over the Sudan. This center attracts.

- ⇨ *Winds from the Gulf of Aden*
- ⇨ *Indian Ocean highs*

These moist south easterly winds blow across central and southern Ethiopia, and they produce the big rains in southeastern Ethiopia.

The same winds produce the little rain of spring for the east central part of the northwestern highlands. These rains are often called *Belg* rain.

Spring is the major rainfall season in the southeastern highlands and associated lowlands (Ogaden, Borena of Oromia and the South Omo zone). The area's second rainfall season is in autumn.

In the southeast peripheral lowlands, the towns of Moyale and Kelafo also receive their rainfall in spring and autumn. Moyale's annual rain is about 1000 mm. Kelafo's is about 500 mm. For Moyale, about 50% occurs in spring, and about 37% occurs in autumn. For Kelafo, the percentage distribution are approximately 60% and 33% respectively.

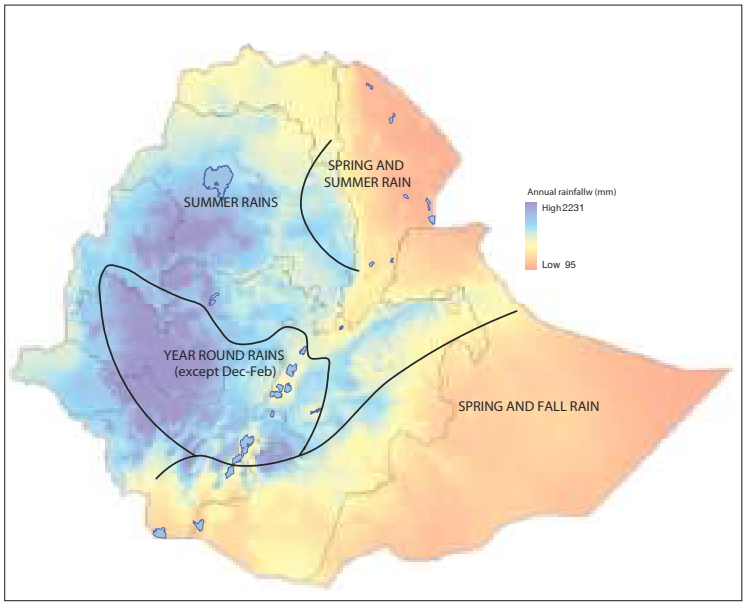


Figure 2.28: **Rainfall Regimes and Climates of Ethiopia**
(*Adapted from the National Atlas of Ethiopia, EMA, 1988*)

2.3.2 Major Climate Controls in Ethiopia

Which geographical factor is more important to the climate of Ethiopia?

Many physical factors influence Ethiopia's climates and their distribution. They are collectively called controls of climate.

Ethiopia's most important climate controls are

- ⇨ *latitude*
- ⇨ *altitude*
- ⇨ *cloud cover*

The above noted factors, together with other less important ones, determine the distribution of climate in Ethiopia. As noted earlier, Ethiopia is located within the Tropics. Therefore, in principle, it is a tropical country and might be expected to

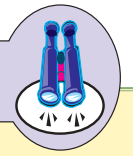
have tropical climate throughout. However, since Ethiopia is a highland country, much of its climate is affected by *altitude*. It is only in lowland areas that a tropical climate (*Kolla*) prevails. Altitude is the most important climate control in the highland parts of the country. For instance, rainfall amount tends to increase with altitude, while, in contrast temperature decreases with increasing elevation. Next to altitude in importance is latitude. See Table 2.1.

Table 2.1: **Relationships between temperature, latitude and altitude**

Town	Latitude	Altitude (m)	Mean annual temperature (°C)
Addis Ababa	9°	2400	17
Awash	9°	916	25
Ambo	9°	2130	18
Nekemte	9°	2005	18.3
Dire Dawa	9.6°	1160	25

In Ethiopia's highlands, cloud cover is another important climate control during the long rainy season – June to September. Although this period has high sun, comparatively low temperatures prevail due to the season's cloud cover, which absorbs and reflects away much of the incoming rays of the sun. The other period of high sun in Ethiopia is March to May. In the highlands, this season is not characterized by cloud cover and its temperatures are relatively high. The northeast and southeast lowlands have both low altitude and clear skies, and therefore their temperature is high.

Focus



Climate controls are factors that act on climate elements and produce different climate types. On a global level, important climate controls include latitude, altitude, distance from the sea, ocean currents, wind and air pressure, major and local relief, and sky conditions. In the Ethiopian context, altitude and latitude are the most important determinants of climate. Although two places might lie on nearly the same latitude, if their altitudes vary, they probably have large temperature differences.

Activity 2.9

Give short answers:

1 Identify the absolute location of Ethiopia.
2 What are the two water bodies that separate northeast Africa from Asia?
3 Which landform divides the Ethiopian highlands in to two?
4 What sort of climate would Ethiopia have if it had no highlands?
5 Is the climate of Ethiopia uniform throughout the country? Is the climate of Ethiopia shaped more by its latitudinal location or its variation in relief?
6 Which season is the warmest, coldest, wettest and driest in your area? Are there relationships between the major wind systems and the distribution of rainfall in Ethiopia?

2.3.3 Main Seasons and Climatic Zones of Ethiopia

Main Seasons of Ethiopia

Which season is the driest in most part of Ethiopia? In which season flowers blossom?

Ethiopia is a tropical country. It is located completely within the tropical zone. Because of its tropical location there is little variation in the length of days and nights. The maximum difference, about 30 minutes, occurs in December and June. Many people of the country are not aware of the differences. There are four main seasons per year: *Keremt*, *Tseday*, *Bega and Belg* (Table 2.2).

Table 2.2: **Temporal distribution of the main seasons in Ethiopia**

Months*	Name of season		Location of the sun
	English	Amharic	
June, July and August	Summer	*Keremt*	Northern hemisphere
September, October and November	Autumn	*Tseday*	Around the equator
December, January and February	Winter	*Bega*	Southern hemisphere
March, April and May	Spring	*Belg*	Around the equator

* *The months noted correspond only roughly to the traditional seasons.*

Traditional Climatic Zones of Ethiopia

The traditional Ethiopian classification of climatic zones is based on altitude and temperature. This system divides the nation into the following five major climatic zones: *Bereha, Kolla, Woina Dega, Dega and Wurch.*

Bereha: *Bereha* is the *hot arid climate*. *Bereha* is the climate of the desert lowlands that are found below 500 m above mean sea level where the average annual rainfall is less than 400 mm, and average annual temperature is over 30°C. *Bereha* is usually characterized by strong wind, high temperature, low relative humidity, and little cloud cover. Evapotranspiration is always in excess of rainfall in some places.

Kolla: *Kolla* is a (*warm*-to-*hot semi-arid climate*). *Kolla* is the climate of the hot lowlands with an altitudinal range of 500 to 1500 m a.s.l. Average annual temperatures are between 20°C and 30°C. Although mean annual rainfall ranges between 410 mm and 820 mm, it can be as high as 1600 mm in the wet western lowlands of Gambella. Rainfall is highly variable from year to year.

This region is intermediate between the hot arid climate and the humid climates.

Woina Dega: This is subtropical warm-to-cool semi-humid zone which corresponds to roughly with what is commonly known as the warm temperate climate. *Woina Dega* has distinct dry and wet months in winter and summer respectively.

The average annual temperature is between 15°C and 20°C, and annual rainfall is generally around 1200 mm.

Woina Dega covers the temperate highlands that fall with altitudes between 1500 m and 2300 m amsl. In the southwest, rainfall reaches 2400 mm.

Dega: *Dega* corresponds *roughly with* the temperate *climate*. *Dega* is the climate of the cool temperate highlands. It covers a region with an altitude range of 2300 m to 3300 m amsl. The *coldest* month is less than 10°C. The area experiences adequate rainfall. Rainfall ranges from about 1000 mm, in most areas, to 2000 mm in higher altitudes.

Wurch: *Wurch* is a type of Alpine climate. The annual average temperature is less than 10°C. Annual rainfall is between 800 and 2000 mm. The zone exists at altitudes equal to or more than 3300 m amsl.

This zone exists as afro-alpine areas on the highest areas of Ethiopia's plateaus. It is found in small isolated high areas such as the Senate plateaus (Bale zone), Semen mountains (north Gonder), Mount Guna (south Gonder), Amara Saint (south Wollo), and the Choke mountains (Gojam).

Table 2.3: **Traditional Temperature and Altitude Zones in Ethiopia**

Traditional Zones	Global	Altitude (meters) Zones	Mean Annual Temperature (°C)
Wurch	Alpine	Above 3300	Below 10°C
Dega	Temperate	2300 - 3300	10°C - 15°C
Woina Dega	Sub - Tropical	1500 - 2300	15°C - 20°C
Kolla	Tropical	500 - 1500	20°C - 30°C
Bereha	Desert	Below 500	>30°C

Source: *Atlas for secondary schools of Ethiopia*

Activity 2.10

I Answer the followings.

1 What are the main traditional classification of seasons in Ethiopia? What are their corresponding names in your mother-tongue language?

2 Which traditional Ethiopian seasons correspond with summer, autumn, winter and spring?

3 Are there any cultural differences between the Kolla and Dega people? Do they cultivate the same crops, rear the same domestic animals, use the same staples and wear similar clothes?

4 Do you think Dega and Kolla crops ripen at the same time? Why do the Dega people send their cattle to Kolla for grazing during rainy seasons?

II Using the following 2008 temperature and rainfall data for Addis Ababa (Table 2.4), perform these tasks:

5 Determine the city mean monthly maximum and minimum temperatures.

6 Calculate the 2008 annual mean temperature.

7 Identify the three warmest and coldest months of that year.

8 Regarding temperature range, identify
   a the month with the greatest range
   b the city's annual range

9 Identify the city's total annual rainfall.

10 Identify the three driest and wettest months.

Table 2.4: **Temperature and rainfall data of Addis Ababa, 2008**

	Unit	J	F	M	A	M	J	J	A	S	O	N	D
Max. temp	°C	23.3	24.1	26.6	25.2	25.8	25.5	21.3	21.3	22.9	23.0	23.9	22.2
Min. temp	°C	9	10	11.9	12.0	12.1	12.3	11.5	11.6	11.9	10.5	8.7	10.7
Rainfall	mm	21.3	2.73	28.4	80.6	58.9	82.6	349.9	388.3	112.9	45.8	4.4	0

2.3.4 Drought in Ethiopia

What is drought? What is famine? Does drought necessarily lead to famine? What are the causes of drought? What are some of the consequences of drought? What is the average recurrence interval of major and minor drought in Ethiopia? Which part of Ethiopia is the most affected by recurring drought? What are some drought-mitigation and drought-adaptation measures? What is drought?

Drought is a condition that happens when much less rain is received than is normally expected. It is a period of abnormally dry weather that is sufficiently long enough to cause serious problems for agriculture and other activities in the affected area. This extended period usually involves months or years during which the region receives consistently below-average rainfall.

Drought is one of the world's major environmental hazards. It affects human and animal life catastrophically, and it can cause severe crop failure.

Consequences of drought

Unless drought-causing conditions are reversed by putting into practice measures of mitigation, drought can have adverse consequences both on the natural environment and on the socio-economic life of the people in drought-prone areas. Some of the general consequences include climate change, drying up of surface and subsurface water sources (ponds, streams, swamps, reservoirs, lakes, etc.),

decline in underground water tables, loss of soil moisture, crop failure, starvation and famine, death of animals and human beings, lack of seeds, livestock and labor, loss of biodiversity and environmental deterioration, desertification, rural out-migration, etc.

Although famine and starvation can result from drought, they are not its necessary consequences, even though this has generally been the case in Ethiopia and other less developed countries.

Drought can happen anywhere in the world. But a countries' ability to resist it is a function of their developmental stage. Less developed countries like Ethiopia are highly vulnerable, and affected by post-drought effects. In addition, their political, economic and social affairs are highly influenced by drought and its product, famine. However, economical well-to-do countries can manage drought and resist its after effects with their systems and wealth. A country under the influences of drought and famine for long periods of time may develop *dependency syndrome*. This may lead to loss of self esteem and national pride and end up in longing for foreign donations.

Drought-Prone Areas in Ethiopia

The three drought-probability zones of Ethiopia include:

i *High drought probability zone* (zone III) covered about 25% of Ethiopia in 1988. This zone includes the *Bereha* climatic zones of the largest part of the Somali and Afar regions, part of the Tigray region, the eastern portion of the Amhara region, and the southern part of the Oromia region.

ii *Medium drought probability zone* (Zone II) covers part of the Somali, Oromia and Afar regions, and small portions of the eastern Tigray and Amhara regions. It covers about 10% of the country.

iii *Low drought probability zone* (Zone I) also covers about 16% of Ethiopia's area, including most of the semi-arid (*Kolla*) climatic zones. It includes part of the eastern highlands of Tigray and Amhara regions, the eastern and southern parts of Harerge, a portion of the Bale, Borena and Guji zones, and the southern portion of the south Omo zone.

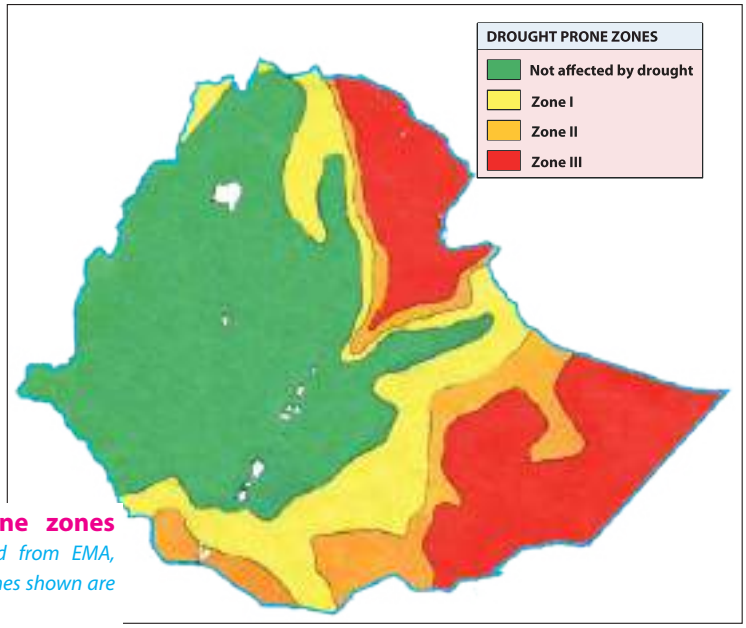


Figure 2.29: **Drought-prone zones in Ethiopia** (*Adapted from EMA, 1988. Internal boundary lines shown are no more in use.*)

Drought-Coping Mechanisms in Ethiopia

What should be done to mitigate and cope with drought and its adverse effects?

Geographers expect major droughts to reoccur in Ethiopia at about ten-year intervals and expect minor droughts at two-years intervals. Hence, the Federal and Regional Governments, the nation's farming community and other stake holders, should make themselves ready for the challenge of reoccurring drought and related problems by mobilizing the resources of rural farming and pastoralist communities and government facilities to avert the situation by implementing as many of these mitigation and adaptation measures as possible.

- *carefully planned land use to increase agricultural productivity and minimize erosion*
- *encouraging farmers in the drier areas to plant crops that have low water-dependencies*
- *drilling deep water wells, installing water pumps and building simple irrigation channels.*
- *rainwater harvesting collecting and storing rainwater on various scales*
- *recycling waste water for reuse after treatment and purifying*
- *building reservoirs and canals and redirecting rivers as massive attempts at irrigation in drought-prone areas*
- *instituting outdoor water-use restriction - regulating the water use of sprinklers or buckets for watering outdoor plants, for filling pools, and for water-intensive home maintenance tasks*

- *planting trees in degraded areas*
- *ensuring wise use of forest rangeland resources*
- *maintaining reserves of food (for example, grains) and other facilities*
- *limiting household size by regulating population growth*
- *instituting water and soil conservation programs.*
- *Other measures include resettlement and rehabilitation of drought victims, the distribution of seeds, oxen, fertilizers and livestock in pastoralist regions, and construction of roads.*

Activity 2.11

1. Why and how might famine affect "the national pride" of a country?
2. Identify the regions which have been most susceptible to frequently reoccurring drought and famine in Ethiopia.
3. Why are most of the western highlands and associated lowlands of the southwest not much prone to drought?
4. Which areas in Ethiopia are in a transitional zone or moderate drought-probability zone?
5. Identify the natural and human factors that result in drought.
6. What are the effects of drought on water resources?
7. What measures do you suggest to combat drought in your locality?
8. What measures are taken by people to fight drought in your local area?
9. What measure is the government taking in your locality to fight drought and famine?
10. Do you think we can solve the problem of famine with international aid only? Discuss.
11. What is the difference between aid and development aid?
12. Which one is important for the future of the country? Discuss this issue in your group.

2.4 ECOSYSTEMS

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

- review the concept of an ecosystem;
- discuss how climate affects the distribution of an ecosystem;
- realize the effect of latitude on the variation of an ecosystem;
- explain the role of altitude on the distribution of ecosystem;
- relate factors that affect the diversity of fauna and flora in the ecosystem;
- identify factors that affect soil in ecosystems.

Key Terms

- ecology
- ecosystem
- abiotic factor
- biotic factor
- habitat
- fauna
- flora
- deciduous
- savanna
- biome

Do you remember the discussion about ecosystem in grade 9? What is an ecosystem? What are the components of an ecosystem? How do organisms interact with each other in an ecosystem?

An ecosystem is all the living and non-living things in an area interacting with each other. Ecology is the study of how all these things interact in order to survive.

Ecosystems vary in size. Some are small and some are much larger like the ecosystem of the desert of Africa, and the rainforest of Brazil that cover large areas of a country or continent.

It doesn't matter where they are or what they look like all ecosystems have the same elements.

The non-living parts of an ecosystem are the ecosystem's abiotic (a'biot'ik) factors. All living things need certain non-living things in order to survive. Abiotic factors include water, minerals, sunlight, air, climate, and soil.

2.4.1 Factors that Affect the Distribution of Ecosystems

Two primary non-biological factors have major impacts on the kind of ecosystem that develops in any part of the world:

- *precipitation*
- *temperature*

In turn, elevation (altitude) affects these primary factors.

Precipitation and Temperature

How does temperature influence the distribution of vegetation?

Precipitation and *temperature* are major factors that determine the vegetation in an ecosystem, In turn, the types of vegetation that result affect everything else in the ecosystem eventually. Figure 2.30 shows the impact of precipitation and temperature on vegetation.

The types and degrees of impact that precipitation has on an environment depend on several aspects of precipitation, including the total amount of precipitation per year, the form in which it arrives (rain or hail or snow), and its seasonal distribution. Precipitation might be evenly spaced throughout the year or it might be concentrated at particular times, creating wet and dry seasons.

Temperature patterns are also important. They vary considerably in different parts of the world. For example, **tropical areas** have warm, relatively unchanging temperatures throughout the year, whereas the **poles** have long winters, with extremely cold temperatures, and relatively short, cool summers. In other areas, temperature variation is between those extremes, creating different types of cold and warm seasons.

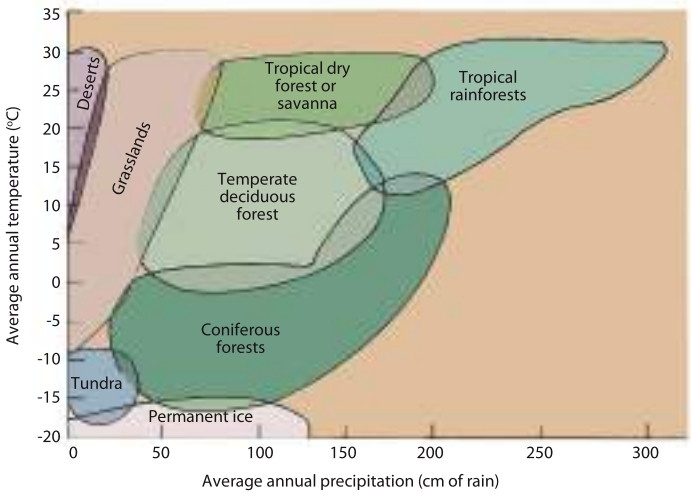


Figure 2.30: **Impact of temperature and precipitation on vegetation**

Figure 2.30 illustrates the way that temperature and moisture influence the kind of vegetation that occurs in an area. Areas with low moisture and low temperatures produce **tundra**. Areas with high moisture and freezing temperatures during part of the year produce **deciduous or coniferous forests**. Dry areas produce **deserts**. Moderate amounts of rainfall or seasonal rainfall support **grasslands or savannas**. Areas with high rainfall and high temperatures support **tropical rainforests**.

The Effect of Elevation on Climate and Vegetation

What makes higher altitudes cool?

As height above sea level increases, the average temperature decreases. As one proceeds from sea level to the tops of mountains, it is possible to pass through a

series of ecosystems that are similar to what would be encountered if one traveled from the equator to the north pole (see Figure 2.31).

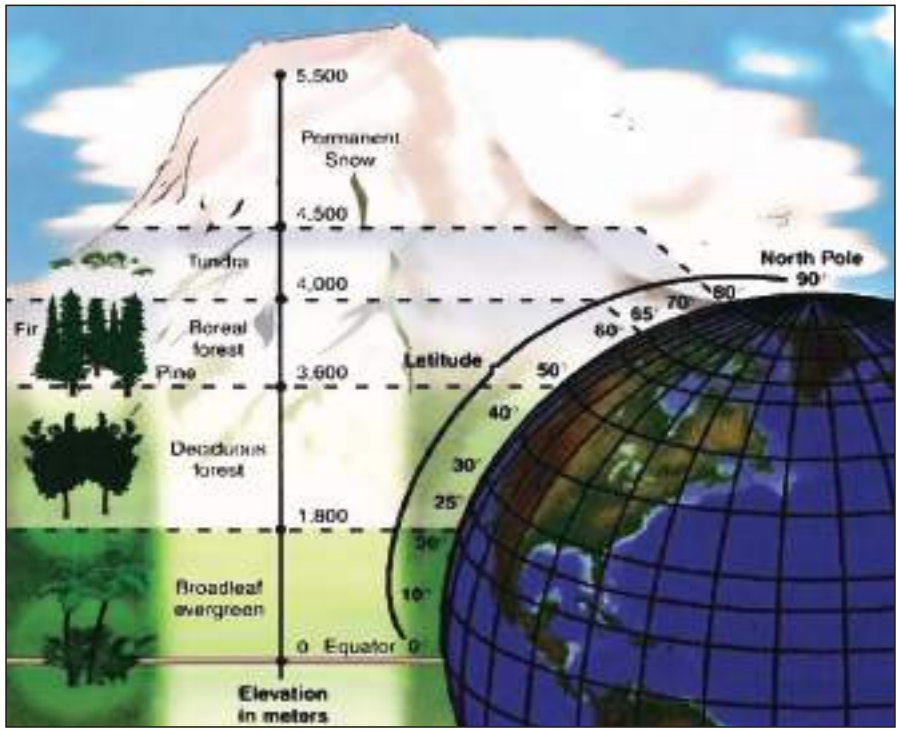


Figure 2.31: **Relationships between altitude latitude, and vegetation**

The higher the altitude, the cooler the climate becomes. For example, This happens when we travel from the peripheral lowlands of Ethiopia to the mountains found in the northwest and southeast of the country. Even in the Tropics, tall mountains can have snow on the top, for example, on Mt. Kilimanjaro (see Figure 2.32). Thus, it is possible to experience the same change in vegetation by traveling up a mountain as one would experience traveling from the Equator to the north pole.

Focus

An **ecological system** or, in short, an **ecosystem,** is a system formed by the interaction of all living organisms with each other in an area and with the chemical and physical factors of the environment in which they live. They are all linked by the transfers of energy and materials that constitutes the *food chain*. **Ecology**, on the other hand, is the scientific study of the inter-relationships between living organisms and the environment. An **ecological factor** is any environmental factor which affects a living organism.

Figure 2.32: **Mount Kilimanjaro**
It is the highest mountain (5895 m) in Africa. It is found in Tanzania along the border with Kenya. It rises to about 4000 m above the surrounding surface, rising through rainforest, moorland, alpine desert, snow fields and ice cliffs, and all of these phenomena are virtually on the equator (3°S latitude)!

2.4.2 Diversity of Fauna, Flora and Soil of Ecosystems

Among many factors that shape the type of fauna, flora and soil type of an ecosystem, climate plays a decisive role in their distribution and activities.

The land on earth is divided into six major kinds of large ecosystems called biomes. The six biomes are: desert, tundra, grass land, decidious forest, taiga and tropical rain forest. Each biome has its own kind of climate, soil, plants and animals. Each biome can be found in different parts of the world. For example a desert biome is found in North America, Africa, South America, Asia and Australia.

Desert

What is desert? What characterizes it?

A lack of water is the primary factor that determines that an area will be a desert. Deserts are areas that generally average less than 25 centimeters of precipitation per year. They are also likely to be windy.

Plants and animals are many species, but they typically have low numbers of individuals. However, those species that are present are specially adopted to survive in dry, often hot or cold environments. For example, water evaporates from the surfaces of leaves. As an adaptation to this condition many desert plants have very small leaves that allow them to conserve water. Some, such as *cactus*, have the ability to store water in their spongy bodies or their roots for use during drier periods.

Other plants are *ephemerals*, only bursting into life when rain falls, flowering and producing seeds which may then lie dormant for years until the next rain falls. The Rose of Jericho, a plant of the Middle East, is a good example of this type.

All of the animals that live in deserts are able to survive with a minimal amount of water. They generally have an outer skin that resists water loss, so they lose little water by evaporation.

Due to lack of moisture and vegetation in hot desert areas there has been little true development of soil, the surface simply consisting of drifted sand, pavements of bare rock, gravel or boulders.

Figure 2.33: **Desert landscape**
Drought-resistant scrubs and camels (A) *and sand dunes* (B).

Figure 2.34: **A desert ecosystem, the Sahara Desert**

Tundra

Why is tundra called a treeless region?

The harsh climate of the high latitudes around the Poles prevents the growth of most plants. Indeed, the very word tundra means' a treeless plain.

Even in mid summer only the top few centimetres of ground thaws out and beneath this it is permanently frozen - Permafrost. In addition to lichens and mosses which are the basic 'building blocks' of the tundra ecosystem, a range of grasses and sedges with dwarf and creeping plants are to be found.

Under natural conditions, the tundra vegetation was grazed by large migratory herds of caribou and reindeer. Other grazing animals of the tundra include the *musk ox*, which survives the cold by means of extremely thick coat. Predators include *polar bears* and the *arctic fox*, which is largely dependant on the huge numbers of ground - nesting birds that migrate to the tundra to breed during the short summer. Among them are several species of *geese*, *wild fowl* and *wading birds*. One of the most remarkable of these is the *Emperor penguin*, adapted to withstand the Antarctic cold by a thick layer of blubber and a fine covering of feathers.

The sub soil remains permanently frozen and the surface layer is waterlogged since water cannot percolate through the impermeable permafrost.

The lack of oxygen in these water logged conditions restricts bacterial action so that the remains of the tundra vegetation only partly decompose and accumulate as a layer of peat, stained black by acid humus.

Grass Lands

Why do grasses become dominant in the region?

Temperate grasslands are also known as *prairies* or *steppes* and typically *savannas* are tropical grass lands (Figure 2.35). Grass lands generally receive between 25 and 75 centimeters of precipitation per year. Grasses make up 60 to 90 percent of the vegetation. Many other kinds of flowering plants are interspersed with grasses.

In areas where the human population is small, huge herbivore animals including *elephants*, *zebras*, *wildebeest*, *gazelles* and *antelopes*, roam across the African plains. Carnivores, such as *lions*, *cheetahs* and *leopards*, prey on the grazing herds, along with scavenging *jackals*, *hyenas* and *vultures*.

The soil of tropical grasslands are strongly influenced by the lengthy droughts that alternate with wet seasons.

Figure 2.35: **Typical East African grassland savanna, a region of wet-and-dry climate (Aw), after Ahrens, 2007**

Deciduous Forest

Why do trees shed their leaves during winter in deciduous forest?

This is a forest biome with many trees that lose their leaves each year. This is where broad-leaved trees grow. Each autumn the leaves turn yellow, orange and red painting the land with glorious colors. Then, the leaves fall to the ground which is what deciduous means and decay. The dead leaves help make the soil rich and fertile. Trees shade leaves to conserve water.

These areas generally receive 75 to 100 centimeters of relatively evenly distributed precipitation per year. In deciduous forests of North America and Europe, common tree species are *maples, birch, beech, elm, oaks*, and other hard woods. In addition many small flowering plants bloom in the spring.

These forests are home to a great variety of insects like beetles, moth larvae, wasps and ants. The birds that live in these forests are primary migrants that arrive in the spring of the year. A few kinds of birds including *woodpeckers*, *turkeys*, *geese* and some *finches*, are year-round residents. Amphibian and reptiles prey on insects and other small animals.

Several kinds of small and large mammals inhabit these areas *mice, squirrels, deer, shrews, moles*, and *opossums* are common examples. Major predators on these mammals are *foxes, badgers weasels, coyotes* and *birds of prey*.

Taiga, (Coniferous Forest)

How does coniferous forests differ from deciduous forests?

The climate is one of short, cool summers and long winters with abundant snowfall. Precipitation ranges between 25 and 100 centimeters per year.

Conifers such as *spruces, firs* and *larches* are the most common trees in these areas. These trees are specifically adapted to winter conditions. The needle - shaped leaves are adapted to prevent water loss.

The branches of these trees are flexible, allowing them to bend under a load of snow so that the snow slides off the pyramid - shaped trees without greatly damaging them.

Most birds are migratory and feed on the abundant summer insect population, which is not available during the long, cold winter. Typical mammals are *deer, caribou, moose, wolves, weasels, mice, snowshoe hares,* and *squirrels*.

In this cold climate, in which precipitation exceeds evaporation, the needles and litter from the coniferous trees are slow to decay.

When they do so, they form an acidic humus soil. This severely restricts the variety of plant species able to grow here. Those that do occur, such as conifers, are those species that require few nutrients.

Tropical Rainforest

In which biome do we find Earths tallest trees?

Tropical forests are located near the equator.

The temperature is normally warm and relatively constant. Most areas receive in excess of 200 centimeters of rain per year - some receive 500 centimetres or more. Because of the warm temperatures and abundant rainfall, most plants grow rapidly; however soils are usually poor in nutrients because water tends to carry away any nutrients not immediately taken up by plants. Many of the trees have extensive root networks, associated with fungi, near the surface of the soil that allow them to capture nutrients from decaying vegetation before the nutrients can be carried away.

They have a greater diversity of species than any others biome. More species are found in the tropical rainforests of the world than in the rest of the world combined. It is typical to have distances of a kilometer or more between two individuals of the same species. *Balsa, teakwood, ironwood, mahogany, ebony* and other ornamental woods are common.

Associated with this variety of plants is an equally large variety of animals. Insects, such as ants, termites, moths, butterflies, and beetles, are particularly abundant. Birds also are extremely common, as are many climbing mammals, lizards, and tree frogs. Because of the low light levels and the difficulty of maintaining visual contact with one another, many of the animals communicate by making noise.

Figure 2.36: Tropical rainforests developed in areas with high annual rainfall (as much as 2400 mm – 4600 mm) and very warm temperatures. They have an extremely diverse mixture of plants – vines, orchids , ferns, and a wide variety of trees (A). Many animals, inhabit tropical rainforests, including more species of insects, reptiles, and amphibians than in any other part of the world. Rainforests are home to all sorts of colorful birds and to monkeys, and to other small and large mammals, including, in some places, elephants (toucan bird, (B))

Activity 2.12

Part I

1 What are some of the adaptive mechanisms of plants in desert ecosystem?
2 What is the reason for desert areas to have little true development of soil?
3 Which plant species form the basic 'building blocks' of the tundra?
4 Write some of the grazing and predator animals in tundra region?
5 What climatic condition influence the soil of tropical grass lands?
6 Which forest ecosystem trees lose their leaves during winter?
7 Why is the coniferous forest plant variety limited?
8 Why is the topical rainforest soils are poor in nutrients?
9 Enumerate some of the hardwoods in tropical rainforest.
10 Compare and contrast the soil types in tundra and tropical rainforest ecosystem.
11 Using Figure 2.38, identify which biome is not found in Africa and North America and why?

Part II

In your geography work group, perform the following tasks.

12 What makes desert soils different from equatorial forest soils?

13 Deforestation of tropical rainforests has become a pressing problem.

- a What is the cause of the problem?
- b How does the international community address the problem?
- c Being a member of the international community, what can be your contribution to the solution?

Work with the other group members to write a report about task 3 and your results and opinions.

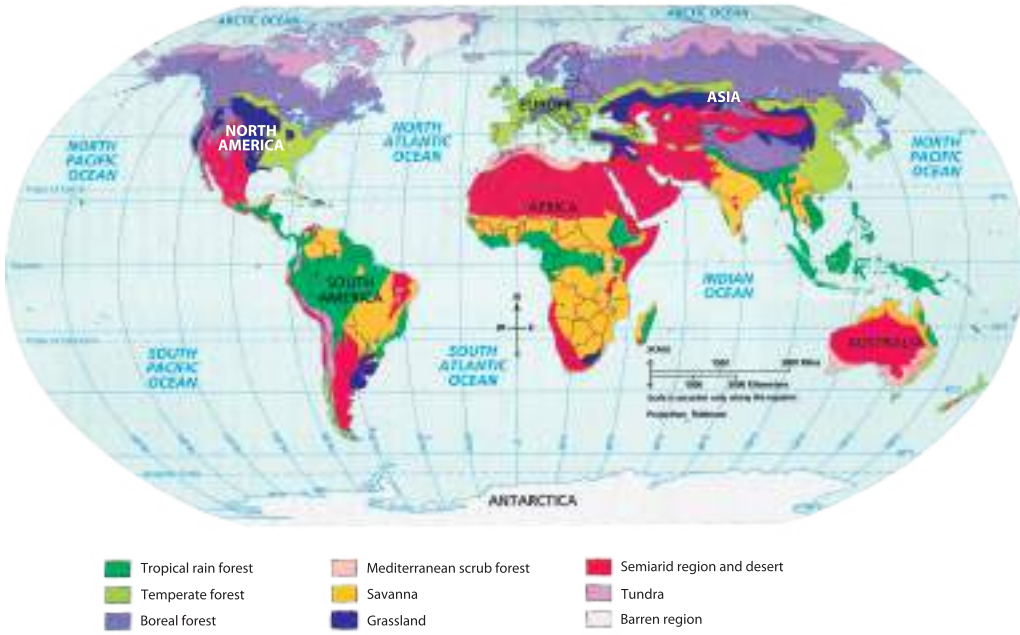


Figure 2.37: **The world's basic biomes**

Unit Review

UNIT SUMMARY

- The birth of our solar system began as dust and gases (nebula). Repeated collision caused the dust particles to change into planets in million years time.
- The earth is one of the nine planets that, along with the others, revolves around the sun
- The earth's origin is related to the process of formation of the solar system
- The earth is composed of a great central core and a series of surrounding layers, collectively known as mantle, and crust.
- Geologists estimate that the earth formed 4.6 billion years ago.
- All divisions in the geological time scale are based on changes in existing fossils of organisms.
- During the Precambrian era, Ethiopia was made up of huge mountains which were folded and faulted.
- Continental drift theory suggests that continents were once joined together and later split and drift apart.
- The earth system can be divided into four physical systems: the atmosphere, the lithosphere, the hydrosphere and the biosphere.
- Rocks are naturally formed solid that is an aggregate of one or more different minerals.
- Igneous rocks cover large areas of the central part of Ethiopia.
- Soil is a complex mixture of inorganic minerals, decaying organic matter water, air and living organisms.
- In the case of good quality soil materials, water and soil, and organic material account 45%, 25% and 5% respectively.
- Some of soil conservation methods in Ethiopia include contour plough, strip cultivation and terracing.
- Water erosion is the main cause of soil erosion in Ethiopia.
- Koppen's widley used classification of world climates is based on seasonsal variations in the annual and monthly averages of temperature and precipitation.
- Climate change may be limited to a specifc region or may occur across the whole earth.
- What the world is more worried about is that the changes that are occuring today have been speeded up because of man's actvities.

- Desertification which is desert-like condition's may spread over human habitats, croplands and wet lands as a consequence of climate change.
- Temperature in Ethiopia is determined primarly by altitude and latitude.
- Rainfall in Ethiopia is seasonal, varying in amount over space and time. There is the long and heavy summer rain accompained by short and moderate rains in autumn, winter and spring collectively known as 'little rains'.
- Ethiopia is a highland country and much of its climate is affected by altitude.
- Drought is a condition that happens when much less rain is received than expected.
- Although famine and starvation can result from drought, they are not its necessary consequences.
- High drought probability zone is Ethiopia include part of the Somali and Afar regions, part of Tigray, eastern Amhara and southern part of the Oromia region.
- Some of drought – coping mechanism in Ethiopia are: careful planned land use, planting crops of low – water dependency, rain water harvesting and planting tree in degraded areas.
- Latitude affects the distribution of vegetation and as a result low latitude support equatorial forests where polar areas entertain tundra vegetation.
- Because of the effect of altitude vegetation variation is similar when we travel up a mountain as one would traveling from the equator to the North pole.
- Climate is the main factor that facilitate the development of soils in different ecosystems.
- Precipitation and temperatrue are major factors that determine the vegetation in an ecosystem.
- As one proceeds from sea level to the tops of mountains, it is possible to pass through a series of ecosystems that are similar to what would be encountered if one traveled from the equator to the north pole.
- Among many factors that shape the type of fauna, flora and soil type of an ecosystem, climate plays a decisive role in their distribution and activities.

REVIEW EXERCISE FOR UNIT 2

I *Match the descriptions given under column 'A' with the terms listed under column 'B'.*

	A		B
1	The study of living and non-living things interacting with their environment.	A	Tundra
2	Photosynthesis can be possible only in its presence.	B	Water
3	Living things in the ecosystem.	C	Desert
4	Includes all species in a certain place.	D	Savannah
5	All the populations living in an area.	E	Tropical rainforest
6	The function and activities of the organism.	F	Abiotic factor
7	The area in which an organism lives.	G	Biotic factor
8	Areas with low moisture and low temperature.	H	Ecology
9	The most diversified ecosystem.	I	Community
10	Global temperature has risen by 0.6^{o}C over the past century.	J	Sandy soil
11	Non-living things.	K	Niche
12	Occupies transitional zone between tropical climate and hot deserts.	L	Habitat
13	It is dry year round.	M	Population
14	Flooding is less likely.	N	Precipitation
15	All forms of moisture that come to the ground from the air.	O	Greenhouse gases

II *Choose the word or phrase that best answers the question.*

16 Which one of these had the longest geological time?

A the Paleozoic era
B the Cenozoic era
C the Precambrian era
D the Mesozoic era

17 In which era did the dinosaurs live?

A Mesozoic
C Cenozoic
B Paleozoic
D Precambrian

18 What two important elements constitute the earth's innermost core?

A Potassium and magnesium
B Nickel and iron
C Granite and basalt
D Magma and lava

19 During which era did huge mountain building take place in Ethiopia?

A Mesozoic
C Cenozoic
B Precambrian
D Paleozoic

20 When was the Ethiopian Rift Valley formed?

A Quaternary period
B Tertiary period
C Carboniferous period
D None of the above

21 Who was the first person who tried to explain the present location and distribution of the seven continents, using the Continental Drift theory?

A Darwin
B Alfred Wegener
C Harry H. Hess
D Sir Francis Bacon

22 Which of the following is an example of a clastic sedimentary rock?

A Limestone
C Sandstone
B Coal
D Chalk

23 During what process are sediments pressed together?

A Cooling
C Compaction
B Melting
D Weathering

24 Which of these is a bioclastic sedimentary rock?

A Salt
C Coal
B Conglomerate
D Limestone

25 In which part of Ethiopia do we find metallic minerals in association with Precambrian rock?

A The western part of the country.

B The southern and eastern parts of the country.

C The northern part of the country.

D In all parts of the country.

26 Which of these soil types has a coarse texture?

A Silt

B Sand

C Loam

D Clay

27 Which land use has made the most critical contribution to the problem of soil erosion in Ethiopia?

A Wildfire

B Deforestation

C Overgrazing

D Road construction

28 According to the Kŏppen classification of climate, letter B stands for:

A Tropical climate

B Polar climate

C Dry climate

D Temperate climate

29 Which months are the warmest in most part of Ethiopia?

A September, October and November.

B March, April and May

C June, July and August

D December, January and February

30 Which part of Ethiopia is the wettest?

A Norther

B Eastern

C Southwestern

D Northwestern

31 Which one of these traditional climate zones is dominated by acacia vegetation?

A Woina dega

B Dega

C Bereha

D Wurch

32 Which traditional climate zone is associated with Afro-alpine areas?

A Kolla

B Dega

C Wurch

D Woina dega

33 Which one of these bodies of water is a source of *keremt* rainfall to most parts of Ethiopia?

A Red Sea
B Indian Ocean
C Atlantic Ocean
D Mediterranean Sea

34 Planting trees to replace trees destroyed by deforestation refers to.

A Afforestation
B Logging
C Reforestation
D Terracing

35 What two non-biological factors contribute the most to ecosystem development?

A Soil and temperature
B Precipitation and temperature
C Water and organisms
D None of the above

36 Which of the following services that forests perform is the most valuable one?

A Their soil-conservation functions
B Their contribution to lumbering activities
C Their service as a sink of carbon
D Their service as a habitat

III *Define the following terms.*

a Pangaea
b tectonics
c transform boundaries
d biosphere
e compaction
f divergent boundary
g extrusive
h sedimentary rock
i cementation
j hydrosphere
k lithosphere
l anthracite

IV *Answer the following questions. Support your answers with reasons appropriate to the issues.*

37 Why are the equatorial forests so valuable?

38 Is there any other carbon storage (sink) on earth than equatorial forests?

39 Why are world equatorial forests shrinking over time?

40 Why are equatorial forest soils nutrient-poor?

V *Study the rainfall map of Ethiopia on Figure 2.28 in association with the political map and answer the following questions.*

41 Which parts of Ethiopia receive the highest and lowest amounts of rainfall?

42 In which rainfall regime are the following towns located?

a Gore

b Gambella

c Mekele

d Gonder

e Dire Dawa

f Semera

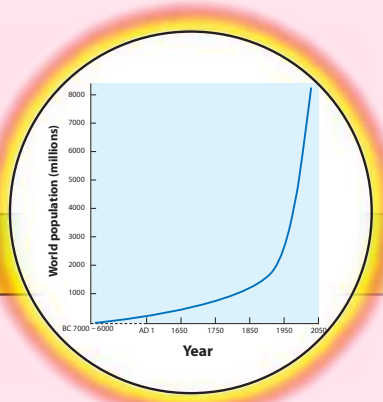
g Hawassa

h Addis Ababa

i Nekemte

j Jijiga

Unit 3



WORLD POPULATION

Unit Outcomes

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

- Understand the size and trend of world population growth;
- State the components of population change and compare the characteristics of population structure between developed and developing countries;
- Show factors affecting spatial distribution of population and compute population densities;
- Recognize and appreciate the process and development of urbanization;
- Explain the general characteristics of the population of Ethiopia.

Main Contents

INTRODUCTION

In the previous unit, you have learnt about the physical environment such as structure, geological events and components of the earth's environment. This unit deals with population of the world and Ethiopia. You will learn about their size and trend of population growth, dynamics of population structure and spatial distribution of population, urbanization, and population policy of Ethiopia.

3.1 SIZE AND TREND OF WORLD POPULATION GROWTH

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

- Compare population size of the world on continental bases;
- Identify three leading populous countries in each continent;
- Describe population growth trends of the world to show doubling time;
- Compare the population trend between Africa and Europe.

Key Terms

- size of population
- doubling time of population
- growth rate of populations
- population explosion
- trend of population growth

What factors have contributed to the growth of world population since 5000 BC, about 7000 years ago?

For most of our history, human populations have been small, compared to those of other species. Studies of hunting and gathering societies (before 5000 BC) suggest that total world population was probably only a few million people. A major change occurred about 10,000 years ago, when humans began to domesticate animals. This advance led to increased food supplies, which allowed the human population to grow, reaching perhaps 50 million people by 5000 B.C. (See Table 3.1).

However, for thousands of years, the human population increased very slowly, and it took more than 1,500 years to reach the 500 million mark. Growth was not steady, but was marked by great fluctuations dictated by climate, food supply, disease and war.

Table 3.1: **World population growth and doubling time**

Date	Population (millions)	Doubling time (years)
5000 B.C	50	-
800 B.C	100	4,200
200 B.C	200	600
1200 A.D	400	1,400
1700 A.D	800	500
1900 A.D	1,600	200
1965 A.D	3,200	65
1990 A.D	5,300	38
2020 A.D (estimate)	8,230	55

Source: *Cunningham and Saigo, 1996*

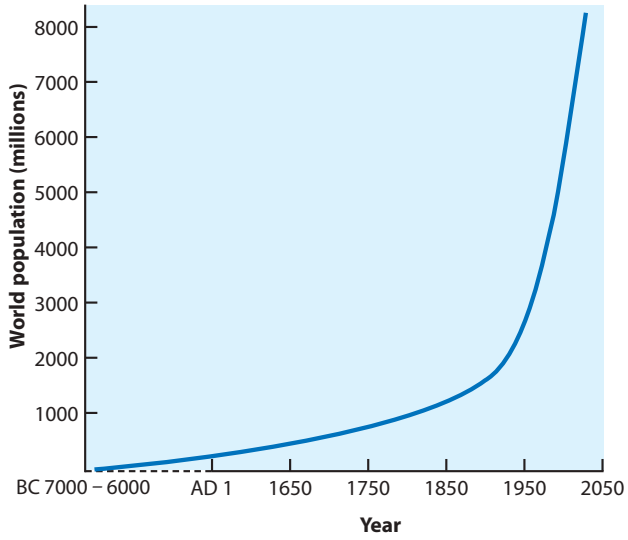


Figure 3.1: **World population growth**

Activity 3.1

In your geography workgroup of three to five students, discuss the following questions.

With the help of Table 3.1 and Figure 3.1, briefly describe changes in world population size and growth trends over time. Consider the following important points during your discussion:

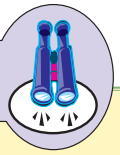
a The 17th century and onwards has been a period of advancement of science and technology.

b Since about 1950, we have had moderate medicine costs, high-yield varieties of seeds, improvements in transport facilities, great declines in death rates, increased life expectancy, and so forth.

Both Table 3.1 and Figure 3.1 show that, by 1900, world population had reached 1.60 billion, and by 1960 it stood at 3.04 billion.

The United Nations estimated that world population reached 6 billion with an annual growth rate of 1.5% by 2000 A.D. The number added to world population per year would increase from 80 million to 90 million if the growth rate of 1.5% continues, and world population would double in a period of 40-50 years from about 2000 A.D. Such rapid and dramatic growth rate of the world population is known as ***population explosion***.

Focus



How do you calculate population doubling time?

Population doubling time is the time taken, in years, for a population of a given region or country to double at a given rate of population growth. It can be calculated using the following formula:

$$\text{Doubling Time} = \frac{70}{\text{Growth Rate}}$$

Population growth rate determines the time required for a population to double. The lower the growth rate, the longer is the doubling time, and the higher the growth rate, the shorter is the doubling time (Table 3.2).

Table 3.2: **World population size growth rate and doubling time**

Region	Population (millions) 2010	Annual growth rate in % 1975 - 2009	Doubling time (year) 1975 - 2010
World	6,909	1.53	46
Asia	4167	1.62	43
Africa	1033	2.59	27
Europe	733	0.23	304
L.America	589	1.73	41
N.America	352	1.07	65
Oceania	36	1.49	47

Source: *World Population Prospects, UN, New York, 2009.*

Activity 3.2

Answer the following questions, based on Table 3.2 and Figure 3.1.

1 Identify the two continents whose population growth rates differ the most.

2 Why do you think that Africa experiences the shortest doubling time in the world?

3 Briefly discuss the consequences of any rapid population growth you have observed in your locality. What measures do you suggest to correct the situation?

4 Why is the beginning of the 20th century taken as a turning point in the history of world population? (Refer to Table 3.1 and Figure 3.1.)

As it is shown in Table 3.2, Europe and Africa have shown very contrasting doubling times. The doubling times of the former and the later are 304 years and 27 years, respectively. This implied that even among the developing regions, Africa has the fastest population growth rate in the world.

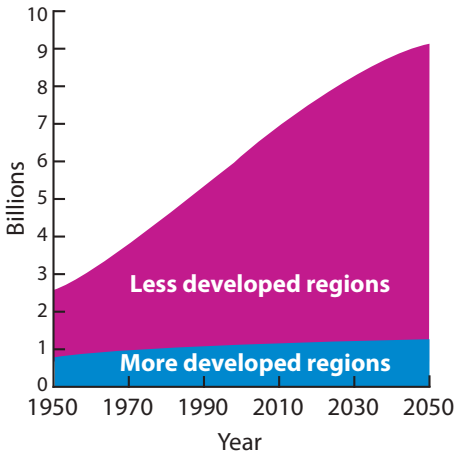


Figure 3.2: **Population growth in more and less developed countries, 1950 – 2050**

Table 3.3: **The world's populous countries in each continent**

2010		2050	
Country	Population (million)	Country	Population (million)
China	1338	China	1747
India	1189	India	1437
USA	310	USA	420
Indonesia	236	Indonesia	297
Brazil	193	Brazil	295
Pakistan	185	Pakistan	282
Bangladesh	164	Bangladesh	260
Nigeria	158	Nigeria	231
Russia	142	Russia	187
Japan	128	Japan	150
Ethiopia	85	Ethiopia	173
Egypt	80.5	Egypt	138
UK	62	UK	77
Germany	82	Germany	72
Colombia	46	Colombia	61
Mexico	111	Mexico	129
Canada	34	Canada	48
Australia	22.4	Australia	34

Source: *2010 Population Reference Bureau*

Generally, nations are considered to be less developed if they have a lower standard of living than the developed nations. A large share of the population in these less developing countries live at subsistence levels, and medical resources

are limited. However, population growth in less developed nations occurs at a much faster rate than in the developed nations.

As of 2000, 1.2 billion people lived in the developed nations of the world, and 4.9 billion people lived in the less developed countries. By region, over half the world's population was in East and South Asia: China, with 1.3 billion inhabitants, India with 1.1 billion, and Indonesia with 0.23 billion were the dominant contributors.

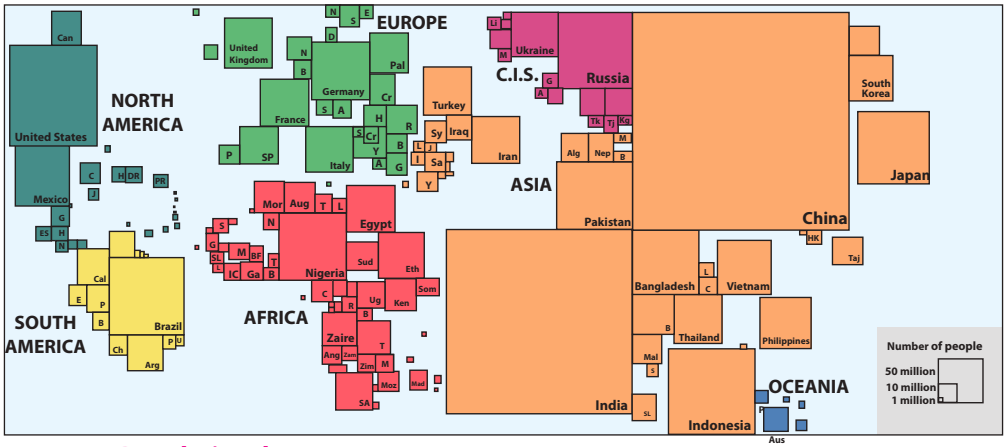


Figure 3.3: **Population, by country**

Europe and the countries of the former USSR contained 14% of the world population, North and South America made up 14%, Africa had 13%, Asia 58% and the Pacific islands had about 1% (see Figure 3.3 and Table 3.4).

Table 3.4: **Percentage distribution of population, over years, by continents**

Continents	1750	1800	1850	1900	1950	2000	2050
Africa	13.4	10.9	8.8	8.1	8.9	13.1	20.3
Asia	63.5	64.9	64.1	57.4	56.2	60.7	59.0
Europe	20.6	20.8	21.9	24.7	21.4	12.0	7.1
L. America	2.0	2.5	3.0	4.5	6.5	8.6	5.3
N. America	0.3	0.7	2.1	5.0	8.6	7.9	7.9
Oceania	0.3	0.2	0.2	0.4	0.5	0.5	0.5

Source: *Microsoft (R) Encarta ® 2006. (C) 1993-2005 Microsoft corporation.*

The nations currently defined as developed represented 20% of the world population in 2000. This percent is expected to fall to 15% by 2050. Nine out of every ten persons who are now being added to the world's population are living in the less developed countries.

More specifically, when we compare the population trends of Africa and Europe (see Table 3.4), Africa's population has increased since 1900. It had added

about 5.0% of the world population between 1950 and 2000. This is expected to increase to 20.3% by 2050. Whereas, the population of Europe has shown a trend of decline by 12.7% in the same period.

Activity 3.3

Work out the following questions in your group.

1. Look at Figure 3.3. Describe the differences in population growth and projected growth, between 1950 and 2050, in the developed and developing countries.
2. Based on Figure 3.3 and Table 3.3, identify the three most populous countries of each continent.
3. Draw a map of the world, identifying these countries on it.

3.2 COMPONENTS OF POPULATION CHANGE

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

- Describe components of population change;
- Compute natural increase rate of the population.

Key Terms

- fertility
- mortality
- emigration
- infant mortality rate
- cohort
- migration
- immigration
- population change
- total fertility rate

What are the components of population change? How do the components affect population structure and population size?

A change in the overall size of a population is the result of the collective effects of changes in **fertility**, **mortality** and **migration**. The three factors are collectively known as population-change *dynamics or determinants or components.* Fertility and mortality are biological factors, while migration is purely non-biological. The combined effect of the three factors controls the changes in population size and composition. Their influence is shown in Figure 3.4.

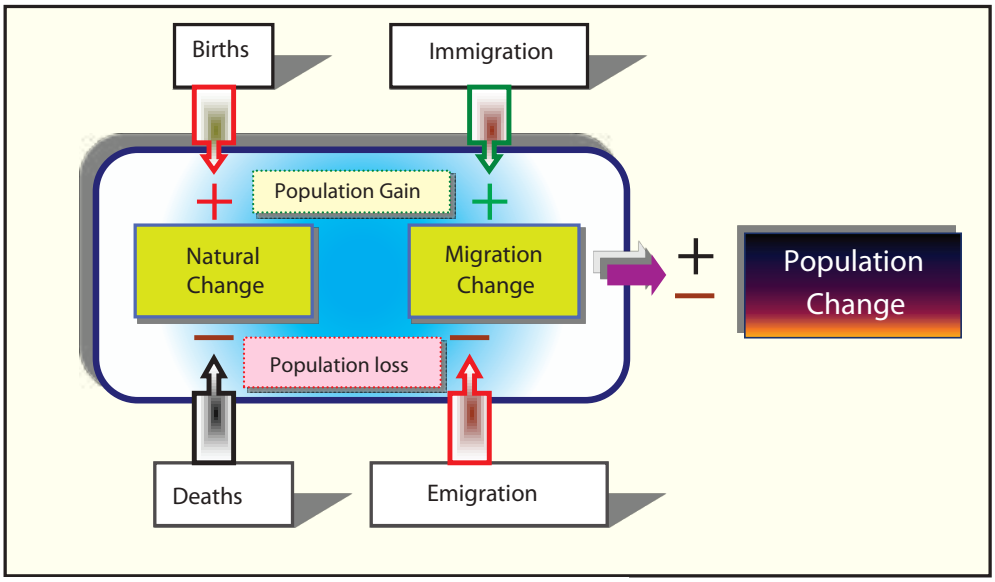


Figure 3.4: **Components of population change**

What do the plus and minus signs imply in the above figure?

As you can see from Figure 3.4, the population size of a particular area is the result of collective effects of birth, death and migration (here, "migration" is the net balance of immigration and emigration). Immigration and birth are positive factors, which tend to increase population size, while emigration and death are negative factors that reduce population size.

Fertility

What is fertility? What factors affect the fertility of a society? How can the fertility of a society be measured?

The study of human fertility occupies a central position in the study of population because it is responsible for biological replacement and maintenance of the population of the human race. The growth of world population depends largely on human fertility. This is so because any society replenishes itself through the process of human fertility. Thus, in population dynamics, fertility is a force of expansion of population by counteracting the force of attrition caused by mortality.

Fertility is the actual occurrence of ***live births*** in a given population; it is the beginning of life. Specifically, fertility refers to the actual *reproductive performance* of a population.

Measures of fertility. Fertility can be determined using different methods, but it is measured most commonly in terms of:

- *Crude Birth Rate (CBR),*
- *General Fertility Rate (GFR) and*
- *Total Fertility Rate (TFR).*

a ***Crude Birth Rate (CBR):*** is the most common and simplest index of fertility. It is simply the number of live births observed in one year among one thousand people in a given region. It can be expressed as a number of live births per thousand people.

$$CBR = \frac{B}{P} \times k$$

where B is the total number of live births during a year, P is mid-year total population and k is a constant, conventionally 1000.

Example

If the number of live births in a population of 70,686,000 was 270,300, the crude birth rate is:

$$CBR = \frac{270,300}{70,686,000} \times 1,000 = 3.8 \; births \; per \; 1,000 \; per \; year.$$

This measure is simple to compute, but it is crude because its denominator includes all persons, regardless of their contribution to fertility (birth). For example all unmarried persons, including children, are included. This is the weakness of the CBR as a measure of fertility.

b ***General Fertility Rate (GFR):*** The easiest method of refining the weakness of CBR is by expressing live births, not in terms of total population, but as a percentage of the number of adults or, even better, of the number of women of reproductive age (typically defined as between the ages of 15 and 49). GFR measures the number of live births in a year per thousand women of reproductive age. It is calculated:

$$GFR = \frac{B}{P_1} \times k$$

where B is the total number of live births during a year, P_1 is mid-year population of women between 15 and 49 years age and k is a constant, conventionally 1000.

Fertility rates differ greatly among continents, regions and countries. Generally, fertility rate is much higher in developing countries than in the developed regions. Let us consider the following example.

Example

The estimated mid-year population of a given country in 2000 was 50,000,000, of which women in their reproductive ages constituted one-fifth. In the course of the year, there were 500,000 live births. Calculate the general fertility rate of this population.

Given:

Number of live births = 500,000

Number of women in their reproductive age was one-fifth of total population = (1/5) × 50,000,000 = 10,000,000

Then, GFR = (500,000/10,000,000) × 1000 = 50 per 1000. This shows that 50 children were born for every 1000 women in their reproductive years.

Activity 3.4

Calculate the following:

1. The number of live births for place "A" was 8400, and its mid year population was 240,000, find CBR.
2. The number of deaths for place "B" was 170,300, and its mid year population was 10,296,000. Calculate CDR.
3. The estimated mid-year population of a given country in 2000 was 100,000,000, of which women in their reproductive ages constituted 25%. In the course of the year, there were 600,000 live births. Find the general fertility rate of the population.

What problem of GFR have you noticed from the above example? Explain to the class.

GFR's drawback is that it does not account for differences in age groups. Each age group is 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 30-49 age groups.

c *Total Fertility Rate (TFR):*

What makes TFR different from the other measures of fertility? How do you calculate it?

TFR is the average number of children that would be born alive to a woman during her lifetime if she were to pass through all her child-bearing years. This happens if the group under question passed through its reproductive span of life with these birth rates in each year of age. It is generally known as an effective summary rate for describing the frequency of child bearing in a year. More importantly, TFR is useful when comparison is made, for it is standardized for age and is a single summary measure. It is helpful for comparing the fertility performance of different populations or social groups.

TFR is the sum of the age-specific birth rates (5-year age groups between 15 and 49) for female residents of a specific geographic area (example: country, kelil, zone, kefle-ketema, woreda kebele, etc.) during a specified time period (usually a calendar year) multiplied by 5. This rate estimates the number of children a hypothetical cohort (person of same age group) of 1000 females in the specified population would bear if they all went through their childbearing years experiencing the same age-specific birth rates for a specified time period. More importantly, TFR is useful when comparison is made, for it is standardized for age and is a single summary measure. It is helpful for comparing the fertility performance of different populations or social groups.

Formula:

$(\sum ASBR) \times 5$, where $\sum$ is summation of, ASBR is each five-year age-specidfic birth rate defined as

$$\frac{B_x}{p_x} \times 1,000$$

where B_x is the number of live births to mothers of age x and P_x is the number of resident women age x. The values or age group represented by B_x 15 - 19, 20 - 24, 25 - 29, 30 - 34, 35 - 39, 40 - 44 and 45+. The values or age groups represented by P_x are 15 - 19, 20 - 24, 25 - 29, 30 - 34, 35 - 39, 40 - 44 and 45 - 49 years. The sum of these ASBRs is multiplied by 5 because each ASBR represents a five-year cohort of women.

Example:

The Total Fertility Rate for a given hypothetical ***kelil*** for year 2007:

Age Group	2007 Births	2007 Female Population	ASBR (Live births per 1000 per ages)
15 - 19	11,000	179,000	61.5
20 - 24	20,000	192,000	104.2
25 - 29	22,000	222,000	99.1
30 - 34	20,000	213,000	93.9
35 - 39	10,000	212,000	47.2
40 -44	2000	210000	9.5
45 - 49	500	200,000	2.5
			Total or ∑of ASBR = 417.9

TFR = 417.9 ×5 = 2089.5 live births per 1000 female kelil residents in 2007 who live through their reproductive years.

Activity 3.5

Calculate the TFR based on the data given below.

The Total Fertility Rate for a given hypothetical kelil for year 2009:

Age Group	2009 Births	2009 Female population
15 - 19	15,000	195,000
20 - 24	25,000	213,000
25 - 29	30,000	232,000
30 - 34	24,000	221,000
35 - 39	12,000	215,000
40 - 44	3000	210,000
45 - 49	800	200,000

Focus

Remember that, although **CBR**, **GFR** and **TFR** are the most common measures of fertility in a community, they are not the only measures. Although the CBR is simple to compute, it is said to be crude because it considers persons of all ages indiscriminately. The GFR refines the CBR, but it has a weakness, in that it regards all females aged 15-49, regardless of differences in their potential birth performances. Note that a woman can bear a child only after the onset of menstruation and can continue to bear children only until she reaches the age of menopause. Statistically, 15 is the age when menstruation begins, and 45-49 is the age span during which menopause occurs. Therefore, on average, women are less likely to bear children before the age of 15 or after the age of 50.

The number of children born to women in developing countries is much larger than to women in the developed regions (see Figure 3.5 and Table 3.6).

Figure 3.5 shows differences regarding birth rate in developing and developed countries.

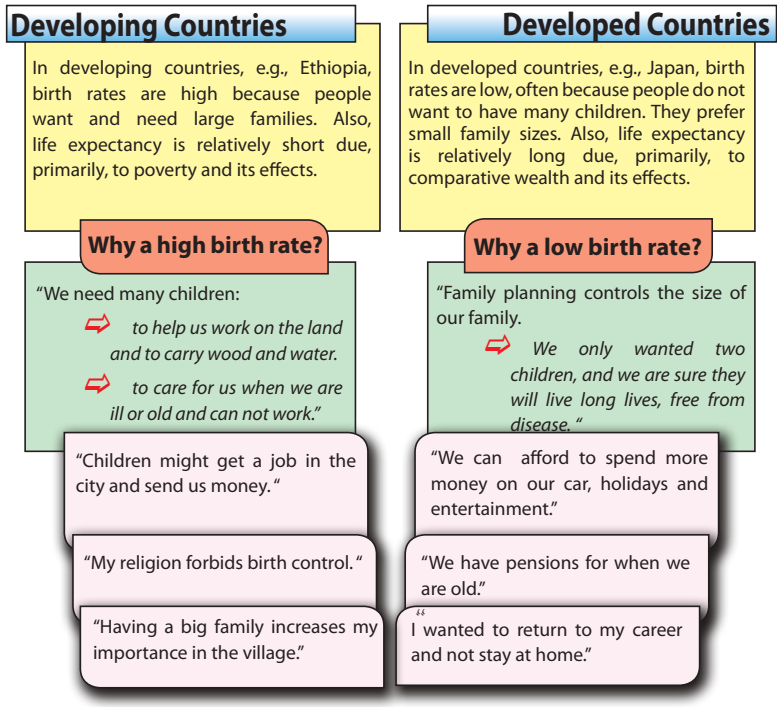


Figure 3.5: **Differences regarding birth rates (fertility), in developing and developed countries**

Activity 3.6

Form a group of not more than five and discuss facts outlined in Figure 3.5 and present your answers to questions 1 - 3 to the class and undertake the fourth activity.

1 What factors affect fertility in developed countries and in developing countries?
2 Give four reasons for each statement.
   i Many families in developing countries are large, with five or more children.
   ii Many families in developed countries are small, often with not more than two or three children.
3 How can birth rates be reduced in developing countries?
4 Design a poster showing the need for family planning for a small village or a neighbourhood in Ethiopia (your locality). Assume that the community members can read and understand it.

Factors of Fertility Distribution

Various factors affect fertility distribution in the world including those presented in Table 3.5.

Table 3.5: **Factors of fertility and their effects**

Factors	Effects
1 **Age at marriage:** the age at which a person marries influences the number of children one can have.	**Early marriage:** more children are born to girls who marry early, because they are exposed to sex for more of their reproductive ages (15-49). They are also exposed to related health problems.
2 **Status of women:** important components of status include access to (or lack of) education, employment, family decision making, etc.	i **Education:** Education usually offers women access to information about how to limit family size, increase their marriage ages, use contraception, and so forth. ii **Employment:** Employment usually motivates women to limit family size, partly because they have less time for performing child-care tasks. Also, employment generally increases access to information about how to limit family size.

	Factors	Effects
3	**Socio-cultural factors:** religion, ethnicity and family structure.	**Religion**: the teachings of some religions oppose the use of contraceptive methods. This encourages large family size. **Ethnicity**: some communities are more biased toward males over females. **Family structure**: Some families need their children to contribute socioeconomically – for example, by working on family farms and by providing their parents with the status of having many children.
4	**Sex preference** (the desire to have children of one sex over the other).	When a family wants children of a particular sex (usually male), but produces children of the other sex, they are likely to keep having more children until they achieve their goals.

Activity 3.7

Part I

Form a group of three to five and discuss fertility conditions in your area. Based on the factors listed in Table 3.5, assess the fertility situation in your specific community. Identify which factor most strongly influences the fertility situation of the community. List the factors, according to their decreasing importance. Cite specific households that are good examples for each factor. Add more effects for each factor.

1 Do you think information on family planning is needed for a woman to be able to make an informed choices that affect her fertility situation? Why?

2 Are there barriers to accessing information about family planning in your locality? If yes, what are they, and how can they be reduced?

Part II

In your geography workgroup, perform these activities:

1 Compare and contrast the population demographics of developed and developing countries. Cite some countries from each group to support your opinions.

2 Discuss relationships between fertility and poverty. Support your opinions with examples from your locality.

3 Work with your group to choose a representative to present the group's opinions to the class.

How Can Birth Rates be Reduced?

The United Nations stated that two basic conditions must be achieved if birth rates are to be controlled. These include

- ⇨ *Improved status of women, including their rights to decide between the use of birth control and having children.*
- ⇨ *Improved educational levels regarding family planning, particularly for women. Also improved access to family-planning supplies.*

A lesser, but still important condition is reduction of poverty and its effects. It was previously believed that high birth rates were a result of poverty. However, in those parts of the world where the status of women has been raised, there have been declines in birth rates even though there have been no obvious reductions in poverty. In all regions of the world, fertility rates are decreasing. However, Africa still has the highest fertility rate in the world.

Activity 3.8

Answer the following questions.

1. Why does Africa have the largest fertility rates? Discuss in pairs.
2. Calculate the crude birth rates for the following two hypothetical regions, A and B:
   - i The number of live births and mid-year population in region A were 4,500 and 160,000, respectively.
   - ii For region B, the number of live births was 20,500, and mid-year population was 2,500,000.
3. Work out the general fertility rates (GFR) for two hypothetical regions, F and G.
   - i In region F, the number of newborn children was 73,060 and the number of women aged 15 – 49 years was 826,000.
   - ii In region G, the number of live births was 50,000, and the number of women aged 15 – 49 years was 950,000.

Mortality

What is mortality? What factors affect mortality?

Mortality is the occurrence of death. Mortality rates, though decreasing worldwide, are higher in the developing countries than in the developed ones. This difference is caused by variations in standards of living, nutrition, medical services, personal hygiene and environmental sanitation.

Mortality can be measured in a number of ways, including the use of *crude death rate and infant mortality rate.*

Measures of Mortality

i ***Crude death rate (CDR):*** is the ratio of the total registered deaths of a specified year in a region to the total mid-year population, multiplied by 1000. It is computed as follows:

$$CDR = \frac{D}{P} \times k$$

where CDR is crude death rate, D stands for total observed deaths, P is total mid-year population, and k is a constant, 1000.

Example:

In a hypothetical region, the total number of deaths observed in 2006 was 60,000, and the total mid-year population was 12,000,000. Therefore, the resulting CDR was:

$$CDR = \frac{60{,}000}{12{,}000{,}000} \times 1{,}000 = 5/1000$$

This number indicates that the deaths of 5 persons were observed for each 1000 people.

What are some of the weaknesses of CDR? Describe them.

ii ***Infant mortality rate (IMR):*** is the number of deaths of infants under the age of one year, per 1000 live births, in a given year.

$$IMR = \frac{\text{Number of deaths below the age of 1 year}}{\text{Number of live births in the year}} \times 1000$$

Example:

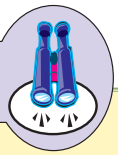
A total of 400,000 babies were born in a certain region in 2010. Of these newborns, 340,000 babies survived their first year of life. Calculate the IMR of this region.

Deaths under age one: 400,000 - 340,000 = 60,000 babies

$$IMR = \frac{60{,}000}{400{,}000} \times 1{,}000 = 150/1000$$

Out of 1000 children born in the year 2010, about 150 infants died before celebrating their first year of life.

Focus



Infant mortality rate is a good indicator of the level of development of any country. In countries with better living conditions, for example, countries in Europe, mortality is comparatively low. In contrast, the less developed countries (example, most African countries, including Ethiopia), infant mortality is quite high, due to malnutrition, various diseases and poor environmental sanitation. **Life expectancy** is the number of years a newborn is expected to live. It tends to increase with standard of living.

Activity 3.9

Based on the following data, answer these questions.

Country	Total population	Total deaths	Number of deaths of infants	Number of newly born children
A	200,000	9,000	4,200	25,000
B	480,000	8,000	2,000	28,000

i Calculate the CDR and IMR for each country.

ii Which country has better standard of living? Why?

Migration

Does migration influence population?

Migration involves movement of people and thereby influences both the rate of growth and distribution of population just like the other two components of population change. (Formal definitions, types and causes of migration are given in section 3.4.3). The most common measures of migration that can affect population growth of an area include:

a **Immigration Rate**: it is the number of people arriving at a destination per 1000 people in a given year.

$$\text{Im migrant rate} = \frac{\text{Number of immigrants}}{\text{Total population at destination}} \times 1000$$

b **Emigration Rate:** it is the number of departing people from an area of origin per 1000 people of the area of origin in a given year.

$$\text{Emigration rate} = \frac{\text{Number of emigrants}}{\text{Total population at origin}} \times 1000$$

c **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 1000 people in the area in a given year.

$$\text{Net Migration Rate} = \frac{\text{Number of Immigrants} - \text{Number of Emigrants}}{\text{Total Population}} \times 1000$$

Example

Suppose the number of emigrants and immigrants of country 'A' are 40,000 and 250,000 respectively. If the total population is 105 million, what is the NMR for country 'A'?

$$\text{NMR} = \frac{250{,}000 - 40{,}000}{105{,}000{,}000} \times 1000$$

$$= \frac{2}{1000} \text{ (i.e 2 per thousand population)}$$

Measures of Population Change

In order to calculate the change in the total population size of a particular nation or place one has to use the following formula (see Figure 3.4).

i **Rate of Natural Increase (RNI):** it is the difference between birth and death rates.

Hence, it is a naturally caused numerical change of a population which results from the interplay between *fertility* and *mortality*. It is expressed as:

$$\text{RNI} = \text{BR} - \text{DR}$$

Example

If the birth rate and death rate of a certain country were 50 per thousand and 28 per thousand, respectively, what was the rate of natural increase (RNI)?

$$\text{RNI} = \text{BR} - \text{DR} = \frac{50}{1{,}000} - \frac{28}{1{,}000} = \frac{22}{1{,}000} = 2.2\%$$

That is, 22 per thousand population or 2.2 per hundred people.

ii **Population Growth Rate (PGR):** in order to find the growth rate of a population, we consider **net migration rate** and **rate of natural increase**.

$$\text{PGR} = \text{BR} - \text{DR} \pm \text{NMR} = \text{RNI} \pm \text{NMR}$$

Example

If the RNI of place 'y' is 2.2% and the NMR is 2/1000, find the population growth rate for place 'y'.

$$PGR = 2.2\% \pm \frac{2}{1000} = \frac{2.2}{100} \pm \frac{2}{1000} = \frac{22}{1000} \pm \frac{2}{1000}$$

$$PGR = \frac{24}{1000} \text{ or } \frac{20}{1000}$$

Activity 3.10

Calculate the following:

1 Supposing the birth rate and death rate of a certain country to be 47 per thousand and 18 per thousand, respectively, calculate the rate of natural increase (RNI).

2 If the rate of natural increase of place "A" is 3.1% and the net migration rate is 20/1000, find the growth rate of population for place "A".

3 The population of Ethiopia was reported as 53 million and 73 million in 1994 and 2007, respectively. What was the annual rate of population growth between the two census periods. Use the formula given below.

$$\left[\sqrt[t]{\frac{P_1}{P_o}} - 1 \right] \times 100$$

where P_o is mid-year population at the beginning of the period, and P_1 is population at the end of the period and t is the number of years between the two periods.

3.3 POPULATION STRUCTURE

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

- interpret population pyramids of developed and developing countries.

Key Terms

- population structure
- average dependency ratio
- sex ratio
- population pyramid
- old age dependency ratio
- youth dependency ratio

What is population structure? How do population structures differ between developed and developing countries?

The *structure of a population* is the distribution of males and females within different age groups. Sex and age structures are basic characteristics and biological attributes of a population, and they affect demographic as well as socio-economic situations. Data on **population age-sex structure** is ideally collected through

census, reflecting a complete population count. A **population pyramid**, also called **age structure diagram**, is a graphical illustration. It normally forms the shape of a pyramid and shows the distribution of various age groups of each sex in a human population.

It typically consists of two back-to-back bar graphs, with the population plotted on the x-axis and age on the y-axis, one showing the number of males and the other showing females in a particular population of five-year age groups (also called **cohorts**). Males are conventionally shown on the left and females on the right, and they may be measured in raw numbers or as percentage of the total population (*See Figure 3.6*).

Population pyramids are often considered to be the most effective way to graphically depict the age and sex distribution of a population. This is partly because of the very clear image that these pyramids present.

Population is divided into age groups of five-year intervals (0-4, 5-9, 10-14, etc.) for each sex. The population of a given country can be further grouped into three categories (segments) of the population consisting of young dependents (0-14), elderly dependents (65+) and the working age groups that are economically active (15-65 years of age). The grouping applies to both males and females of all ages (*See Figure 3.6.*).

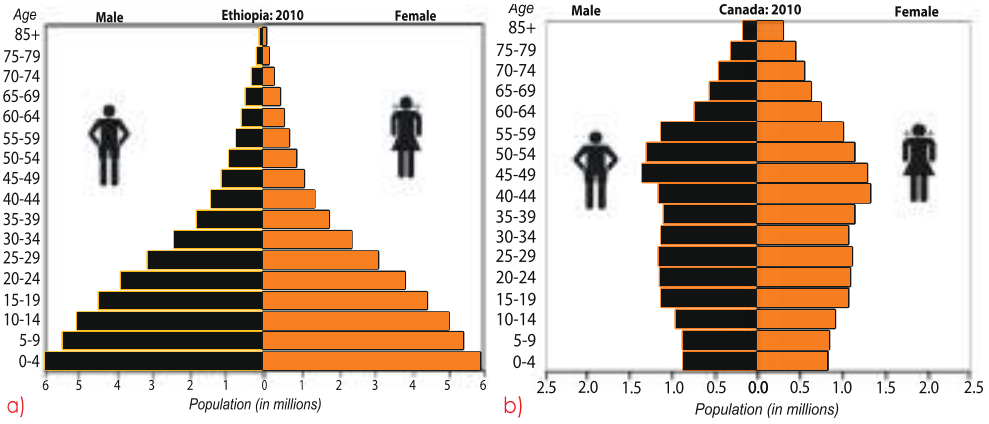


Figure 3.6: **Typical examples of population pyramids of developing (a) and developed (b) countries**

A great deal of information about a population, broken down by age and sex, can be read from a population pyramid. For example, it can shed light on the extent of development and other aspects of the population.

The proportion of the three age groups varies from region to region and among countries. Most developing countries have a large proportion of their population

in the young age group. But in developed countries, people in the adult and old age group account for the largest proportions of the population. As a result, the shape of the population pyramids of the two groups of countries is not the same (see *Figure 3.6*).

Observing different characteristics of a population pyramid can tell you a lot about the population it presents.

- **Width of the base of the pyramid**: *birth rate varies with the width of the base. A wide base indicates a high birth rate, and a narrow base indicates a low birth rate. The former is typical of populations of developing countries.*
- **Symmetry:** *statistically speaking, pyramids are relatively symmetrical. Any asymmetry indicates a size difference between males and females.*
- **Shape of sides:** *concave sides indicate a high death rate, and convex sides indicate a low death rate. The population pyramid of Ethiopia exhibits concave sides, indicating a high death rate.*

Table 3.6: **Age distribution of the world population and of selected countries (2010)**

Region	Percentage distribution of population, by age		
	Under 15	15 – 64	65 and over
World	27	65	8
Developed regions	17	67	16
Developing regions	30	64	6
Africa	41	56	3
N. America	20	67	13
L. America	29	64	7
Asia	26	67	7
Europe	16	68	16
Oceania	24	65	11
Ethiopia	44	53	3
Uganda	49	48	3
Sweden	17	65	18
Afghanistan	44	54	2

Source: *2010 Population Reference Bureau, http://www.prb.org/pdf10/10wpds eng.pdf.*

Sex Structure or Composition

What is sex structure? Which sex is dominant in your locality? Why?

A population pyramid also tells how many people of each sex live in an area. This statistic is typically defined in terms of what is called ***sex-ratio (SR)***, which is a numerical measurement. It is the number of males per 100 females, or otherwise- for example, the number of females per 100 males. Sex ratio is expressed in percentage or ratio form.

$$SR = \frac{P_m}{P_f} \times 100$$

Where SR is sex ratio which may also be referred to as *masculinity ratio* P_m stands for the total number of males, and P_f stands for total number of females.

$$SR = \frac{P_f}{P_m} \times 100$$

This is also possible and gives the number of females per 100 males. This can be called *femininity ratio* as well as sex ratio.

Example:

Say total students of a given school was 5000. Out of this 3000 were females. What was sex-ratio of student population?

Solution:

$$S.R = \frac{P_m}{P_f} \times 100$$
$$= \frac{2000}{3000} \times 100$$
$$= 66.7m / 100f$$

Dependency Ratio

What is dependency ratio? Is the dependency ratio of your locality or region high or low? Why?

Why do we need to know about dependency ratio?

The working age of people varies. Traditionally people worked until they were 65 years old. The common trend now is for people to retire closer to 55 years of age. However, for statistical purposes, we recognize people between 15 and 65 as the workers of a society. People under 15 and over 65 are considered dependent upon the working population. The age dependency ratio (ADR) of a population indicates how many people are dependent upon every 100 workers.

$$ADR = \frac{Young + Elderly}{Adults} \times 100 = \frac{(Population\ 0 - 14) + (Population\ 65+)}{(Population\ 15 - 64)} \times 100$$

Activity 3.11

By referring to the table below answer the questions that follow:

Country	Total Population	Female population	Child Population (%)	Old age population (%)
x	800,000	500,000	42	8
y	1,250,000	790,000	20	15
z	930,000	465,000	50	6

a Calculate both the sex ratio and the ADR of each country (use SR = pm x 100).

b Which country has comparatively better socio-economic development?

c Which country shows the greatest dependency ratio? What do you suggest to correct the situation?

Focus

Age-sex structures of the population of different countries vary, depending upon variation in the socio-economic settings and demographic history of the individual countries. This is reflected in the shapes of their population pyramids. There are three classes of population:

i **Expansive or expanding** population pyramids, which have the classic triangular shape with wide base and narrow top, indicating a high birth rate and a high death rate.

ii **The sides of stationary or stable** population pyramids have a half-ellipse shape, which is a characteristic of a high standard of living due to low birth rate (due to good family planning), financial planning, education, etc.

iii **Contractive or contracting** population pyramids have a narrower base than the reproductive age population. This indicates a decreasing population trend. The low birth rate is indicative of a well-developed country.

Activity 3.12

Part I

Test Yourself.

1 What does the vertical axis on population pyramids represent?
2 What type of population pyramid is indicative of a developing country?
3 What does a narrow base on a population pyramid indicate?
4 What type of population is shown in a pyramid that has a triangular shape?
5 What type of population pyramid is wider for the reproductive ages than for the prereproductive ages?
6 What types of population pyramid are depicted in Figures 3.6 a and b?
7 Which of the two population pyramids (Figure 3.6 a and b) indicate high birth and death rates?
8 On the two pyramids, identify the age intervals of the three population segments: young dependents, economically independent people and elderly dependents.
9 Which of the two population pyramids shows a smaller population for the working ages, compared to the two dependent age groups?

Part II

In your group answer the following questions.

10 Copy the table given below and complete it using information from Figure 3.6. Which of the two countries (Ethiopia or Canada) is represented by each population characteristic that is listed in the first column? Indicate your choice, in one of the two right-hand columns, by drawing a tick (✓).

Population characteristics	Ethiopia	Canada
Broad based and narrowing pyramid at the top		
It has the highest birth rate.		
It has fastest natural increase of population.		
Highest infant mortality rate		
Highest % living to middle age		
Lowest life expectancy.		
Many people survive beyond the age of 65.		
Highest dependant age group		

11 Write a short report about the population structures of the two countries.
12 What would happen to the shape of Ethiopia's population pyramid if there were rapid declines in its birth rate and death rate?

3.4 SPATIAL DISTRIBUTION OF WORLD POPULATION

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

- Discuss the factors affecting spatial distribution of world population;
- Compute crude and agricultural population density;
- Realize causes and types of human migration;
- Recognize what urbanization is;
- Compare level of urbanization at continental level;
- State factors affecting urbanization process.

Key Terms

- population cluster
- population distribution
- crude population density
- agricultural population density
- population density
- urbanization

Why is the distribution of world population uneven?

What factors have influenced the distribution of world population?

The most important characteristic feature of current world-population distribution is its extreme unevenness. It was estimated, some years ago, that one-half of the world's people was contained within about 5% of the earth's land area while, in contrast, about 57% of the land area contained less than 5% of the population. World population distribution, and hence concentration, varies considerably across the earth, among different continents, between individual countries, between developed countries and developing countries, between rim lands and hinterlands, between highlands and lowlands, and between the Northern Hemisphere and the Southern Hemisphere (*see Figure 3.7*).

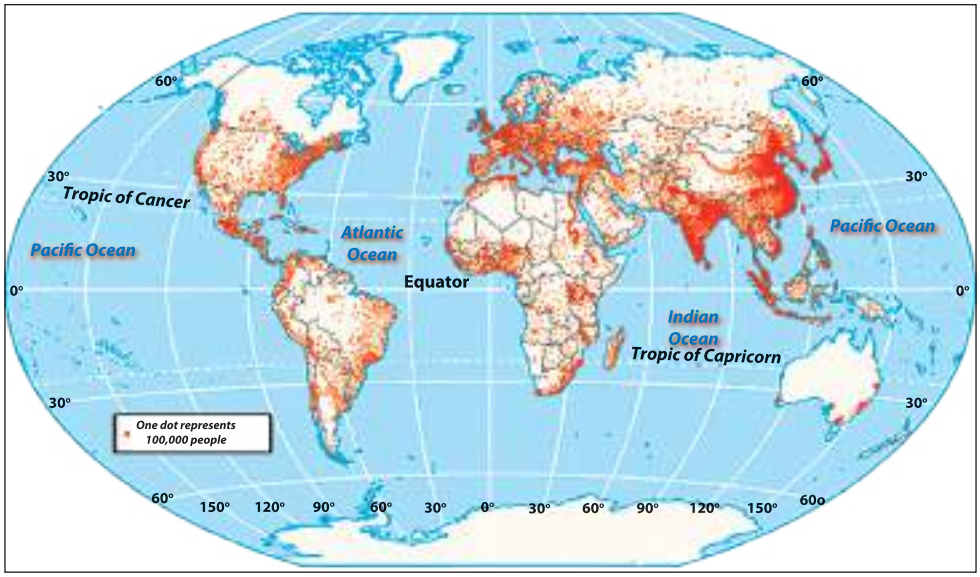


Figure 3.7: **Dot map showing world-population distribution, 2000 (Source:** *Maps.com***)**

3.4.1 Factors of Population Distribution

Numerous factors have positively and negatively influenced population distribution. The extreme current unevenness in population distribution is due to these factors:

- *Ecological (physical) factors*
- *Socio-economic factors*
- *Political factors*
- *Demographic factors*

Some factors, for example, favourable climate, fertile soil, adequate water supply, and industrial development positively influence population concentration (See Figure 3.8a). Others, such as unfavourable climate (for example, extremely hot or cold and dry climates), mountainous regions of very rugged topography with poor soils, and inhospitable areas where communication and trade are difficult, discourage large human settlements (see Figure 3.8b).

The four population clusters and the sparsely populated regions are found in varying geographical locations, have different population sizes and socio-economic characteristics. Table 3.7 gives an overview of the various centers of high and low population concentrations, their locations and determining factors.

Figure 3.8: The Nile Valley in Egypt, one of the world's most fertile places, is intensively irrigated and densely inhabited. It exists in the heart of the Sahara Desert (A); the Sahara Desert is very inhospitable for permanent human settlement because of its hostile climate which is very hot and dry (B).

Table 3.7: **Overview of the major densely and sparsely populated areas of the world**

Population distribution	Regions or areas	Distribution factors	
		Ecological	Socio-economic
Areas of very high population concentration	Asiatic population belt (supports more than 60% of world population). ⇨ East Asia-China, Japan and Korean Peninsula (supports 25% of world population). ⇨ South Asia - India, Pakistan, Bangladesh, Myanmar (Burma) and Sri Lanka (supports) accounts for about 25% of world population.	Favourable climatic condition for agriculture.	Birthplace of one of the principal human races. Ancient history of habitation; high industrial development (Japan).
		Favourable monsoon climate,	Pre-modern civilization of small-scale agriculture, which essentially is traditional in nature and subsistence levels. Irrigation technology (for rice cultivation).
	Europe (more than 10% of world population).	Enjoys a very favourable climate.	Largest portion of its land area is devoted to agriculture. High industrial development.
	American cluster: Northeastern part of the USA and Canada (supports about 5% of world population).	Favourable climate, Short growing season, Rich natural resources.	During its formative period, large influx of immigrants and fast natural increase of the population. Efficient agricultural management. High industrial development.
Sparsely populated areas	Tundra (part of N. America and Eurasia).	Very cold climate (no cultivation).	
	Hot and dry lands (tropical deserts).	High temperature. Shortage of water.	
	Hot and humid regions: Amazon, Congo and Indonesia basins.	Very high humidity, rainfall and temperature.	
	High relief areas.	High mountains with rugged topography, Cold temperature.	
	Areas with poor soil.	Poor soil, badly degraded lands.	

Activity 3.13

In your geography work group, perform these activities.

1 Study the following table and then make a copy of it.

2 On your copy, fill in the blanks in the two right-most columns.

Factors	Explanation	Example	Encourages or discourages people
Low rainfall	Little water for farming	Sahara desert	Discourages
Fertile soil	Good soil for farming	Alexandria, Egypt	Encourages
Very hot and dry climate		Dallol depression	Discourages
Warm & humid climate		Amazon forests	Discourages
Icecaps		Greenland	Discourages
Alluvial plains		Mesopotamia	Encourages

3 On another piece of paper, create two columns with these headings:

- ⇨ Encourage settlement
- ⇨ Discourage settlement

In each column list as many factors you can think of, except those in the preceding table. Consider all of these types of factors:

- ⇨ ecological, such as amount of rainfall and its seasonality, topography, including plains and steep mountains
- ⇨ natural hazards, such as flooding
- ⇨ socio-economic, such as poor standards of living
- ⇨ cultural, such as political unrest

4 Consider your own locality and the factors that have caused people to settle there, and also the factors that have caused them to leave. On a third piece of paper create the same columns as you did in the preceding task. Then list the factors you have thought of for your own locality.

Next perform the same task for your woreda, zone, or region.

5 Figure 3.7 shows the distribution of world population. Use it to identify the regions which are densely populated, sparsely populated, moderately populated and uninhabited. List them in writing.

Discuss the following questions and list them, and the group's answers, on a new piece of paper:

- ⇨ What are some possible consequences of increasing concentrations of people in rural and other areas? What are consequences of falling concentrations in different types of areas?
- ⇨ Can balances be achieve d between the number of people in a region and that region's ability to support people? Consider different types of regions.

➪ How do we define overpopulation and underpopulation? Which areas of the world are overpopulated and which are underpopulated?

6 Considering the information that your group has created on the various pieces of paper, work with the group to create a report that summarizes the data.

3.4.2 Population Density

How can we measure and otherwise quantify world-population distribution? What measure was used to create Table 3.8?

It was noted earlier that population distribution over the earth's surface lacks uniformity. Some areas are overcrowded, while others are sparsely settled or uninhabited.

Table 3.8: **Population density of the world and its regions in 2000**

Continent	Population, in million	Area, in km²	Density (p/km²)
World	6,892	150,000,000	46
Africa	1030	30,251,000	34
Asia	4157	45,066,000	92.2
Europe	739	10,530,750	70.2
Latin America	585	17,825,479	33
North America	344	24,346,000	14.1
Oceania	37	7,772,021	4.7

Source: *Population Reference Bureau 2010; Microsoft (R) Encarta (R) 2006. (C) 1993 – 2005.*

Population density, also termed as the spread of population over space, is measurable in various ways. For example, we can *relate numbers of inhabitants to area of lands inhabited*:

a ***Crude density or Arithmetic density***

b ***Agricultural density*** or ***Rural density***

a **Crude density or Arithmetic Density:** is a measure of the number of inhabitants per unit area. This type of measurement is also known as ***human-land ratio.***

$$\text{Crude density} = \frac{\text{Total population of an area}}{\text{Total area, in sq.km, of the area}}$$

Activity 3.14

Calculate the following:

1 The population of Ethiopia was estimated at 79 million in 2010 (CSA 2010) and its total area is 1,106,000 km^2. Find the crude population density.

2 The total population and total area of China in 1999, were 1, 264, 536,000 and 9,596,960 km^2, respectively. Find the crude density.

b **Agricultural density or Rural density:** It is the ratio of agricultural (rural) population to cultivated land. Agricultural density considers only agricultural population, the segment of an area's population whose livelihood depends on agricultural activities. The area under consideration can be a single contiguous piece of land, or it can be multiple unjoined areas – such as the land occupied by all rural populations in all developing countries. In countries like Ethiopia, almost all rural areas are occupied by people who are engaged in agricultural activities and whose livelihoods depend mainly on agricultural income. This may not be the case in the developed regions.

Activity 3.15

Part I

Perform the following activities:

1 Ethiopia has a total territorial expanse of about 1,106,000 km^2, out of which about 16% was under cultivation in 2007. Its urban population was about 16.2% of the country's total population which stood at about 73.9 million people. Rural population, was about 61.9 million, and the area under crop was about 176,960 km^2. Find agricultural density.

2 Why is agricultural density a better measure of rural population density than the crude population density in countries like Ethiopia?

3 What advantages does agricultural density have for a country?

4 What is the weakness of crude density in this respect?

Part II

Answer the following questions, based on the table below:

Country	Area (km²)	Population (thousands)	% of urban population	% of cultivated land
A	95,000	18,000	25	30
B	90,000	22,000	80	10
C	150,000	30,000	45	35

5 What are the crude and agricultural population densities of each country?

6 For which country does agricultural density appear to be a better measure than crude population density? Why?

Agricultural population density is a more meaningful measure than crude population density for developing countries where agriculture is the dominant economic activity. It also gives a better indication of population pressure on natural resources.

3.4.3 Human Migration

What is migration? Can we consider all kinds of people's movements as "migration"? Why or why not?

Definition and Types of Migration

Many geographers consider migration to be the permanent or quasi-permanent relocation, for a substantial duration of an individual or group of individuals from a place of origin to a place of destination. Migration begins in an *area of* ***origin*** and is completed at *an area of* ***destination*** and might involve a stay of a substantial period one year or more. In order to avoid ambiguity, the term ***permanent migration*** is used for situations in which the mover has no intention of returning to the place of origin.

When migrants cross an international frontier, they are referred to as either ***emigrants,*** if they are leaving a country or ***immigrants,*** if they are entering. Migrants who move within a country are referred to as ***out-migrants*** or ***in-migrants*** depending on whether they are leaving or entering a region.

When migrants cross an international boundary, the movement is called ***international migration*** (*see Figure 3.9*). However, if the movement is within a national territory, it is referred to as ***internal migration***. A movement in which

a migrant arrives at the last destination after a series of short-term moves to other locations is referred to as ***step migration.*** When people move out with the intention of returning back to their place of origin after a few months or a season or more, this movement is called ***seasonal migration***. Seasonal migration takes place commonly in rural Ethiopia during peak and slack seasons of agricultural labour.

Figure 3.9: **Major international migration flows** **Source:** *IGCSE, 2009*

Migration can take the form of ***refugee*** migration, when people move for political reasons, war, ethnic conflicts and discrimination or religious persecution; or ***evacuee*** migration, if movement is caused by natural calamities like earthquake, volcanic eruption, flooding, drought, etc.; or **resettlement** migration**,** when people are displaced by war, natural calamity, etc. and are moved by government to a new location and, generally, given assistance in order to establish themselves therein.

Activity 3.16

In your geography workgroup, discuss the following questions.

1. Which forms of migration are common in your community? Is anyone a migrant among your family members? Were all your household members, including Dad and Mama, born and raised in your area?
2. What is the difference between 'refugee' and 'evacuee'?
3. What do you call the people whom the present government moved, some years back, from densely populated areas to sparsely populated parts of the country and settled them there?

Causes of Human Migration

Many factors affect migration. These include ***economic, social*** and ***ecological considerations***, which, in turn, are affected by ***individual perceptions*** and ***behaviour***. These factors act in such a way as to '***push'*** or '***pull'*** migrants (*see Figure 3.10*). Pull factors are those which attract the migrant to a particular destination. For example, good social and welfare services, a pleasant environment and political stability are typical pull forces.

Push factors, on the other hand, are forces which work in the migrant's home area. They impose pressures which persuade or compel a person to move away. For example, push factors include the impacts of natural disasters (drought, flood, and famine), low wages, poor employment and political instability.

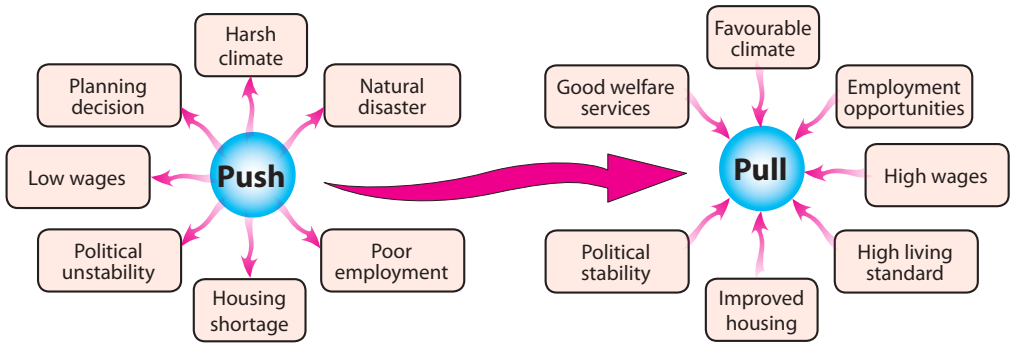


Figure 3.10: **Some forces of migration: 'push' and 'pull' factors**

- ***Economic factors:*** are often regarded as the main motivation for migration, acting as pull or push factors. The principal economic force is the search for employment, accompanied by the exploitation of natural resources, such as minerals, and the availability of good communication networks.
- ***Social factors:*** that influence migration, negatively and positively, include social oppression, political control and the availability of housing, health care and training.
- ***Ecological factors:*** Environmental crises such as droughts, desertification and industrial accidents can have profound impacts on human migration. Environmental or ecological refugees have become the single largest class of displaced people in the world.

Activity 3.17

In your geography workgroup, perform these activities.

1 Classify the factors noted in Figure 3.10 as ecological, economic, socio-cultural and political factors.

2 By asking ordinary people and government office holders in your community, identify economic, social and ecological reasons that make people migrate.

3 What are some of the possible consequences of migration, both in areas of origin and destination?

3.4.4 Urbanization

What is urbanization? What factors affect the process of urbanization?

What is Urban and What are Urban Settlements?

The term urban is something (for example a settlement) relating to, belonging to, characteristic of, constituting, or forming part of a town or city. It is the opposite of *rural*. ***Urbanism*** on the other hand refers to a city or town characteristic, the typical condition of a city or town, or a way of life characteristic of a city or town.

Urbanization, in conventional terms, refers to the process through which society is transformed from being predominantly rural, in economy, culture and life style, to being predominantly urban. It is also a process of territorial reorganization, in that it shifts the locations, as well as the characteristics, of a population and its production activities. *Typically,* urbanization *is commonly defined as the process by which large numbers of people become permanently concentrated in relatively small areas, forming cities or towns.*

Some of the criteria used to identify urban settlements and desiginate them as towns or cities include the status of an urban settlement, population size and of population function.

In terms of population size, the minimum population of a locality considered as a city varies from 1000 or less (example: Canada) to 50,000 (Japan). In most countries, this threshold varies from 2000 to 5000. In Ethiopia, a settlement is designated as *urban* if the number of inhabitants equals or exceeds 2000, and if most of them are engaged in non-agricultural activities. Another defining characteristic is that the area is an officially municipality.

The course of human history has been marked by accelerating urbanization. In 1800, less than 3% of the world's population lived in cities. During the post industrial revolution, sometimes defined as 1900, about 20% lived in cities. By 1950, 30% lived in cities. By the end of 1999, 47% lived in cities. Currently (2010) the percent of the world's population in cities equals or exceeds that in rural areas (see Table 3.9.)

Table 3.9: **Level of world urbanization, 1950 – 2000**

Region	Percentage of urban population as compared to the total			
	1950	1975	2000	2010*
World	30	38	47	50
Developed	55	70	75	75
Developing	52	67	73	44
Africa	15	25	37	38
Europe	64	74	77	71
North America	50	76	79	79
Japan	18	27	56	86
Asia	15	22	36	43
Latin America	42	61	75	77

Source: *2010 Population Reference Bureau, http://www.prb.org/pdf10/10wpds_eng.pdf.*

Activity 3.18

In your geography workgroup, perform these activities:

1 Compare the level of urbanization at the continental level and identify the most and the least urbanized continents.

2 Why do the more developed regions of the world have higher percentages of urban populations than the less developed regions?

3 Why do the proportions of urban populations in the developing regions show faster growth rates than in the more developed regions?

4 About three-fourths of the population of the developed countries live in urban centres. How do people in these regions earn their living?

Work with your group to choose a representative to present the group's opinions to the class.

Factors that affect Urbanization

In your previous discussions, you might have considered, directly or indirectly, some of the factors that affect urbanization. Can you mention some of them to your class?

One can attribute the growth and development of urbanization to several factors, including:

- ***High rate of natural increase of population:*** *This is happened when birth rates remain high, but death rates fall rapidly due to great improvements in social facilities and in food production, that resulted in population growth and so does urbanization*
- ***Significant of rural to urban migration:*** *Many large cities in developing countries are growing at a faster rate due to rural 'push' factors that forced the people to leave the country side, and due to urban 'pull' factors where people migrate to cities hoping (in reality doesn't exist) for better job prospects better social services, etc.*
- ***Industrialization:*** *In the 19thC, industrialization led to a huge demand for labour in mining and manufacturing centers, in what are now referred to as developed countries. In these countries, urbanization was the result of economic development triggered by industrialization.*

Activity 3.19

In your geography work group, answer the following questions and perform the following activities.

1. Which factors have positively contributed to the growth of urbanization in Ethiopia?
2. By referring to a world atlas or other sources, identify the ten largest cities of the world. Create a world map that emphasizes these big cities.
3. What are the five largest urban centres (cities/towns) in Ethiopia?
4. What are the main problems of rapid urbanization in less developed countries like Ethiopia? Suggest possible ways of solving the problems.

3.5 POPULATION OF ETHIOPIA

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

- Compare the present population size of Ethiopia with the past;
- Describe the spatial distribution of Ethiopia's population;
- Show the demographic characteristics of Ethiopia's population;
- Analyze the population structure of Ethiopia;
- Realize population policy of Ethiopia.

Key Terms

- annual growth rate
- population policy
- physical factors
- pro-natalist
- human factors
- anti-natalist

3.5.1 Population Size, Distribution and Growth Rate

When did the population of Ethiopia started growing very fast?

The population of Ethiopia was about 12 million toward the beginning of the 20th century (1900). It had an annual growth rate of 0.2%. Had this growth continued, the population would have doubled in 346 years. The rate of growth of the population was relatively very slow until 1920. But, after 1920, the population of Ethiopia started growing very fast, and it took only 60 years to double. The 1950's was another remarkable period. By 1960 the growth rate quadrupled, doubling the size of the population to 23.5 million. Then, between 1960 and 1990, i.e., within thirty years, the population once again doubled. During that period, its growth rate tripled, compared with the rate of 1920. The smallest doubling period recorded was in 1996, after which it started increasing again.

Ethiopia conducted its first census in May 1984. So far, the governments have conducted three successive population and housing censuses. The first census report showed that the population of Ethiopia (together with Eritrea) was 42.2 million. When we compare the 2007 census results with those of 1984 and 1994, we see that the population of the country increased by more than 31 and 21 million over 23 and 13 years, respectively. The population growth rate increased from 2.9% in 1984-1985 to 3.0% in 1994-1995.

Table 3.10: **Estimates of population growth in Ethiopia**

Year	Population (million)	Annual Growth Rate (%)	Population Doubling Time (year)
1900	11.8	0.2	346
1910	12.1	0.5	139
1920	12.9	1.0	69
1930	14.4	1.2	58
1940	16.2	1.5	46
1950	19.2	2.0	38
1960	23.5	2.2	32
1970	29.5	2.3	30
1980	37.7	2.8	25
1990	51.2	3.0	24
1993	53.4	3.1	23
1996	60.0	3.2	22
1999	61.6	2.9	24
2000	63.4	2.8	25
2010	79.0	2.6	27

Source: *Central statistical Authority (CSA), 1994 and 2010*.

Since 1999, the growth rate has decreased at an average rate of about 0.2% per year (*see Table 3.10*). By 2010, the rate had dropped to about 2.6% per year. With the current growth rate of 2.6%, the country's population is projected to grow by 1.9 million annually, and to attain a size of about 79 million by 2010, 94.5 million in 2015, about 118 million by 2025. This trend would make Ethiopia the most populous country in Africa, next to Nigeria. This rapid growth seriously strains socio-economic development.

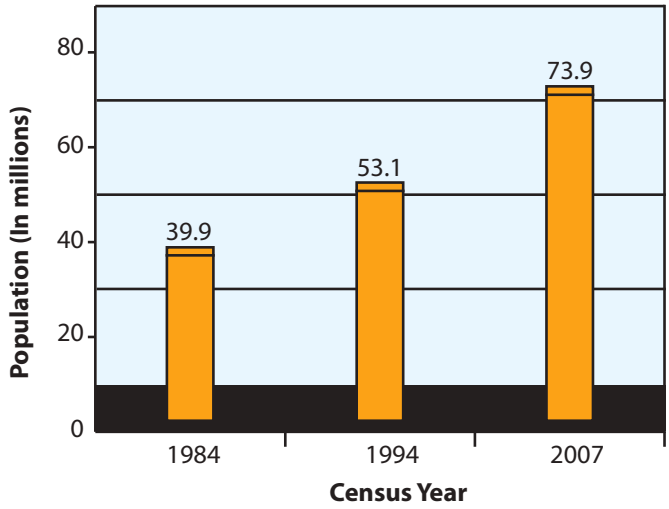


Figure 3.11: **Population size of Ethiopia (in million) 1984 – 2007 (***CSA, 2007***)**

Activity 3.20

With your geography workgroup, study Table 3.11 and Figure 3.11. Then perform the following tasks.

1 Assess the changes in these population characteristics in Ethiopia between 1900 and 2010.
- ⇨ size
- ⇨ growth rate
- ⇨ doubling time

2 Draw a line graph to illustrate the changes that you investigated in Task 1;
- ⇨ growth rate
- ⇨ doubling time

Under the graph, create a note that describes the changes in words.

3 Study your graph. Can you divide the entire graph of changing growth rates and doubling times into approximately equal parts?
How many approximately equal periods are there for the growth-rate changes? How do their slopes differ? How many for the doubling time?

4 Consider the results of Task 3 and the effects they probably had on Ethiopia's
- ⇨ natural resources
- ⇨ food production
- ⇨ investment and national savings opportunities
- ⇨ social services, such as health and education

5 What do you think Ethiopians can do to control population growth? Consider actions that can be taken at all of these levels.
- ⇨ individual
- ⇨ household
- ⇨ community
- ⇨ regional government
- ⇨ federal government

6 During your lifetime, in what different ways could you affect population growth? Do you expect to contribute to the problem or to the solution? How?

Spatial Distribution of Population

What does spatial (areal) distribution of population mean? Which parts of Ethiopia are densely and sparsely populated? Why?

Spatial distribution of population is the pattern created as a result of human occupation of land surface for settlement. The pattern of Ethiopian population distribution is markedly uneven. For example, we have very high population densities in the highlands. On the other hand, the peripheral lowlands of the country, which account for more than 50% of the total area of the country, are

very sparsely populated. There are variations in the distribution at the national level as well as at lower levels for example, between and within regions, zones, weredas and kebele administration units. Table 3.11 shows the country's population distribution at the regional level.

Table 3.11: **Ethiopia's population distribution, by region: 1994 and 2007**

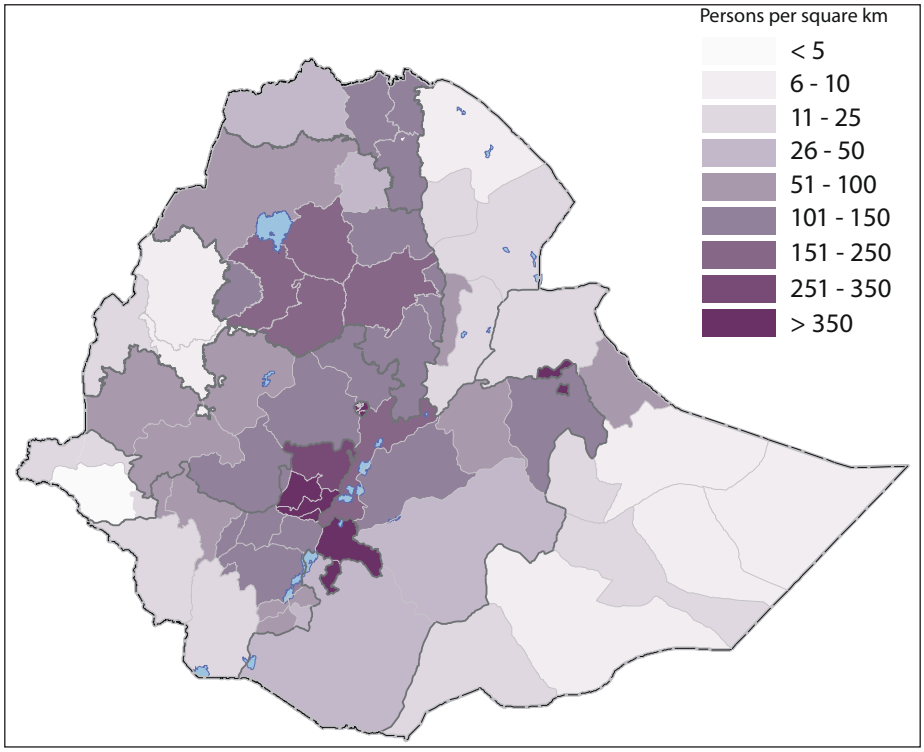
Region	1994		2007	
	Number	%	Number	%
Tigray	3,136,267	5.9	4,314,456	5.8
Afar	1,060,573	2.0	1,411,092	1.9
Amhara	13,834,297	25.0	17,214,056	23.3
Oromiya	18,732,525	35.0	27,158,471	36.7
Somalia	3,198,514	6.0	4,439,147	6.0
Benishangul Gumuz	460,459	0.9	670,847	0.9
SNNP	10,377,028	19.4	15,042,531	20.4
Gambella	181,862	0.3	306,916	0.4
Harari	131,139	0.2	83,344	0.2
Addis Ababa	2,112,737	4.0	2,738,248	3.7
Dire Dawa	251,864	0.5	342,827	0.5
Special Enumeration	Not available	Not available	96,570	0.1
Country total	53,477,265	100.0	73,918,505	100.0

Source: *2007 population and housing census report, CSA, 2008*.

What have you observed from Table 3.11? Which regions were the most and least populous in the country in 2007? What factors are responsible for this variation? Which regions showed decrease or increase in their population proportion as compared to others, and why?

More than 80% of the population lived in three regions – Oromiya, Amhara and Southern Nations, Nationalities and Peoples Region (SNNPR). Their populations accounted for 36.7%, 23.3% and 20.4% of Ethiopia's total population, respectively.

According to the 1984 Ethiopian census, the nation's crude population density was 34 persons per square kilometer. By 1994, 10 years later, it had increased to 48.3. By 2007, the crude population density was almost double that of 1984 – about 67 persons per square kilometer.



Source: *Atlas of the Ethiopian Rural Economy*.

Figure 3.12: **Population density of Ethiopia**

Table 3.12 presents Ethiopia's ten most densely and sparsely populated zones, as of 2009. Population densities exceeded 150 persons per square kilometre. All of the zones listed in the first half of the table, except for the last four shown in the table, are in the SNNPR and are enset-growing areas. Of the SNNPR zones, the most densely populated are Gedeo Kembata and Tembaro, and Sidama. Their densities exceed 400 persons per square kilometre. In contrast, there are places with very low population densities, below 25 persons per square kilometre. Almost all very low-population areas are found in the peripheral lowlands of Benishangul Gumuz, Gambella, Afar and Somali regions. Some of zones of very low-population densities include Agnewak, Metekel, Kemashi, Zone one (Afar), Etang, Zone two (Afar), Asossa zones, Warder zone, Korahe zone and Fik zone.

Table 3.12: **Ethiopia's ten most densely and most sparsely populated areas at the zone level, 2009**

No.	The ten most densely populated areas		No.	The ten sparsely populated areas	
	Zone	Density (persons/km²)		Zone	Density (persons/km²)
1	Gedeo	772.6	1	Agnewak	5.7
2	Kembata Tembaro	535.8	2	Metekel	10.1
3	Sidama	482.5	3	Kemashi	11.5
4	Wolayita	386.0	4	Zone 1 (Afar)	14.8
5	Hadiya	368.1	5	Etang Special Zone	18.8
6	Gurage	231.0	6	Zone 2 (Afar)	20.6
7	West Arsi	183.7	7	Asossa	22.5
8	East Shewa	177.6	8	Warder	6 - 25
9	Jimma	175.5	9	Korahe	
10	East Hararge	167.2	10	Fik	

Source: *Central Statistical Authority (CSA), 2010*.

The spatial distribution of Ethiopia's population is uneven, characterized by high population density on the highlands while lowlands have very low population density. Such uneven distribution of population has been the result of ecological (physical) factors and human factors (see Figure 3.13). More important physical factors include climate (mainly rainfall and temperature), soil, vegetation and relief (altitude). The human factors primarily consist of historical factors, for example peopling of the country and migration, development of infrastructure, types of economic activities and political factors related to government policies such as resettlement programs, land tenure system, villagization process, etc. All these factors individually or collectively have influenced human settlements favorably or adversely. They have either encouraged or discouraged settlement.

Activity 3.21

In your geography workgroup, perform these tasks.

1. Find a political map of Ethiopia that shows the nation's administrative units. Locate the ten most densely populated and most sparsely populated areas of the country. (See Table 3.12 again.)
2. Which ecological and human factors, for example, those shown in Figure 3.13, could have influenced the patterns of population distribution, you considered in Table 3.13?
3. Variation of physical factors such as climate (temperature and rainfall), soil, and vegetation, are strongly correlated with altitude. With this fact in mind, explain the impacts of changes in elevation on population distribution.

Table 3.13: **Population distribution, related to altitude**

Altitude (metre)	% of total area of Ethiopia	% of total population of Ethiopia (1984)	Density (persons/ km²) (1984)
> 2600	5.8	10.4	85.0
1800 – 2600	31.8	67.1	157.5
1400 – 1800	28.1	11.5	68.14
1000 – 1400	13.4	8.5	69.14
< 1000	21.5	2.8	29.0
Total	100.0	100.0	6.2

Source: *Aynalem Adugna, The Population of Ethiopia, I.D.R, 1987*.

4 Analyse the data in Table 3.13. What percent of the total population of Ethiopia live in the lowlands, areas found below 1500 m above sea level? Why?

5 In Ethiopia, areas found between 1800 m and 2600 m are the most densely populated. They are inhabited by about 67% of the total population. Why?

6 Briefly explain the impacts of such high population density on the environment.

7 Suggest possible measures to improve the situation in the lowland areas, enabling them to support more population, and also measure to help the over-populated highland areas, motivating their people to settle in the lowlands.

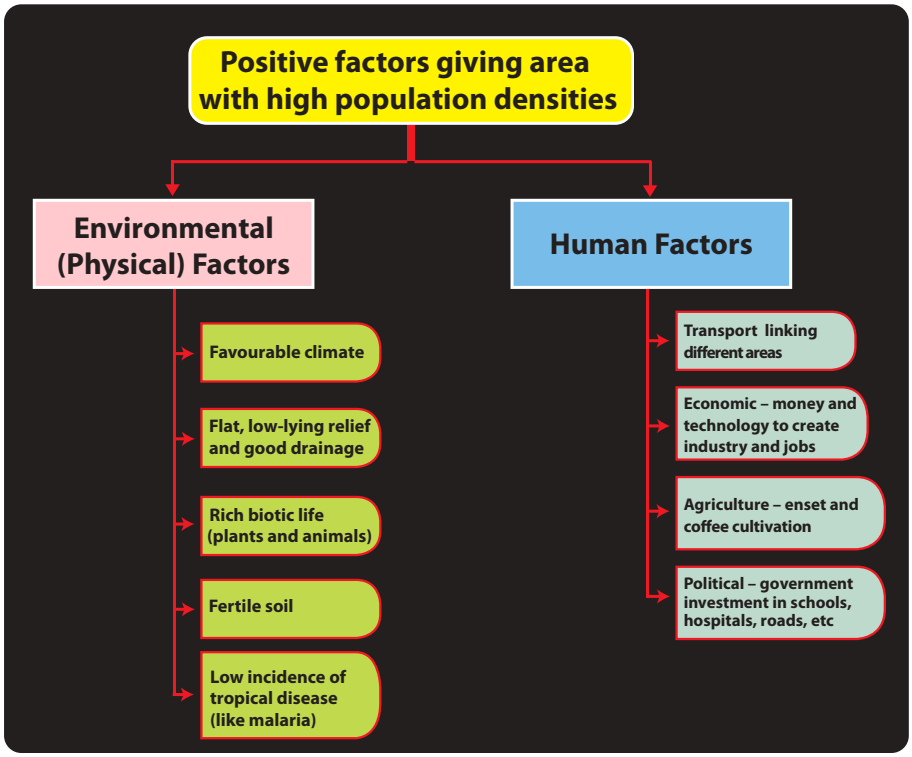


Figure 3.13: **Factors that contributed to high population density in Ethiopia**

3.5.2 Components of Population Change in Ethiopia

What factors affect fertility, mortality and migration? How does the three components of population change influenced growth rate of the population of Ethiopia?

Fertility in Ethiopia

Is the rate of birth higher or lower in Ethiopia, compared to the rest of Africa and to the world at large?

What are the trends of fertility in Ethiopia? Is fertility decreasing or increasing? Why? What measures, if any, have been taken to improve the situation in your locality? If none have been taken, why is that?

Ethiopia's total fertility rate is one of the highest in the world. In 1984, TFR was 7.52 per woman. By 1994 it dropped to 6.74 (*see Table 3.14*), and then to 5.4 in 2010.

There is significant fertility variation between urban and rural areas. For example, in 1984, TFR in urban areas was 6.33, while it was 8.08 in rural areas. In 2010 these rates, respectively, dropped to 4.5 and 7.19.

Fertility also varies from region to region. In 1994, Oromiya and the SNNPR recorded the highest TFRs, reaching as high as 7.26 and 7.16, respectively. In contrast to this, Addis Ababa, Dire Dawa, Harari and Gambella recorded TFRs of less than 4.3.

Table 3.14: **Measures of fertility in Ethiopia, by major regions, 1994**

Region	Total		Urban		Rural	
	TFR	CBR	TFR	CBR	TFR	CBR
Ethiopia	6.74	4.434	4.50	34.88	7.19	45.80
Tigray	6.95	43.89	5.38	39.33	7.28	45.11
Afar	6.39	36.21	4.47	39.51	6.61	36.05
Amhara	6.76	43.86	5.40	43.40	6.94	43.95
Oromiya	7.26	45.63	6.10	44.14	7.42	45.83
Somali	6.73	36.38	5.84	35.04	6.89	36.67
Benshangul and Gumuz	6.46	45.63	5.46	44.70	6.56	44.61
SNNPR	7.16	49.95	6.42	48.06	7.22	49.72
Gambella	4.72	36.24	4.19	38.14	4.82	35.10
Harari	4.68	36.50	3.40	26.63	6.98	51.48
Addis Ababa	2.14	18.78	2.09	16.37	7.40	41.10
Dire Dawa	4.95	37.82	4.28	35.21	6.89	43.37

Source: *CSA, 1999*.

Activity 3.22

In your geography workgroup, study Table 3.14 and answer the following questions.

1. Which regions have the highest CBR in their rural and urban areas? Why?
2. Why do rural areas have higher TFRs than urban areas? What do you suggest to improve the situation?
3. Why is that both CBR and TFR are lower in urban areas than in rural areas?
4. Why are crude birth rates as well as TFR generally higher in Ethiopia than in most of the rest of the world?
5. Choose 10 families (households), including yours, in your locality and answer the following question:
   - i How many children does each family have?
   - ii Do parents in your community tend to have many or few children? Why?
   - iii Do women in your locality have easy access to medical, education and family planning services? If no, why not? What is the effect of such availability or lack of availability?

Mortality in Ethiopia

Has the number of deaths in your community per year increased or decreased during your lifetime? Your parents' lifetimes? What causes death most often in your locality? Among which age groups is death observed most frequently in your community?

Mortality is the measure of frequency of deaths in a population. Ethiopia has one of the highest levels of mortality in the world (see Table 3.15). The main causes of such high mortality are the effects of poverty, low living standards and poor access to health services.

Other significant factors include civil war, and recurrent drought and famine. Deaths of children under the age five accounts for over half of all deaths in the country. The main causes of children death are measles, malaria, malnutrition, and acute respiratory infections such as pneumonia and influenza.

However, despite all of the current factors that cause deaths in Ethiopia, mortality rates have decreased because of improved medical technology and the population's improved access to health services. During the last two decades, crude death rate dropped from 20 per 1000 population in 1970 to 16.4 per 1000 in 1990 and then to 12 per 1000 in 2010. Similarly, the infant mortality rate declined from 153 deaths per 1000 live births in 1970 to 110 in 1990 and then to 77 in 2010 (see Table 3.15 again).

Unfortunately, however, many people now fear that such decreasing trend (and that of increasing life expectancy) will soon be reversed due to the increasing prevalence of HIV/AIDS in Ethiopia's population. For 1999, estimates put the number of infected people in the country at 3 million. Now, ten years later, some experts are predicting increases in mortality rates and decreases in life expectancy.

Table 3.15: **Crude death rate, infant mortality rate and life expectancy in Ethiopia, 1970 – 2010**

Year of Survey	Crude death rate			Infant mortality rate			Life expectancy	
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
1970	20.0	16.9	20.0	155	134	153	43.8	45.0
1981	18.1	15.7	17.9	141	117	139	46.5	46.8
1984	17.2	14.17	17.1	112	94	110	46.0	58.1
1990	–	–	–	111.6	94.2	110.1	47.4	49.4
1998	17.8	14.0	17.0	109.9	92.0	109.0	48.0	50.9
2010*			12			77	–	51

Source: *Central Statistical Authority (CSA), 1994; * Population Reference Bureau, 2010*.

Activity 3.23

1 Based on Table 3.15, answer the following questions:
   - i Are the trends of CDR and IMR in Ethiopia increasing or decreasing? What about life expectancy at birth? Why?
   - ii Why is the IMR higher in rural areas than urban areas of the country? How can we improve the situation?

2 Can we relate high mortality rate with poverty and environmental degradation in Ethiopia? Support your answer with examples.

3 It is known that HIV/AIDS have direct impacts on mortality.
In your opinion, what roles should teachers and students play to control the expansion of HIV/AIDS in your locality?

3.5.3 Population Structure of Ethiopia

Can you remember the factors that influence population structure? How does population structure influence the process of Ethiopia's socio-economic development?

Age Structure

Which age group is greatest in Ethiopia? What are the socio-economic and demographic implications of its size? Does the shape of Ethiopia's population pyramid correspond to that of most developing countries?

Table 3.16 presents Ethiopia's population age distribution. As you can see from the recent population pyramid of Ethiopia shown in Figure 3.6a and from the data in Table 3.16, Ethiopia's population is predominantly young. It has persistently remained so, at least since 1970. On average, about 45% of the population is young and economically dependent. Elderly people account for about 3% of the total. This would mean only 52% of the population is economically active and supports both itself and the rest of the population. Ethiopia has one of the largest non-productive populations in the world. This is a direct result of the country's high fertility rate.

Table 3.16: **Age structure (composition) of the Ethiopian population**

Year	Population in millions	Percentage distribution of population by age		
		Under 15	15 – 64	65 and over
1970	-	45.3	51.5	3.2
1981	-	45.5	51.0	3.5
1984	41.1	48.1	47.1	4.8
1990	-	50.0	43.8	6.2
1994	53.4	45.4	51.4	3.2
1999	-	43.8	53.1	3.1
2007	73.9	45.0	51.8	3.2
2010*	79.0	44.0	53.0	3.0

Source: *Central Statistical Authority (CSA), 1999 and 2007 and Population Reference Bureau 2010.*

With such a large dependent young population, government expenditure for education, health, shelter, food and other basic social services is very high. The only way that Ethiopia can release this large amount of budgetary resources for more economically productive investments is by reducing its dependency ratio.

Focus

Fast population growth, like that of Ethiopia and many other developing countries, produces a youthful population dominated by children who are economically dependent. This age-structure has the potential to increase the momentum of population growth as those numerous children grow up and enter their reproductive years and have multiple children of their own. This demographic instability of large, highly dependent and consuming, rather than effectively producing, populations cripples the socio-economic development process and can impede sectorial planning. Moreover, unemployment and under employment tend to prevail due to national economic issues.

Sex Structure

What is the importance of studying sex structure?

Sex is one of the basic demographic characteristics of a population. Sex structure is very important for demographic analysis because it provides useful information about reproductive potential, human resources, and so on.

Table 3.17: **Population size, by sex and by region, in Ethiopia (2007)**

Region	Sex			
	Male		Female	
	Number	%	Number	%
Country – total	37,296,657	50.5	36,621,848	49.5
Tigray	2,124,853	49.2	2,189,603	50.8
Afar	786,338	55.7	624,754	44.3
Amhara	8,636,875	50.2	8,577,181	49.8
Oromiya	13,676,159	50.4	13,482,312	49.6
Somali	2,468,784	55.6	1,970,363	44.4
Benshangul – Gumuz	340,378	50.7	330,469	49.3
SNNP	7,482,051	49.7	7,560,480	50.3
Gambella	159,679	52.0	147,237	48.0
Harari	92,258	50.3	91,086	49.7
Addis Ababa	1,304,518	47.6	1,433,730	52.4
Dire Dawa	171,930	50.2	170,897	49.8
Special Enumerations	52,834	54.7	43,736	45.3

Source: *Central statistical Authority (CSA), 2010*.

What does Table 3.17 show you? For example, which sex is most numerous at national and regional levels?

In 2007, Ethiopia had an almost balanced (one-to-one) sex ratio, both in rural and urban areas. The sex ratio for the whole country was 100.8. This meant that in the 2007 estimate, males slightly outnumbered females. Earlier, 1999, estimates indicated slightly different sex ratios. In rural areas, males slightly outnumbered females – the sex ratio was 101.2. In urban areas, females slightly outnumbered males – the sex ratio was 98.5.

Regional sex-ratio data generally supported the preceding data for the nation as a whole, showing slight variations.

Male populations exceeded female populations in all regions except in Addis Ababa, Tigray and the SNNPR. In Addis Ababa, whose population is nearly 100% urban and may be considered 'representative' of other urban centres of the country, the number of females is considerably higher than the number of males.

Activity 3.24

In your geography work group, study Table 3.16 and perform the following tasks.

1 Calculate, for 1984, 1994, 2007 and 2010
   - i ADR (age dependency ratio)
   - ii young age dependency burden
   - iii old age dependency burden Inter the economic implications of these series of numbers.

2 What measures should be taken to reduce Ethiopia's ADR? Support your answer by citing examples from your locality.

   Along with each of the students in your workgroup, list your household members, giving their age and sex.

3 Form a group consisting of 10 classmates. Let each student consider his or her household and list each person's age and sex with your group, aggregate the results for all of the householdes by creating a table that shows the age-sex structure of the combined households. Then compare the
   - a Age distribution
   - b ADR
   - c Youth dependency burden ratio

4 Using population data, from Table 3.17 calculate the sex ratio of all regions. Which region(s) has the highest and lowest sex-ratio? Why?

5 Calculate the sex-ratio for each grade or grades (10-12) in your school? Which grade has the highest sex-ratio? What does the ratio indicate?

3.5.4 Population Policy of Ethiopia

What is population policy? Why has the government of Ethiopia formulated a population policy? When did it do that? What type of population policy has been adopted in Ethiopia? Do you support the idea of this type of policy? Why or why not?

Population policy is defined in a variety of ways. Some of them include:

- ⇨ *"All deliberate government actions intended to influence population growth, size, distribution and composition";*

- ⇨ *"A deliberate effort by a national government to influence the three demographic variables: fertility, mortality and migration."*
- ⇨ *"Measures initiated by governments to influence, in a targeted direction, the size, rate of change, composition or geographic distribution of a population."*

What did you understand from the three above definitions of population policy? What is the main issue stressed by all of the definitions?

Generally, population policies are used as guidelines to create positive relationships between population and resources. To this end, they are used to ensure balanced growths of population and economy. Maintaining a balance between a country's population and its economy helps improve the peoples' quality of life while improving the environment.

There are two major types of population policy used by different countries in the world:

a. ***Pro-natalist (populationist) policies:*** they are designed to encourage population growth. Such policies are adopted with the objective of achieving various goals such as maintaining military strength, economic production and national pride. When more-developed countries have expanding economies but very low growth rates, they adopt pro-natalist population policy programs. Examples: the Netherlands, Kuwait and Israel.

b. ***Anti-natalist policies:*** they are designed to reduce birthrates. Such policies are promoted for several reasons. For example, moderating rapid population growth and preventing related social problems such as shortages of housing, education and services. Example; China.

As you know, Ethiopia has a rapid population growth rate and one of the fastest growing populations in the world. Because of this, the government adopted an ***anti-natalist*** population policy since 1993. As such the population policy of the country aims at attaining these general objectives:

a. Closing the gap between high population growth and low economic productivity through planned reduction of population growth and increasing economic returns;

b. Speeding up economic and social development processes through holistic, integrated development programs designed to speed up the structural differentiation of the economy and employment;

c Reducing the rate of rural-to-urban migration;

d Maintaining and improving the carrying capacity of the environment by taking appropriate environmental-protection and conservation measures;

e Raising the economic and social status of women by freeing them from the restrictions and hard work of traditional life and making it possible for them to participate productively in the larger community;

f Significantly improving the social and economic status of unprotected or easily affected groups;

g Facilitating research programs in reproductive health;

h Developing population programs specially designed to promote male involvement in family planning;

i Diversifying methods of contraception with particular attention to increasing the availability of male-orientated methods.

Activity 3.25

In your geography workgroup, answer the following questions and perform the following activities.

1 Of the two main types of population policy, which one is more appropriate for the demographic characteristics of the population of Ethiopia? Why?

2 Explain briefly how anti-natalist population policies can contribute to the well being of the environment in your locality.

3 How can the traditional institutions like "Edir", "Equb", "Mahaber" and others contribute to implementing population policies in your locality? Identify the obstacles that have hindered these institutions from acting as facilitators for such changes. Suggest possible strategies to overcome the obstacles.

Unit Review

UNIT SUMMARY

- Until 1650, the world's population grew quite slowly. But by 2000 A.D, it had reached six billion. The current annual world growth rate is quite large-about 1.5%. But developing countries have higher growth rates, and these rates are much higher than those of the developed countries.
- For instance, Africa and Europe has shown a very contrasting population growth trends. The former has shown fastest growth rate with shortest doubling time but the later has revealed an opposite trends.
- By 2010, world population has reached 6.9 billion. The first three populous continents may include Asia, Africa and Europe, and then followed by L. America, N. America and Oceania according to their size of population.
- The three leading populous countries in Asia (China, India and Indonesia), in Europe (Geromany, UK and Italy), in North America (USA,Mexioc and Canada), in Latin America (Brazil, Argentina and Colombia) and in Africa (Nigeria, Egypt and Ethiopia).
- The population of any area is determined by fertility, mortality and migration. The difference between birth and death rates is known as rate of *natural increase*. Overall, growth rate is determined by the net effect of natural increase and net migration rate. The three main age groups that determine *population structure* are young, adult and old age.
- Population pyramids show considerable differences in population age structures between developed and developing countries. In the former, it is rectangualr at the middle adn narrow both at the base and at the top. But in the later, it is narrow at the top and very broad at the base.
- Population is unevenly distributed across the earth's surface. This distribution is dictated by positive and negative factors. Favourable climate, fertile soil, adequate water supply and industrial development positively influence population concentration. Where as unfavourable climate (extremely hot or cold and dry climates) mountaiinous regions of very rugged topography with poor soil, and inaccessible areas discourage large human settlements.

- Urbanization is the increase in the proportion of people living in cities. It is most rapid in cities of developing countries, where it causes considerable problems.
- Population denisty, which shows the spread of population over space, can be measured using crude (arithmetic) density and agriculatural (rural) density. The former is the best measure of population density in agrarian countires such as in Ethiopia.
- The major causes of migration include economic factors (employment opportunities, communication and transport networks, etc), social factors (social facilities, political control, etc) and ecological factors (ecological crises such as droughts, desertification, etc).
- There are many factors that affect urbanization like rate of natural increase, rural to urban migration, establishment of large number of industries, the development of commerce, transportation and communication, etc. N. America, L. America and Europe are the most urbanized continents followed by Asia and Africa accordingly.
- By 1900, the estimated population of Ethiopia was only 11.8 million. Since then, it has grown at a rapid rate. At the current rate, the country's population is projected to grow by 1.9 million persons annually. Fertility and mortality are the main factors in population growth rates. Migration has very little effect because most of the population has low mobility across international boundaries.
- The pattern of Ethiopiain population distribution is marked unequal. High population densities observed in the highlands but teh peripheral lowlands of the country are very sparsely populated.
- Ethiopian population is predominatly young, which is economically dependent with elderly people upon the economically active population. This adversely affect the development of the country at large.
- The population pyramid of Ethiopia is very wide at the base that indicates a high birth rate and very narrow towards the top due to a high infant mortality rate and relatively short life expectancy. The country also has almost a balanced sex ratios both in rural and ruban areas.
- There are two main types of population policy: pro-natalist and anti-natalist. Ethiopia's population policy's main goal is to achieve a balanced population growth rate. It was launched in 1993 and is essentially anti-natalist.

REVIEW EXERCISE FOR UNIT 3

I *Write 'true' for correct statements and 'false' for wrong statements*

1 Population growth in the developed nations occurs at a much faster rate than in less developed countries.

2 Anti-natalist population policies refer to policies proposed to reduce the birth rate.

3 In Ethiopia, fertility is higher in urban centers than in rural areas.

4 Standard of living is one of the factors that affects fertility.

5 There is a direct relationship between fertility and education.

6 The Nile Valley of Egypt is one of the most densely populated regions of the world.

7 The rate of urbanization is higher in developing countries than in the developed countries.

8 The shape of population pyramids of developing countries is broad-based.

II Matching Item: *Match the items under column "A" with those under column "B"*

A		B	
9	Doubling time	A	Number of live births per 1000 women
10	Early marriage	B	Sex structures
11	Mortality	C	Increases fertility rate
12	Migration	D	It has little effect on population change in Ethiopia
13	Age dependency ratio	E	Average number of children that would be born alive to a woman
14	Total fertility rate	F	The time needed for a population to double in size.
15	General fertility rate	G	The rate of frequency of death in a population

III *Multiple-choice items: choose the correct answer from the given options.*

16 A population pyramid is a drawing that shows population distribution by

A Age group and death rate
B Sex and birth rate
C Sex and age group
D Age group and growth rate

17 Which one of the following is a 'push' factor of migration?

A High living standard
B Poverty and poor employment
C Hostile climate
D Land scarcity
E All except 'A'.

18 The most densely populated part of Ethiopia is

A The enset-growing regions of the SNNPR
B The southwestern part of Ethiopia
C The Gambella and Somali regions
D The Cereal-growing regions of Bale and Arsi

19 The age structure of the Ethiopian population implies that:

A There is a low dependency ratio in Ethiopia.
B There is a high dependency ratio in Ethiopia.
C The old age group is twice as large as that of the middle age group.
D The middle age group and the old age group are roughly equal in number.

20 If the birth rate of a population is 50/1000, and the death rate is 30/1000, then the natural increasing rate is equal to:

A 8% B 80% C 2% D None

IV *Fill the following blank spaces with appropriate word(s).*

21 An exceptionally fast world-population growth is known as_____.

22 Policy that designed to encourage population growth is _____.

23 The *adult* age group is also known as _____.

24 Among the measures of population dynamics, _____ can be regarded as a good indicator of level of development.

25 The main population agglomeration centres of world population are called _____.

V *Workout Items.*

26 The birth rate of country "X" was 47/1000, and its death rate was 18/1000. Find the rate of natural increase.

27 Suppose the demographic characteristics of a certain region are:

Total population = 120,000;

Urban population = 25,000;

Total area = 5000 km^2

Area of arable land = 3000 km^2. Based on the above data, calculate:

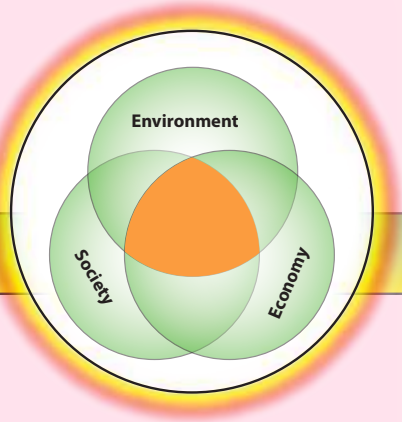
i crude density ii agricultural density

28 By mid 1995, the population size of a hypothetical country, "X", was 100 million, of which 35% of the people were under 15 years of age, and 40% were adult. What is the ADR of this population?

29 The population size of a hypothetical country "Y" was 75 million, of which 30% were under 15 years of age and 10% were in old age. Calculate the ADR of this population.

30 A hypothetical country "A" has a sex ratio of 88%. If the female population is 10 million, what is the total population?

Unit 4



ECONOMIC SYSTEM AND DEVELOPMENT

Unit Outcomes

After completing this unit, you will be able to:

- Recognize types of economic systems;
- State the concept of sustainable development and its indicators;
- Recognize the role and contribution of economic organization and realize the concept of globalization.

Main Contents

INTRODUCTION

As you remember, in grade nine you learnt about the five major economic activities (primary, secondary, tertiary, quaternary and quinary) with their associated characteristics.

In this unit you will read about the three major categories of economic systems of the world and issues related to sustainable economic development.

You will also examine the role and functions of world economic organizations such as the World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO). The concept and the various impacts of globalization will also be treated.

4.1 TYPES OF ECONOMIC SYSTEMS

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

- Discuss the concept of different economic systems;
- Compare and contrast the types of economic systems.

Key Terms

- Traditional economy
- Mixed economy
- Market economy
- Command economy

A major change occurred about 10,000 years ago, when people began to produce crops and to domesticate animals. This advance led to increased food supplies.

Start-up Activity

Discuss the following questions in your group.

1. Why have different countries of the world followed different types of economic systems?
2. Which economic system is currently used for Ethiopia's economy? Why?
3. What factors affect the economic decisions of a society? Mention some of them and describe their roles in your locality's economic affairs.

What is an economic system?

An economic system is the means or structures in a society within which decisions about what to produce, how and when to produce goods and services and where to allocate them are made and implemented.

The way a society makes economic decisions may closely reflect the pattern of its culture. It also tells about the society's politics, religion, and even its approach to family.

To achieve economic growth and development, different countries use different approaches or systems. That means economic problems can be solved in various ways. Here are the major economic systems practiced in the world:

- Traditional economic system
- Free market economic system
- Command economic system
- Mixed economic system

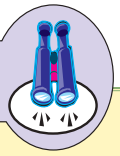
Traditional Economy

What are traditional economies? Can you cite a primitive people who still live in traditional economies (especially in Africa)? Do we have such communities in Ethiopia? What are the basic features of a traditional economy?

It is an economic system in which primitive people produce just to feed their households with very little goods or services left over for sale or exchange in the market. Production is geared towards subsistence and basic survival. The system employs simple, backward and traditional means (techniques) in the process of food production.

Market and money are of little importance, and trade is mainly by a barter system. Thus, exchange of goods is limited. Answers to the "for whom" and "how much" questions are fixed by custom, habit, religion, or law in traditional cultures. *Example*, the Bushmen of the Kalahari Desert have rules for sharing their kills among the hunters and their families. The largest share usually goes to the best hunter. In this way, the best hunters survive when games are secured.

Focus



Traditional economic systems are practiced in extremely backward areas or primitive societies like hunters and gatherers. Generally, it is characterized by:

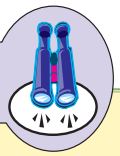
- ⇨ *lack of knowledge of science and technology,*
- ⇨ *low productivity.*
- ⇨ *a low level of exchange of goods.*

Market Economy

What is market economy? What is the role of the government in a market economy? How is market economy different from traditional economy? What are the weak and strong sides of market economy?

Market economy is an economic system in which individuals, rather than government, make the main decisions regarding economic activities and transactions. Individuals are free to make economic decisions concerning their employment, how to use or accumulate capital, what expenditures to make, and whether to use their resources now or to save them for later consumption.

Focus



In a market economy, the basic economic questions are answered by the interplay of buyers and sellers. There is no overall planning, as there is with command economic systems. The guiding principle of market systems is self-interest. Sellers want to sell at the highest prices. Buyers want to buy at the lowest prices. The bargains that buyers and sellers make, therefore, give the answers to the questions.

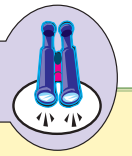
It is important to know that there is no pure free-market economy in the world. Governments interfere in organizing market economy in many ways and for many reasons. Most governments play an important role in dealing with problems of inflation and employment. They are also concerned with providing education for the society, strengthening national defense, controlling prices of power supply and food, and imposing taxes.

The main proponents of free-market economies believe and forward a number of advantages of free market economies, such as encouraging individual

responsibility for decisions. They also believe that economic freedom is essential to political freedom.

Free-market economies are also criticized. Opponents believe that a free-market economy cannot ensure basic social values such as alleviating poverty or ensuring equitable income distribution. It may also permit the accumulation of wealth and strong vested interests that could threaten the survival of political freedom.

Focus



Generally, market economy is characterized by:

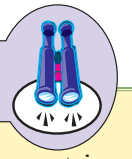
- ⇨ *private property.*
- ⇨ *economic freedom.*
- ⇨ *prices that are determined by the law of supply and demand.*
- ⇨ *decentralized decision making.*

Command Economy

What does "command economy" mean? Which countries of the world still follow command economic systems? What are the unique features of command economy?

In a command economy, the government makes decisions about production and consumption. This implies that the government decides what to produce, how to produce and for whom to produce. Also the governments own all factories, land, housing, etc.

Focus



The command economic system still exists in some countries, such as North Korea, Cuba and China. It is characterized by:

- ⇨ *a master plan for supply and price.*
- ⇨ *the government develops and enforces plans.*
- ⇨ *goods and services are distributed through government agencies.*

State ownership of resources actually reduces personal incentive, effort and initiative. At best, in a command economic system, the basic economic questions are answered by a group of planners. They have the power to make economic decisions for the society as a whole. However, this type of economy is fading away in the world.

Mixed Economy

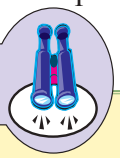
What are the roles of government and private sectors in mixed economic system?

In this type of economic system, both government and private sectors play an important role in answering the "what", "how' and "for whom" questions concerning society as a whole.

In the mixed system, the government may not only own and run key industries, means of transport, power, and water supply, etc., but it also intervenes to prevent monopolies and ensure free competition. In addition, it might influence prices of agricultural products, rather than allowing them to be influenced by market forces. It might also offer incentives (tax relief, grants, exemptions or penalties) to encourage particular activities (e.g., tree planting).

Most countries of the world have mixed economies (for example, France and Sweden). Some are close to command economy while others rely more on market economy. In a mixed economy, there is competition between the government and the private sectors. Sometimes, those that are unable to compete soon die away.

Focus



Traditional economic systems make decisions the way they have always been made in the past. Command systems permit a group of planners to answer the basic economic questions. Market systems rely on exchange and a network of prices to determine issues of *what, how, for whom,* and *how much*, while mixed economy is characterized partly by free-market.

Activity 4.1

Discuss the following in your group. Then present your findings to the class.

1. What are the advantages and disadvantages of free-market economy in the context of Ethiopia?
2. Compare and contrast the role of the government in Ethiopia's economy before 1991 and after 1991 (i.e., the economic policies of the "Derg" and of the current government). What improvements did you observe? Why? Support your answer with evidence from your locality.
3. Do you think that Ethiopia strictly follows free-market economy these days? Why?

4.2 SUSTAINABLE ECONOMIC DEVELOPMENT

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

- Explain the concept of sustainable economic development;
- Justify the indicators of economic development.

Key Terms

- sustainable development
- environment
- gross domestic product
- gross national product
- developed countries
- precipitate income
- standard of living
- developing countries

Activity 4.2

Discuss the following in your group.

1. Why does Ethiopia lag behind rich countries in its standard of living?
2. How can Ethiopia catch up with the rich countries without endangering its environment?
3. What are the means for harmonizing the relationship between development and environment in your locality?
4. How do you relate fast economic development and global warming?

Concept and Indicators of Economic Development

What is development? How do you relate sustainability with development? What does sustainable development mean?

Development is a difficult concept to define. The term *development* means different things to different people. Therefore, possible definitions include a wide range of elements (see Figure 4.1).

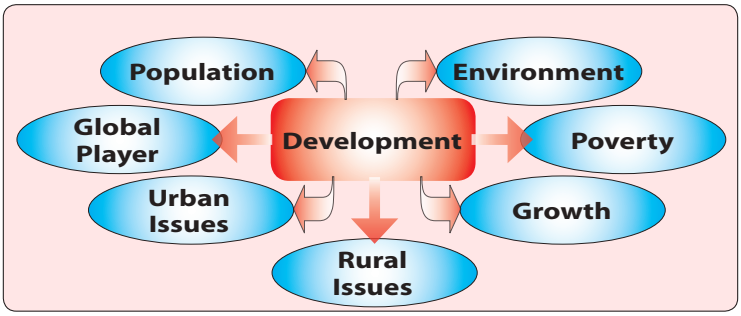
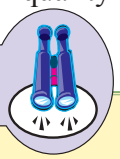


Figure 4.1: **The Environment of development**

What do you understand from Figure 4.1? How do you relate development with the terms noted in each box of Figure 4.1?

Despite the complexity of the issue, we have some definitions that can go well with the term *development*. Development is a process by which members of a society increase their personal and institutional capacities to mobilize and manage resources to produce sustainable improvements in their quality of life.

Focus



The most recent definition of development: *Development* – represents the whole package of change by which an entire social system moves away from a condition of life perceived as unsatisfactory towards a situation or condition of life that is materially and spiritually better (Todaro and Smith, 2009: 16).

What are the main points included in the definition? Can you explain them briefly? What are the main objectives of development in any society?

Development in any society must have at least the following three objectives:

a To increase the availability and widen the distribution of basic life-sustaining goods, such as food, shelter, health services and clothing.

b To raise living standards and levels of income, employment, education and attention to cultural and human values.

c To expand the range of economic and social choices.

What should be done to accomplish the above objectives? Can you mention some of the efforts made in your locality?

Generally, economic development strategies should give due attention to increasing the productive capacities of human wealth and the health of the environment. This is done by concentrating on the following:

i Making sure that the nation has a labor force that is ready to work, hardworking and energetic.

ii Improving the skill and the ability of the working force.

iii Ensuring the human labor force has adequate medical care (in order to maintain its productiveness).

iv Improving the supply, multiplication and distribution of modern and environmentally friendly technology and other inputs.

In addition, in order to ensure sustainable development attention must be given to the environment.

What does sustainable development mean?

Focus

According to the World Commission of Environment and Development (1987), "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

In other words, sustainability implies that future growth and overall quality of life are critically dependent on the quality of the environment. To destroy the environment in the pursuit of short-term economic goals, jeopardizes present and especially future generations. This is the level of extraction that could be maintained without lessening future levels.

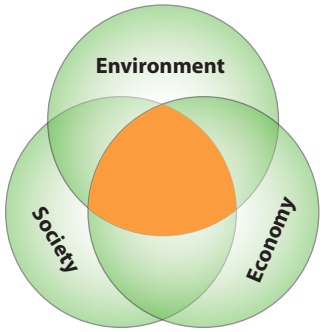


Figure 4.2: **Components of sustainable development**

That is why sustainability is a current paradigm for thinking about a future in which environmental, societal and economic considerations are balanced in the pursuit of development and improved quality of life.

Sustainable development has three components, which are shown in Figure 4.2. The area of overlap (i.e., the intersecting and shaded part of the three circles at the center) represents human wellbeing. As the environment, society and economy become more aligned, the area of overlap increases, and so does human wellbeing.

Generally, in order to achieve sustainable development, environmental protection must constitute an integral part of the development process, and cannot be considered in isolation from it. Eradicating poverty and reducing disparities in living standards in different parts of the world are essential goals for achieving sustainable development and meeting the needs of the majority of people.

Activity 4.3

Perform the following in your geography workgroup by citing examples from your locality:

1 Briefly describe how the following affect the working culture in Ethiopia:
   i choice of jobs and considering one type of job inferior to the other.
   ii lack of punctuality in working hours and holidays.
2 How can you improve and develop the habit of hard work in your locality?
3 Is it possible to achieve economic growth in your locality without damaging the environment? How?

Indicators of Economic Development

What are the tools used to measure development? How do we classify countries at different levels of development?

Indicators of development are measures, to a certain level, of development in a given country.

The main indicators of development in the world include:

- GDP
- Per-capita income
- Standard of living

Gross Domestic Product (GDP)

What is the GDP?

The GDP is a measure of the market value of commodities. It is the total value of currently produced final goods and services within a country's borders, usually in a year, irrespective of who owns the outputs.

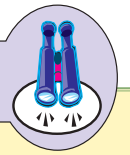
In developing countries, the GDP is not only low, but it is also dominated by primary commodities. On the other hand, secondary and tertiary economic activities contribute the biggest shares to the GDP in the developed countries

Per-Capita Income

How can the per-capita income of a country be measured?

It is another indicator of development. It is strongly related to the GDP. Of course, as a measure of peoples' quality of life it is indicative of their standard of living.

Focus



The Gross National Product (GNP) is the total value of goods and services produced by a country in a year, including incomes secured from abroad, through varied activities.

You can calculate per-capita income, using the following formula:

$$\text{Per-capita income} = \frac{\text{GDP}}{\text{Total Population}}$$

$$= \frac{\text{GDP} \pm \left(\begin{array}{l}\text{Income secured from abroad} \\ \quad - \text{income taken away by foreigners}\end{array}\right)}{\text{Total population}}$$

Example

Suppose gross domestic product (GDP) of a country for a given year is \$50 billion, total population is 25 million, income earned by foreigners from the domestic economy is \$100 million, and income earned by nationals from abroad is \$250 million. What is the percapita income for the country?

$$\text{Per capita Income} = \frac{50\,\text{bill} \pm (250\text{mill} - 100\,\text{mill})}{25\,\text{mill}}$$

$$= \frac{50 \text{ bill } \pm 150 \text{ mill}}{25 \text{ mill}}$$

$$= \frac{50\,\text{bill} + 150 \text{ mill}}{25 \text{ mill}}$$

(you have to add them, because income secured from abroad is greater than income taken away by foreigners)

$$= \frac{50,150,000,000}{25,000,000}$$

$$\text{Per capita income} = \$2006$$

In the same way as the GDP, per-capita income for developed countries is very high and growing. This is the result of ever-increasing GDPs that are based on diversified urban industrial and commercial economies. Developing countries, on the other hand, have low per-capita incomes, whose bases are primary economy that lack diversification.

Standard of Living

Why is living standard considered the best measure of development?

Living standard is perhaps the best measure of the quality of life of a given society. It is directly related to both the GDP and per-capita income. This is because, as the latter get higher, the former improves, and vice versa. Developed countries have high and constantly growing living standards, while people of the developing world are characterized by low living standards.

Based on the above and other indicators of development, countries of the world can be classified and named in different ways such as *rich/poor*, d*eveloped/ developing, north/south, first/second world*, and *more developed/less developed*. Also, using current development status as a criteria, they can be grouped as: *developed*, *less developed* and *least developed*.

How do you explain the economic improvement you observe in less developed countries like Ethiopia? What are the dominant economic activities that define each group of countries?

The developed countries are the world's richest nations. This is because their economy is urban-based, industrial and specialized in commercial activities, supported by sophisticated technology and infrastructure (see Table 4.1). Less developed countries include the bulk of the world's countries, which are found in Africa, Latin America, and Asia. They have traditional economic systems, largely based on agriculture, mining or a combination of both.

Table 4.1: **The world's top 10 developed countries**

Country	GDP per-capita income (US$) (1) (2008)	Adult literacy (%) (2)	Annual population growth rate (%) (3) (2009)	Life expectancy (years) (4) (2010)	Urban population (%) (4) (2010)
USA	46,108	99	0.6	78	79
Japan	38,591	99	0.19	83	86
France	44,121	99	0.56	81	77
Norway	94,505	99	0.34	81	80
Germany	44,394	99	-0.05	80	73
Canada	45,049	99	1.3	81	80
United Kingdom	43,149	99	0.47	80	80
Switzerland	65,167	99	1.1	82	73
Italy	38,302	98.9	-0.05	82	68
Sweden	52,236	100	0.48	81	84

Source: *(1) UNCTAD Handbook of Statistics, UN; New York 2009; (2) UNDP Report 2009; (3) CIA world fact book 2009; (4) 2010 Population Reference Bureau.*

The least developed countries, as their name implies, are the poorest nations of the world. By all standards, these countries have the most backward economic and social systems. Hence, mass poverty is a common feature of the majority of the populations of these countries (see Table 4.2).

Table 4.2: **The least developed countries of the world**

Country	GNP per-capital in come (US$) 2008 (1)	Adult literacy (%) 2009 (2)	Annual population growth rate (%) (3) 2009	Life expectancy (years) 2010 (4)	Urban population (%) (4) 2010
Afghanistan	425	28.1	2.6	44	22
Bangladesh	485	53.5	1.4	66	25
Benin	773	40.5	3.0	59	41
Burkina Faso	553	28.7	3.4	53	23
Bhutan	2025	52.8	1.5	50	15
Burundi	148	59.3	2.8	50	10
Central African Republic	464	48.6	1.9	49	38
Chad	817	30.8	2.07	49	27
Comoros	801	75.1	2.4	64	28
Ethiopia	261	35.9	2.6	55	16
Guinea	437	29.5	2.6	57	28
Guinea – Bissau	272	64.6	2.02	46	30
Haiti	849	62.1	1.6	61	48
Laos	849	68.7	1.8	65	27
Lesotho	755	82.2	0.8	41	23

Activity 4.4

Perform the following activities in pairs and present your opinions to the class.

1. Compare and contrast Table 4.1 and Table 4.2 in relation to the prevailing socio-economic and demographic differences that exist between the developed and the least developed countries.
2. What measures can be taken to improve the development processes of the developing countries? What roles could be played by developed countries in this respect?
3. What new jobs have been created for the working population in your locality in the last 10 years? If none, why?

4.3 ECONOMIC ORGANIZATIONS OF THE WORLD

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

- identify world economic organizations;
- realize the contribution of world economic organizations to development;
- discuss the concept of globalization;
- compare and contrast the advantages and disadvantages of globalization.

Key Terms

- World Bank
- IMF
- Structural adjustment
- Intellectual property rights
- WTO
- Globalization
- Deregulation
- GATT

4.3.1 Economic Organizations of the World

Can you name economic organizations that serve at a global level? How do they contribute to the economic development of nations across the world? What influences and pressures are created by these global organizations upon the developing countries?

Three key institutions serve as economic organizations of the world. They are the World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO). All three organizations trace their origins to the end of World War II (1939-1945), when the United States and the UK decided to set up new organizations and rules for the global economy. Since then, these three economic organizations have played a large role across the world. The following subsections highlight each of them.

World Bank

What roles are played by the World Bank in developing countries? Can you cite some examples from Ethiopia?

The World Bank is a specialized agency of the United Nations. It was established in 1944. It grants loans to member nations for the purpose of reconstruction and development. Officially, it is called the International Bank for Reconstruction and Development (IBRD).

The World Bank is the largest known private development bank. It operates internationally and has its headquarters in the United States in Washington, D.C. It makes large loans to governments of developing countries to finance projects intended to strengthen the economies of these nations. The World Bank finances projects such as building roads, dams for power generation, and industries. Beginning in 1968, the bank also focused on low-cost loans for health, education and other basic needs of the world's poor.

International Monetary Fund (IMF)

What makes the IMF different from the World Bank?

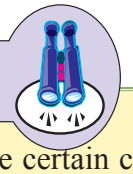
The IMF was established in the same year as the World Bank (1944) with the aims of encouraging exchange stability, eliminating exchange controls, promoting international monetary cooperation, and expanding world trade.

In other words, the IMF makes loans so that countries can maintain the values of their currencies and repay foreign debt. Countries accumulate foreign debt when they buy more from the rest of the world than they sell abroad. They then need to borrow money to pay the difference, which is known as balancing their payments. After banks and other institutions will no longer lend them money, they turn to the IMF to help them balance their payment positions with the rest of the world.

The IMF initially focused on Europe, but by the 1970's it changed its focus to the less developed economies.

What preconditions do the World Bank and the IMF demand of developing countries before providing the aforementioned benefits? Do the demands favor the developing countries? Why?

Focus



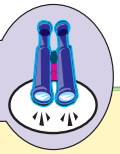
Both the IMF and the World Bank usually impose certain conditions for loans and require what are called *structural adjustment programmes* from borrowers. The programs are based on a strategy that is geared towards promoting free markets, including privatization (the selling of government enterprises); deregulation (removing rules that restrict companies); and trade liberalization (opening local markets to foreign goods by removing barriers to exports and imports). Finally, the strategy also calls for shrinking the role of government, reducing taxes, and cutting back on publicly provided services.

World Trade Organization (WTO)

How does the WTO differ from the World Bank and the IMF? Do you support or oppose the WTO? Why?

The World Trade Organization is an international body that promotes and enforces provision of trade laws and regulations. It has the authority to administer and put in place new and existing free trade agreements, to oversee world trade practices, and to settle trade disputes among member states.

Focus



The WTO was established in 1994 to replace the General Agreement on Tariffs and Trade (GATT) and began its operation on January 1,1995 in Geneva, Switzerland. Since then, the WTO has increased the scope of trading agreements. Today such agreements no longer involve only the trade of manufactured products but also involve services, investments and the protection of intellectual property rights (that is, creative works that can be protected legally), such as patents and copyrights. For example, the United States receives over half of its international income from patents and royalties for use of copyrighted material.

The WTO is also a formally structured organization whose rules are legally binding for its member states. The organization provides a framework for international trade law. Members can refer trade disputes to the WTO, where a dispute panel composed of WTO officials serves as arbitrator. Members can appeal to this panel's rulings to a WTO affiliated body whose decisions are final. Disputes must be resolved within the time limits set by WTO rules.

Since its creation, the WTO has attracted both supporters and opponents across the world. On the one hand, the opponents argue that:

- ⇨ *the organization is too powerful because it can declare the laws and regulations of sovereign nations in violation of trade rules, in effect pressuring nations to change these laws,*
- ⇨ *WTO trade rules do not sufficiently protect workers' rights, the environment, or human health,*
- ⇨ *It also lacks democratic accountability because its hearings on trade disputes are closed to the public, the press, etc.*

On the other hand, WTO supporters argue that it plays a critical role in helping expand world trade and raise living standards around the world.

Generally, the three key institutions that you have just learned about are considered the main actors or players who are shaping the current era of globalization.

Activity 4.5

Discuss the following questions in your group.

1. Could Ethiopia benefit from the WTO, if it were one of the member states? Why?
2. How does the lack of strong enforcement of intellectual property rights laws adversely affect domestic trade in Ethiopia? Support your answer with examples.
3. What possible measures do you suggest to enforce the respect of copyrights in your locality?

4.3.2 Globalization

What is globalization? How do the least developed countries benefit from globalization? What are the effects of globalization?

Globalization is the process by which people their ideas and their activities (economic, cultural, political) in previously relatively separated parts of the world become interconnected, and are drawn to the same social space at the same historical time. It does not imply homogenization, or the elimination of regional differences or uneven development. It leads to increased ecological inter-dependence; and the global world economy is based particularly on the transnactional movement of information and the mobile factors of production (capital, labour, technology).

It is said that globalization is a powerful force for poverty reduction, but billions of people in the world are still left out of this process. However, with the development of the present trend, it seems evident that the world will be truly a global village.

It must also be noted that there are continuing controversies and disputes over the value of globalization for the common good in society. Some argue that globalization works to the advantages of the leading industrialized countries of Europe and North America. They argue that a good deal of economic exchange takes place between regions rather than worldwide. For example, the European

Union countries mostly trade among themselves, while those of Asia or North America do the same thing. Therefore, there is no international trade that benefits the world community as a whole. And so, globalization adds more to the misery and despair of the already poor and underdeveloped nations, while increasing the wealth of the rich countries.

There are also others who have an opposite and positive view of globalization. These contenders argue that globalization is not only an economic phenomenon, as it affects all aspect of life. Therefore, they say, it is unavoidable. Because, according to them, the dramatic expansion of science and technology is interwoven with international relations among people of the world and no nation, whether poor or rich, can do away with globalization, but must adjust themselves to this new trend.

The Advantages and Disadvantages of Globalization

Advantages

What advantages do you think globalization has for third-world countries?

1. It creates new opportunities and benefits. For instance, currently some of the Western industrialized nations removed tariff restrictions and opened their markets for the products of third-world countries.
2. There are rules and principles by which globalization is governed. For example, some of the provisions require a country to open up its financial markets and eliminate controls on capital flow (both in and out). This will increase foreign direct investment, promote economic growth and lift the poor from poverty.
3. Payments, known as "remittances" that developing countries international migrants send back to their countries (home) have become an important measure of the performance of a globalized world economy. For example, in 2009, remittances exceeded $300 billion, almost three times the total of foreign aid disbursements.

Disadvantages

What are the main disadvantages of globalization for developing countries?

1. Globalization is unable to avoid the divergent interest clashes between the rich Western industrialized countries and the poor Developing countries.
2. So far, globalization has not brought equality among nations. Although it can minimize the risk of one country harming another, it is difficult to think

it will bring equality between the countries. This is because the nature and characteristics of globalization do not allow it to do so.

3 The strong and wealthy nations have the power to promote certain of their advantages.

4 Governments of the Western industrialized nations are ready to accept the principles of free market and make them practical in their relationships with developing countries. But they do this only when they are quite sure that their transcontinental corporations are the winners in the market competition.

5 When the industrialized countries import products from the developing countries, they impose high tariffs because they want to protect and safeguard the interests of their local industries. This clearly shows that they do not exercise free-market principles. Rather they stick to a non-free-market economic system.

6 Another problem is that governments of Western industrialized nations subsidize their farmers because they want them to sell their agricultural products at lower prices than those of the imported ones from the developing countries. This throws doubt on the sincerity of the Western industrialized nations when they talk about the importance of globalization for the reduction of poverty in developing countries.

7 Local markets in the developing countries may be dominated by the goods (particularly industrial) imported from industrialized countries the moment they open their doors to globalization.

8 Globalization disregards the protection of the environment and hence developing countries suffer greatly from environmental degradation.

Activity 4.6

Discuss the following in your group and then present your findings to the class.

1 By providing practical examples, show how the disadvantages of globalization operate in Ethiopia.

2 Some people say that globalization has lost its broader meaning and has become synonymous with the advance of capitalism. Others go farther and perceive globalization as Americanization in a new form of cultural invasion. Do you agree or disagree with this statement? Why?

3 Do you think that compensation from industrialized countries is necessary to developing countries (like Ethiopia) in order to maintain third-world environments from the adverse (negative) effects of globalization? Why?

Unit Review

UNIT SUMMARY

- The main economic systems of the world are grouped into traditional, free market, command and mixed economies. Each one of these systems has its own rules (decisions) and approaches to the economy that it runs.
- Traditional economic systems are practiced in extremely backward areas and characterized by lack of knowledge of science and technology, low productivity and a low level of exchange of goods.
- Market economy is an economic system which is characterized by private property, economic freedom (relatively), prices are determined by the law of supply and demand, and decentralized decision making.
- In a command economy, the government makes decision about production and consumptions. Whereas in mixed economy system both government and private sectors play an important roles and may also compete to each other.
- Sustainable economic development is the improvement of quality of life (both material and spiritual) without endangering future generations. Gross domestic product (GDP), per-capital income and living standards are some major indicators of economic development. Based on these measurements, countries of the world are often classified as developing and developed, although other terms are also used for this purpose.
- The World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO) are the three key financial institutions that play a great role in shaping the current era of globalization.
- Despite their short comings, the world economic organizations have been playing a great roles in fostering development. For instance, World Bank have financing (through large loans) different projects in developing countries like building roads, dams (for HEP), industries, etc. IMF provide loans to those countries which couldn't balance their foreign payments. WTO also plays a critical role in helping expand world trade and raise living standard around the world.

- Globalization is the process by which people their ideas and their activities (economic, cultural, political) in previously relatively separated parts of the world become inter-connected, and drawn to the same social historical time.
- Some of the advantages of globalization include creation of new opportunities and benefits (such as the removal of tariff restrictions), increment of direct foreign investment, remittance to home countries, etc. Its disadvantage is mainly related to the widening of the economic gaps between the rich and the poor nations.

REVIEW EXERCISE FOR UNIT 4

I *Write True for correct statements and False for wrong statements.*

1 Most countries of the world have a free market economy.

2 A traditional economic system is highly characterized by low productivity with intensive use of money in the market.

3 Sustainable development is dependent on the quality of the environment.

4 The GNP and GDP are more or less identical and are used to measure economic development.

5 The WTO is dominated by wealthy industrialized countries and does not give less developed nations enough of a voice in formulating new trade rules.

6 Less developed countries cannot benefit from globalization.

II *Match Column B with Column A.*

	A		B
7	Environment of development	A	Per-capital income
8	IBRD	B	IMF
9	Sustainable development	C	Population, poverty, growth etc.
10	Trade liberalization	D	WTO
11	The best measure of economic development	E	Brundtland commission
		F	Living standard

III *Fill in the blanks in each statement.*

12 _____ is removing rules that restrict companies from working in free-market economic systems.

13 The three main components of sustainable development are _____, _____ and _____.

14 Currently, Ethiopia follows a _____ economic system.

15 The three main institutions that are shaping the current era of globalization are _____ ,_____ and _____.

16 _____ and _____ are two examples of intellectual property rights.

IV *Answer the following questions in detail.*

17 Describe briefly how you and your school communities benefit from globalization.

18 Why do Western industrialized countries subsidize their farmers? What impacts does this have upon the indigenous farmers of developing countries?

19 Explain briefly the negative impacts of globalization on your local environment.

20 The IMF requires developing countries to implement structural adjustments before they can receive loans. Do you think that this is fair? Why?

Glossary

Abiotic factor: *A nonliving part of an ecosystem.*

Agriculture: *The business of growing crops and raising animals.*

Agricultural Density (Rural Density): *It is a measure that defines the size of agricultural or rural population inhabiting a square area of cultivated land. It is the best measure of population and resource relationships in agricultural countries like Ethiopia.*

Altitude: *The height of any place, measured vertically from mean sea level.*

Anti-natalist policies: *Are designed to reduce birth rates. Such policies are promoted for several reasons. For example, moderating rapid population growth and preventing related social problems such as shortage of housing, education and services.*

Astronomer: *A scientist who studies other planets and the stars.*

Atmosphere: *The layer of gases that surrounds the earth.*

Benchmarks: *Represent precise heights along high ways or railways. They are shown on stones, bricks or bronze plates on walls of building and other convenient places.*

Bearing: *The direction of one place or object from another.*

Biodiversity: *a measure of the variety of kinds of organisms present in an ecosystem.*

Biome: *a kind of plant and animal community that covers large geographic areas.*

Biotic factor: *living portions of the environment.*

Biosphere: *The parts of the earth in which all of the planet's plant and animal life exists.*

Broad leaf: *Having wide leaves: said of hardwood trees that may drop their leaves in the winter.*

Canal: *An inland waterway built for transportation or irrigation.*

Cardinal direction: *One of the main direction of the globe; north, south, east and west.*

Cartography: *the branch of geography that studies maps and map making.*

Cause: *An event that makes something else happen.*

Chlorophyll: *pigment found in plant leaves that traps the energy in sunlight for use by the plant.*

Circle graph: *A graph in the shape of a circle that shows the sizes of different parts of a whole; also called a pie graph.*

Cliff: *A vertical rock-face common along sea coasts, mountain ridges and river courses.*

Climate: *The pattern of weather of a certain place over many years.*

Coast: *The land next to the ocean or sea.*

Cohort: *a group of persons, i.e. the same generation all born at the same time, or in same cases, those circumcised at the same ceremony.*

Command Economy: *Is an economy in which resources and business activity are controlled by the government.*

Compass rose: *a small drawing on a map that shows directions. A directional indicator that has arrows pointing north, south, east and west*

Concave slope: *A slope with a gentle gradient at the foot and steep gradient near the top.*

Coniferous forest: *a middle-latitude forest whose plants remain green year-round.*

Conservation: *the careful use of a natural resource.*

Continent: *one of Earth's seven large bodies of land-Africa, Antarctica, Asia, Australia, Europe, North America, and South America.*

Continental drift: *the theory proposed that continents were once joined together and later split and drifted apart.*

Contour (Also called Isohypse): *A line on a map connecting all points with the same known altitude above a specific mean sea level.*

Convex slope: *A slope with a steep gradient near the base and a gentle gradient near the top.*

Crop rotation: *A method of preserving soil fertility in which different types of crops are grown on the same piece of land over time.*

Crude Birth Rate (CBR): *indicates the number of live births observed in one year among one thousand people in a given region.*

Crude Death Rate (CDR): *Is the number of deaths occurring in a given year among one thousand people in a given region.*

Crude Density (Arthmetic Density): *Is the number of inhabitants per square kilometres of any geographical area.*

Dam: *a wall built across a river to control the flow of water or to create a lake.*

Deciduous: *plants that shed their leaves before a period of dormancy.*

Deforestation: *The loss of forest by cutting down all of its trees.*

Degree: *A unit for measuring distance on Earth's surface. Also a unit for measuring temperature. Represented by the symbol.*

Dependency Ratio: *Is a measure of the degree of burden created by the unproductive (children and old) population over the productive (adult) population.*

Deregulation: *Is removing rules that restrict companies.*

Desert: *a dry area that gets less than 25 centimeters of precipitation each year.*

Desertification: *a process by which desert-like conditions are created by a loss of plant cover and soil due to human activity.*

Developed countries: *Are countries that have good living standard and strong economic structure because they have a wide variety of industries and a higher per-capita income when compared with developing countries.*

Developing countries: *countries with low living standard and unreliable economy because they are dependent on traditional agriculture; also called third world.*

Development: *Is the extent to which natural resources of a nation have been brought to productive use in order to raise people's standard of living and to improve the quality of life.*

Dip slope: *The more gentle slope of a mountain ridge.*

Doldrums: *calm areas centered along the equator.*

Drought: *a period in which very little rain falls or long dry period with little or no rain.*

Drought prone areas: *areas that are inclined to a long dry period with little or no rain.*

Dry farming: *methods of growing crops in arid areas where two seasons rain is used for one season's harvest.*

Easting: *parallel line of the GRID which runs from the top to the bottom border of a map sheet.*

Ecology: *the study of how living things and their environment interact.*

Ecosystem: *an interdependent community of plants and animals combined with their physical environment.*

Elevation: *the height of land above sea level. Height on the earth's surface above or below sea level.*

Emigration Rate: *Is the number of people departing an area of origin per 1000 population of the area of origin in a given year.*

Environment: *the surroundings in which people, plants, or animals live.*

Epoch: *the smallest unit of geological time. Periods are divided into epochs.*

Equator: *An imaginary line that lies halfway between the North pole and the South Pole, at 0° latitude.*

Era: *a geological lime unit.*

Erosion: *the action of water, wind or ice in wearing away soil and rock.*

Escarpment: *The steep slope of a plateau.*

Evaporation: *the process in which water is changed from a liquid to a gas.*

Even slope: *A slope where the gradient remains constant from base to top.*

Fallow: *unused, as crop land.*

Fauna: *all of the animals present in a given region.*

Famine: *an extreme shortage of food*

Fertile soil: *good for growing crops.*

Fertility: *Refers to the actual reproductive performance of a population.*

Field distance: *The distance that considers the ups and downs of the surface of the earth.*

Fertilizer: *chemicals added to soil to make it more fertile.*

Flora: *all the plants present in a given region.*

Formlines: *An inaccurate contour (broken or pecked lines) which have been drawn in by estimate, usually with the help of a few spot heights, but not instrumentally surveyed.*

Fossil fuel: *a fuel that may have been formed from the remains of prehistoric plants and animals.*

Galaxy: *a large volume of space containing many billions of stars, held together by mutual gravitational attraction.*

GATT (General Agreement on Tariffs and Trade): *was negotiated during the UN conference on trade and employment and was the outcome of the failure of negotiating governments to create the International Trade Organization (ITO). GAAT was signed in 1947 and lasted until 1993, when it was replaced by the World Trade Organization in 1995. The original GATT text (GATT 1947) is still in effect under the WTO framework, subject to the modifications of GATT 1994.*

Geographic grid: *the grid formed by the meridians and parallels used for accurate locations of points on the surface of the earth.*

Geological time scale: *a chronological arrangement of geological time subdivided into units.*

General Fertility Rate (GFR): *Is the number of live births per 1000 women aged 15-49 years in a given year.*

Geography: *the study of earth and the way people, plants and animals live and use it.*

Geographic gird: *the criss-crossing lines of latitude and longitude on a map or globe.*

Globalization: *Is the process by which people their ideas and their activities (economic, cultural, political) in previously relatively separated parts of the world become interconnected, and drawn to the same social space at the same historical time.*

Globe: *a scale model of the earth, especially useful for looking at its entire surface or at large areas of its surface.*

Gradient: *The rate of change in altitude of a slope expressed basically as a proportion between vertical changes per horizontally unit length.*

Granite: *a specked, hard, crystalline rock formed deep in the earth's crust.*

Graph: *a diagram that shows information in a picture. See circle graph, line graph.*

Greenhouse effect: *the warming of the earth caused by the buildup of carbon dioxide in the lower atmosphere, possibly as a result of human industrial activity.*

Green house gas: *gas in the atmosphere that allows sunlight to enter but retards the outward flow of heat from the earth.*

Grid: *a pattern of lines that circle the earth in east-west and north-south directions.*

Grid north: *the direction indicated by the Verticals representing the Easting's of the grid.*

Grid origin: *the point from which the numbering of all grid lines of a given network begins.*

Gross Domestic Product (GDP): *Is the total value of currently produced final goods and services within a country's borders, usually in a year, irrespective of who owns the outputs.*

Gross National Product (GNP): *Is the total value of goods and services produced by a country in a year, including incomes secured from abroad and varied activities.*

Habitat: *the specific kind of place where a particular kind of organism lives.*

Hachure: *A line on relief map drawn down the slope, made thicker and drawn closer together where the gradient is steeper. Usually nowadays used together with contours to show minor but important details lost between the contours of a normal contour map.*

Hemisphere: *half a sphere; one of the four hemispheres.*

Human factors: *are factors that include technology, human labour, etc.*

Humidity: *the amount of water vapor in the air.*

Humus: *an important ingredient of soil, made of decayed plant or animal matter.*

Hydrosphere: *the physical system made up of all of Earth's water.*

IMF (International Monetary Fund): *Is a global economic organization established (in 1994) with the aims of encouraging exchange stability, eliminating exchange controls, promoting international monetary cooperation, and expanding world trade.*

Immigration Rate: *Is the number of people arriving at a destination in a given year.*

Infant Mortality Rate (IMR): *Is the number of deaths of infants under the age of one year, amongst 1000 live births in a given year.*

Insolation: *the amount of the sun's energy that reaches Earth at a given time and place.*

Intellectual property rights: *are creative works that can be protected legally. Example patents and copy rights.*

Intermediate direction: *any direction in between two cardinal directions – north east, southeast, southwest, northwest.*

Inter Tropical Convergence Zone (ITCZ) *– the boundary between two air masses produced within the trade wind system.*

Irrigation: *the use of ditches or pipes to bring water to fields.*

Land mark: *is an object that is easily seen from a distance.*

Layer coloring (Layer tinting): *The distinctive shading or coloring of a map between particular pairs of contours in order to reveal the pattern of distribution of high and low land at a glance.*

Lava: *melted liquid rock, or magma, from within the earth that spills out on the earth's surface.*

Latitude: *a measure of distance on earth north or south of the equator.*

Leaching: *the process by which nutrients are washed down out of top soil by rainfall.*

Life expectancy: *Is a statistical measure of the average number of years that a group of people of a certain age expect to live at birth.*

Least developed countries: *Are the poorest nations of the world, which have the most backward economic and social systems. Hence, poverty is a common feature of the majority of the people of these countries.*

Less developed countries: *Are counties which are found in Africa, Latin America and Asia. They have traditional economic systems, largely based on agriculture, mining or a combination of both.*

Line graph: *a graph that shows how a piece of information changes over time.*

Lithosphere: *the solid surface of the planet that forms the continents and the ocean floor.*

Logging: *the process by which trees are cut down and transported out of the forest.*

Longitude: *a measure of distance on earth east or west of the prime meridian.*

Market Economy: *Is an economy in which prices and wages are determined mainly by supply and demand, rather than being regulated by a government.*

Meridian: *a line of longitude.*

Meteorology: *the field of geography that specializes in weather and weather forecasting.*

Migration: *the movement of man, birds, or animals to a place that offers a better life (forced or voluntary).*

Mineral: *a non-renewable natural resource that is found in the earth.*

Mixed Economy: *Is an economic system in which both government and private business exercise influence over various sectors of the economy.*

Mortality: *Is the occurrence of death.*

Natural resource: *something found in the environment that people can use.*

Net Migration Rate (NMR): *Shows the net effect of immigration and emigration in an area's population.*

Nonrenewable resource: *a natural resource that is limited in supply and cannot be replaced, such as a fuel or minerals.*

Northing: *Parallel lines running from the left – hand to the right hand border of a map sheet.*

Ocean: *one of earth's four largest bodies of water; the Arctic, Atlantic, Indian and Pacific oceans.*

Old age dependency: *the proportion of elderly (>65) to the working age group (15 - 64) multiplied by 100.*

Ozone: *a gas formed from an interaction between oxygen and sunlight; the ozone layer is a region in the earth's upper atmosphere that protects life beneath it by filtering out dangerous ultraviolet solar radiation.*

Pampas: *a large, grassy plain with fertile soil in Argentina.*

Parallel: *a line of latitude.*

Per-capita income: *Is a measure used to evaluate the standard of living (quality of life). It is strongly related to the GDP.*

Period: *a geologic time unit longer than an epoch and shorter than an era.*

Permafrost: *water below a tundra surface that remains frozen throughout the year.*

Petroleum: *a fuel, commonly called oil that formed underground from dead plants and animals.*

Photosynthesis: *the process by which a plant converts sunlight into chemical energy.*

Physical factors: *are factors that include land forms, climate, soil, vegetation, etc.*

Physiographic diagram: *The depiction of relief on a map by the application of standardized, convention, pictorial symbols, based on the simplified appearance of physical features as they are seen from the side or obliquely.*

Plain: *a large area of nearly flat land.*

Planet: *a spherical object that orbits around a star.*

Plantation: *a large farm where cash crops are grown such as cotton or coffee.*

Plate: *large broken section of the earth's crust.*

Plateau: *a high landform that rises steeply above the surrounding land.*

Plate boundary: *a boundary between two plates.*

Plate tectonics: *the concept that the outer surface of the Earth consists of large plates that are slowly moving over the surface of a plastic layer.*

Population cluster: *refers to a large population concentration.*

Population distribution: *Is concerned with how people are distributed spatially.*

Population doubling time: *Is the time taken, in years, for a population of a given region or country to double at a given rate of population growth.*

Population change: *is any change of population size due to the impact of fertility, mortality or migration.*

Population density: *the ratio of population per unit area in which they live.*

Population explosion: *Is rapid (sudden) increase of population.*

Population growth: *the increase in population.*

Population growth rate (PGR): *Is a measure of population change, which can be obtained by adding or subtracting net migration rate from rate of natural increase.*

Population Polices: *are used as guidelines to create positive relationships between population and resources.*

Population Pyramid: *Is a diagrammatic representation of the age-sex composition of a given country's population.*

Population size: *refers to the total number of peoples that inhabit an area.*

Population structure: *refers to the age-sex composition of any population.*

Precipitation: *the moisture that falls to the ground as rain, snow, sleet, or hail.*

Prime meridian: *the line of longitude, marked 0° , from which other meridians are numbered.*

Privatization: *is the selling of government enterprises.*

Pro-natalist (populationist) policies: *are designed to encourage population growth. Such policies are adopted with the objectives of achieving various goals such as maintaining military strength, economic production and national pride.*

Rainfall regime: *the annual or seasonal variation or distribution of rainfall in an area.*

Rainforest: *a warm, wet forest where trees and other plants grow close together.*

Range: *difference between highest and lowest limit.*

Rate of natural increase (RNI): *Is a measure of population change, which can be calculated by subtracting death rate from birth rate.*

Reforestation: *a process by which forests are renewed through the planting of seeds or young trees.*

Region: *an area with common features that is set apart from other areas.*

Relief: *A feature or landform of an area that has a variety of different heights or altitudes. It includes landforms such as plains, hills, plateaus, valleys, ridges, etc.*

Renewable resource: *a natural resource that can be replaced for later use, such as forest.*

Rock weathering: *the process that breaks up rocks and causes them to decay.*

Scale: *the relationship between the distance shown on a map and the real distance on earth.*

Sahel: *a region of bush savanna and grasslands along the southern edge of Africa's Sahara.*

Scarps slope: *The steeper slope of a mountain ridge.*

Sex Preference: *Is the desire to have children of one sex over the other.*

Sex ratio (SR): *refers to the number of male population for every 100 females.*

Slope: *The inclination of a surface from horizontal.*

Soil: *a mixture of mineral material, organic matter, air, water, and living organisms, capable of supporting plant growth.*

Soil conservation: *the practice of protecting soil from erosion.*

Species: *a group of organisms that can interbreed and produce off spring capable of reproduction.*

Spot heights: *lesser survey points which have been measured to determine their positions and especially their heights.*

Standard of living: *The economic level at which an individual, family or nation lives. It may be measured by determining the value of goods and services consumed by the individual, family or nation during a given period. It is the best measure of quality of life.*

Stepped (terraced) slope: *In the case of this type of slope, the gradient changes several times between the foot and the top of the slope.*

Structural adjustment programme: *are the policies implemented by the International Monetary Fund (IMF) and the World Bank in developing countries. These policy changes are conditions for getting new loans from the IMF or World Bank, or for obtaining lower interest rates on existing loans. Conditionalities are implemented to ensure that the money lent will be spent in accordance with the overall goals of the loan.*

Sustainable development: *Is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

Savanna: *a tropical grassland with scattered trees and shrubs.*

Sediment: *small particles of mud, sand, or gravel created by rock weathering.*

Shelterbelt: *a row of trees along a field that blocks the wind and protects the soil.*

Silt: *sediment coarser than clay but thinner than sand.*

Soil salinization: *salt building up in the soil, often caused by evaporation of irrigation water.*

Solar system: *the sun and the nine planets and all other objects that revolve around the sun.*

Subsoil: *a layer of soil beneath the top soil that contains little humus and usually much gravel.*

Taiga: *the huge forest region, located in the Northern Hemisphere just south of the Tundra, of tall, evergreen needle-leaf trees.*

Temperature: *a measurement of how hot or cold something is, often the air.*

Top soil: *the fertile, dark-colored surface soil.*

Total fertility rate (TFR): *Is the average number of children that would be born alive to a woman during her reproductive age if she were to pass through all her child bearing years. It can be obtained by summing up birth rates at each age-group throughout the child bearing age.*

Trade liberalization: *Is opening local markets to foreign goods by removing barriers to exports and imports.*

Traditional climate zone: *climate zones classified based on indigenous knowledge, functional only to that local area.*

Traditional economy: *Is an economic system that is practiced in extremely backward areas or primitive societies like gatherers and hunters.*

Trade wind: *N.E or S.E wind that blows from the subtropical high-pressure zone toward the equatorial low-pressure zone.*

Tree line: *the elevation, on mountain slopes, above which trees cannot grow.*

Trigonometrical points (Trigonometrical station): *A place chosen and marked by surveyors as the corner or intersection of carefully measured triangles. Hill-tops, mountain peaks and other easily visible places are most commonly used.*

Tropics: *warm areas in the low latitudes.*

True north: *the direction of the north pole indicated by the meridian passing through the point in question.*

Universe: *everything that exist everywhere; all the stars, planets, their satellites, etc.*

Urbanization: *Is the process of concentration of people in areas whose functions are non-agricultural.*

Vertical interval (V.I.): *The difference in vertical height between two points or two consecutive contour lines.*

Weather: *the condition of the air at a certain time in a certain place, including temperature, precipitation, and wind.*

Westerly: *N.W or S.W wind that dominates the middle latitudes, blowing from the subtropical high-pressure zone to the sub-polar low-pressure zone.*

Wet lands: *areas of stagnant water, such as swaps, marshes, and bogs.*

World Bank: *Is a specialized agency of the United Nations that grants loans to member nations for the purpose of reconstruction and development.*

WTO (World Trade Organization): *Is an international body that promotes and enforces provision of trade laws and regulations among member states.*

Youth dependency ratio: *the proportion of children (<15) to the working age group (15 - 64) multiplied by 100.*

GEOGRAPHY

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