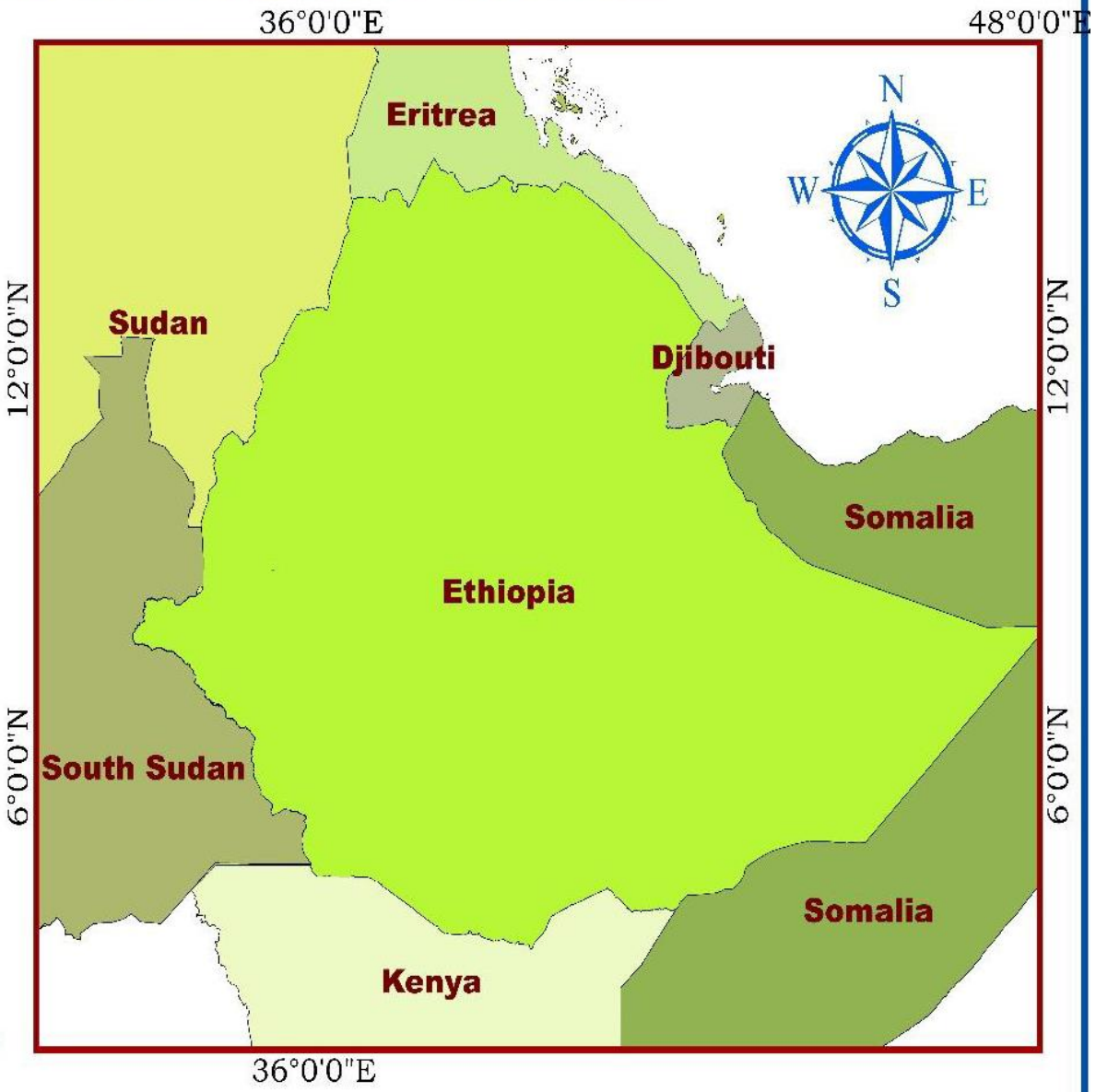
Geography of Ethiopia and The Horn





CHAPTER ONE
INTRODUCTION

OBJECTIVES

At the end of this chapter, the learners will be able to:

- *Comprehend the **meaning** and **scope** of Geography;*
- *Explain the **themes** of Geography;*
- *Explicate the implications of **location, shape** and **size** of Ethiopia and the Horn **on the physical environment, socioeconomic** and **political aspects**;*
- *Acquire basic skills of **map reading**;*

Meaning of Geography

- Geography is the scientific study of the Earth that ***describes and analyses spatial and temporal variations of physical, biological and human phenomena, and their interrelationships and dynamism over the surface of the Earth.***
- Geography has now ***acquired the status of science*** that explains the ***arrangements of various natural and cultural features*** on the Earth surface.

The Scope, Approaches and Themes of Geography

- ***The scope of Geography*** is the surface of the Earth, which is the very thin zone that is the interface of the ***atmosphere, lithosphere, hydrosphere and biosphere,*** which provides the habitable zone in which humans are able to live.

- ***Geography can be approached by considering two continuums:*** ***- a human-physical continuum and***
  - a topical-regional continuum.

- The **topical (systematic) fields** of Geography *view particular categories* while **regional geography** is concerned with the *associations within regions of all or some of the elements and their interrelationships*.

- ***Geography has five basic THEMES namely location, place, human-environment interaction, movement, and region***

- **Location:** It is defined as a particular place or position.
  - Location can be of two types: *absolute* location and *relative* location.
- **Place:** It to the physical and human aspects of a location.
- This theme of geography is associated with ***toponym*** (the name of a place), ***site*** (the description of the features of the place), and ***situation*** (the environmental conditions of the place).

Cont'd

- ***Human-Environment Interaction:*** Humans have always been on ceaseless interaction with their natural environment and it involves three distinct aspects:

- ***Dependency*** refers to the ways in which humans are dependent on nature for a living.
- ***Adaptation*** relates to how humans modify themselves, their lifestyles and their behaviour to live in a new environment with new challenges.
- ***Modification*** allowed humans to "conquer" the world for their comfortable living.

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- **Movement:** entails to the ***translocation of human beings, their goods, and their ideas from one end of the planet to another*.**
- The physical movement of people allowed the human race to inhabit all the continents and islands of the world.
- Another aspect of movement is the transport of goods from one place on the Earth to another.
- The third dimension of movement is the flow of ideas that allows the unification of the human civilization and promotes its growth and prosperity.

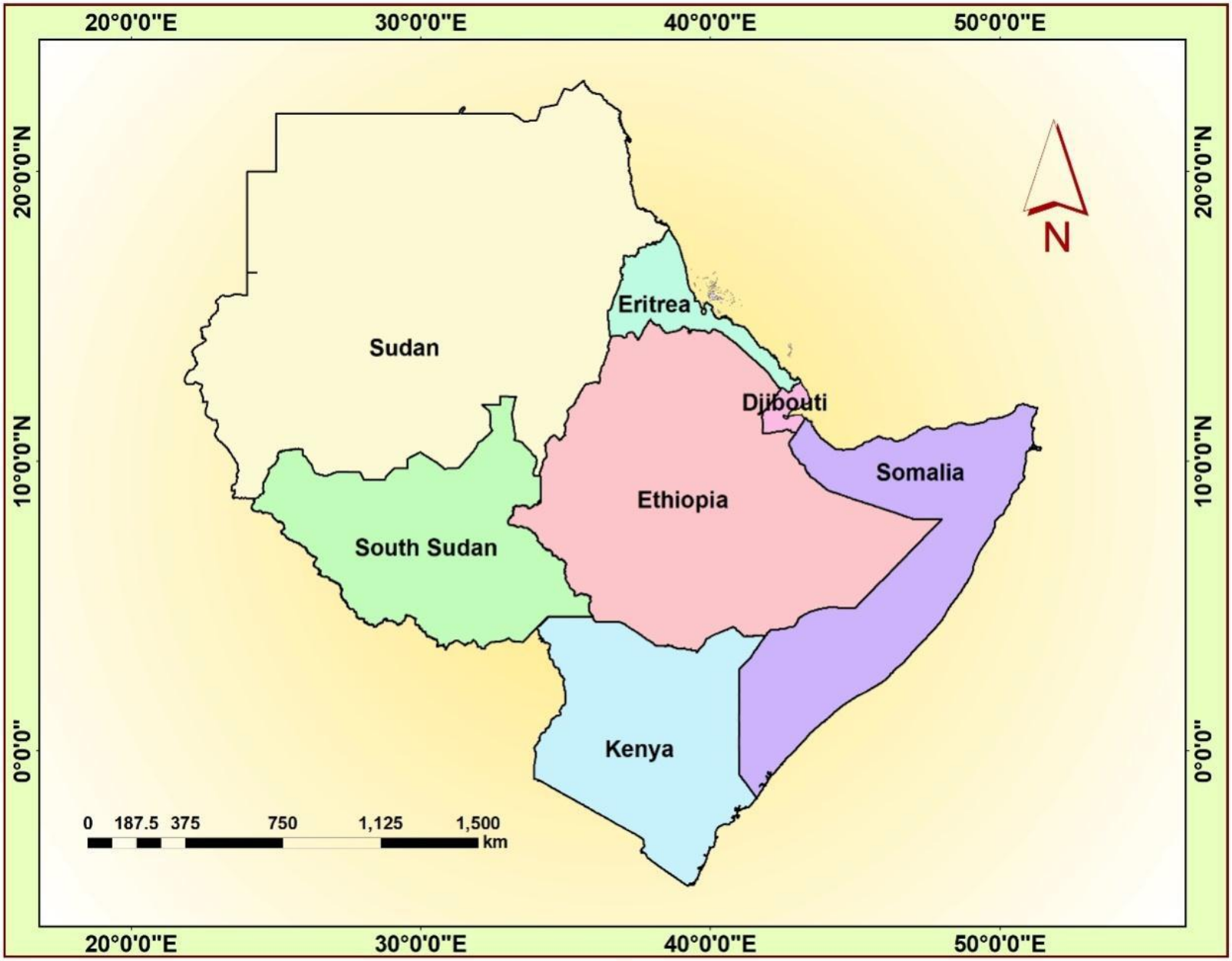
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- **Region:** A region is a *geographic area having* ***distinctive characteristics that distinguishes itself from adjacent unit(s) of space*****.**
- It could be a formal region that is ***characterized by homogeneity in terms of a certain phenomenon*** (soil, temperature, rainfall, or other cultural elements like language, religion, and economy).
- It can also be ***a functional or nodal region characterized by functional interrelationships in a spatial system defined by the linkages binding particular phenomena*****.**

Location, Shape and Size of Ethiopia and the Horn

❑*Location of Ethiopia*

- ***Astronomically***, Ethiopia is a country located between 3° N (*Moyale*) and 15° N (*Bademe* - the northernmost tip inTigray) latitudes and 33° E (*Akobo*) to 48° E (the tip of *Ogaden* in the east) longitudes.
- ***Relative*** location expresses the location of countries or places with reference to the location of other countries (*vicinal*), *landmasses* or *water bodies*.


20°0'0"E
30°0'0"E
40°0'0"E
50°0'0"E
20°0'0"N
10°0'0"N
0°0'0"
N
Sudan
Eritrea
Djibouti
Somalia
Ethiopia
South Sudan
Kenya
0 187.5 375 750 1,125 1,500
km

The Implications of the Location of Ethiopia are Described as Follows:

- ***Climate***: The fact that Ethiopia is located between 3°N and 15°N implies that the country has a tropical climate, though modified by its altitude. Furthermore, due to its ***longitudinal extension*** there is a *difference of one hour* between the most easterly and most westerly points of the country
- ***Socio-cultural***: Ethiopia is one of the earliest recipients of the major world religions namely ***Christianity, Islam and Judaism*** due to its proximity to the Middle East, which was the origin of these religions.

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- **Political:** The political history of Ethiopia has been considerably influenced by:
  - *Geopolitical considerations of superpowers.*
  - *Adjacency to the Red Sea (a major global trade route).*
  - *The Middle East geopolitical paradigms.*
- As a result, Ethiopia has been exposed for external invasions in a number of times; though the country resisted foreign intervention and remains free of external domination.
- **Size of Ethiopia**:- Ethiopia with a total area of approximately ***1,106,000*** $\boldsymbol{Km^2}$ is the **8th** largest country in Africa and **25th** in the World.

Cont'd

- **Advantages of Ethiopia's large size**
  - *Possess diverse agro ecological zones*
  - *Variety of natural resources*
  - *Own extensive arable land*
  - *Have larger population size*
  - *Home for diverse cultures*
  - *Greater depth in defence external invasion*
- **Disadvantages**
  - *Demands greater capital to construct infrastructural facilities*
  - *Requires large army to protect its territory*
  - *Difficult for effective administration*
  - *Difficult for socio-economic integration*

The shape of Ethiopia and its Implication

- Countries of the World have ***different kinds*** of shape that can be divided into five main categories: ***compact, fragmented, elongated, perforated, and protruded***.
- These shapes have implications on defence, administration and economic integration within a country.
- ***Compact shape countries:*** The distance from the geographic centre of the state to any of the borders does not vary greatly. It is *easier for defence, socioeconomic and cultural integration*.

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- ***Fragmented shape countries:*** They are divided from their other parts by either water, land or other countries. E.g., Indonesia, Philippines
- ***Elongated shape countries:*** They are geographically long and relatively narrow like Chile.
- ***Perforated shape countries:*** A country that completely surrounds another country like the Republic of South Africa.
- ***Protrude shape countries:*** Countries that have one portion that is much more elongated than the rest of the country like Myanmar and Eritrea.

- **There are various ways of measuring shape of countries (indices of compactness).**

1. Area-Boundary ratio: The higher the A/B ratio, the greater the degree of compactness.
2. Boundary-Circumference ratio: It measures how far the boundary of a country approximates the circumference of a circle of its own size. Therefore, the nearer the ratio to 1 the more compact the country is.
3. Area-Circumference ratio: It compares the area of the country with the circumference of a circle that passes touching the extreme points on the boundary of the country. The higher the A/C ratio, the greater the degree of compactness.

❖ ***In these or other criteria, the shape of Ethiopia could be described as compact (see the table below).***

Table 1.3: Ethiopia's shape compared to its neighbors in the Horn

Country	Area(km^2)	Boundary (km)	A/B ratio	B/C ratio	A/C ratio
Ethiopia	1,106,000	5,260	210.27	1.41	296.61
Djibouti	22,000	820	26.83	1.56	41.83
Eritrea	117,400	2,420	48.51	1.99	96.83
Kenya	582,644	3,600	161.85	1.33	215.28
Somalia	637,657	5,100	125.03	1.80	225.22

Basic Skills of Map Reading

- *A map is a two-dimensional scaled representation of part or whole of the Earth surface on a flat body such as piece of paper, black board, wood or cloth.*
- ***Importance of maps***

➢ *Provide the basis for making geographical details* of regions represented.

➢ *Maps are powerful tools for making spatial analysis* of geographical facts of areas represented.

➢ Maps are *useful for giving location* of geographical features.

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- Maps are used on various disciplines like land use planning, military science, aviation, tourism, marine science, population studies, epidemiology, geology, economics, history, archaeology, agriculture etc.
- Map makes storage of the geographical data of areas represented.
- Maps are potentially used to asses‟ reliable measurements of the geographical features. The measurements can be of area size, distance etc.

Types of Map

Broadly maps can be classified into two:

- **Topographical maps:** Topographic maps depict one or more natural and cultural features of an area.
- **Thematic or Special purpose maps:** These are maps, which illustrate the geographical distribution of a *particular theme* or phenomenon.

Based on scale, maps can be classified into three

- **Large scale maps ≥ 1:50,000;** to represent higher level of detail.
- **Medium scale maps between** 1:50,000 to 1:250,000; used for medium sized areas.
- **Small scale maps** ≤ 1:250.000; used for maps of wide areas.

Marginal Information on Maps (Elements of Maps)

- **Title:** It is the heading of the given map
- **Key (legend):** It is the list of all convectional symbols and signs shown on the map with their interpretation.
- **Scale:** It is the ratio between the distance on the map and the actual ground distance.
- **North arrow:** It is indicated with the north direction on a map; used to know the other important directions of the mapped area like east, west, south, and west.
- **Margin:** Is the frame of the map. It is important for showing the end of the mapped area.
- **Date of compilation:** It is a date of map publication. This enables map users to realize whether the map is updated or outdated.

CHAPTER TWO
THE GEOLOGY OF ETHIOPIA AND THE HORN

2.1 Introduction

- Geology is an Earth science that studies the evolution of the earth, the materials of which it is made of, and the processes acting upon them.
- This chapter will focus on the ***geology of Ethiopia and the Horn***. In this chapter, you will study the ***geologic forces acting up on earth and their resulting land form, geological time scale and age dating techniques***.
- ***Objectives***:

- *Analyze the geologic processes and the resultant land forms of Ethiopia and the Horn.*
- *Examine the formation of the Rift Valley.*
- *Recognize the current status of Ethiopian mineral endowment associated with geologic processes.*

Origin of the Universe: The Big Bang Theory

- The universe is the result of the explosion of matter which has extremely high density and temperature.
- Some 10 to 20 billion year ago, all matter in the known universe were once concentrated into a single point called cosmic egg.
- The reason for the wide acceptance of this theory is that the universe and galaxies are still moving apart at a tremendous speed.
- The universe, shortly after explosion, comprised an expanding cloud of gases composed of nearly 73% hydrogen, and 27% helium.
- Within these gas clouds, future Galaxies, gravity produced much denser and more localized concentrations of gas, thermonuclear fusion (union) was spontaneously initiated, and stars were born.

The Theory of Continental Drift

- The earth's continents were once bunched up together in to a single huge continent called ***Pangaea***; which then split into **Gondwanaland** and **Laurasia**; and later into smaller fragments over the last million years.
- Australian Climatologist **Alfred Wegener** proposed the hypothesis called the ***Continental drift Theory***. He's principal observations were:
- ***Fit of the continents***
- ***Match of mountain belts, rock types***
- ***Distribution of fossils***
- ***Paleoclimate***

2.2. **The Geologic Processes: Endogenic and Exogenic Forces**

- ***The internal processes (Endogenic)*** include ***volcanic activity*** and all the ***tectonic processes*** (*folding, faulting, orogenesis, and epeirogenesis*). These processes result in building of structural and volcanic features.
- ***The external (Exogenic) processes*** include ***weathering, mass transfer, erosion and deposition***. They act upon the volcanic and structural landforms by modifying, roughening and lowering them down.

2.3. The Geological Time Scale and Age Dating Techniques

- The geological history is divided in to Eras. Each Era is divided into periods.
- An eon is the largest period of geological time.
- The Eras are given names that indicate the kind of life that existed in them. For instance, the ***Paleozoic Era (ancient life)*** is the age of invertebrates, the ***Mesozoic Era (the middle life)*** is the age of reptiles while the ***Cenozoic Era (recent life)*** is the age of mammals.
- The division of time units in the geological time scale is usually based on ***the occurrence of significant geological events.***

The Geological time scale

Era	Period	Began (in Million Years)	End (my)	Major Events (million years ago)
Cenozoic	Quaternary	1.6	Present	Major glaciers in North America and Europe (1.5)
	Tertiary	70	1.6	Rocky Mountains (65), individual continents take shape.
Mesozoic	Cretaceous	146	70	Dinosaurs extinct (65), western interior seaway and marine reptiles (144 – 65)
	Jurassic	208	146	Pangaea (one land mass) begins to break up (200)
	Triassic	225	208	First mammals and dinosaurs

The Geological time scale

Paleozoic	Permian	290	225	Greatest extinction on Earth (245)
	Pennsylvanian	322	290	First reptiles
	Mississippian	362	322	Coal-forming forests
	Devonian	408	362	First land animals and first forests (408)
	Silurian	439	408	Life invades land
	Ordovician	510	439	First fish appeared
	Cambria	600	510	Great diversity of marine invertebrates
Precambrian	Proterozoic	2,500	600	Marine fossil invertebrates (600)
	Archean	4,500	2,500	Earliest fossils recorded (3,500), earliest rock formation (4,000)

Age Dating Techniques

A. **Relative Dating:** one way is ***to look at any fossils the rock may contain***. The other is "***What is on top of the older rocks***?"

B. **Absolute Dating:** /Radiometric techniques: The regular rates of decay for unstable, radioactive elements were found to constitute virtual "clocks" within the earth's rocks. Every radioactive element has its own half-life.

- ***Carbon-14 Technique****: Upon the organism's death, carbon-14 begins to disintegrate at a known rate, and no further replacement*
- ***Potassium-Argon Technique****:The decay is widely used for dating rocks.*

2.4. Geological Processes and the Resulting Landforms of Ethiopia and the Horn

The Precambrian Era Geologic Processes (4.5 billion - 600 million years ago)

- The Precambrian Era covers **5/6th** of the Earth's history.
- ***Orogenesis*** accompanied by **intrusive igneous activity** resulted with the formation of **huge mountain ranges**.
- there were long periods of **denudation** and ***pen-planation***
- The Precambrian rocks are overlaid by recent rock formations.

Cont'd

- However, as surface rocks covering 25% of the land mass of the country; they are found exposed in the following areas:
  - **In the northern part**: Western lowlands, parts of northern and central Tigray.
  - **In the western Part**: Gambella, Benishangul-Gumuz (Metekel and Asossa), western Gojjam, western Wellega, Illuababora, and Abay gorge.
  - **In the southern Part**: Guji, southern Omo, and parts of southern Bale and Borena.
  - **In the eastern part**: Eastern Hararghe.

The Paleozoic Era Geologic Processes (600 million - 225 million years ago)

- The Paleozoic Era lasted for about 375 million years. The major geological process of this Era was denudation.
- At the end, the once gigantic mountain ranges were reduced to a "**peneplained**" surface. Undulating plain with some residual features (**inselbergs**) here and there was formed.
- Because of the limited deposition within Ethiopia, rocks belonging to this Era are rare in the country.

The Mesozoic Era Geologic Processes (225-70 million years ago)

- It was an Era of alternate slows sinking and rising (epeirogenesis) of the landmass.
- As the land sank slowly the sea invaded it starting from Somalia and Ogaden and slowly spreading north-westward.
- This was in late Triassic. This phenomenon continued up to Jurassic period.
- Through time, compression by the overlying rocks and by cementing minerals, the sands and lime were compacted to form sandstone and limestone layers respectively.
- These are known as the **Adigrat** sand stone and **Hintalo** limestone layers.
- They are named after place names in Tigray where they might have been first identified.

Cont'd

- In the Horn of Africa and Ethiopia, the slow rise of the land and consequently the regression of the sea began in the **Upper Jurassic**. It continued throughout the **Cretaceous period**.
- With the retreat of the sea, another process of deposition occurred. The uppermost layer is known as the **Upper sandstone**.
- The **Adigrat sandstone** is older and thicker in the southeast and progressively decreases in age and thickness north-westward. The **Upper sandstone**, on the other hand, is thicker and younger (Upper Cretaceous) in the Southeast, while in the Northwest it is older and thinner.
- As surface rocks, these old marine sediments are extensively found in the **Southeast lowlands**. Other exposures include central Tigray, and along the gorges of Abay and Wabishebelle rivers

The Cenozoic Era Geologic Processes (70million years ago - Present)

- The tectonic and volcanic activities that took place in this Era have an important effect in the making of the present-day landmass of Ethiopia and the Horn of Africa.
- The major geologic activities are:

- **Uplifting of the Arabo-Ethiopian landmass and outpouring of lava flood:**
  - The whole of the Arabo-Ethiopian landmass was **pushed up** in blocks as one mass.
  - This immense tectonic force also **fractured** the crust at many places.
  - Huge quantity of **lava** came out through these fractures.
  - Where the lava comes out through vents, huge volcanic rocks were piled up to form many and huge **Volcanic Mountains**" towering the flat basaltic plateau.
  - This volcanic material is known as **Trappean lava** or **Trap**

Cont'd

- The Formation of the Rift Valley
  - The Rift Valley may be lying on the Earth's crust below which lateral movement of the crust in opposite directions producing ***tensional forces*** that caused parallel fractures or faults.
  - As the tension widened the fractures, the central part of the landmass collapsed to form an extensive structural depression known as the ***Rift Valley*** **.**
  - The Rift Valley region of Ethiopian is the ***most unstable*** part of the country.
  - There are numerous hot springs, fumaroles, active volcanoes, geysers, and frequent earthquakes.

Cont'd

- The formation of the Rift Valley has the following structural (physiographic) effects:
  - It divides the Ethiopian Plateau into two.
  - It separates the Arabian landmass from African landmass.
  - It causes the formation of the Dead Sea, Red Sea and the Gulf of Aden troughs.
  - It creates basins and fault depressions on which the Rift Valley lakes are formed.
- Quaternary Volcanic Eruptions and Depositions
  - It occurred in the form of **renewed rifting/faulting** and **more volcanism**.
  - This activity was generally limited to the floor of the Rift Valley and the region south of Lake Tana

Cont'd

- The basic volcanic features of the Aden series include the following:
  - Numerous and freshly preserved volcanic cones, many of which have explosive craters. Some of these are active.
  - Volcanic hills and mountains, some of which are semi-dormant.
  - Extensive lava fields and lava sheets some of which are very recent.
  - Lava ridges.
  - Thermal springs, fumaroles

Cont'd

➢ Quaternary Deposition

- This was the time of the last **"Ice Age"** in the middle and high latitude areas and the time of the "**Pluvial Rains**" in Africa.
- The excessive rain resulted in an excessive surface flow; rivers were many and large. They carried a lot of water and sediments.
- Lake and marshy areas became numerous and deep. Many were enlarged and covered much area and even merged together. For example, Ziway-Langano-Shalla; Hawasa-Shallo; Chamo-Abaya;
- After the "Pluvial Rains", the Earth's climate became warmer and drier. Thus, it increased the rate of evaporation that diminished the sizes of the lakes.

Cont'd

- Today, there are lacustrine deposits of continental origin in many parts Ethiopian
  - ***Lacustrine deposits:*** Deposits on former lakebeds, and swampy depressions.
  - ***Fluvial deposits:*** Deposits on the banks of rivers, flood plains both in plateau, foothills etc.
  - ***Glacio-fluvial deposits and erosional features:*** These are occurred on high mountains, such as Bale and Kaka Mountains.
  - ***Aeolian deposits:*** Are **w**indblown deposits.
  - ***Coastal and marine deposits:*** Deposits on sea invaded and sea-covered places.
- The quaternary deposits are mainly found in the Rift Valley, Baro lowlands, southern Borena, and parts of north-western low lands.

Rock and Mineral Resources of Ethiopia

- The occurrence of metallic minerals in Ethiopia is associated with the Precambrian rocks.
- The exploitation and search for mineral deposits in Ethiopia has been taking place for the past 2,000 years.
- **Brief Facts and Current State of Main Minerals in Ethiopia:**
  - Geological surveys proved that Ethiopia has abundant mineral resources of metals and precious metals, coal, and industrial minerals.
  - Gold, Platinum, Tantalum, Gemstones, Potash, Gypsum and Anhydrite, Clay, Marble, Construction stones

Mineral Potential Sites of Ethiopia

- According to the Ethiopian geological survey, the geologic formations that host most mineral potentials of Ethiopia includes ***three major greenstone belts*** and other formations.
- The Western and South-western-greenstone belt
- The Southern greenstone belt: It is known as the Adola belt.
- The Northern greenstone belt(Tigray)

CHAPTER THREE
THE TOPOGRAPHY OF ETHIOPIA AND THE HORN

Introduction

- The topography of Ethiopia is largely determined by the geologic activities of the Cenozoic Era.
- The **uplifting** of the Arabo-Ethiopian swell and the subsequent **outpouring**, spreading and thick accumulation of Trapean lava have given rise to an outward sloping highland plateau and mountains.
- The major **faulting** resulted in the division of the plateau into two broad units and the formation of a great structural valley.

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- The Ethiopian landform is characterized by great diversity. There are flat-topped plateaus, high and rugged mountains, deep river gorges and vast plains.
- Altitude ranges from 125 meters below sea level (Kobar Sink) to the highest mountain in Ethiopia, Mount Ras Dashen (4,620 m.a.s.l), which is the fourth highest mountain in Africa.
- Ethiopia has the largest proportion of elevated landmass in the African continent.
- It is sometimes described as the Roof of East Africa because of its height and large area.

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- Characteristics of Ethiopian highlands:
  - Moderate and high amount of rainfall (>600 mm/year).
  - Lower mean annual temperature (<20°C).
  - The climate is favourable for biotic life.
  - Rain-fed agriculture is possible.
  - Free from tropical diseases.
  - Attractive for human habitation and densely settled.
- The Ethiopian lowlands are characterized by:
  - Fewer amounts of rainfall and higher temperature.
  - High prevalence of tropical diseases.
  - Lower population densities.
  - Nomadic and semi-nomadic economic life.
  - Vast plain lands favourable for irrigation agriculture along the lower river basins.

The Physiographic Divisions of Ethiopia

The Western Highlands and Lowlands

a. The Tigray Plateau

- It lies to the southeast of the upper course of the Mereb/Gash River and to the northeast of Tekeze River Gorge.
- There are high mountains in this plateau with elevations of over 3000 meters, namely Mount **Tsibet** (3988 m.a.s.l), Mount **Ambalage** (3291 m.a.s.l), and Mount **Assimba** (3248 m.a.s.l).
- The famous monastery at **Debre-Damo,** a tableland that can only be climbed by a rope pulley is also located in this plateau region.

Cont'd

B. North Central Massifs

- Fifty-eight percent of the region is at an altitude of more than 2,000 meters, making it, next to the Shewan Plateau, the second highest physiographic division.
- Mount Ras Dashen (4,620 m.a.s.l), Mount Weynobar (4462 m.a.s.l), Mount KidisYared (4453 m.a.s.l), and Mount Bwahit (4437 m.a.s.l) in the Simen Mountain System. Mount Guna (4,231m.a.s.l) in the Debre Tabour Mountain System, Abune Yoseph (4,260 m.a.s.l) in the Lasta highlands of Wello and Mount Birhan (4,154 m.a.s.l) in the Choke Mountain System in Gojjam

Cont'd

- *The Mountain systems in Gonder and Gojjam are separated from the eastern group of mountains in Wello by impenetrable and deep gorges.*
- At one point though, they are connected by *Yeju-Wadla Delanta land bridge* (ridge).
- This land bridge has been significant in history. It served as a route of penetration by the Turks, Portuguese, and Italians etc.
- The Woreta-Debre Tabor-Woldya road constructed to link the northwestern region with Asseb through Woldya and Dessie took advantage of this land bridge.

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C. The Shewa Plateau/central highlands

- The Shewan plateau is bounded by the Rift Valley in the east and southeast, by the Abay gorge in its northern and western limit, and the Omo gorge in the south and west.
- *Nearly three-fourth* of its area is at an altitude of more than *2,000* meters above sea level. It has, therefore, the largest proportion of elevated ground.
- The Shewa plateau is drained, outward in all directions by the tributaries of *Abay, Omo, and Awash*. It, therefore, *forms a water divide for* these three river basins.

Cont'd

- The highest mountain in the Shewan plateau is Mount Abuye-Meda (4,000 m.a.s.l) in Northern Shewa, Mount Guraghe in the south is 3,721 meters high.

D. The Southwestern Highlands

- This Physiographic subdivision consists of the highlands of *Wellega, Illuababora, Jimma, Kaffa, Gamo and Gofa*.
- This region is separated from the adjacent highlands by the Abay and Omo river valleys.
- It extends from the Abay gorge in the north to the Kenya border and Chew Bahir in the south.

Cont'd

- The southwestern plateau is the wettest region in Ethiopia. It is drained by Dabus, Deddessa (tributaries of Abay), Baro, Akobo and the Ghibe/Omo rivers
- Guge Mountain is the highest peak With 4,200 meters above sea level

The Western Lowlands

- It extends from Western Tigray in the north to southern Gamo-Gofa in the South.
- This physiographic sub-region is further subdivided into four by the protruding ridges. These are Tekeze lowland, Abay-Dinder lowland, Baro lowland, and Ghibe lowland from north to south.
- With the exception of the *Baro* lowland, the region is generally characterized by arid or semi-arid conditions.
- In the Western lowlands, there are small but important towns. These are *Humera*, *Metema*, *Omedla*, *Kurmuk*, *Gambella* etc.

The South-eastern Highlands and Lowlands

The South-eastern Highlands

A. The Arsi-Bale-Sidama Highlands

- The Arsi Highlands are made up of flat rolling uplands and dissected mountains. The well-known mountains in this area are Mount Kaka (4,180 m.a.s.l), Mount Bada (4,139 m.a.s.l) and Mount Chilalo (4,036 m.a.s.l).
- The Bale highlands are separated from the Arsi highlands by the head and main stream of Wabishebelle. They consist of a platform looking basaltic plateau in the north-central part and high mountain massif to the south.

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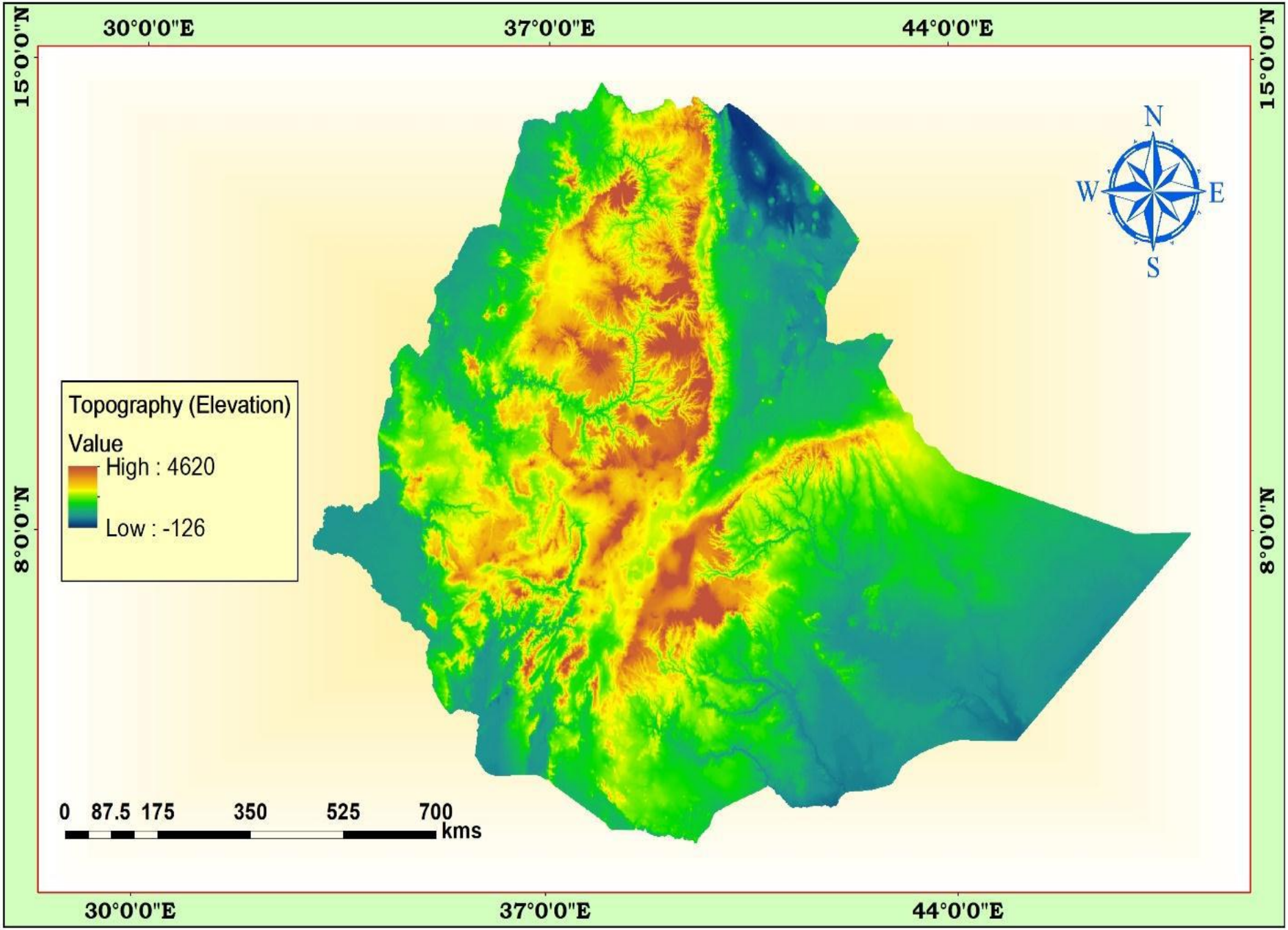
- The highest mountain peaks in this region are Tulu-Demtu (4,377 m.a.s.l) and Mount Batu (4,307 m.a.s.l).
- The Sidama Highlands are separated from the Bale Highlands by the Ghenale river valley. They occupy the southwestern corner of this region. The prominent feature here is the Jemjem plateau, an important coffee growing area.
- Rivers Wabishebelle and Ghenale along with their tributaries have dissected this physiographic region. Specially, Weyb River, tributary of Ghenale, has cut an underground passage (Sof Omar cave) through the Mesozoic Limestone rocks.

B. The Hararghe Plateau

- This plateau is a north-easterly extension of the south-eastern highlands. It extends from the Chercher highlands in the south-west to Jigjiga in the east.
- Rising sharply from the Rift Valley floor, it immediately but gently descends east and southeastward.
- Much of the Trappean lava is removed and the Mesozoic rocks are extensively exposed. The highest mountain here is Mount Gara-Muleta (3,381 m.a.s.l).

The South-eastern Lowlands

- The Southeastern lowlands are located in the southeastern part of the country and they are the most extensive lowlands in Ethiopia.
- They include the plains of Ogaden, Elkere, and Borena. South-eastward sloping plains characterize these lowlands.
- These extensive plains are interrupted here and there, by low hills, low ridges, inselbergs and by shallow and broad river valleys and depressions.
- The economic potential for this region includes animal husbandry, irrigation, agriculture and perhaps exploitation of petroleum and natural gas.


30°0'0"E
37°0'0"E
44°0'0"E
15°0'0"N
8°0'0"N
N
W
E
S
Topography (Elevation)
Value
High : 4620
Low : -126
0 87.5 175 350 525 700
kms

The Rift Valley

- The Rift Valley is a tectonically formed structural depression. It is bounded by two major and more or less parallel escarpments.
- The floor of the Rift Valley is made up of interconnected troughs, grabens and depressions.

- **The Afar Triangle**

- It is the largest and widest part of the Rift Valley.
- It hosts one of the most **hostile environments** on Earth (maximum temperatures can exceed 50°C during the summer wet season; Dallol, at the northern tip of Afar.

Cont'd

- The area is characterized by faulted depressions (grabens), volcanic hills, active volcanoes, volcanic ridges, lava fields and low lava platforms.
- Lakes (*Abe*, *Asale*, and *Afrera)* occupy some of these basins.
- A prominent feature in this region is the *Denakil Depression* (*Kobar Sink*). Separated from the Red Sea by a 200 meters high land barrier, much of it lies below sea level.
- The economic importance of this region includes salt extraction, irrigation along the Awash River and electric potential from geothermal energy.

Cont'd

- ***The Main Ethiopian Rift/Central Rift***

- It refers to the narrow belt of the Rift Valley that extends from Awash River in the north to Lake Chamo in the south.
- The prominent features, however, are the numerous lakes formed on tectonic sags and fault depressions.
- Because of altitude, the lakes region is generally milder and watery. Here rain-fed agriculture is practiced. Other resource bases include the recreational value of the lakes, the agricultural importance of some streams and lakes, and the geothermal energy potential.

Cont'd

- ***The Chew Bahir Rift***

- This is the smallest and the southern-most part of the Rift Valley.
- Gneissic highlands of Konso and the surrounding highlands separate it from the Main Ethiopian Rift to the north.
- The characteristic feature of this region is the broad and shallow depression, which is a marshy area covered by tall grass, into which the **Segen** and **Woito** streams empty.

The Impacts of Relief on Biophysical and Socioeconomic Conditions

- **Agricultural practices**

➢ Relief influences farm size and shape in that in an area of rugged terrain the farmlands are small in size and fragmented and tend to be irregular in shape.

- ✓ Choice of farming techniques and farm implements are highly influenced by relief as in rugged terrain mechanized farming techniques are difficult to practice.
- ✓ Relief influences crop production as some corps are well adapted to higher altitudes (barley, wheat) and others to low altitude (sorghum, maize).
- ✓ The practice of animal husbandry is also influenced by relief as most equines and sheep are reared in the higher altitudes and camels and goat are well adapted to lower altitudes

Cont'd

- **Settlement pattern**

- Highlands of Ethiopia that experience a temperate type of climatic condition that are mainly free from most of the tropical diseases are densely settled.
- Rugged and difficult terrain hinders the development of settlement and its expansion.
- The highlands of Ethiopia are characterized by sedentary life and permanent settlements while lowlands that are inhabited by pastoralists have temporary settlements.

Cont'd

- **Transportation and communication**

- The highly dissected nature of the landscape is a barrier to the development of internal surface transportation that resulted in the long-term isolation of many communities
- The difficult terrain makes infrastructure development and maintenance costly.
- TV and radio communications are also highly influenced by relief.
- The rugged topography rendered rivers less navigable due to the waterfalls, deep gorges and steep cliffs.

Cont'd

- **Hydroelectric power potential**

➢ The great difference in altitude coupled with high rainfall created suitable conditions for a very high potential for the production of hydroelectric power in Ethiopia.

- **Socio-cultural feeling**

➢ The rugged terrain as a result of excessive surface dissection resulted in the long-term isolation of communities that led to the occurrence of cultural diversity.

➢ People who live in the highlands have been identifying themselves as *degegnas* (mountaineers) and those who live in the lowlands as *kollegnas* (lowlanders).

Cont'd

- **Impacts on climate**

➢ The climate of Ethiopia is a result of the tropical position of the country and the great altitudinal variation of the general topography.

➢ Highlands with higher amount of rainfall and lower rate of evapo-transpiration tend to be moisture surplus compared to the moisture deficit lowlands.

- **Impacts on soil**

➢ Steep mountain slopes provide low angle of rest, unstable surface materials and subject to degradation processes and relatively form shallow and little developed soils.

- **Impacts on natural vegetation**

➢ Relief through its effect on climate and hydrology affect the type of natural vegetation grown in an area.

CHAPTER FOUR
DRAINAGE SYSTEMS AND WATER RESOURCE OF ETHIOPIA AND THE HORN

- **Introduction**

- About 71% of the earth's total surface is covered by water bodies. Of the earth's total water surface, nearly 97.5% is alkaline accumulated in ***seas and oceans***. The remaining 2.5% is fresh water, of which nearly 68.7% is deposited in ***glaciers***, 30.1% in ***ground water***, 0.8% in ***permafrost*** and 0.4% in **surface waters**.
- Water in lakes, rivers, atmosphere, soils and wetlands are considered as surface waters. Surface and ground waters are by far the most abundant and easily available fresh waters.
- However, fresh water is distributed unevenly throughout the world following varied latitudinal locations, climatic and topographic setups.

Cont'd

- The diverse topographical setup, relatively higher rainfall and its nearness to equator made the country to have larger volume of ground and surface water.
- Around 0.7 % of the total land mass of Ethiopia is covered by water bodies. Consequently, many call Ethiopia, the water tower of ***"Eastern Africa"***.

❑ ***Objectives***

- Describe the major drainage systems in Ethiopia and the Horn,
- Examine the surface and ground water resource potentials of Ethiopia,
- Understand economic potentials of the water sector in Ethiopia.

Major Drainage System of Ethiopia

- The flow of water through well-defined channel is known as **drainage**.
- **A drainage system** is made up of a principal river and its tributaries (the rivers that flow into it).
- **A drainage pattern** is branched network of stream channels together with the adjacent land slopes they drain.
- **A drainage basin** is the topographic region from which a river and its tributaries collect both the surface runoff and subsurface flow.
- The general patterns of major river basins in Ethiopia are determined by topographical structures which can be clarified as:
  - The topography of the outward sloping of the *Western and South eastern plateaus*
  - The structural formation *of the Rift Valley* with its in-ward-sloping escarpments resulting mainly in an inland drainage system.
  - Faults and joints that structurally influence part of the courses of many rivers.

The Major Drainage Systems

- ***The Western Drainage Systems***

- The Western Drainage Systems are the largest of all drainage systems draining ***40 percent*** of the total area of the country and carry ***60 percent*** of the annual water flow.
- This drainage system comprises four major river basins namely the ***Tekeze, Abay, Baro-Akobo, Ghibe (Omo).***

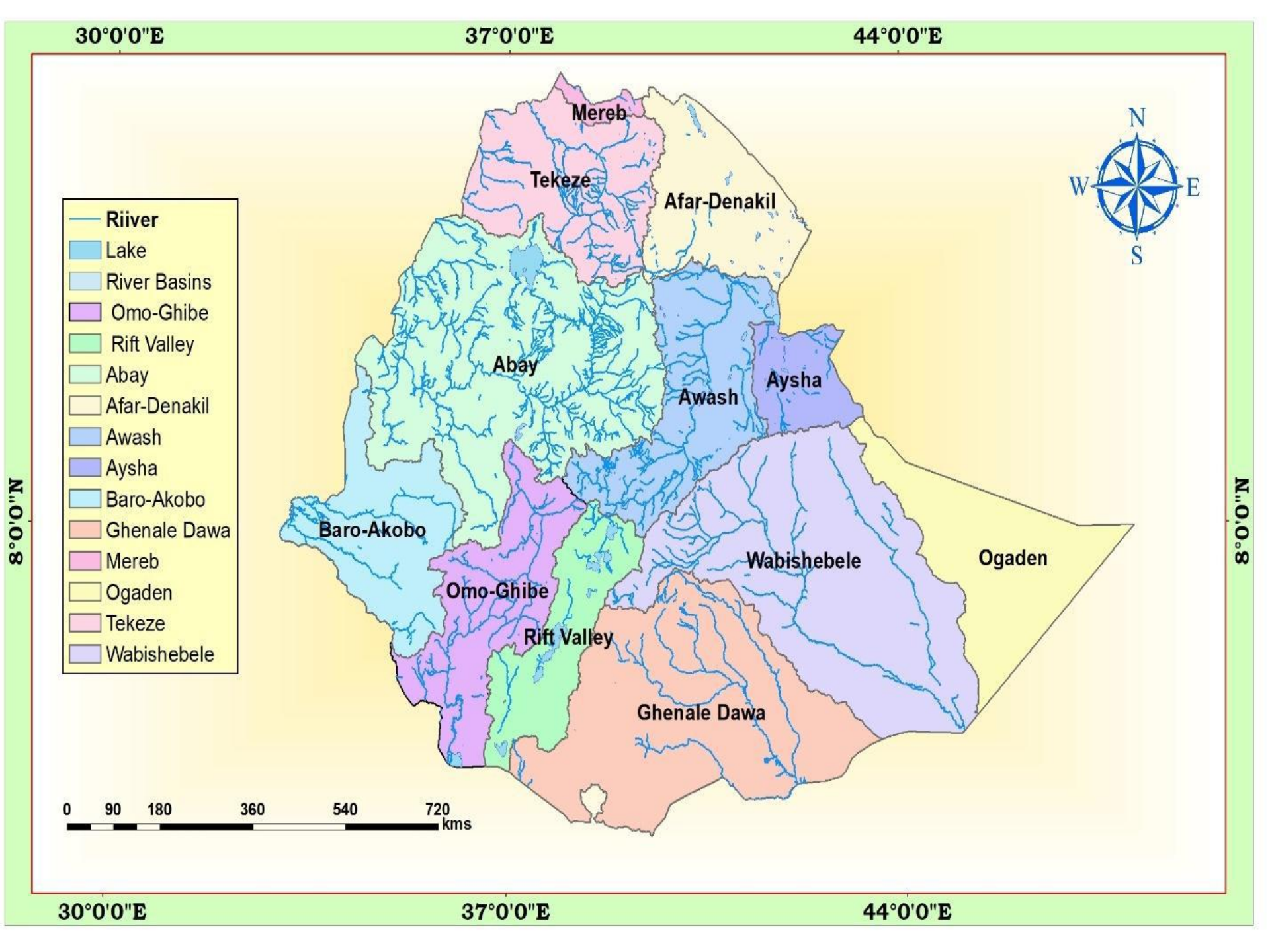
- ***The Southeastern Drainage Systems***

- The basin which is mainly drained by ***Wabishebelle*** and ***Ghenale***, slopes south-eastwards across large water deficient plains.

Cont'd

❑ *The Rift Valley Drainage System*

- The Rift Valley drainage system is an area of small amount of rainfall, high evaporation and small catchment area.
- The size of the drainage area is restricted by the outward sloping highlands, which starts right from the edge of the escarpment.
- The only major river basin is that of the **Awash**.
- The Southern part of the Rift Valley sub-basin is characterized by a number of lakes and small streams. It is also described as lakes region.


30°0'0"E
37°0'0"E
44°0'0"E
8°0'0"N
Riiver
Lake
River Basins
Omo-Ghibe
Rift Valley
Abay
Afar-Denakil
Awash
Aysha
Baro-Akobo
Ghenale Dawa
Mereb
Ogaden
Tekeze
Wabishebele
N
W
E
S
0 90 180 360 540 720
kms

Water Resources: Rivers, Lakes and Sub-Surface Water

- **The Ethiopian Rivers**
  - Unlike many other African countries, Ethiopia is endowed with many rivers. Majority of the rivers originate from highland areas and cross the Ethiopian boundary.

Table 4-1: major rivers of Ethiopia

River	Catchment Area(km^2)	Annual Volume BMC	Terminus/Mouth	Major tributaries
Abay	199,812	4.5	Mediterranean	Dabus, Dedessa, Fincha, Guder, Muger, Jema, Beshilo
Wabishebelle	202,697	3.4	Coast of Indian Ocean	Ramis Erer, Daketa Fafan
Genale Dawa	171,042	6	Indian-Ocean	Dawa, Weyb, Welmel, Mena
Awash	114,123	4.9	Inland (within Ethiopia)	Akaki, Kesem, Borkena, Mile
Tekeze	87,733	8.2	Mediterranean	Goang, Angereb
Gibe (Omo)	79,000	16.6	Lake Turkana	Gojeb
Baro Akobo	75,912	23.23	Mediterranean	Akobo

Cont'd

❑ General Characteristics of Ethiopian Rivers

- ✓ Almost all major rivers ***originate from the highlands*** elevating more than 1500 meters above sea level,
- ✓ Majority of Ethiopian rivers are ***trans-boundary***,
- ✓ Ethiopian rivers are ***characterized by extreme seasonal fluctuation***.
- ✓ Due to surface ruggedness ***they have rapids and waterfalls*** along their course,
- ✓ ***They have cuts, steep-sided river valleys and deep gorges*** along their courses,
- ✓ Rivers in Ethiopia ***flow on steep slopes having steep profiles***.
- ✓ Some of the rivers ***serve as boundaries, both international and domestic administrative units***.

The Ethiopian Lakes

- Relatively Ethiopia is rich in lakes. Almost all Ethiopian lakes are result of tectonic process that took place during Quaternary period of Cenozoic era.
- Except few Ethiopian lakes, majority of lakes are located within the Rift Valley System.
- Lake Tana, the largest lake in Ethiopia occupies a shallow depression in the highlands.
- Ethiopia is also gifted with crater lakes.
- These include the lakes at and around Bishoftu, Wonchi (near Ambo), Hayk (near Dessie) and the Crater Lake on top of Mount Zikwala. Lake Ashenge (Tigray) is formed on a tectonic basin.
- Other types of lakes in Ethiopia are man-made such as Lakes Koka, Fincha and Melka Wakena, and many other lakes dammed following hydroelectric power generation projects.

Table 4-2: Lakes of Ethiopia

Lake	Area (km^2)	Max. Depth(m)	Lake	Area (km^2)	Max. Depth(m)
Tana	3600	9	Abijata	205	14
Abaya	1162	13.1	Awassa	129	10
Chamo	551	13	Ashenge	20	25
Ziway	442	8.95	Hayk	5	23
Shala	409	266*	Beseka	48.5	11
Koka	205	9			

Subsurface (Ground) Water Resource of Ethiopia

- As compared to surface water resources, Ethiopia has lower ground water potential.
- Climatic and geophysical conditions determine the availability of groundwater resource.
- Based on existing scanty knowledge, the groundwater potential of Ethiopia is estimated to be *2.6 - 6.5 BMC*.
- However, this estimate is now considered underestimated.

Water Resources Potentials and Development in Ethiopia

a) Hydro-electric Potential: Ethiopian rivers have a very high potential for generating electricity.

b) Irrigation and Transportation:

- The terrain in Ethiopia is so rugged that it limits the uses of Ethiopian rivers both for irrigation and transportation. In the highlands, steep slopes, rapids, waterfalls, narrow and deep valleys and gorges are important obstacles.
- Majority of Ethiopian rivers are not suitable for transportation. The ***Baro*** at its lower course is the only navigable river.

a) Fishing and Recreation: The majority of Ethiopian lakes are rich in fish. Currently the annual production of fish is estimated to be 31.5 thousand tons.