MINISTRY OF EDUCATION
GHANA GEOGRAPHERS ASSOCIATION

Geography

for Senior High Schools

Year 2

Raymond Nsiah-Asare
Frank Jerome Glago
Prof. Ishmael Yaw Dadson
Susuana Adwoa Appiah

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TABLE OF CONTENTS

FOREWORD

Ghana's new Senior High School Curriculum aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, knowledge, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, progress to further studies and enter the world of work. This is the first time that Ghana has developed a Senior High School Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

The Ministry of Education is proud to have overseen the production of these Learner Materials which can be used in class and for self-study and revision. These materials have been developed through a partnership between the Ghana Education Service, teacher unions (Ghana National Association of Teachers- GNAT, National Association of Graduate Teacher -NAGRAT and the Pre-Tertiary Teachers Association of Ghana-PRETAG) and National Subject Associations. These materials are informative and of high quality because they have been written by teachers for teachers with the expert backing of each subject association.

I believe that, if used appropriately, these materials will go a long way to transforming our Senior High Schools and developing Ghana so that we become a proud, prosperous and values-driven nation where our people are our greatest national asset.

Haruna Iddrisu, MP
Minister for Education

Geography Year 2

SECTION 1

THE EARTH'S DYNAMIC PROCESSES AND LANDFORMS

THE EARTH AND ITS NEIGHBOURHOODS

The Earth and Its Features

Introduction

In Year One, you discovered the Earth was a sphere, spins on an axis and orbits the sun. In this section, you will learn about the internal structure of the Earth, the concept of continental drift, and the theory of plate tectonics. You will find out that over the vast length of geological time, the Earth's crust has constantly been created and destroyed, and parts are always on the move. For example, millions of years ago, an old continent broke up and the pieces of it have drifted into the positions that can now be recognised as Africa, Asia and the Americas. Finally, you will learn about the processes which create two of the Earth's major landforms, mountains and plains.

Key Ideas

- Mountains and plains are of economic and social importance to humans. They both play unique and significant roles in human economies and societies.
- Mountains are features formed by the movements of the Earth's crust.
- Mountains are worn down by the processes of erosion and flat plains are created.
- Plains are areas of flat land and can be created by erosion and deposition.
- The concept of continental drift explains why sections of the crust have moved position over geological time on the surface of the Earth.
- The internal structure of the Earth can be divided into three layers, the crust, mantle and core.
- The movements of the Earth's crust cause rock faulting, folding, and volcanic and earthquake activity.

THE INTERNAL STRUCTURE OF THE EARTH

In this section, you will explore the internal structure of the Earth. Just like slicing a boiled egg or a pear reveals what's inside, a cross-sectional view of the Earth shows that it is made up of three distinct layers.

The layers are:

1. the crust
2. the mantle
3. the core

Figure 1.1 shows the layers of the Earth.

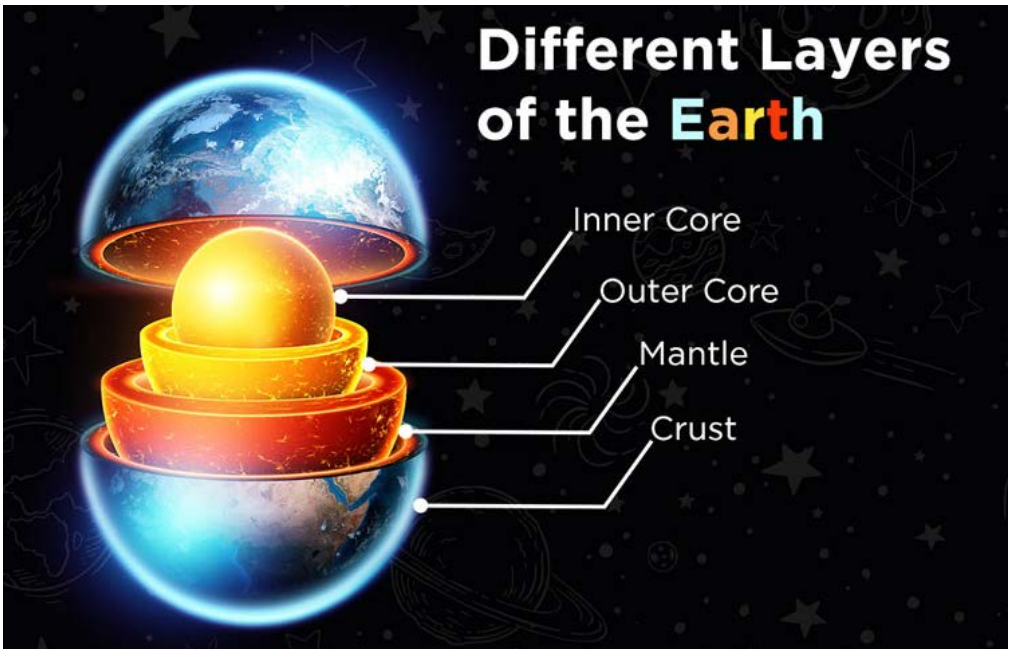


Figure 1.1: Internal structure of the Earth (istockphoto.com)

The Crust

It is the outermost layer of the Earth's internal structure It is composed of many varied rocks and soil. The technical name for the outer layer of the Earth is **lithosphere**, which includes the crust and the uppermost part of the mantle.

Characteristics of the crust

The crust has the following characteristics.

a. It is the first or the outermost layer of the internal structure of the Earth. This is where rocks, surface water and soil are found. It is also where humans, animals and plants live.
b. It is composed of a variety of rocks and minerals. Rock types such as igneous, sedimentary and metamorphic are found in the crust.
c. There are two types of crust, continental and oceanic.

d. The continental crust varies in thickness, averaging around 30-50 kilometres, but can be up to 70 kilometres thick in some mountain regions like the Himalayas. It is much thicker than the oceanic crust, which is only about 5-10 kilometres thick.
e. Continental crust is less dense than oceanic crust. It contains a big percentage of the mineral silica and the metal aluminium. Because of this continental crust is also called Sial.
f. Oceanic crust is denser than continental crust. It contains a big percentage of the mineral silica and the metal magnesium. That is why it is sometimes called Sima.
g. The continental crust is primarily composed of granitic rocks while the oceanic crust is made up of basaltic rocks.
h. The average density of the crust ranges from 2.7 g/cm^3 to 3.0 g/cm^3
i. The layer that separates the crust from the mantle is called Mohorovicic discontinuity or simply, Moho.

The Mantle

It is the layer below the crust. It is divided into two distinct layers. Technically, the upper mantle is called the asthenosphere, and beneath it is the lower mantle referred to as the mesosphere. The upper mantle (asthenosphere) behaves like a semi-fluid. Convection currents in the upper mantle are the main cause of the crustal fractures and movements. Lower areas of the mantle are heated by the core causing it to rise, cooling when it reaches the upper area of the asthenosphere, the cooler material returning down in a opposite current to be re-heated. The fracture and movement of the crust is called tectonic activity. The lower mantle (mesosphere) is more solid due to the high pressures created by the overlying layers.

Characteristics of the Mantle

The Mantle has the following characteristics.

a. It is found directly beneath the Earth's crust.
b. It is composed of rock (peridotite), primarily a mix of silicate minerals like olivine and pyroxenes (for example the mineral augite).
c. Its thickness is about 2900 km.
d. The mantle is divided into two parts: the upper mantle, which is solid but behave like a semi fluid and the lower mantle, which is solid and more rigid.
e. It is the thickest layer, accounting for about 84% of the Earth's volume.
f. It is also less dense than the core, with values ranging from 3.3 g/cm^3 to 5.5 g/cm^3
g. Convection currents in the upper mantle are responsible for tectonic activity in the crust.
h. It is the origin of most of the Earth's major land shaping processes such as mountain building, rock faulting and folding and earthquake and volcanic activity.
i. The layer that separates the mantle from the core is called Gutenberg discontinuity.

The Core

The technical term for the core is the Barysphere. It is found beneath the mantle, literally at the centre of the Earth. It has two parts, an outer and inner core.

Characteristics of the Core

The core has the following characteristics

a. It is the deepest and innermost layer of the Earth.
b. It consists of two distinct parts: the inner core and the outer core.
c. The outer core forms a 2400-kilometre-thick band around the inner core.
d. The outer core has a viscous flowing nature with a density of 10 g/cm^3
e. The inner core has a radius of about 960 kilometres.
f. The inner core is solid, with a density of 13 g/cm^3
g. Both the outer and inner core are composed primarily of iron and nickel.
h. Despite high temperatures (up to about 6,000°C), it remains solid due to immense pressures of overlying material.

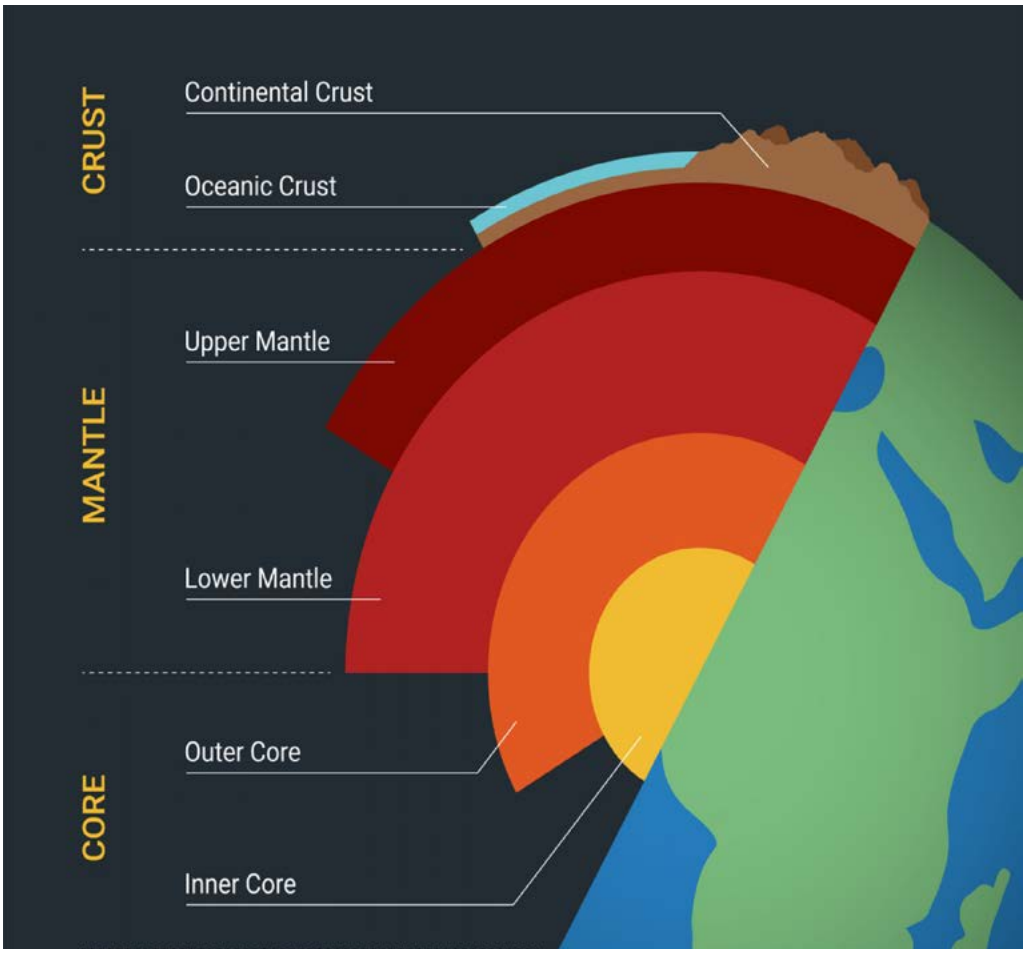


Figure 1.2: Internal structure of the Earth.

I hope you can identify the oceanic and continental crust. What is the main difference between the two?

Activity 1.1 The Structure of the Earth

Using the links and the images below, watch the videos and pictures carefully and describe in your own words the structure of the Earth to a friend. Relate your location to the description of the structure.

- https://youtu.be/eXiVGEEPQ6c.
- https://youtu.be/WjXSCumeqxo

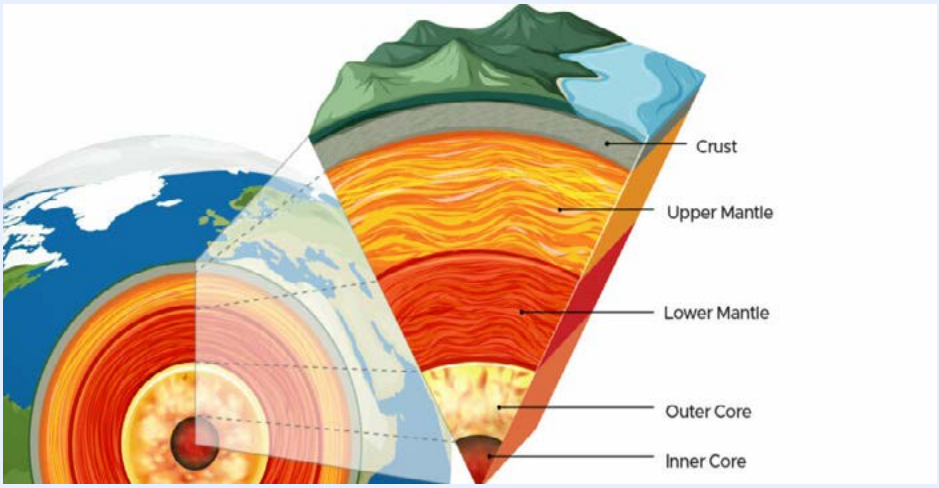


Figure 1.2: The structure of the Earth

1. Describe the **variations** in the crust or lithosphere to a friend in class.
2. Sketch a section to show the Earth's internal structure: Create a detailed sectional diagram of the Earth's internal structure, **using a proportional scale**. Clearly label the crust, upper mantle, lower mantle, outer core, and inner core. Ensure that the relative thicknesses are accurately represented using the scale you have chosen.

Describe Each Layer

a. Crust: Detail the differences between the oceanic crust (thinner, denser, basaltic) and the continental crust (thicker, less dense, granitic).
b. Mantle: Explain the upper and lower mantle's composition and the role of the asthenosphere in tectonic activity.

   c. Core: Detail the outer core's liquid state and the solid inner core made mainly of iron and nickel.
3. Create a separate box for the crust with an arrow pointing from it to the outer edge of your section.
4. Sketch the crust in this box: Show the oceanic crust and continental crust and relative thickness of each. (This cannot be shown on the main structure diagram because the crust is so thin compared to the other layers)
5. Add a comparison comment: Highlight that the crust is only 1% of Earth's volume, emphasising its thinness compared to the other layers.

THE CONCEPT OF CONTINENTAL DRIFT

Until very recently, people in Europe thought that the world was one big land area with rivers and seas dividing it up. Once Europeans started to travel the oceans this idea was questioned. Eventually it was recognised that in truth there were several large and quite different land areas, each one many miles from each other. These became known as continents, and each was given a name. While Europeans changed their ideas about the number of land areas or continents, they still believed that they had been in that place all the time, they just needed to be discovered. Remember your work from year 1 about proving that the Earth was not flat? This helped to confirm exactly how many land areas or 'continents' there were on Earth. Finally in 1912 a scientist published some research work which suggested that the continents did not stay in the same place. They were like pieces of a giant puzzle which moved around the surface of the Earth. In this section you will discover the evidence for this idea of drifting continents and the mechanism which causes it.

Keep in mind that the drifting of continents, like all geological processes is very slow, large movements taking millions of years. Average rates of movement are 2.5 centimetres per year, which is roughly the rate at which your fingernails grow.

Understanding Continental Drift

The concept of continental drift describes the gradual movement of continents across the Earth's surface over geological time. The mechanism by which this happens is explained by **the theory of plate tectonics**.

Plate tectonics is the scientific theory that explains the large-scale movement of the Earth's crust (or lithosphere). The crust is not one solid piece it is divided into several very thin, rigid sections known as 'plates'. (imagine a large sphere with paper plates covering all the surface) When you put an object into water which is less dense than the water, it will float. The theory of plate tectonics works on the same principle. The plates of the crust are less dense than the mantle so 'float' on top of the semi-fluid part of the mantle, the asthenosphere. Plate movement is driven mainly by convection currents in the upper mantle, as shown in **Figure 1.3.**

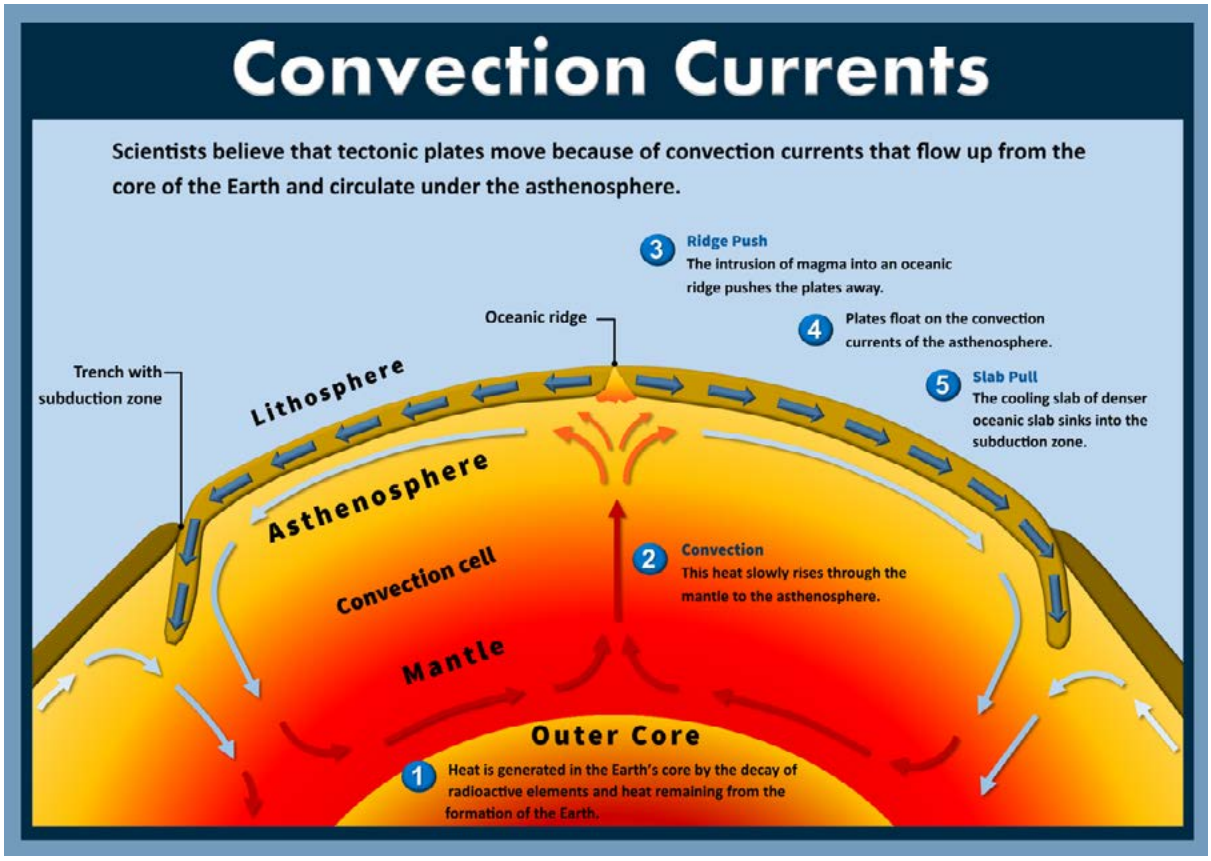


Figure 1.3: The movement of crustal plates are driven by mantle convection currents.

There are three main types of plate boundaries which are driven by different mantle current movements.

1. **Divergent Boundaries:** Plates move in the opposite direction or apart from each other as a result of a rising current. When this happens, magma (melted material from the mantle) rises from below to fill the space between the two plates which are moving away from each other, creating a new crust. An example is the Mid-Atlantic Ridge.
2. **Convergent Boundaries:** Plates move toward each other as a result of a falling current, causing one plate to be forced beneath another in a process called subduction. This often leads to the formation of mountains, where there is volcanic activity, and earthquakes. Convergent boundaries result in intense folding of rocks, such as in the formation of the Himalayas.
3. **Transform Boundaries:** Plates slide or move past each other horizontally as a result of currents causing lateral, or side-by-side, movements. This lateral movement can cause significant earthquakes along fault lines, such as the San Andreas Fault in California.

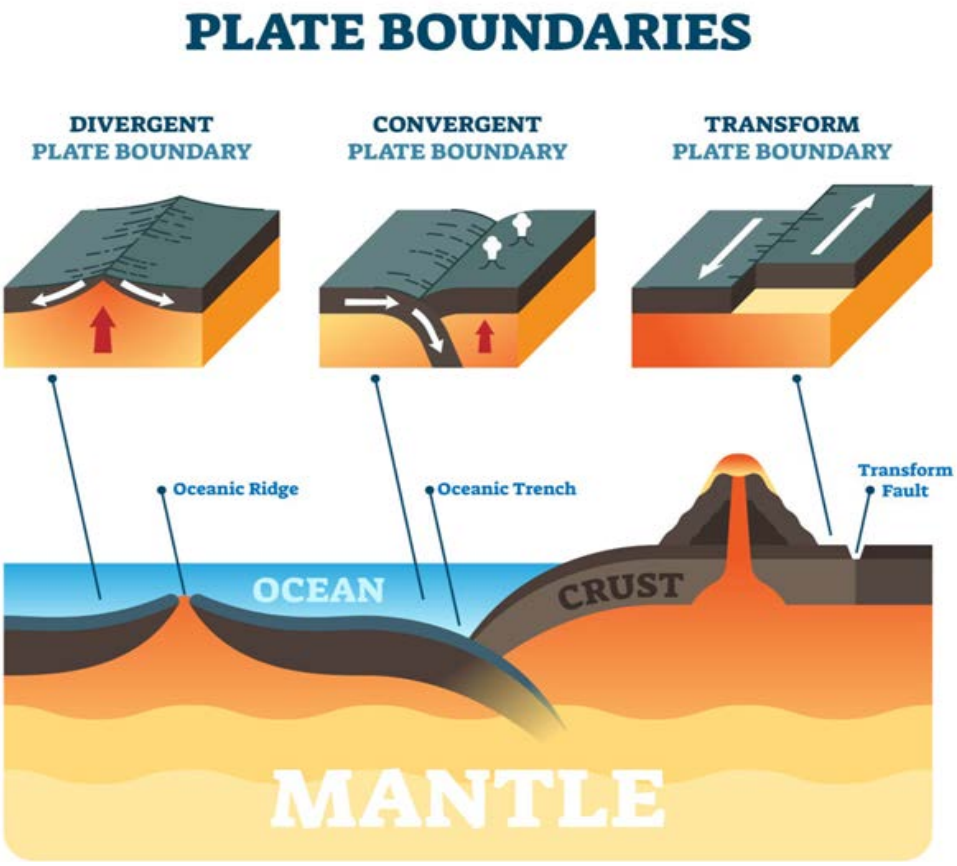


Figure 1.4: Movements plate boundaries

The Evidence for Continental Drift

In 1912, a German Meteorologist and Explorer, Alfred Wegener, presented his idea of continental drift. He explained that evidence showed that the continents were once joined in one big landmass and have over millions of years slowly drifted apart to their present positions. He named this supercontinent Pangaea, a Greek word meaning "all land". The rest of the Earth's surface was covered by a massive ocean called Panthalassa. Over time, Pangaea split into two subcontinents namely, Laurasia and Gondwanaland separated by the Tethys Sea. Laurasia in the north contained present-day Asia, Europe, and North America. Gondwanaland in the south included South America, Africa, India (then separate from Asia), Australia and Antarctica. Wegener's theory was not accepted by all scientists at the time because he could not explain what mechanism caused the continents to move to their current positions. This is solved by the theory of plate tectonics which explains how the continents have moved to their current positions.

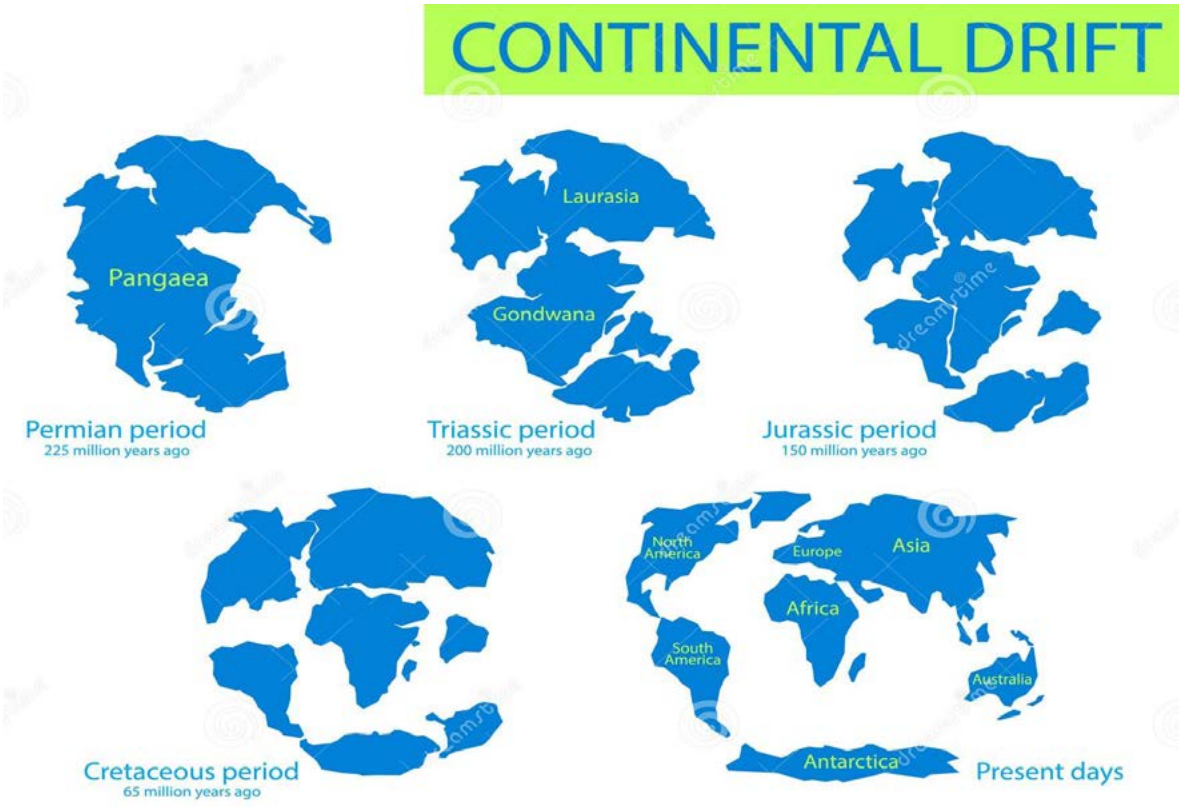


Figure 1.5: Chronology of plate movements for the splitting up of the supercontinent of Pangaea.

Evidence of Continental Drift

1. **Fitting of the Continents:** One piece of evidence to suggest that the continents were once much closer together is the shape of the coastlines of South America and Africa which can be fitted perfectly together like puzzle pieces. Take your atlas and have a look at the coastline along the eastern bulge of South America and the western bulge of Africa. Can you see that the two could fit together as one continent. This observation was one of the first to spark the idea of continental drift. See Fig 1.6.

2. **Fossil Distribution:** Fossils of the same species of plants and animals have been found on continents that are now widely separated by oceans. Do you know what fossils are? They are the remains of plants and animals. It means that the same or similar types of fossils have been found on some continents such as South America and Africa. An example is the fossils of the reptile Mesosaurus have been found in both South America and Africa. These land-based creatures would not have been able to swim across vast oceans, indicating that these two continents were once together.

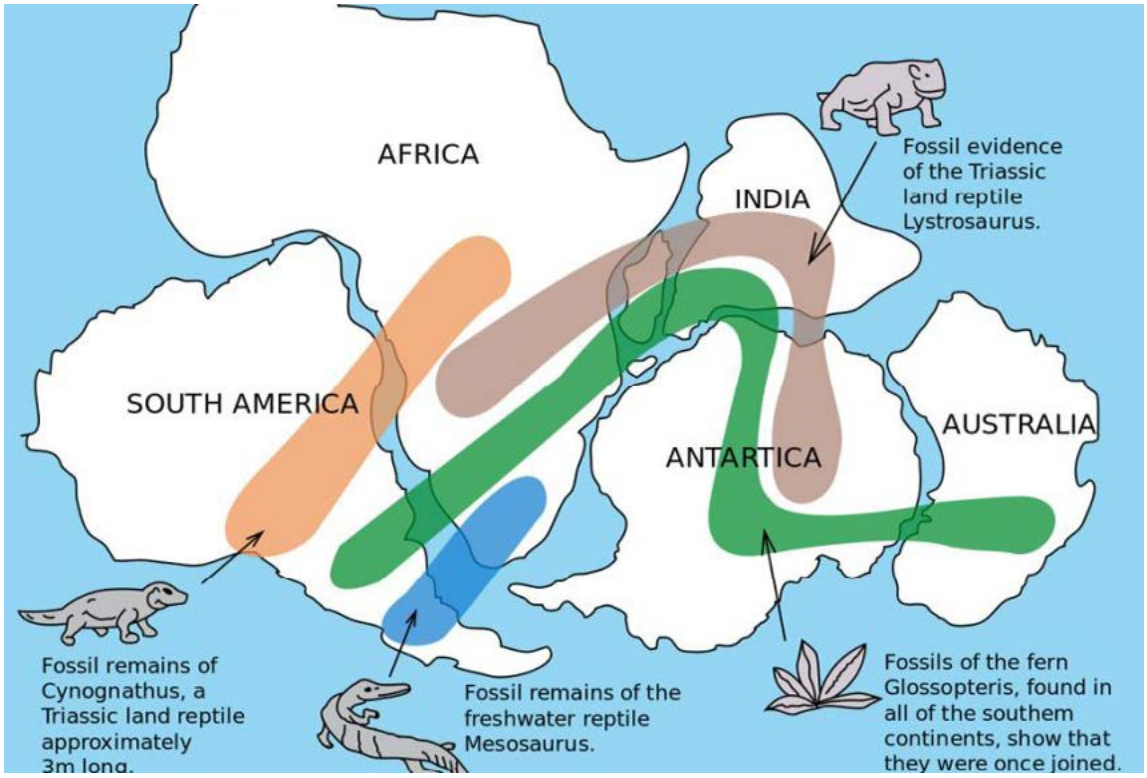


Figure 1.6: Fitting of the continents and distribution of fossils as evidence of continental drift and location of present-day continents (nationalgeographic.org)

3. **Rock Formations:** Similar rock formations and mountain ranges are found on continents that are now separated by oceans. For instance, the Appalachian Mountains in the north-eastern portion of North America have similar formations to the Scottish Highlands; the rock strata of the Karroo system of South Africa match correctly with the Santa Catarina system in Brazil and Ghanaian mountain ranges (the Akuapem-Togo ranges).

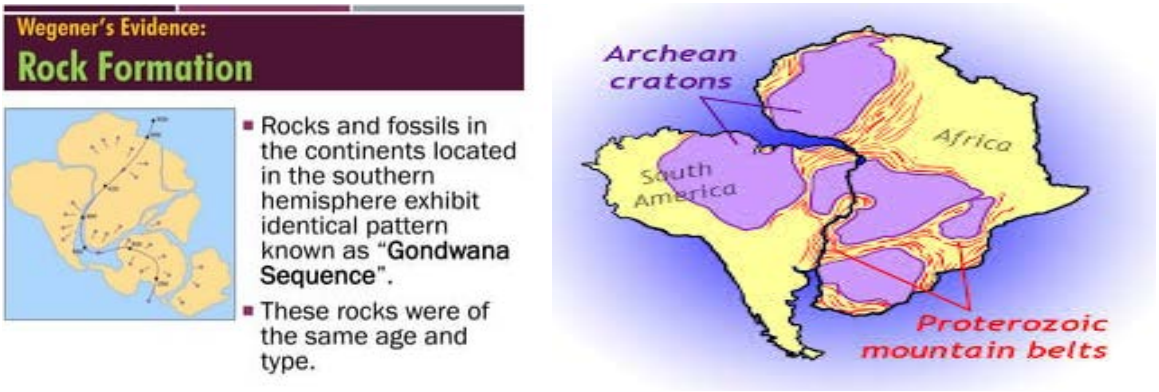


Figure 1.7: Matching rock formation and mountain ranges

4. **Ancient Climate Evidence:** Scratches left by glaciers on rocks in continents like Africa, South America, India, and Australia all point to a time when these land masses were closer together near the South Pole. This would not be possible if the continents had always been in their current positions.

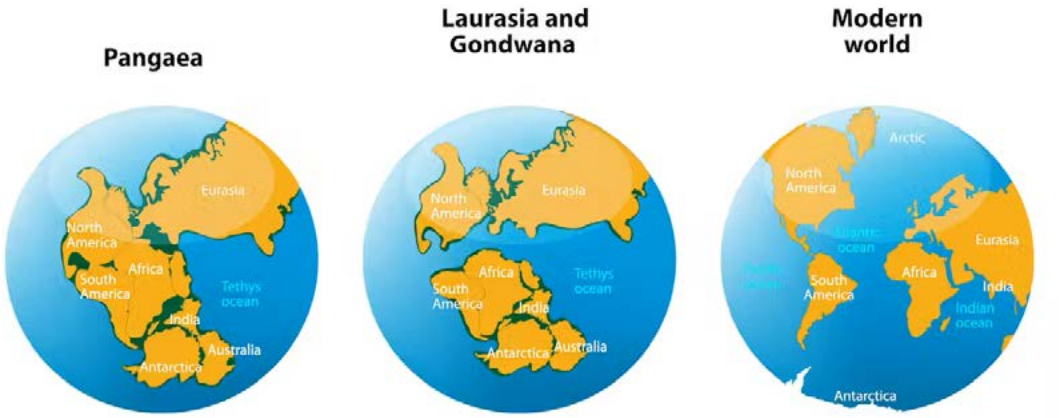


Figure 1.8: Evolution from continental drift to present-day continents

Activity 1.2 Continental Drift and Plate Tectonics

1. Use the internet, school or community library and relevant books to search for more information on Continental Drift and Plate Tectonics.

Links to online resources

a. https://letstalkscience.ca/educational-resources/backgrounders/continental-drift-and-plate-tectonics
b. https://geo.libretexts.org/Bookshelves/Geology/Fundamentals_of_Geology_(Schulte)/05%3A_Plate_Tectonics/5.05%3A_Continental_Drift
c. https://www.ias.ac.in/article/fulltext/reso/004/07/0024-0041

d. After your research, explain to a friend what the theory of continental drift is about and what mechanism causes the continents to drift over the surface of the Earth.
e. State the evidence you will use to convince your friend or sibling that the present-day continents used to be one landmass.
f. Rate your understanding of continental drift on a scale of 1 to 5 (1 = not at all, 2 = Basic Understanding, 3 = Moderate Understanding, 4 = Good Understanding, 5 = thorough understanding).
g. Write 2-3 sentences about what information surprised you in this activity and how your views on the position of the continents might have changed.

Activities 1.3 Continental Drift Puzzle Creation

1. Use a world map or printout, to trace or cut out the continents. Label each one and fit them together to make the super continent Pangaea. Stick the shapes down and put on arrows to show direction of movement needed to give the modern places of each of the continents.
2.
   a. Write a short report on Continental Drift by sourcing diagrams, illustrations and pictures from the Internet.
   b. Make a list of the modern continents which originated from the ancient ones of Laurasia and Gondwanaland.
   c. Use software to create an interactive map showing continental movement.
   d. Present your findings to a friend in class.

Activity 1.4 Plate Boundaries

1. Use the numbered information in the Convection Currents diagram to describe how these currents form in the mantle and how they cause movements of the Earth's tectonic plates.
2. Draw a labelled diagram for each of the following:
   a. Divergent plate boundaries
   b. Convergent plate boundaries
   c. Transform plate boundaries
3. On each diagram, include arrows to show plate movement direction. Write an explanation for each to show how convection currents in the mantle lead to the different movements. Give an example of the location of each type of plate boundary.

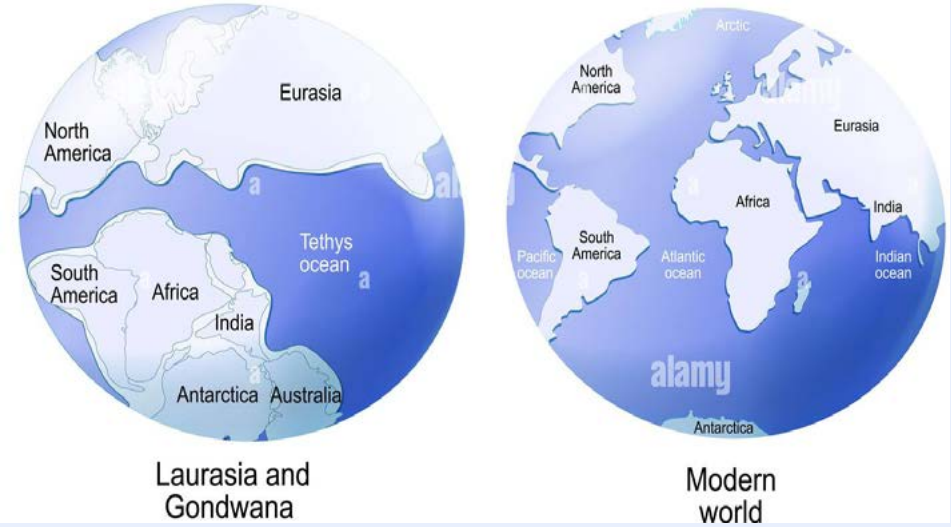


Figure 1.9

MOUNTAINS AND THEIR IMPORTANCE

Do you remember in Year 1 when you studied the relief of Ghana and you discussed highlands and lowlands? In this part, you will learn about the formation, types, characteristics and importance of mountains.

Meaning of Mountains

Mountains are highlands with elevations higher than the surrounding lands. Mountain building is driven by tectonic forces. Many mountains are formed at convergent plate boundaries. When mountains are formed at these plate boundaries, the rocks are folded, faulted, and areas can experience volcanic and earthquake activity. They are characterised by several key features such as high elevation, steep slopes, limited summit area and occur in isolation or as ranges.

Types of Mountains

There are different types of mountains based on the process of formation. Fold mountains, volcanic and block mountains are based on the process of formation.

1. Fold Mountains

They are mountains that are formed where two or more of Earth's tectonic plates are pushed together (convergent boundaries move through compressional forces). When these plates move towards each other, the sedimentary rock strata or layer found between them is bent and crumpled into a dome-shaped upland called an anticline, which forms the fold mountain. These forces cause sediments to squeeze towards each other. The bending or crumpling of the rock layers that are ductile (bendable) as opposed to brittle (hard but liable to break) is often referred to as folding systems. This leads to the formation of a series of upfolds and downfolds called anticlines and synclines, respectively. The bending and crumpling lead to five types of folding systems depending on the nature of the compressional forces. These are simple (symmetrical), asymmetrical, overfold (overturn), recumbent and overthrust (napped) folds as shown in **Figure 1.10**.

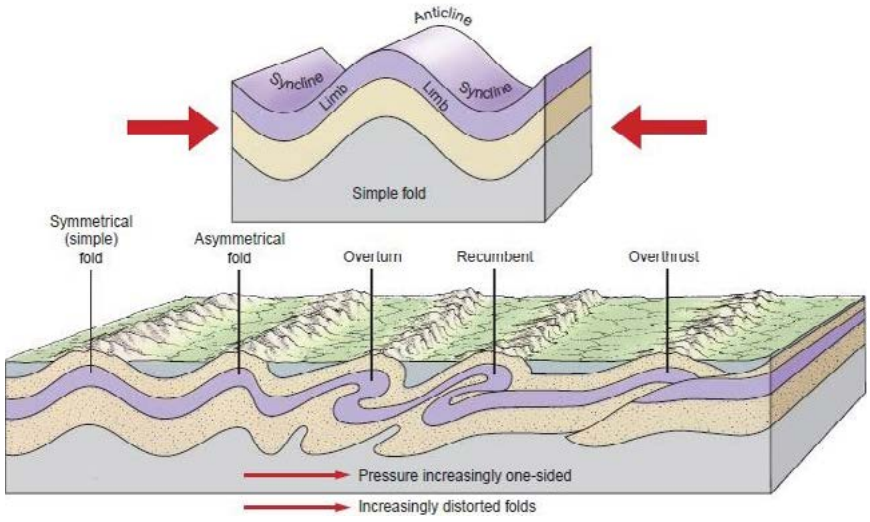


Figure 1.10: Types of fold systems (Peterson et al., 2019).

Fold types are

a. **Symmetrical or simple fold**: The fold has equally sized limbs.
b. **Asymmetrical folds:** One limb of the fold is steeper than the other.
c. **Overfold:** One limb of the fold is pushed over the other.
d. **Recumbent fold**: This occurs when the forces are intense, and in extreme cases, an overfold overlaps lower folds.
e. **An overthrust fold**: This occurs when the topmost part of the fold overrides the bottom part along a fault plane.

Characteristics or Features of Fold Mountains

a. They are formed by sedimentary rock strata
b. They are formed from sedimentary rocks and are usually in layers
c. They formed along convergent plate boundaries through compressional forces.
d. They are dome-shaped. The tops of fold mountains are typically convex in shape, forming an upward-curving arch or domelike structure.
e. They usually occur as long mountain chains known as ranges. Fold mountains can stretch for hundreds or even thousands of kilometres. For example, the Akuapem-Togo ranges, otherwise called Akuapem-Togo Atakora mountains, stretch from Ghana through Togo and Benin.
f. They are relatively easily eroded (worn down) due to their sedimentary origin.
g. They are usually formed at the coastal margins of continents and are linked to processes found at continental and oceanic plate boundaries. Please refer to a relief map of the world. You will notice that most of the fold mountains around the globe are found along the coast.
h. Examples of fold mountains are the Akuapem-Togo Mountains in Ghana, the Atlas in Morocco and the Rockies in North America.

Process of Formation

a. The formation of the mountains begins when oceanic and continental tectonic plates collide. The denser oceanic plate is subducted (sinks) beneath the less dense continental plate, leading to the creation of a deep, elongated depression or trench between the continental crust and oceanic crust.
b. Sediments are then accumulated in the trench over time. The accumulated sediments become compacted and cemented, forming sedimentary rock.
c. The layers of the sedimentary rock are then subjected to compressional forces, causing them to slide up over the ocean crust and crumple to form a series of upfolds.
d. This will eventually trigger volcanic activity and earthquakes, caused by frictional forces as the two plates collide and rub against each other.
e. Elongated ranges called fold mountains are formed as shown in **Figure 1.11**.
f. Fold mountains can also be formed as a result of sediments deposited in continental interiors, as shown in **Figure 1.11.**

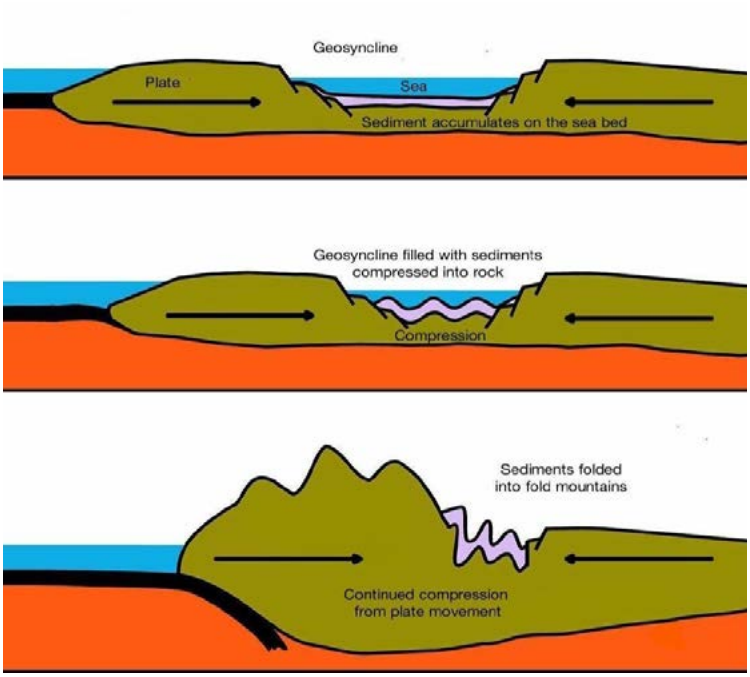


Figure 1.11: Processes leading to the formation of Fold Mountains in continental areas

Sediments accumulate in a large, low-lying area called a geosyncline. Compressional forces occur. Sediments are crumpled and bend upward to form fold mountains

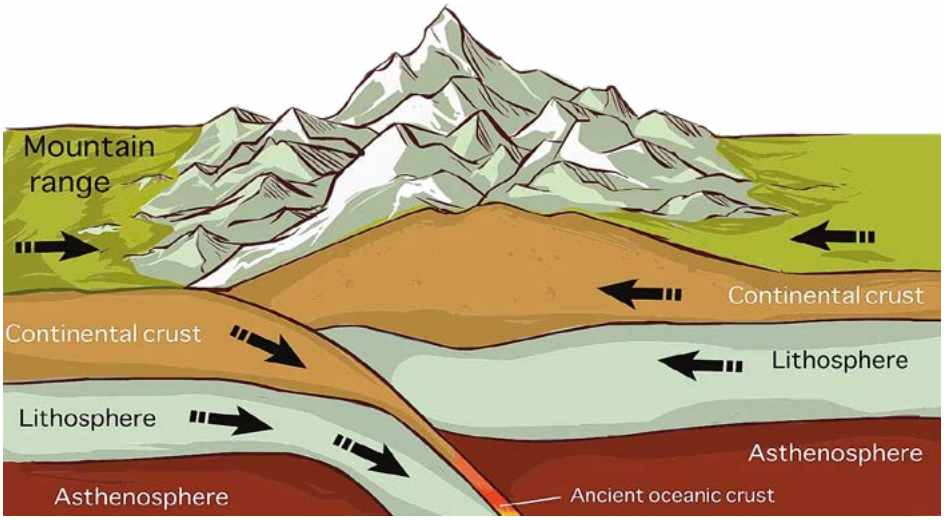


Figure 1.12: Processes leading to the formation of Fold Mountains at the edge of continents. Less dense sediments are pushed upward to form fold mountains.

2. Volcanic Mountains

They are formed from the eruption and accumulation of molten rock (magma) from the Earth's interior. When volcanism occurs, some of the erupted materials, such as lava, ash, broken rocks and other volcanic materials, accumulate to form uplands or mountains. Examples are Mount Cameroon, Kilimanjaro and Fujiyama. Do you know where these mountains are located?

Characteristics of Volcanic Mountains

Volcanic mountains have the following characteristics

a. They are formed from molten rocks and other volcanic erupted materials.
b. They are layered structures of alternating lava flows, volcanic ash, and other volcanic debris.
c. Some volcanic mountains are conical in shape. Vesuvius in Italy.
d. Some have steep and conical slopes. This occurs when the lava is highly viscous (sticky). Etna or Stromboli in Italy.
e. Some volcanic mountains have low cones and broad bases. Their base can cover several kilometres. The Hawaiian and Icelandic volcanoes.
f. Volcanic mountains that are formed from violent eruptions usually have a bowl-shaped depression called a crater or caldera.

Types of Volcanic Mountains

The types are based on the following:

a. **The nature of the eruption**
   i. *Quiet or non-violent eruption (Effusive) Volcanoes:* They are volcanoes characterised by the relatively gentle and non-explosive eruption of lava. They have broad and low lava cones.
   ii. *Explosive Volcanoes: These* are volcanoes characterised by violent and powerful eruptions that release a mixture of hot gas, ash, and rock fragments. These have large craters and or a large cauldron-like depression called a caldera, the result of explosive forces.

b. **Frequency of occurrence**
   i. *Active Volcanoes:* These are volcanoes that have erupted recently and are likely to erupt again. This type of volcanic mountain has a history of several episodes of occurrence, and there is a high probability that it will erupt again. Examples are Mt. Stromboli in Italy and Mt. Cameroon.
   ii. *Dormant or sleeping volcanoes:* These are volcanoes that have erupted in the last 2000 years and have not erupted again but may erupt in the near future. An example is Mt. Vesuvius in Italy.
   iii. *Extinct Volcano:* These are volcanoes that have not erupted in recent historical times (living memory), and there is no evidence of future eruption. Some of these volcanoes exhibit signs of volcanism but have never erupted in living memory. An example is Mt. Thielson in Oregon, USA, and Kilimanjaro in Tanzania.

c. **Structure**
   i. *Shield Volcanoes:* They are volcanoes shaped like a bowl or shield in the middle with long gentle slopes made by basaltic (highly fluid) lava flows. These are formed by the eruption of low-viscosity (runny) lava that can flow a great distance from a vent. Examples are Mauna Loa, in Hawaii, and Pico do Fogo in the Cabo Verde Islands.

ii. *Cinder Volcano/Cone:* They are circular or oval cones made up of small fragments of lava from a single vent, which has exploded due to a build-up of pressure when the vent is plugged by solid lava from a previous eruption. Cinder cones result from these eruptions and are made up of small pieces of scoria and pyroclastics that build up around the vent, with subsequent violent eruptions. Examples are Paricutin (Mexico), Lava Butte (USA) and Jos Plateau in Nigeria.

iii. *Composite Volcano (Strato volcano):* They are steep-sided volcanoes composed of many layers of volcanic rocks, usually made from acidic (highly viscous) lava, ash, and rock debris. These types of volcanoes are tall conical mountains composed of lava flows and other ejected materials in alternate layers. They are formed from the slow built-up of the repeated or series of eruptions, with lava, pyroclastic and ash, forming a cone-shaped feature with steep sides and a large crater at the top. Examples are Mount Kilimanjaro (Tanzania) and Mount Fuji (Japan).

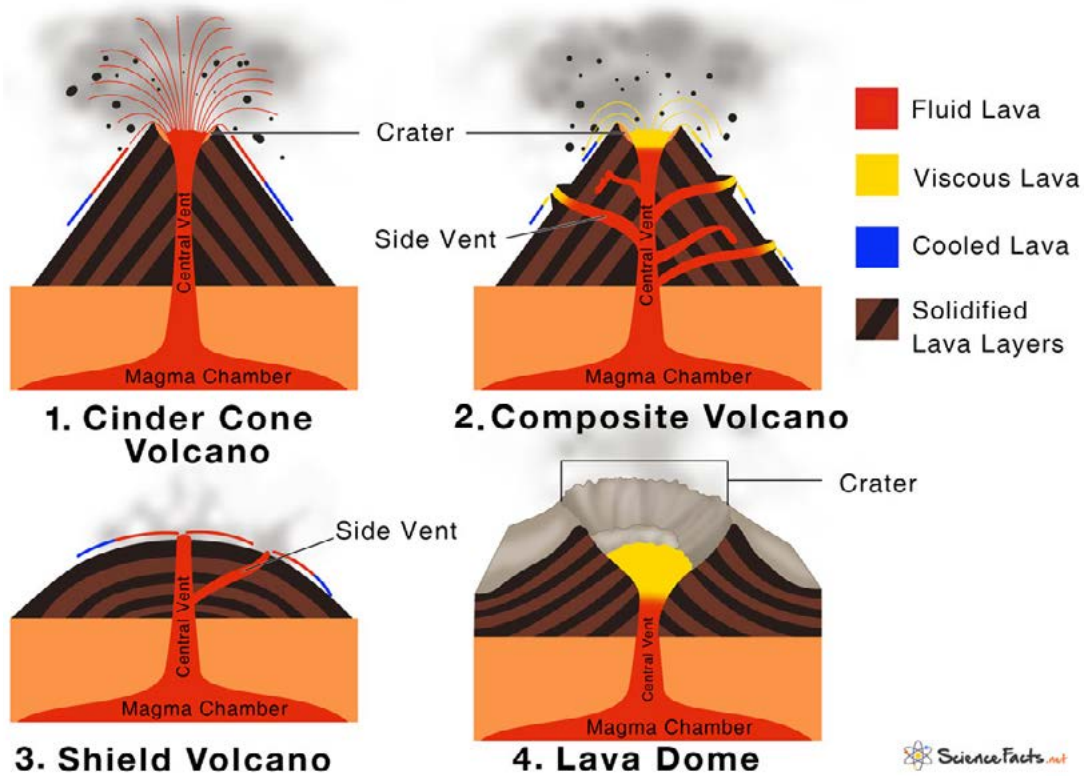


Figure 1.13: Types of volcanoes

3. Block Mountains

These are mountains that are formed by the movement of rocks along a fault line as a result of considerable pressure (compressional and tensional forces). A fault is a crack or line of weakness in the rock along which movement can take place.

Figure 1.14: A rock with a visible fault line (simply a crack) produced by tensional and compressional forces.

There are three types of faults, normal, reverse and tear. These are shown in **Figure 1.15.**

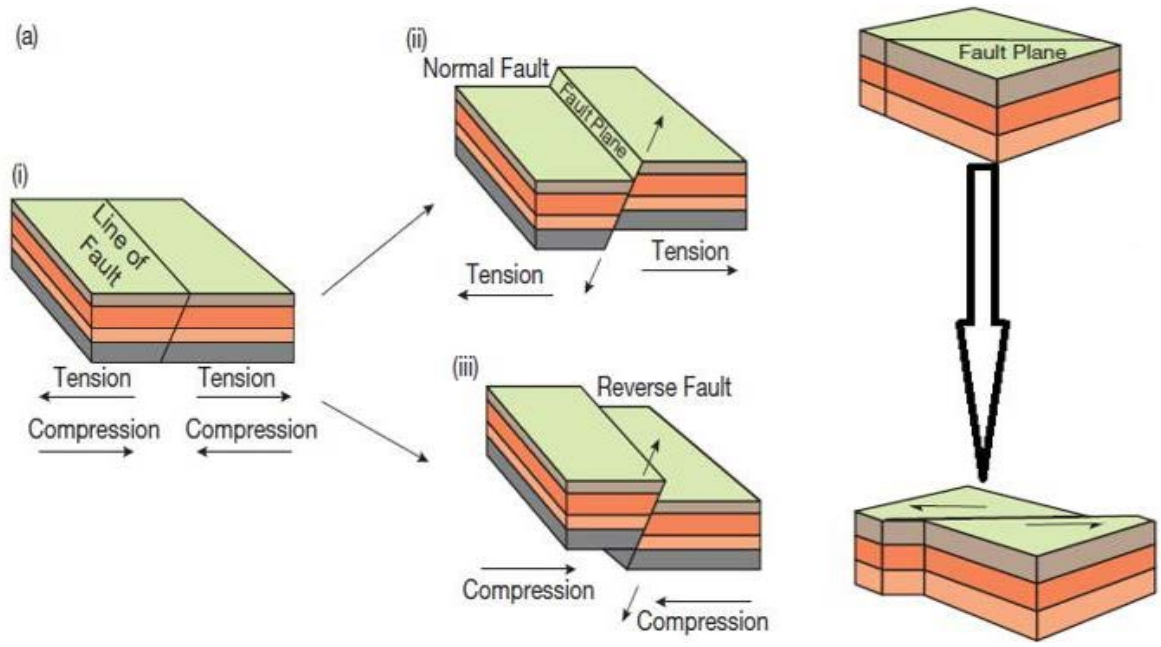


Figure 1.15: Tensional and compressional forces produce different types of faults (Peterson et al., 2019)

Types of faults

a. **Normal Fault:** It formed as a result of tensional forces that pull the Earth's crust apart. In a normal fault, the hanging wall (the block that lies above the fault line) moves downward relative to the footwall (the block that lies below the fault line). They are often associated with features such as fault scarps and graben/rift valley as the hanging wall subsides. The bedding plane forms an obtuse angle ($> 90° < 180°$) with the fault plane/line. The normal fault causes crustal stretching. Examples include the Great Rift Valley (East Africa), the Great Basin of Utah (USA), Death Valley (California, USA) and the Basin and Range Province (Western USA).

b. **Reverse fault:** It is formed as a result of compressional forces that push the Earth's crust together. In a reverse fault, the hanging wall moves upward relative to the footwall. They are commonly associated with features such as fault thrusts, mountain ranges and block mountains/horsts as the hanging wall is thrust upwards. The bedding plane forms an acute angle ($< 90°$) with the fault plane/line. The reverse fault causes crustal shortening. Examples include the Himalayan Mountains (Asia), the Andes Mountains (South America), and the Alps Mountains (Europe).

c. **Tear Fault:** It is also known as a wrench fault, strike-slip fault or transcurrent fault**.** It is formed as a result of the lateral or horizontal movement of the Earth's crust. In other words, the crustal blocks slide past each other horizontally. The movement along a tear fault is parallel to the strike of the fault plane. They can create linear scarps or cliffs on the Earth's surface, where the horizontal movement has caused a displacement of the land. They are often associated with earthquakes, as the horizontal movement can generate significant seismic energy. Examples include the San Andreas Fault (California) and the Alpine Fault (New Zealand). See **Figure 1.16** for illustrative diagrams

Figure 1.16: Types of faults

Characteristics of block mountains

a. They are formed through faulting
b. They have steep sides on one side and a gentle slope on the other due to the tilting.
c. They have relatively flat summits and are thus associated with a plateau
d. They are separated by rift valleys.
e. Examples include Mt. Ruwenzori (DR Congo), the Vosges (eastern border of France) and the Black Forest (Germany).

Processes Leading to the Formation of Block Mountains

a. The formation of block mountains begins with the development of fault lines in the Earth's crust.
b. The fault lines are usually caused by disturbances within the earth's crust through tensional or compressional forces, which begin to act on the opposite sides of the block where the fault lines have developed.
c. In the case of tensional force, the two blocks outside the fault lines are pulled apart, leading to the sinking of the central block, thereby leaving the outside blocks standing as block mountains.
d. Block mountains formed from compressional forces occur when the two blocks outside the fault lines are pushed toward the centre, leading to the uplift of the central block as a block mountain.
e. The uplifted blocks may either be tilted to form block mountains (tilt blocks), or they may be horizontal to form horsts.

Importance of Mountains to Socio-economic Development

1. **Source of minerals**: Some mountains are a source of precious minerals such as gold, diamonds and manganese. For example, in Ghana, many valuable minerals are mined in highland areas such as Obuasi, Tarkwa, Kenyasi and Bibiani.

2. **Source of Water:** Some mountains serve as sources of water, such as rivers and streams. For example, the Volta River takes its source from the Moshi Highlands in Burkina Faso, while Pra, Ayensu and Densu take their source from Atiwa Highlands. This water is vital for drinking, irrigation, hydropower, and industrial purposes.

3. **Serve as a tourist attraction:** With stunning landscapes, diverse ecosystems, and adventure opportunities, some mountains are popular tourist destinations. Tourism in these areas can generate income, create jobs, and support regional development. Examples are Mt. Afadja and Mt Ejuanema in Ghana.

4. **Habitat for plants and animals:** Mountains harbour a significant portion of the world's biodiversity, with unique species of plants, animals, and ecosystems. This biodiversity is essential for maintaining healthy ecosystems, providing ecosystem services, and inspiring scientific research.

5. **Climate Regulation**: Mountains play a vital role in regulating global climate by influencing weather patterns, storing carbon, and reflecting solar radiation. Some high mountains produce orographic rainfall, especially those that are on the edge of continents near to the sea.
6. **Promote agriculture:** Mountains provide habitat and fertile soils for crop production and animal rearing. Volcanic mountains, for instance, provide fertile soil for food crop production. Some other mountainous areas provide grass for livestock to feed on. Examples are the Fouta Djallon, Jos Plateau and Guinea Highlands. Mount Cameroon, for instance, provides fertile soils for crop production.

Activity 1.5 Exploring Mountains Through Nature Walks, Videos and Photos

1. Discuss with your classmates or friends what you already know about mountains and hills.

Consider these questions.

   a. What factors do you think cause mountains to form?
   b. Have you seen a mountain? Describe what you saw to a friend.

2. Now take a nature walk in your school or community and look for visible highlands. As you walk, pay attention to the details of your surroundings. Specifically, observe:

   a. elevation changes (Use the link https:// whatismyelevation.com/ to check your current elevation from your digital device).
   b. The rock type (Igneous, sedimentary or metamorphic)
   c. The slope and nature of the summit of hills
   d. Vegetation types on the hills
   e. Use your notebook or digital device to jot down observations and sketches of what you see.
      i. Take photos or short videos of interesting geological features you encounter, if possible.
      ii. After finishing the walk, rate your observation skills on a scale of 1 to 5: (1 = Not observant, 2 = Slightly observant, 3 = Moderately observant, 4 = Very observant, 5 = Extremely observant).
      iii. What can you do to improve your observation skills?
      iv. Share your information with a friend in class.

3. Use the internet to explore the following: 'How tectonic forces play a part in mountain building'.

   a. Use software to create a presentation for the class on how tectonic forces play a part in mountain building.

b. Cut and paste any useful diagrams and pictures to create slides but write your explanations.
c. Collect together a list of the sources of information you used in your research.

Here are some ideas for the content of each slide.

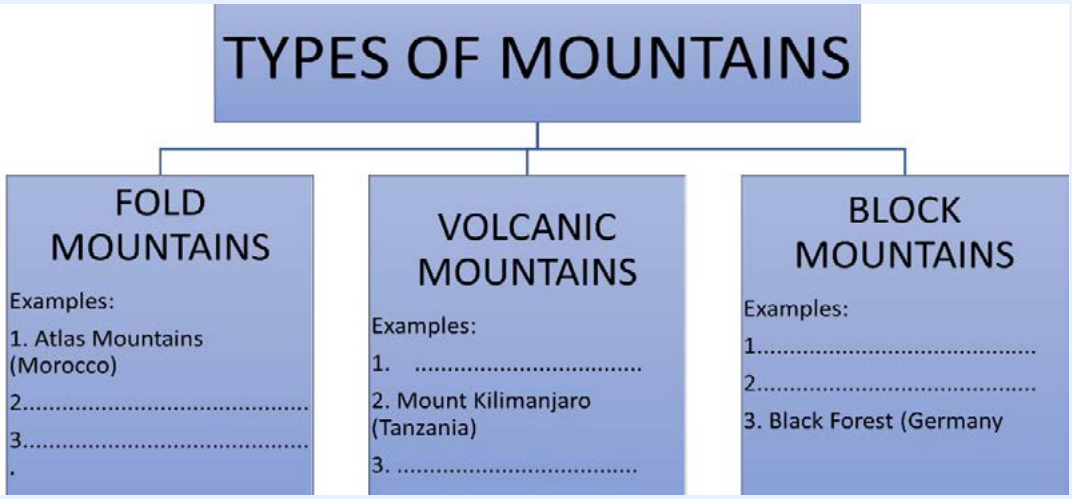
i. Slide 1, Plate Collision: When an ocean tectonic plate collides with a continental plate the denser ocean plate is forced under the continent.
ii. Slide 2, Subduction Zones: Where the ocean plate is forced under the continent an ocean trench is formed where sediments from the land build up.
iii. Slide 3, Crustal Deformation: The collision pushes the continental crust and sediments above the oceanic crust, leading to the formation of fold mountains.
iv. Slide 4, Volcanic Activity: Frictional forces created by the two plates rubbing together cause melted rock (Magma) from the mantle to rise through the crust at plate boundaries, building volcanic mountains.
v. Slide 5, List of sources of information.

Activity 1.6 Creating Posters on Mountains their Features, Processes, And Benefits

1. Use a large piece of poster board or digital software (like Google Slides) to create a visually engaging poster. Make sure to include the following elements:
   a. Title: Clearly state the name of your mountain type.
   b. Images: Include relevant photos or drawings of the mountain type.
   c. Information Sections: Create distinct sections for features, processes, and benefits using bullet points for clarity.
   d. Creativity: Use colours, diagrams, and infographics to make the poster informative and visually appealing.
2. Make sure your poster is well-organised and easy to read. Keep in mind that the visual layout is just as important as the information presented.
3. Prepare a brief presentation and share with your class the poster you have created.
4. After your presentation, reflect on your speaking skills and rate your presentation performance
5. What was the most interesting thing you learned about your assigned mountain type?
6. What challenges did you encounter while creating the poster and how did you overcome them?
7. Share your information with a friend in class or someone at home

Activity 1.7 Exploring and Identifying Mountains on Maps

1. Add examples of mountain locations in the spaces provided in the diagram below. One has been done for you in each case.
2.



   a. Locate the block, volcanic, and fold mountains from your table using an Atlas.
   b. Share your findings with a classmate.

Activity 1.8 Importance of mountains to Ghana

Write a letter to your local Chief explaining the importance of mountains to Ghana and the need to protect them for the community. Structure your letter in the following way:

Head the letter with your name, school address, the Chief's name and address.

Dear Chief [Chief's Last Name],

1. Introduction
   a. Brief introduction of yourself
   b. Purpose of the letter
2. Environmental Importance
   a. Role in climate regulation
   b. Biodiversity and wildlife habitats
   c. Water sources from mountain snowmelt
3. Economic Significance
   a. Natural resources (minerals, timber)
   b. Tourism and recreational activities
   c. Agriculture and grazing lands

4. Conclusion
   a. Summarise the importance to Ghana
   b. Suggestions for protection, conservation and involving the community

Activity 1.9

1. Study carefully the 25 entries in the box below, which have the names of mountains in Ghana and all over the world.

Vosges Mountains	Black Forest
Mount Amedzofe	Togo-Atakora Mountains
Mount Elgon	Harz Mountain
Cape Fold Mountains	Rocky Mountains
Mount St. Helens	Sierra Nevada
Mount Afadjato	Mount Vesuvius
Mount Kenya	Mount Fuji
Atlas Mountains	Mauna Loa
Mount Ruwenzori	The Kwahu Plateau
Mount Kilimanjaro	The Akwapim-Togo Range
Appalachian Mountains	Himalayas
Alps	Mount Etna
Mount Cameroon	

2. Use the internet and an Atlas to research the type of mountains they are and their location. Use your research to copy and complete the following table.

TYPE OF MOUNTAIN					
FOLD MOUNTAIN		BLOCK MOUNTAIN		VOLCANIC MOUNTAIN	
NAME	LOCATION	NAME	LOCATION	NAME	LOCATION

PLAINS AND THEIR IMPORTANCE

Meaning of Plains

Plains are vast, mostly relatively flat, or gently rolling expanses of land, with low elevation. A plain's elevation stays roughly the same across its area. The Accra Plains, located in Ghana, generally have an elevation of about 150 metres (500 feet) above sea level and cover an area of over 5000km^2 (1930 square miles), they are pictured in **Figure 1.17** and **Figure 1.18**, below.

Figure 1.17: Parts of Accra plains (google.com)

Figure 1.18: Parts of Accra plains (google.com)

General Characteristics of Plains

1. They are generally considered lowlands, rarely exceeding a few hundred feet above sea level.
2. They show a gently rolling or undulating topography.
3. They are vast and stretch for hundreds or even thousands of kilometres. For example, the Accra plains cover around 5,000 km^2.
4. They can be subject to water erosion and floods, especially in the wet season.
5. They are often wetlands, having many streams and larger river systems, together with lakes and lagoons. For example, the coastal plains of Ghana have a number of wetlands such as the Sakumono, Densu and Keta.

Figure 1.19: A plain

Which of the characteristics mentioned above can you identify from **Figure 1.19**?

Types of Plains

1. **Structural plains.** They are plains formed by the uplift or subsidence of relatively undisturbed sedimentary rock in the Earth's crust. They are not formed by the processes of erosion or deposition. Examples include the Russian Platform, the Great Plains of the USA, and Australia's central lowlands.
2. **Erosional Plains:** They are formed by the work of natural forces like rain, rivers, ice, and wind. Erosion is significantly accelerated by the presence of materials like sand, small pebbles, and boulders. These materials act like sandpaper, grinding and wearing down surfaces as they are transported by wind, water, or ice. These agents wear down the Earth's surface, smoothening out bumps and eventually reducing even towering mountains to gently rolling plains over millions of years. These plains, often called peneplains, where the land is gradually worn away.

Forms of Erosional Plains

a. **Erosional Plains formed by Rivers:** Rivers, as they flow from their source to the sea, use the sand and stones they carry to carve out valleys and widen their banks. This process, along with erosion of the land between rivers, lowers the overall elevation of the area, creating a flatter landscape. The Plains of Canada and the Niagara Plains of the USA are examples of erosional plains in the world.

b. **Erosional Plains formed by Winds:** In dry and semi-dry regions, wind plays a significant role in shaping the land. Wind carries sand and small particles which act like sandpaper helping to break down rocks. The worn material is blown away, lowering the ground level and creating vast plains. These plains, often covered in gravel or stones, are called 'regs' or desert pavements in Africa. In these arid regions, weathering also contributes to the formation of gently sloping plains called pediments or pediplains, as land is gradually worn down.

c. **Erosional plains formed by Ice:** Glaciers and massive ice sheets, in regions where they exist, have a powerful impact on the landscape. As they move, the rocks embedded in the heavy ice help to carve and smooth the land, creating vast, flat plains known as ice-scoured plains. The weight and movement of the ice also create depressions in the land, which often fill with water to form lakes. This process is clear in northern Europe and Canada, where extensive ice-scoured plains are found. Finland, for example, is a country dotted with over 35,000 lakes, covering a significant portion of its land.

3. **Depositional Plains:** These are plains formed by the deposition of materials brought by various agents of transportation. They are comparatively level but rise gently towards adjacent highlands. Their fertility and economic development depend greatly on the types of sediments that are deposited. The Northern Plains of India is an example of the depositional plains.

Forms of Depositional Plains

a. **Depositional plains formed by Rivers:** Some of the world's largest plains are formed by the deposition of sediment carried by major rivers. As rivers flow from their mountainous sources, they erode the land, carrying away vast amounts of sediment. This sediment is then deposited in the lower reaches of the river, creating fertile alluvial plains, floodplains, and deltas. These plains are incredibly productive for agriculture, supporting a wide range of crops and dense populations. The Nile Delta in Egypt is famous for its rice and cotton, the Ganges Delta for rice and jute, and the North China Plain, where the Yellow River has deposited a thick layer of sediment, is home to a wide range of valuable crops like rice.

b. **Depositional plains formed by Wind:** In deserts, weathering and wind erosion break down rocks into fine particles called loess. These particles are then picked up by strong winds and carried away, eventually settling in more distant areas. When enough loess accumulates, it can form vast, flat plains known as loess plains. Examples of these plains can be found in parts of Argentina, where they are known as the Pampas, and in northern China.

c. **Depositional plains formed by Ice:** As glaciers and ice sheets melt, they deposit a mixture of unsorted sand, gravel, and boulders, creating outwash plains. These plains are often barren, like some parts of Holland and northern Germany. However, when glaciers deposit a mix of boulders and clay, known as boulder clay, it can create fertile till plains or drift plains. These areas, like the Midwest of the USA and East Anglia in England, are often valuable for farming.

d. **Depositional plains formed by the action of Waves:** In coastal regions, waves and winds often drive beach materials like mud, sand, or shingle, landwards and deposit them on the coastal plain to form marine swamps, mudflats, tidal and estuarine lowlands. An appreciable portion of the coastal lowlands of Belgium, the Netherlands and the Gulf Coast of the U.S.A. were formed in this way. Uplift may raise the coastal lowlands slightly and they then form an emergent coastal plain e.g. the coastal margins from Florida to Texas.

Importance of Plains to Socio-economic Development

1. **Provide fertile soils for crop farming**: Plains often have fertile soils, formed by the deposition of sediments from rivers, wind, or glaciers. This makes them ideal for agriculture, allowing for large-scale cultivation of crops and raising livestock. An example is The Great Plains of North America and the Accra Plains in Ghana.

2. **Serves as habitats for humans**: The ease of building and infrastructure development (roads, river travel and railways) on flat land makes plains attractive for human settlements. Major cities and transportation hubs are often located on plains. An example in Ghana is the plain where the capital city Accra is situated.

3. **Source of mineral deposit:** Plains provide easily accessible deposits of minerals and other natural resources. An example is the Amazon Basin in Brazil which is not only known for its rainforest but also has significant deposits of minerals, including iron ore, bauxite, and manganese.

4. **Support diverse ecosystems**: Grasslands, savannas, and wetlands are all commonly found in plains, providing habitats for a variety of plant and animal life.

5. **Serves as a receptor of flood waters**: Most plains serve as places where excess flood water settles. Water from highland areas, especially during the wet season, flows and settles in low-lying areas thus reducing the tendency of floods in a larger area.

Activities 1.10 Plains and their Importance

1. Research the following **plains** using books or the internet:
   a. The Canadian Shield, Canada
   b. The Sahara Desert, North Africa
   c. The Po Valley, Italy
      i. Sketch a map to show the global location of each plain.
      ii. State the land area covered by each of the plains
      iii. Identify the type of erosion that has been mainly responsible for the formation of each plain, water, wind, or ice.
      iv. Use the information you have gathered in your research to describe formation and the features of each of the plains.
2. Sketch a plain landscape and discuss with a friend how plains are formed.
3. Make a model of a plain using clay or cardboard.
4. Design a map of a plain and label key features.
5. Explore plains using Google Earth or virtual tours.
6. Research the processes involved in the formation of different types of plains and present them to the class.
7. Discuss with a friend the impact of human activities on plain ecosystems.
8. With your knowledge of the relief of Ghana and your discussions on plains, identify any two areas in Ghana with a relatively low-lying plain. Discuss with a friend how these plain areas can help the development of the local community and at the same time pose challenges to the development of the area.
9. Develop a plan for sustainable development on a plain.
   a. Write a short essay on the importance of plains, and how has plains influenced human activities.
   b. Share your information with a friend.

Review Questions

Earth's Internal Structure: Layer Match Puzzle

Instructions:

1. Match the layer names with their descriptions.

Layer Name	Description
Crust	The outermost solid layer, ranges from 5-70 km thick.
Inner Core	The liquid layer is composed of iron and nickel, approximately 2,250 km thick.
Mantle	The innermost solid layer, composed of iron and nickel, with temperatures up to 5,500°C.
Outer Core	It is the thickest layer, composed of hot, solid rock, approximately 2,900 km thick, accounting for about 84% of the Earth's volume.
Lithosphere	The outer part of the mantle and crust combined, broken into tectonic plates.

2. What is the outermost layer of the Earth?
3. Which layer is composed of hot, viscous rock?
4. What is the thinnest layer of the Earth?
5. Which layer is divided into tectonic plates?
6. What is the centre of the Earth called?
7. Describe the main differences between the crust and the mantle or how is the Earth's crust different from the mantle.
8. Describe the internal structure of the Earth, including the layers and their characteristics.
9. Explain the theory of plate tectonics
10. Describe the differences between ocean and continental crust.

The Concept of Continental Drift

1. How does the concept of Continental Drift explain the current position of the Earth's major land masses.
2. Who proposed the theory of continental drift?
3. What theory explains the large-scale movement of the Earth's crust?

4. What are tectonic plates?
5. How do tectonic plates move?
6. What are the three types of plate boundaries?
7. What geological features can be found at convergent plate boundaries?
8. Give an example of the location of each of the types of plate boundaries.
9. How do earthquakes relate to plate tectonics?
10. How do volcanoes relate to plate tectonics?

Mountains and their Importance

1. In what ways can you describe a block mountain and the process of formation to a friend
2. Write a brief description of a block mountain.
3. How do block mountains differ from fold mountains?
4. What is the economic importance of block mountains
5. What is a volcanic mountain, and how is it formed?
6. Describe the stages of volcanic mountain formation
7. How do volcanic mountains impact the environment
8. What is a fold mountain, and how is it formed?
9. Describe three types of folds
10. Give examples of fold mountain ranges in the world.
11. What is the economic importance of fold mountains?

Plains and their Importance

1. Explain the difference between structural plain and an erosional plain.
2. Describe how an erosional plain can be formed by the action of water.
3. Describe how an erosional plain can be formed by the action of wind.
4. Describe how an erosional plain can be formed by the action of ice.
5. Explain the difference between an erosional plain and a depositional plain.
6. Give one example of a depositional plain from any continent in the world and explain its formation.
7. Explain the role of plains in supporting agriculture and food production.
8. What is the importance of plains for the development of towns and cities?
9. What is the importance of plains for the development of transport infrastructure (roads, rivers, railways)?
10. Explain the importance of plains to biodiversity.
11. Plains are often subject to floods. Explain why this is the case and assess the impact on farming, settlement and transport infrastructure.

Geography Year 2

SECTION 2

MAP SKILLS AND ANALYSIS

NAVIGATING OUR ENVIRONMENT

Maps: Their Elements and Analyses

Introduction

This section covers important skills for reading and understanding maps. First, it shows how to make maps bigger or smaller for different needs. You will also learn how to measure distances and areas on special maps called topographical maps, which show land features. The section also covers bearings and directions, helping you navigate maps accurately. Additionally, you will discover sectional drawing, a way to visualise a three-dimensional landscape from a flat map. By calculating the gradient, you can understand how steep a slope is. Together, these skills will help you read and use topographical maps effectively, making exploring and understanding different terrains easier.

Key Ideas

- A sectional profile (cross-section) provides a precise diagram between two points on a map that includes slopes, their shape, land height and any notable features like rivers and roads.
- Directions are shown on maps using cardinal points while bearings or angles are measured in degrees
- Map reduction is the process of making a map smaller while map enlargement is about making a map bigger.
- The distances measured on topographical maps can be either straight or curved

TECHNIQUES OF MAP ENLARGEMENT AND REDUCTION

Techniques of Map Reduction

Map reduction is the process of making a map smaller while maintaining its accuracy and details. The relationship between the map scale and the size of the area it shows is the opposite. Large-scale maps have a smaller number in their scale fraction, which means they cover a smaller area but show more details. On the other hand, smaller-scale maps have a larger number in their scale fraction, so they cover bigger areas but show less detail.

For example, a map with a scale of 1:50,000 is a large-scale map because it provides more details over a smaller area. On the other hand, a map with a scale of 1:100,000 covers a larger area but has less detail.

The scale factor (S.F.) is a number that tells you how much to increase or decrease the size of a map or an object. It helps you understand the relationship between the original size and the new size after resizing. It also refers to the ratio of the original scale to the new scale. The formula is given as:

$$\text{S.F.} = \frac{\text{New Scale}}{\text{Old (original Scale)}} \text{ or S.F.} = \frac{\text{Denominator of Old (original) Scale}}{\text{Denominator of New Scale)}}$$

A fraction is usually obtained as the scale factor, and this is used to determine the length and breadth of the new map outline.

Procedure to Reduce a Topographical Map

1. First, find the scale of the original map, which is usually located at the bottom of the mapped area. Also, decide what the new scale will be for the reduced map. If a scale factor is provided, you will need to calculate the new scale and write it at the bottom of the new outline.
2. To calculate the scale factor, divide the denominator of the original scale by the denominator of the new scale.
3. Use a ruler to measure the length and breadth of the original map.
4. Next, find the new length and breadth by multiplying the original measurements by the scale factor. This will give you the smaller dimensions.
5. Finally, use the smaller dimensions to outline the new map, and make sure to write the new scale below the map.

Worked Example

Study **Figure 2.1** (MAP EXTRACT C) with a scale of 1:50,000 and draw a new map of the area covered by the map to a scale of 1:100,000.

Note *Use the procedure given above to reduce the map of EXTRACT C*

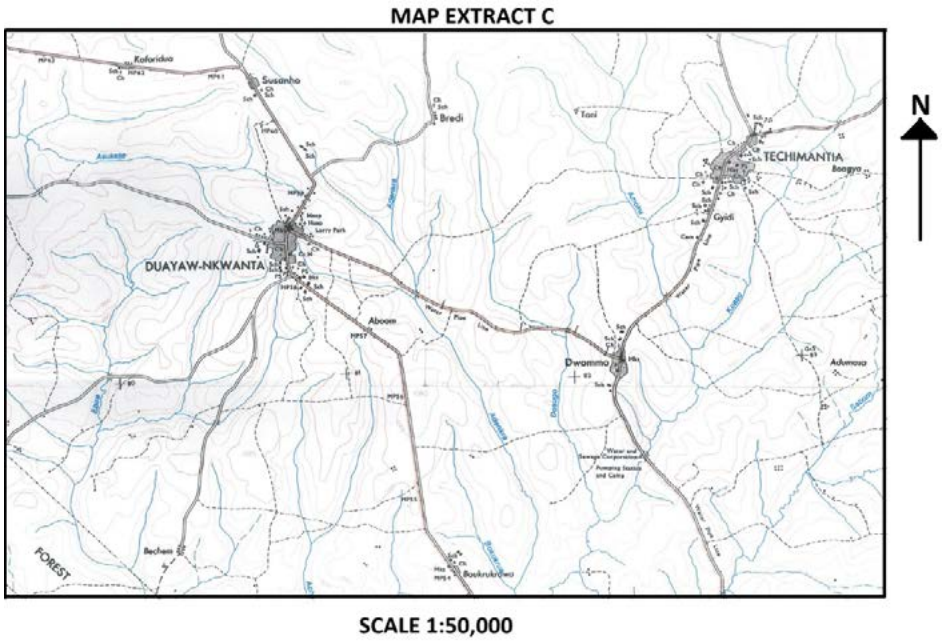


Figure 2.1: Map extract C

Solution

Step 1

Identification of the original scale and the new scale

The scale of the original map as shown in Fig. 5.1 is 1:50000 and the new scale given in question is 1:100,000

Step 2

Calculate the Scale Factor (S.F.) using any of the formulas below

$$\text{S.F.} = \frac{\text{New Scale}}{\text{Old (original Scale)}} \text{ or S.F.} = \frac{\text{Denominator of Old (original) Scale}}{\text{Denominator of New Scale)}}$$

$$\text{S.F.} = \frac{1:100,000}{1:50,000}$$

$$= \frac{1}{1:50,000} \div \frac{1}{50,000}$$

$$= \frac{1}{1:50,000} \div \frac{50,000}{1}$$

$$= \frac{50,000}{100,000}$$

$$\text{S.F.} = \frac{1}{2}$$

Note: anytime you get a fraction as a scale factor it means that the map will be reduced

Step 3

Use a ruler to measure the length and breadth of the original map. Assume that the length of the in Fig. 5.1 (MAP EXTRACT C) is 12.6cm and the breadth is 17cm

Step 4

Multiply the original length and original breadth with the scale factor to get the new length and the new breadth

$$\text{New length} = \frac{1}{2} \times 12.6\text{cm}$$
$$= 6.3\text{cm}$$
$$\text{New breadth} = \frac{1}{2} \times 17\text{cm}$$
$$= 8.5\text{cm}$$

Step 5

Use the new length and the new breadth to outline the new map as shown in **Figure 2.2**.

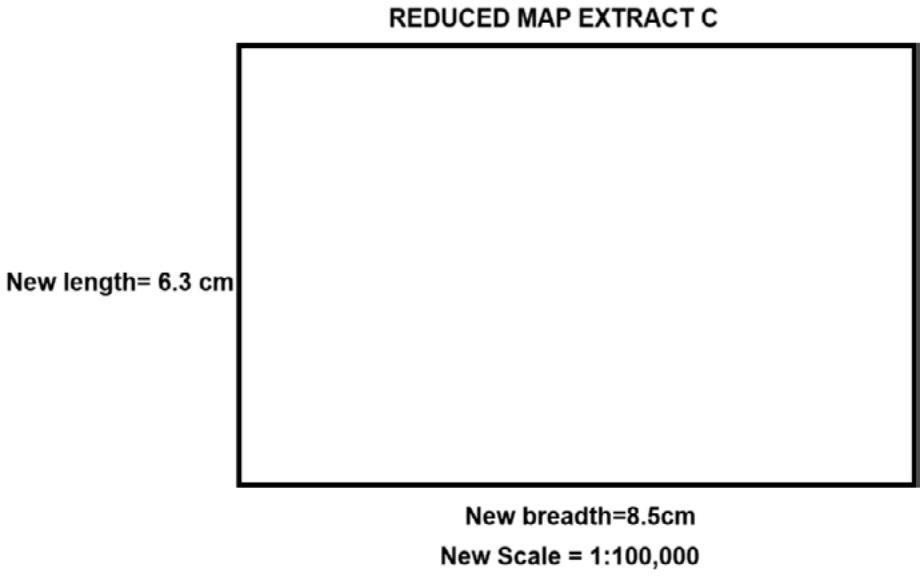


Figure 2.2: Reduced Map Extract D

Techniques of Map Enlargement

Map enlargement is about making a map bigger so that it is easier to see details. When you enlarge a map, you change its scale to make everything larger. The scale factor tells you how much bigger the new map will be compared to the original one. For example, if you use a scale factor of 2, everything on the map will be twice as big. This way, you can get a clearer view of the areas and features on the map.

Procedure to Enlarge a Topographical Map

1. Identify the scale of the original/old map, typically found at the bottom of the mapped area. Also, note the desired scale (new scale) for the map enlargement. In the case where the scale factor is given, the new scale must be calculated and quoted, typically at the bottom of the new outline.
2. Calculate the scale factor by dividing the denominators of the original scale ratio by the new scale.
3. Measure the length and breadth of the original map using a ruler.
4. Determine the new length and breadth by multiplying the original length and breadth by the calculated scale factor. This will give you larger dimensions.
5. With the obtained larger dimensions, draw a new map outline and state the new scale beneath the map.

Worked Examples

Study **Figure 2.3** (MAP EXTRACT D) with a scale of 1:50,000 and draw a new map of the area covered by the map to a scale of 1:25,000. Note: Use the procedure given above to enlarge MAP EXTRACT D

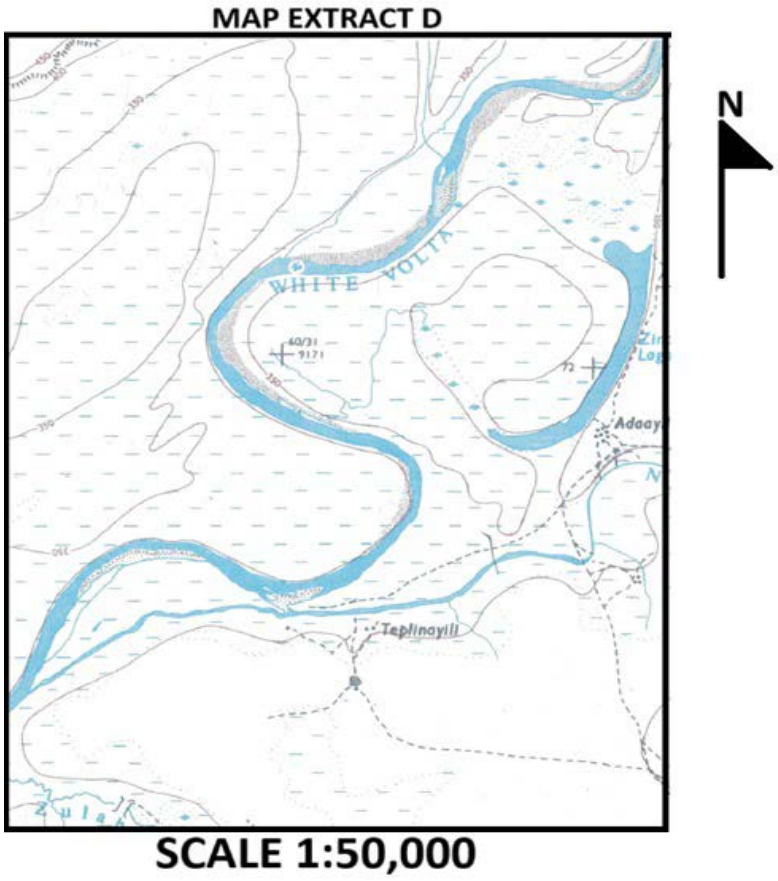


Figure 2.3: Map extract D

Solution

Step 1

Identification of the original scale and the new scale

The scale of the original map as shown in Fig. 5.3 is 1:50000, and the new scale given in the question is 1:25,000

Step 2

Calculate the Scale Factor (S.F.) using any of the formulas below

$$\text{S.F.} = \frac{\text{New Scale}}{\text{Old (original Scale)}} \text{ or S.F.} = \frac{\text{Denominator of Old (original) Scale}}{\text{Denominator of New Scale)}}$$

$$\text{S.F.} = \frac{1:25{,}000}{1:50{,}000}$$

$$= \frac{1}{25{,}000} \div \frac{1}{50{,}000}$$

$$= \frac{1}{25{,}000} \div \frac{50{,}000}{1}$$

$$= \frac{50{,}000}{25{,}000}$$

$$\text{S.F.} = 2$$

Note: *anytime you get a whole number of more than one as a scale factor it means that the map will be enlarged*

Step 3

Use a ruler to measure the length and breadth of the original map. Assume that the length of the in Fig. 5.3 (MAP EXTRACT D) is 8 cm and the breadth is 6cm

Step 4

Multiply the original length and original breadth with the scale factor to get the new length and the new breadth

New length $= 2 \times 8\text{cm}$
$= 16\text{cm}$

New breadth $= 2 \times 6\text{cm}$
$= 12\text{cm}$

Step 5

Use the new length and the new breadth to outline the new map as shown in **Figure 2.4**.

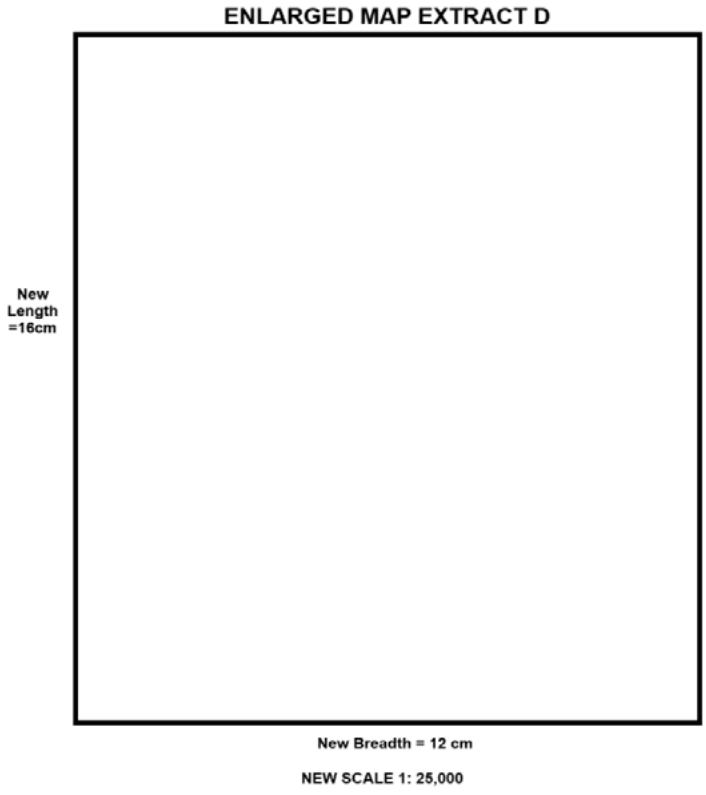


Figure 2.4: Enlarged Map Extract D

Inserting Features on a Reproduced or Enlarged Topographical Map

Both natural features (like mountains and rivers) and cultural features (like roads and buildings) can be shown on topographical maps, whether they are reduced in size or enlarged. To represent these features accurately, maps use a scale and a key that explains the symbols (called conventional signs). Grid lines on the map also help you find specific locations easily.

Procedure to Insert Features on Topographical Maps

1. Use a pencil to divide the original map into equal-sized squares, which is called a grid system. Remember, the more grid lines you have, the more accurate your new map will be.
2. On plain paper, draw the same number of squares for your new map, using the scale factor to make them either bigger or smaller.
3. Look at the original map and pick out the features from each square one at a time. Then, transfer those features to the correct spots on your new map.

Activity 2.1 Video Exploration and Research on Map Reproduction

1. Use the YouTube App to search for videos explaining map scales, map reduction and enlargement.

   In addition to the videos, use your web browser to search for how map scales can help you reproduce a map by enlarging or reducing its size.

   If you cannot access the video or online materials, check your school or local library or look for an internet café near your home.

2. From the information gathered on your research activity:
   a. explain the steps or procedures you will use to reduce or enlarge a map to a friend in class.
   b. describe how conventional signs are relevant to town planners in map reproduction.
   c. outline the steps or procedures you will use to insert features on a reduced or enlarged map.

Activity 2.2 Understanding Scale Factor

1. In your own words, describe the scale factor and its relevance to map reproduction.
2. Imagine you have a small map of your town that is 5 cm by 7 cm. You want to create a new map that is twice as large so everyone can see it better during a school project. Describe to your friend in class the steps you will follow in coming out with the new map and the formula for finding the scale factor.

Activity 2.3 Practical Map Reproduction

Study MAP EXTRACT E below with its conventional signs on a scale of 1:25,000 and use it to perform the following activities.

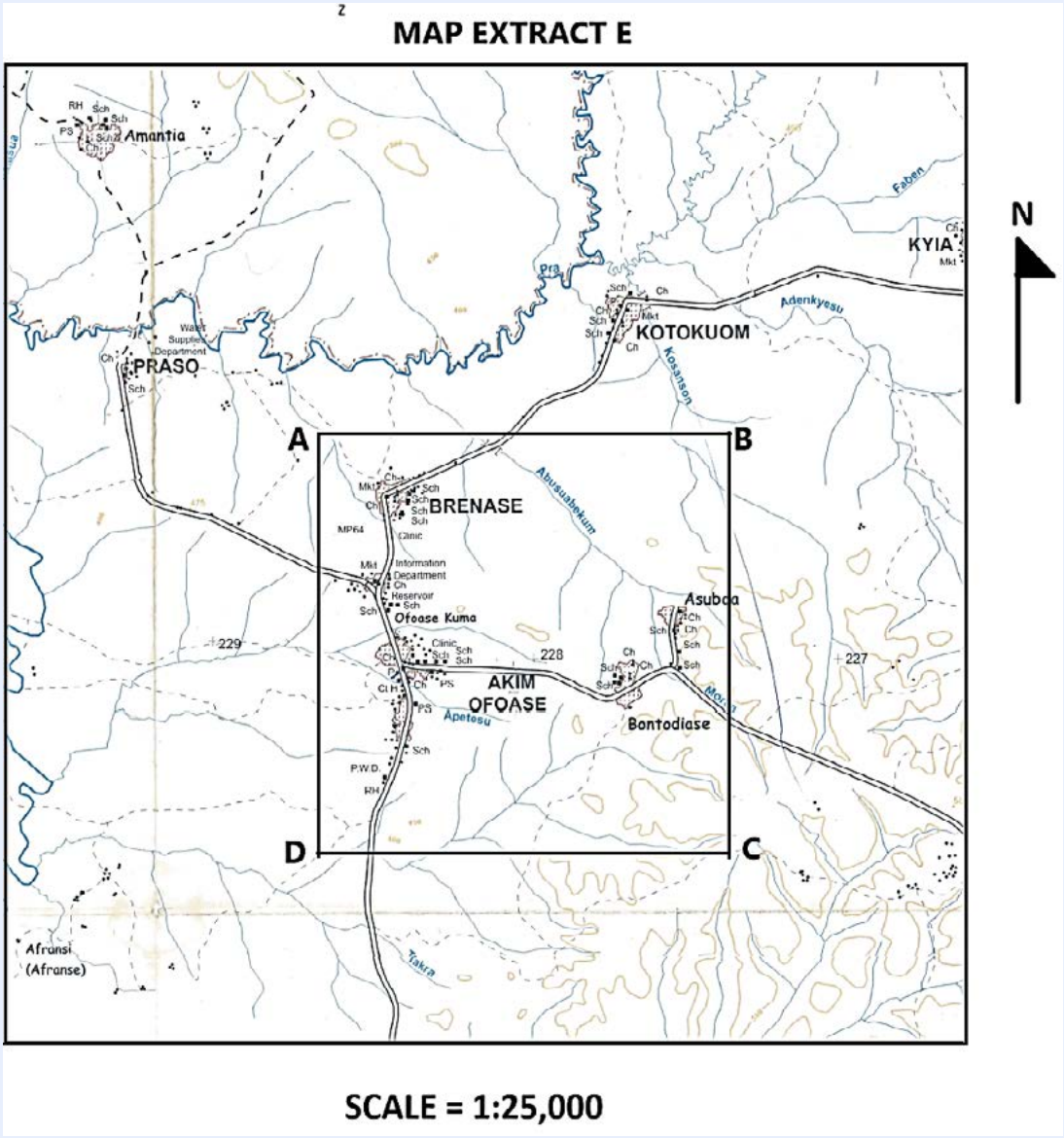


Figure 2.5: Map Extract E

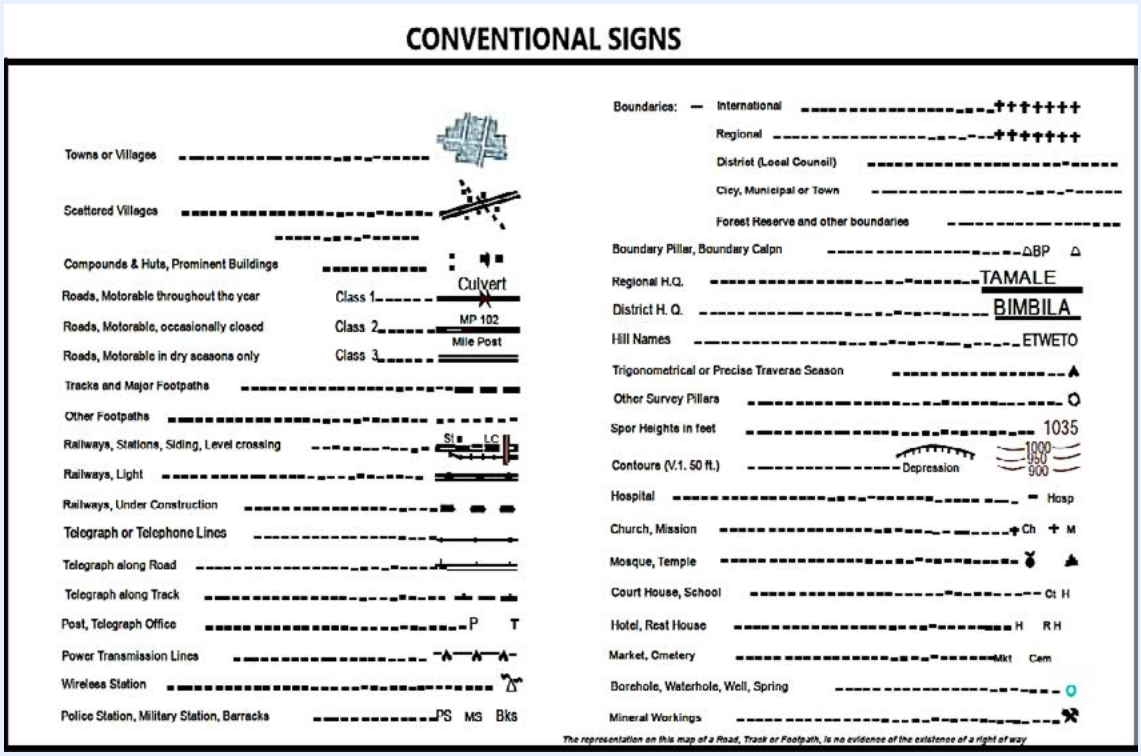


Figure 2.6: Conventional signs

1. Draw a new outline of MAP EXTRACT E on a scale of 1:50,000.
2. On your new outline, insert and name:
   a. PRASO and AKIM OFOASE settlements
   b. the Class 3 road linking PRASO to AKIM OFOASE
   c. the entire length of River Pra
3. Draw a new outline of area ABCD on the MAP EXTRACT to twice its original size and state the new scale of your new outline. Share your new map with a friend in class or someone at home.
4. On your new outline ABCD, locate and name:
   a. BRENASE and Bontdiase settlements.
   b. the class 3 road connecting BRENASE to Bontodiase.
   c. the entire length of River Abusuabekum.
5. Show your work to the class teacher for constructive feedback.

MEASUREMENT OF DISTANCES AND AREAS ON TOPOGRAPHICAL MAPS

Measurement of Distances on Topographical Maps

The distances measured on topographical maps can be either straight, like a crow flying directly from one point to another, or curved, like the paths of roads, railways, footpaths, and rivers.

Measuring Straight/Crow/Plane Flight Distances between Two Points

When measuring the straight/crow flight distances between two points on a topographical map, the following methods are used:

1. Ruler Method

Procedure:

a. Identify the two points involved and draw a straight line to join them
b. Place the ruler along the straight line and take the map distance measurement in cm
c. Using the RF Scale of the map, calculate the actual/ground distance.

The formula is given as $= \frac{\text{Map distance} \times \text{denominator of a map scale}}{100000}$

Note: *100,000cm = 1 km*

2. Pair of Dividers Method

A pair of dividers is commonly used to measure short straight distances between two points.

Procedure:

a. Identify the two points involved and draw a straight line to join them.
b. Open the pair of dividers to measure the distance along the line, use a ruler to get the distance in cm.
c. Using the RF Scale of the map, calculate the actual/ground distance

The formula is given as $= \frac{\text{Map distance} \times \text{denominator of a map scale}}{100000}$

Note: *100,000cm = 1 km*

Measuring Curved Distances between Two Points

When measuring curved distances between two points on a topographical map, the following methods are used:

1. Thread Method

Procedure

a. Take a piece of thread (a white one is best so you can see it clearly) and lay it carefully along the curved path on the map. Start by marking the starting point on the thread with a pen, then continue to measure the curved feature by guiding the thread along It on a topographical map.
b. Make sure to follow the curves and bends closely so the thread stays tight and does not bend.
c. Gently straighten the thread and lay it flat next to a ruler to measure the distance in from the map.
d. Finally, use the RF scale of the map to calculate the actual distance on the ground.

The formula is given as $= \frac{\text{Map distance} \times \text{denominator of a map scale}}{100000}$

Note: *100000cm = 1 km*

2. Paper Method

Procedure

a. Place one edge of your paper at the starting point of the curved line on the map.
b. Carefully move the paper along the curve, putting little marks on your paper that match the bends and twists of the line on the map.
c. Measure the Line: After you have traced the curve, use a ruler to measure the total length of the marks you made on your paper. This will give you the distance in cm from the map.
d. Use the scale on the map to calculate the ground distance.

The formula is given as $= \frac{\text{Map distance} \times \text{denominator of a map scale}}{100000}$

Note: *100000cm = 1 km*

Measuring Areas on Maps

To find the area of a square or rectangle, you use the formula: Area = Length x Breadth. Topographical maps often look like squares or rectangles, so you can use the same formula to find their area. To measure the map, you first measure the length and breadth of the map in the units you need (like inches or centimetres). Once you have the measurements, multiply the length by the breadth to get the area of the map.

Procedure

a. Measure the length and breadth of the area on the topographical map provided using a ruler or a pair of dividers.
b. Look at the map's scale to determine what the measurements mean. This will help you determine the area in square kilometres or miles.

Worked Example

Calculate the area of EXTRACT F map (Fig.: 5.5) in square kilometres if it has a scale of 1:100000 and if the measured map Length is 10.2 cm and the map Breadth is 10.5 cm

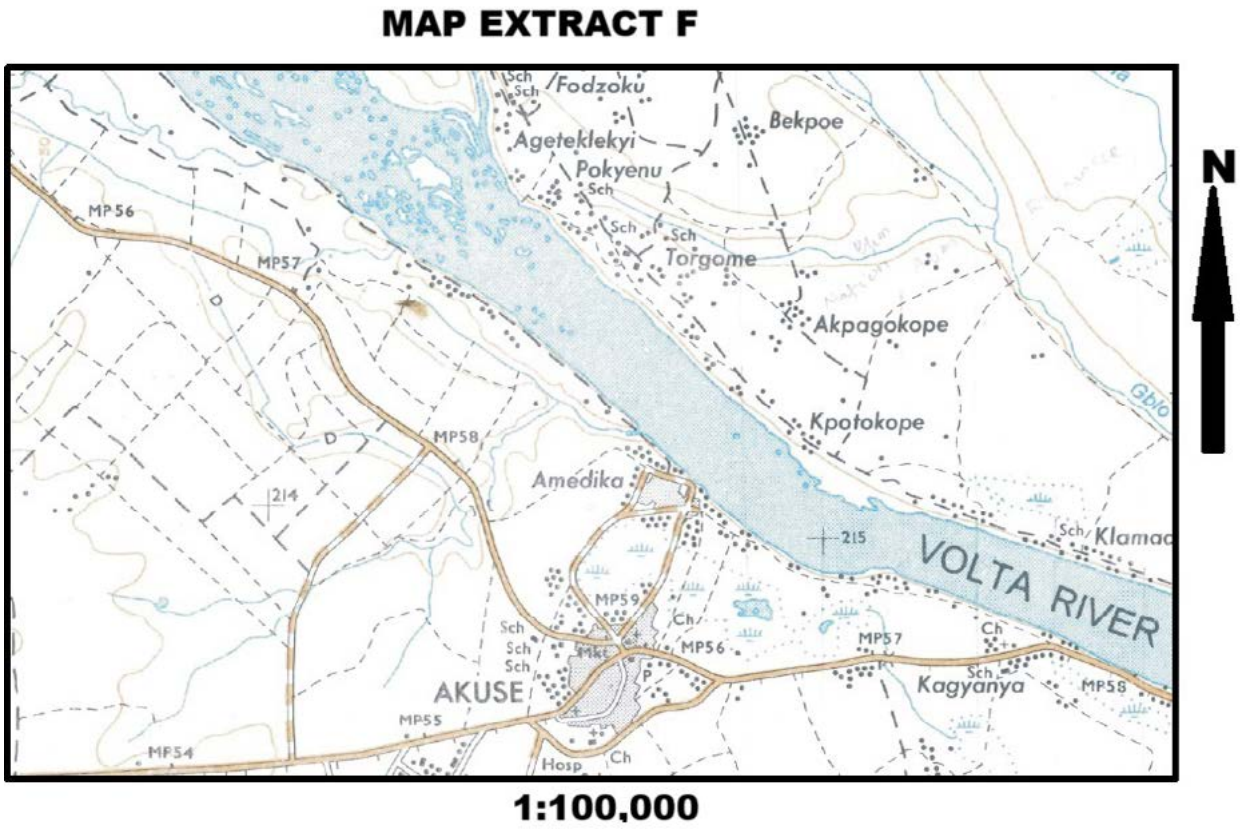


Figure 2.7: Map Extract F

Solution

Step 1

Map Length =10.2cm

Map Breadth =10.5cm

Step 2

Map Scale 1:100,000

Step 3

Find the Ground Length by multiplying the Map Length by the scale given, and then dividing it by the scale

$$\text{Actual Length} = \frac{10.2 \times 100000}{100000}$$

$$= 10.2 \text{ km}$$

Step 4

Find the Ground Breadth by multiplying the Map Breadth by the scale given and then dividing it by the scale

Map Breadth $= 12.5$ cm

Actual Breadth $= \frac{12.5 \times 100000}{100000}$

$= 12.5$ km

Step 5

Now find the Area on the map

Area $= 10.2 \text{ km} \times 12.5 \text{ km}$

$= 127.5 \text{ km}^2$

Activity 2.4 Vide Exploration on Measurement of Distance and Areas On Maps

1. Use YouTube or a web browser to search and watch a video on the measurement of distance and areas on maps and carefully observe the techniques demonstrated for measuring distance and area on maps.
2. In your notebook or digital device, write the most important concepts or takeaways you have learnt from the video. Here are some examples to guide you.
   a. The significance of understanding the map's scale.
   b. Different methods for measuring distance, such as using a ruler or a compass.
   c. The importance of accuracy in measurements for various applications.
3. Write down any questions that arise during or after watching the video. Here are some potential questions that may help you.
   a. How can I accurately measure irregular shapes on a map?
   b. Are there specific guidelines for choosing the appropriate measurement method based on the map's scale and the purpose of the measurement?
   c. Share your observation with a friend in class.

Activity 2.5 Map Exploration

1. Discuss with your friend in class, what you learnt from watching the video above.
   a. Identify various elements or features that will help you in measuring distances and areas.
   b. Share with your friend in class the key ideas as well as the methods to measure distances and areas on topographical maps. Which of the methods do you find most convenient to use and why?

Activity 2.6 Practical Distance Measurement Using Topographical Maps

1. Ask your class teacher for a topographical map and perform the following activities.
   a. Choose two specific locations on the topographical map provided. These could be landmarks, cities, or any points of interest.
   b. If the distance between the two locations is a crow/plane flight (that is, straight) use a ruler but if the distance is irregular (such as a road, railway or footpath), use a string or a straight-edged paper before transferring it to the ruler. Note that this only represents the map distance and not the real-world distance. To calculate the real-world distance, use the scale of the map.
   c. Share your information with a friend in class.
2. Use the MAP EXTRACT E above and perform the following activities.
   a. Find the actual distance as the crow flies from AKIM OFOASE to PRASO.
   b. Calculate the actual distance between AKIM OFOASE and PRASO by road.
   c. Share your findings with a classmate. Discuss any differences in measurements and calculations. Consider asking them questions like:
      i. Did you get similar results as mine? Why or why not?
      ii. What factors might affect the accuracy of your measurements?
   d. Think about how this skill might be useful in real-life situations, such as planning a trip or understanding geographical distances.
   e. Explore with a friend in class how you can use interactive digital maps, like Google Earth, to easily measure distances between two places.

Activity 2.7 Practical Area Measurement Using Topographical Maps

1. Using MAP EXTRACT E:
   a. Find the area of the entire map extract.
   b. Find the area enclosed by ABCD.
2. Discuss with your friend in class the methods you will use to measure areas of irregular features such as a lake or an administrative region in Ghana.

Activity 2.8 Real-world Distance and Area Measurements

1. With a classmate or a friend, pick a section of the school compound and measure the ground distance using a tape measure. With your classmate or friend, follow the guided procedures below to help you in this activity.
   a. Decide on a specific area of the school compound or building to measure. This could be the school's football field, a playground or a pathway.
   b. Make sure you have a clear understanding of the boundaries of the area you want to measure. If possible, use a map of the school compound to visualise the area and plan your measurements.
   c. Before starting, discuss safety guidelines with your partner. This includes:
      i. Being aware of your surroundings and avoiding obstacles.
      ii. Respecting personal space and staying a safe distance from others.
      iii. Looking out for potential hazards, such as uneven ground or broken glass.
      iv. Checking in at regular intervals to ensure everyone is safe.
   d. Use the tape measure to measure the distance (that is, the length and breadth) of the specific area of the building you selected. Make sure to hold the tape measure tight and straight without any looseness.
   e. Record the measurements accurately in your notebook or digital device.
   f. If the distance is irregular, consider breaking it down into smaller, more manageable sections.
   g. Once you have measured the length and breadth of the area, calculate its area using the appropriate formula (For example, length x breadth for a rectangle).
   h. Review your activity, state what you did well, what could have been improve the accuracy of your measurements.

DIRECTIONS AND BEARINGS

Measurement of Direction

In map reading, "direction" can mean two important things:

- The first meaning is the path or direction that something is moving in, like how a river flows or a road goes. It shows where a geographical feature is heading.
- The second meaning tells you where one place is compared to another. It helps you understand how two places or features on the map are in relation to each other.

The Compass Rose

A compass rose is placed on maps to show you which way is north, south, east, and west. It helps you understand directions when looking at the map.

The Compass Rose Divisions

1. **Cardinal directions** are the four main points on a compass: North, South, East, and West. You can remember them by their first letters: N for North, S for South, E for East, and W for West. These directions help us know where we are going and are sometimes called cardinal points. This is shown in **Figure 2.8**.

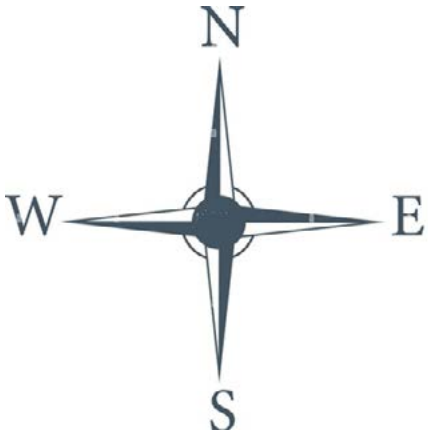


Figure 2.8: A compass rose showing just the cardinal points of North, South, East, and West

2. **Ordinal directions** are the directions that are halfway or midway between each of the cardinal directions. On a compass rose, these ordinal directions sit between the cardinal ones. For example, NE stands for Northeast, which is halfway or midway between North and East. A compass rose that shows both cardinal and ordinal directions has eight points: North (N), Northeast (NE), East (E), Southeast (SE), South (S), Southwest (SW), and Northwest (NW). This makes it easier to figure out directions compared to a compass rose that only shows the cardinal points. This is shown in **Figure 2.9**.

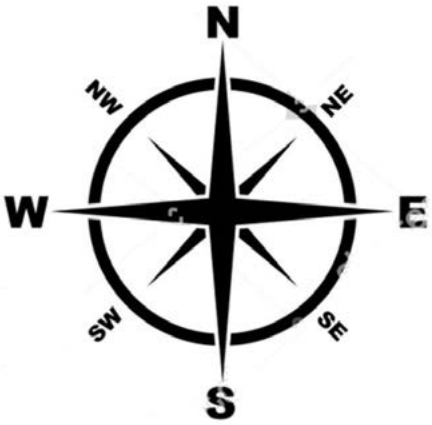


Figure 2.9: A compass rose shows cardinal and ordinal directions

3. **Secondary intercardinal directions** are the directions that are halfway or midway between each cardinal and ordinal direction. Some examples include North-northwest (NNW), North-northeast (NNE), and East-northeast (ENE). A compass rose that shows cardinal, ordinal, and secondary intercardinal directions has a total of 16 points: N, S, E, W, NE, SW, NW, SE, NNE, SSW, NNW, SSE, WNW, ESE, ENE, and WSW as shown in **Figure 2.10**.

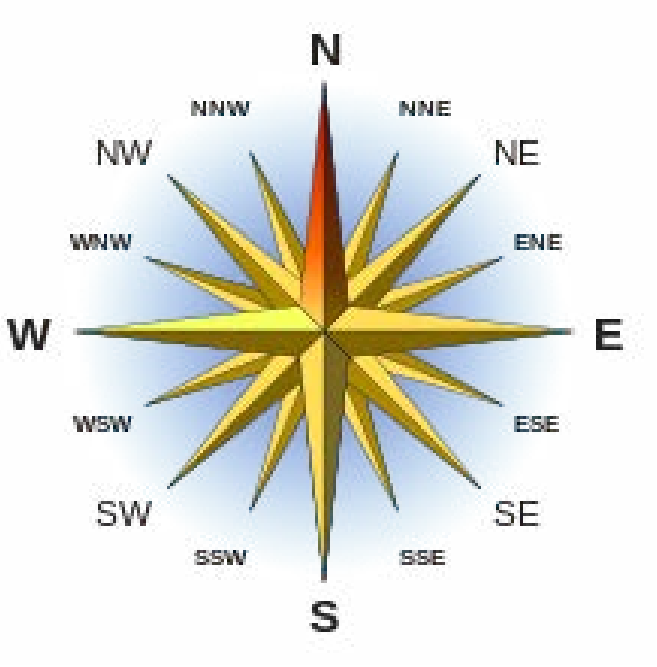


Figure 2.10: A compass rose showing cardinal, ordinal directions and secondary intercardinal directions

Procedure for Measuring Direction on a Map

When using a printed map, it is important to know which way it is facing. Most maps have the top pointing North, and there's usually compass rose labelled "NORTH" to show this. Other hints, like numbered lines, can also help you figure out North. However, some maps, especially tourist maps, might not follow this rule, so always double-check.

Figure 2.11: A pocket compass showing the arrow pointing to magnetic north

If you own a compass, you can use it to find directions. Place the compass at your starting point and make sure the North points to the top of the map. If you do not have a compass, you can use a protractor to measure angles. Each of the 16 compass points represents 22.5 degrees (360/16)

Step-by-step procedure using a compass

1. Find the two places you are looking at, like Town A and Town B.
2. Place the centre of your compass on Town A since you want to find the direction **TO** Town B.
3. Use a ruler to draw a straight line from Town A to Town B. Check where north is on the map and turn the compass until north points that way. See which compass point sits on the line.
4. The compass point that is on the line or close to it shows you the direction to Town B from Town A.

Measurement of Bearing

Bearing is a way to describe the direction of one place from another using degrees. Imagine you have a compass that can measure not just the main directions (like north, south, east, and west) but every direction in between. It helps show the direction between two points more accurately than a compass, which has only 16 points. Bearings are measured clockwise from north, and you usually use a protractor on maps for this.

Make sure that 0 degrees on the protractor point to the north. If the bearing is over 180 degrees, turn the protractor so 0 degrees faces south and then add 180 degrees to your reading. Always be clear about which direction you are measuring: if you want the bearing from point A to point B, place the protractor on point A. If you want it from point B to point A, place the protractor on point B. This is shown in **Figure 2.12**.

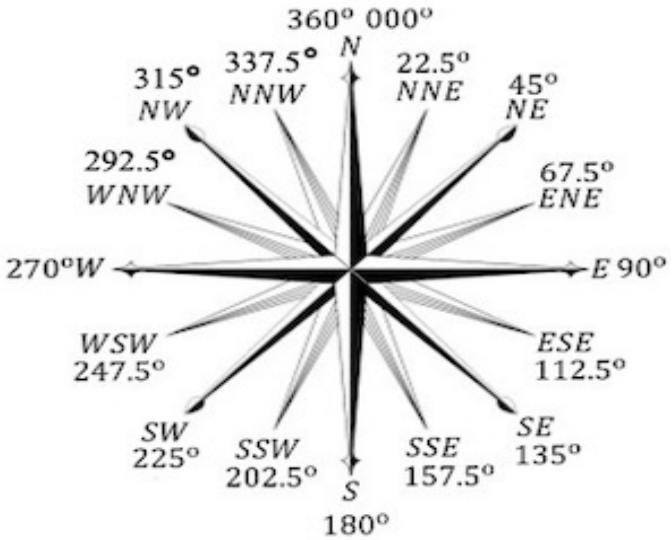


Figure 2.12: Compass points and their bearings

Procedure for Measuring Bearing on a Map

1. Find the two places on the map, which are Town A and Town B.
2. Put the centre of your compass or protractor on Town A if you want to find the bearing from Town A to Town B. Make sure that north (0 degrees) is pointing straight up to the top of the map.
3. Use a ruler to draw a straight line from Town A to Town B.
4. Place the centre of your protractor on Town A and make sure the bottom edge of the protractor (the line that shows 0 to 180 degrees) lines up with the north line on the map.
5. Check where the line from Town A to Town B crosses the protractor's scale. That number tells you the bearing from Town A to Town B in degrees.

Activity 2.9 Video Exploration and Discussion on Directions and Bearings

1. Use a device with internet access to search and watch a video related to determining directions bearings and measuring bearings on maps. Pay close attention to the techniques and examples presented. Present your findings with a friend in class

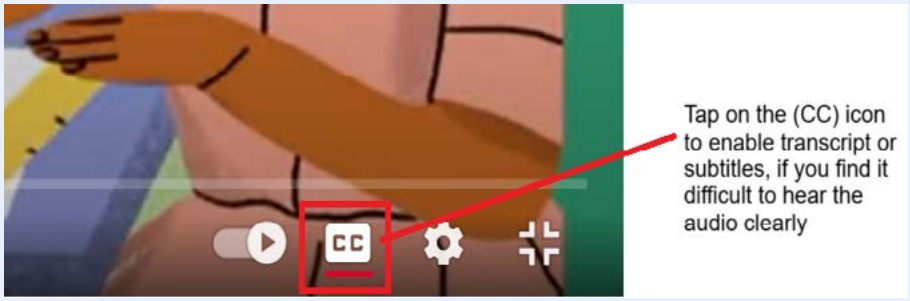


Figure 2.13

If you cannot access the video, check your school or local library or look for an internet café near your home.

   a. While watching, jot down important points, techniques, or tips that stand out to you. Focus on aspects that enhance your understanding of the process of measuring bearings and directions.
   b. After the video, write down three new things you learned. These could include:
      i. A specific technique for measuring bearings.
      ii. The significance of bearings in navigation.
      iii. How to apply these concepts in real-world situations.
   c. As you discuss, consider the following questions:
      i. How do these techniques improve the accuracy of travelling from your place to another community?

ii. Can you think of situations where understanding bearings is crucial?

iii. How might these skills be applied in various fields, such as transportation, urban planning, engineering, or outdoor activities?

d. Using the compass points, describe how you will direct a friend or sibling from your house to a market in or near your community.

Activity 2.10 Practical Measurements of Directions and Bearing on Topographic Maps

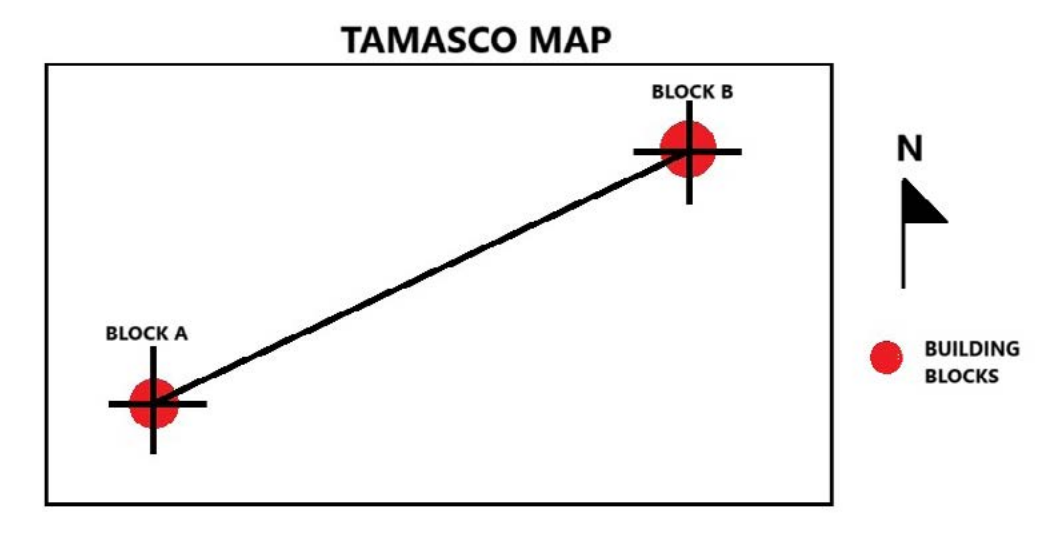


Figure 2.14: TAMASCO MAP

1. Study the TAMASCO MAP above and answer the questions that follow
   a. Determine the direction of BLOCK A from BLOCK B
   b. Determine the direction of BLOCK B from BLOCK A
   c. Find the bearing of BLOCK A from BLOCK B
   d. Find the bearing of BLOCK B from BLOCK A
   a. Compare your answers with a friend in class.

2. Study the TECHI TOWN map below to help you undertake the task that follows with a classmate.

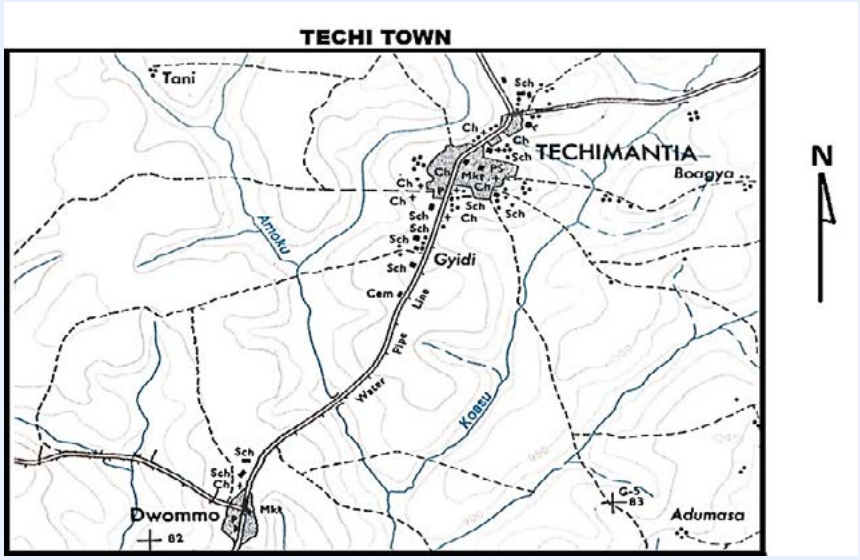


Figure 2.15: Techi town map

a. Discuss the steps you will take to measure the direction of TECHIMANTIA from Dwommo.
b. Determine the direction of TECHIMANTIA from Dwommo.
c. Find the direction of Dwommo from TECHIMANTIA.
d. Share your answers with your friend in class.

3. Study the map extract below to help you undertake the task that follows.

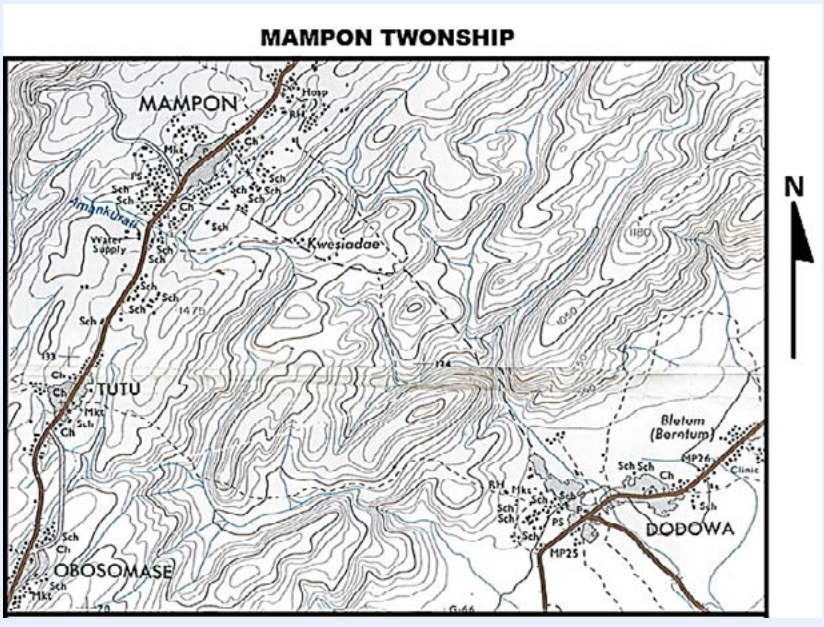


Figure 2.16: Mampong Township Map

a. Determine the bearing of OBOSOMASE to MAMPON.
b. Determine the bearing of MAMPON to OBOSOMASE.
c. Find the bearing of DODOWA to TUTU.
d. Discuss with your friend in class how you can find the bearing of your community from a nearby community

SECTIONAL PROFILE DRAWING AND CALCULATION OF GRADIENT

A sectional profile, also known as a cross-sectional drawing, is a way to represent what something looks like when you cut through it. Imagine slicing a cake to see the layers inside; that is similar to what a cross-section does for objects or landscapes. The cross-sectional drawing involves the use of the following scales:

A vertical scale is a way to show heights or depths on a drawing or map. It helps you understand how tall or deep something is compared to other things. The vertical scale helps you see how high something is compared to sea level or how deep a valley is. For instance, if a mountain is 1,000 meters tall, the vertical scale will help you visualise that height compared to nearby features.

The horizontal scale of a map shows how distances on the map compare to real distances on the ground. It tells you how much the actual distances have been shortened to fit on the map. The horizontal scale is also called the map scale, and it is usually shown as a fraction or ratio. For example, if two towns are 5 kilometres apart in real life, the scale shows you how that distance looks on the map

Using these two different scales helps the cross-section to accurately show both the height and the distances of the land or features on the map. This allows for a clear and true-to-scale view of the shape, changes in elevation, and other important details of the area.

Procedure for Drawing a Cross-Profile/Section

1. Draw a straight line between the two points on the map if there is not one already.
2. Place a straight edge of paper over the line and use a sharp pencil to mark the contour lines, paths, roads, rivers, and other important features. Be sure to label everything.
3. On graph paper, draw the baseline, which is the horizontal distance between the two points, and transfer the marked points onto this line.
4. Draw straight vertical lines at both ends of the baseline to represent ground level.
5. Choose a vertical scale based on the height differences shown on the map, keeping in mind that the horizontal scale should match the original map's scale.
6. Use dots or asterisks to mark where the tips on the baseline intersect with their heights.
7. Once all points are plotted, connect them with a smooth line and shade the area inside the cross-section for a better visual look.
8. Label Features: Write down all the important things you see along the line, like forests, rivers, roads, valleys, towns, plateaus, ridges, and plains.
9. Give your cross-section a clear title.
10. Make sure to state both the vertical scale (for height) and the horizontal scale (for distance).

Importance of Cross-Profile/Section

1. A cross-section is like cutting a vertical slice through a map to create a side view of the land which helps you see what the terrain looks like.
2. This side view lets you see hills, valleys, slopes, and other features clearly, making it easier to understand the landscape.
3. It helps you figure out how steep a slope is by looking at how close or far apart the contour lines are in the cross-section.
4. By looking at a cross-section, you can spot different features like ridges, valleys, plateaus, and cliffs.
5. Cross-sections show how different features relate to each other in height. For example, you can see how deep a river is compared to the surrounding valley.
6. Cross-sections are important for planning activities like hiking or climbing. They help hikers know what kind of terrain to expect on their route.

Vertical Exaggeration

Vertical exaggeration (V.E.) is when the height (or vertical scale) of features on a map or cross-section is stretched compared to the horizontal distance (or horizontal scale). This makes hills, valleys, and other elevation changes appear taller or more pronounced than they are. The formula that helps one know the number of times the elevation has been magnified is given as:

$$\text{V.E.} = \frac{\text{Vertical Scale}}{\text{Horizontal Scale}}$$

Calculation of Vertical exaggeration

Worked Example 1

Suppose the vertical scale for drawing a cross profile is 1 cm to 200 metres (thus if the elevation is measured in metres), and the representative fraction (R.F.) of the horizontal scale is 1:50000, we can calculate the vertical exaggeration as follows:

Vertical Scale = 1 cm to 200 m
= 1: 200 ×100 (that is, converting the metres into centimetres)
= 1: 20000 (in R.F). Note: 100cm = 1m

Horizontal Scale = 1: 50000

$$\text{Then V.E.} = \frac{\text{Vertical Scale}}{\text{Horizontal Scale}} = \frac{1:20000}{1:50000} = \frac{1}{20000} \div \frac{1}{50000}$$

$$\text{V.E.} = \frac{1}{20000} \times \frac{50000}{1} = 2.5$$

This indicates that the elevation of the cross-section drawn has been magnified 2.5 (two and a half) times more than reality.

Worked Example 2

Suppose the vertical scale for drawing a cross profile is 1 cm to 100 feet (thus if the elevation is measured in feet), and the representative fraction (R.F.) of the horizontal scale is 1:50000, we can calculate the vertical exaggeration as follows:

$$\begin{aligned}\text{Vertical Scale} &= 1 \text{ cm to } 100 \text{ feet}\\ &= 1: 100 \times 12 \times 2.54\\ &= 1: 3048 \text{ (in R.F).}\end{aligned}$$

Note: *12 inches = 1 ft and 1 inch = 2.54 cm*

$$\text{Horizontal Scale} = 1: 50000$$

$$\text{Then V.E.} = \frac{\text{Vertical Scale}}{\text{Horizontal Scale}} = \frac{1:3048}{1:50000} = \frac{1}{3048} \div \frac{1}{50000}$$

$$\text{V.E.} = \frac{1}{3048} \times \frac{50000}{1}$$

$$\text{V.E.} = 16.4$$

This indicates that the elevation of the cross-section drawn has been magnified 16.4 times more than reality.

Gradient

The gradient of a map refers to how steep the land is in a certain area, showing how much the elevation changes over a distance. the gradient measures the change in height (elevation) between two points. It tells you how steep a hill or slope is. It is expressed as a ratio of vertical distance to horizontal distance. This is shown in **Figure 2.17**.

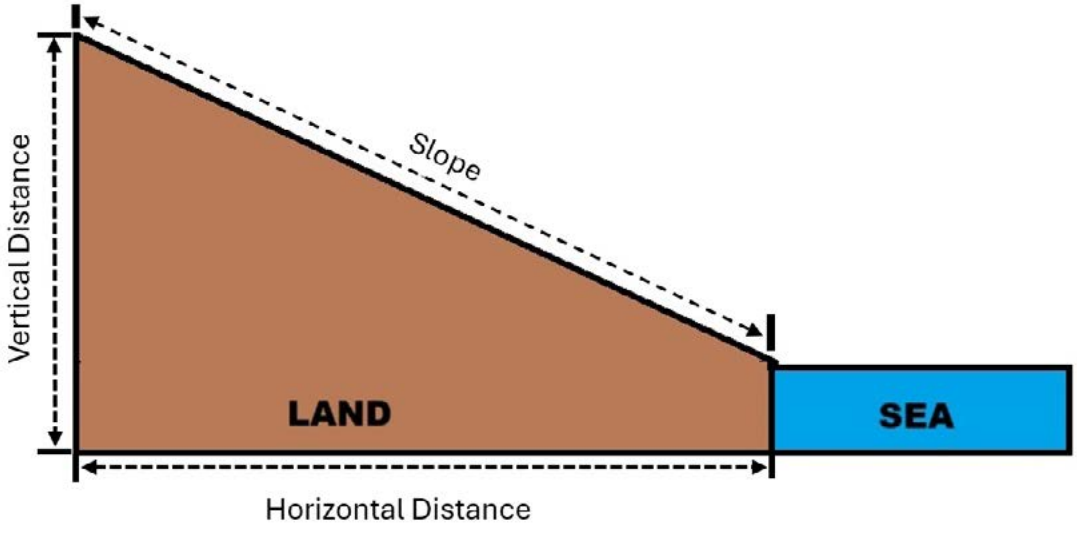


Figure 2.17: cross-section of Slope between two points

Calculation of Gradient

The gradient is calculated by applying mathematical principles, and the formula reads as follows:

$$\text{Gradient} = \frac{\text{Vertical Interval}}{\text{Horizontal Equivalent}}$$

Vertical Interval (V.I.) is the steady difference in height between two nearby contour lines. In this case, it means the difference in elevation between two specific points.

The Horizontal Equivalent (H.E.) is the flat distance between two points on a map. You can find this by measuring straight from one point to another and using the map scale to convert to a distance on the ground.

The steepness of a slope is linked to the fraction used to show it. If the denominator (the bottom number) is smaller, the slope is steeper. If the denominator is larger, the slope is gentler. For example, a slope of 1 in 15 is steeper than a slope of 1 in 20.

Worked Example 3

Calculated the gradient of the slope between points X and Y as shown in the MAP EXTRACT G in **Figure 2.18**.

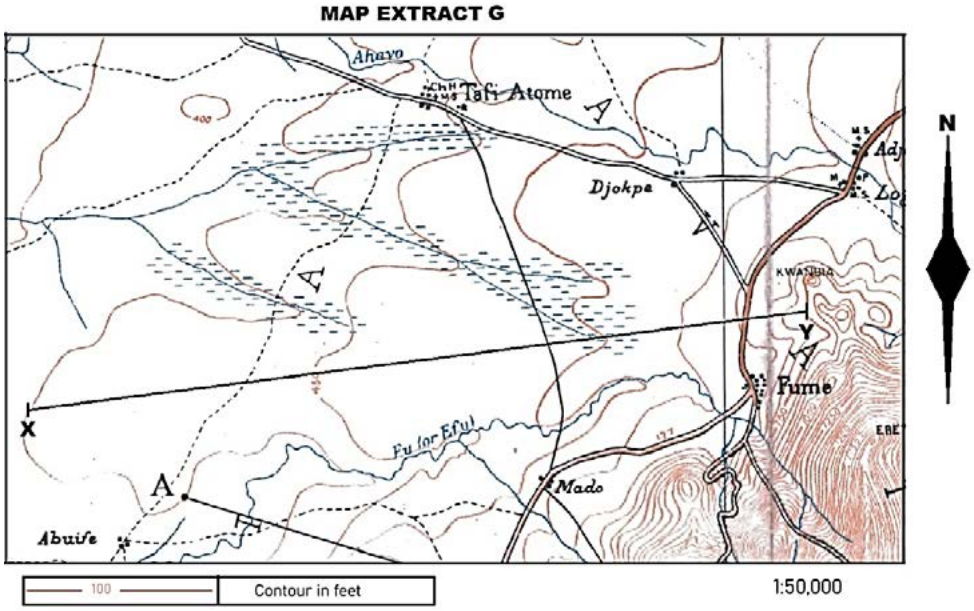


Figure 2.18: Map Extract G

Solution

$$\text{Gradient} = \frac{\text{Vertical Interval}}{\text{Horizontal Equivalent}}$$

Vertical Interval (V.I) = Elevation of point A − Elevation of Point B

Elevation of Point X = 750 ft

Elevation of Point Y = 400 ft

$$\text{V.I.} = 750\text{ ft} - 400\text{ ft}$$
$$= 350\text{ ft}$$

$$\text{Horizontal Distance} = \frac{\text{Map distance} \times \text{Denominator of Map Scale}}{100000}$$
$$= \frac{7.5 \times 50000}{100000}$$
$$= 3.75\text{km}$$

$$\text{Gradient} = \frac{350\text{ft}}{3.75\text{km}}$$
$$= \frac{(350 \times 12 \times 2.54)\text{cm}}{(3.75 \times 100000)\text{cm}}$$

Note: 12 inches = 1 ft, 1inch = 2.54 cm, and 100000 cm = 1km

$$= \frac{10668 \div 10668}{375000 \div 10668}$$
$$= \frac{1}{35.2} \text{ or 1 in 35.2}$$

This can be interpreted as; with every ascent (vertical movement) of 1 unit, there is a horizontal movement/distance of 35.2 units.

Activity 2.11 Video and Resource Exploration on Cross-Section Drawing.

1. Use your devices to find and watch a video about drawing cross-sections on topographic maps. Look for additional resources, like articles or tutorials, which explain the process. You may use the links below to search for videos and other online materials to add to your resources.
   a. https://youtu.be/JqTtErqFHQY - Video on cross-section drawing
   b. https://news.hselspark.co.za/wp/wp-content/uploads/2020/05/Cross-section-final-.pdf - Document on cross-section drawing
   c. As you watch, jot down:
      i. Key steps in drawing cross-sections.
      ii. Tools and materials you will need.
      iii. Why annotated cross-sections are important to your community town planner and other fields.

4. Present your findings to a friend in class. Your presentations should include:
   a. Procedures or steps in drawing annotated cross sections using topographical maps.
   b. The tools and materials needed; and
   c. Importance of annotated cross-sections in geography and other fields.

Activity 2.12 Drawing Annotated Cross Section Between Places on Topographical Maps

1. Study BEPOSO COMMUNITY map and its conventional signs below with a classmate and use it to answer the questions that follow.

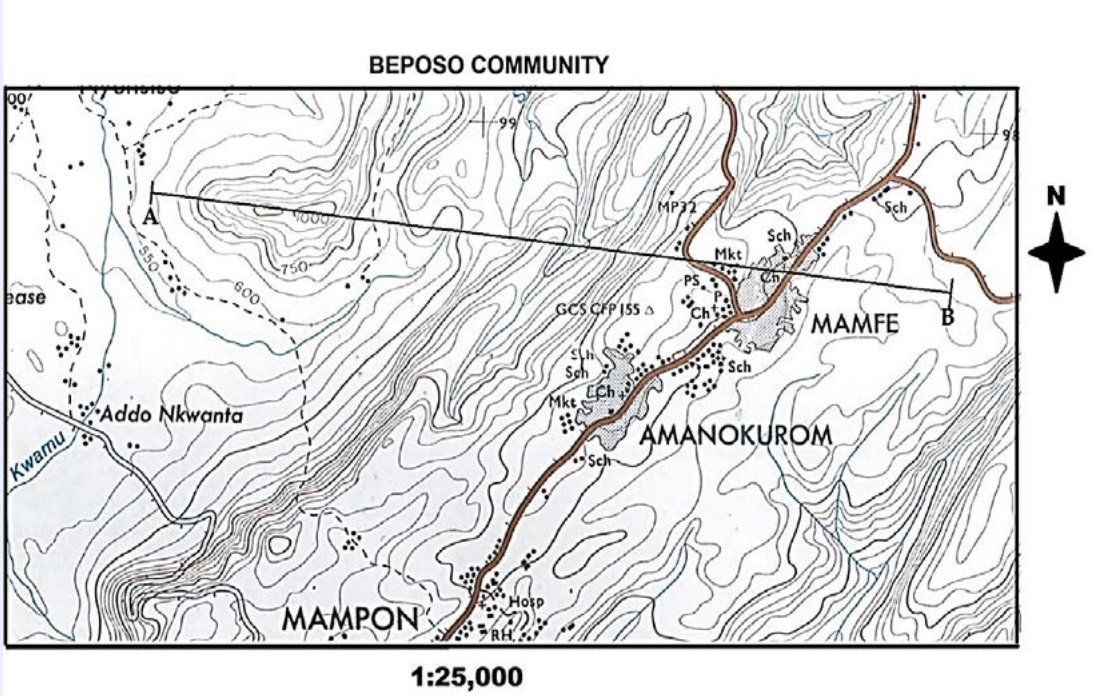


Figure 2.19: Beposo Community

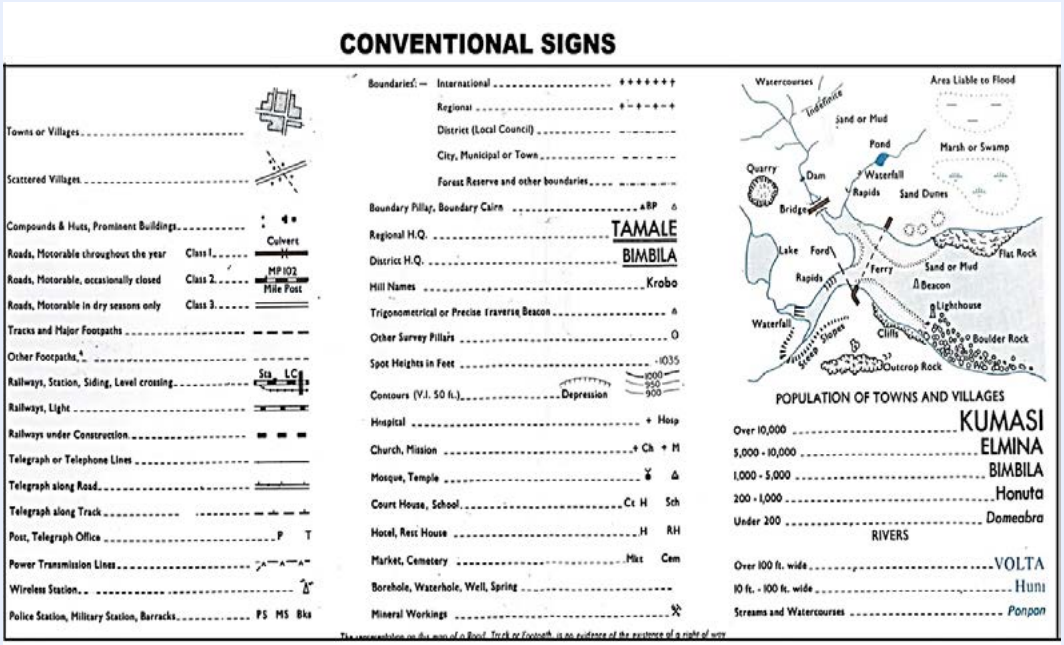


Figure 2.20: Conventional Signs

a. On a graph sheet, draw an annotated cross-section along the line **A—B** scale using your vertical scale. Give a reason for the choice of your vertical scale
b. Discuss three importance of the cross section you have drawn.
c. From the cross-section drawn, determine the Vertical Exaggeration.
d. Using ICT tools like PowerPoint or Google Slides, present your information to a friend in class.

Activity 2.13 Calculation of Gradient of a Slope

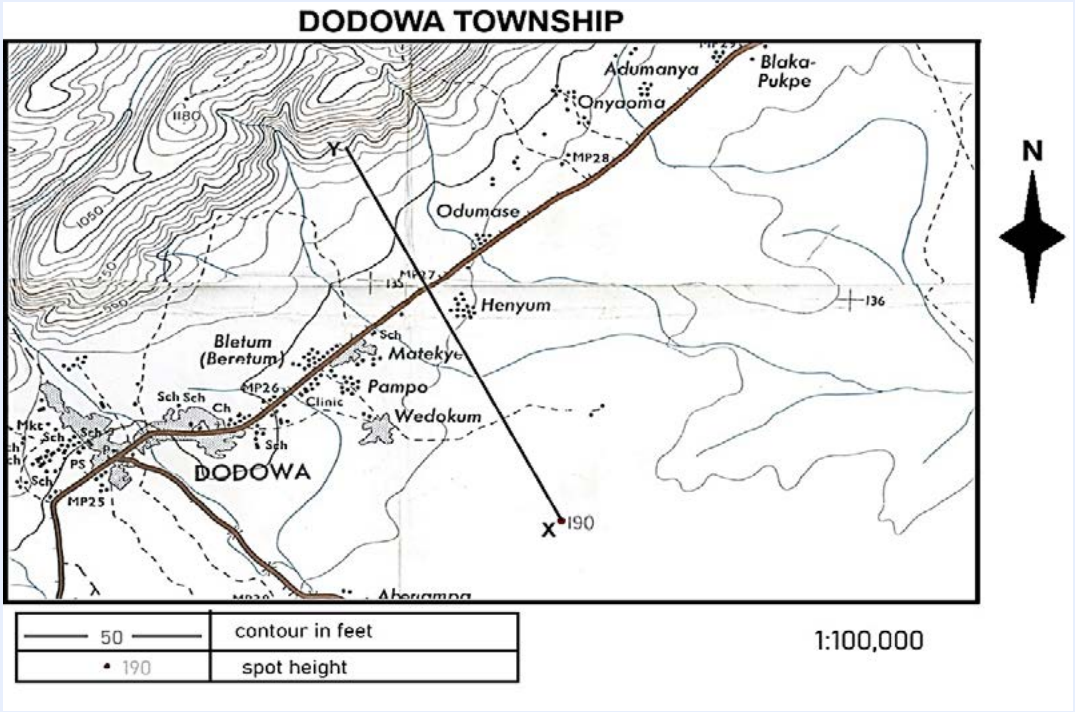


Figure 2.21: Dodowa Township

1. Calculate the gradient of the slope between points A and B as shown in the DODOWA TOWNSHIP map above.
2. You are using map E to plan a walk with some friends. Would you rather:
   a. walk from X to Y
   b. walk from Y to X?
   c. Give a reason for your answer.
3. Share your information with a friend in class

Review Questions

Techniques of Map Enlargement and Reduction

1. What is a map scale?
2. State the formula for finding a scale factor in the context of map enlargement or reduction.
3. Describe two benefits of reproducing a small-scale map to a large-scale map.
4. If the original dimensions of a map are 5 cm by 7 cm and the scale factor for enlargement is 3, what will the new dimensions be?
5. Discuss the advantages of using a grid system when reproducing or enlarging maps. What challenges might arise if grid lines are not used?
6. Design a project where you would need to enlarge a topographical map for a hiking trail. Describe the steps you would take and any calculations involved.

Measurement of Distances and Areas on Topographical Maps

1. Describe the ruler method for measuring straight distances on a topographical map.
2. If a map distance measures 5 cm and the scale is 1:50,000, what is the actual distance in kilometres?
3. A topographical map shows a curved path between two points. Discuss the advantages and disadvantages of using the thread method or the paper method for measuring the distance.
4. If the area of a district is calculated using a map scale of 1:100,000 and the map length is 15 cm and breadth is 10 cm, what is the area in square kilometres? Show your calculations and reasoning.

Directions and Bearings

1. List the four cardinal directions.
2. What graphical symbol is used on maps to indicate direction?
3. What is the name of the instrument used to measure bearings on maps?
4. When trying to find the position of a place or point about another on a map, it is better to know exactly where it is: directions or bearings. And why is one better than the other?
5. Carefully study ATOME MAP below and use it to answer the questions that follow.

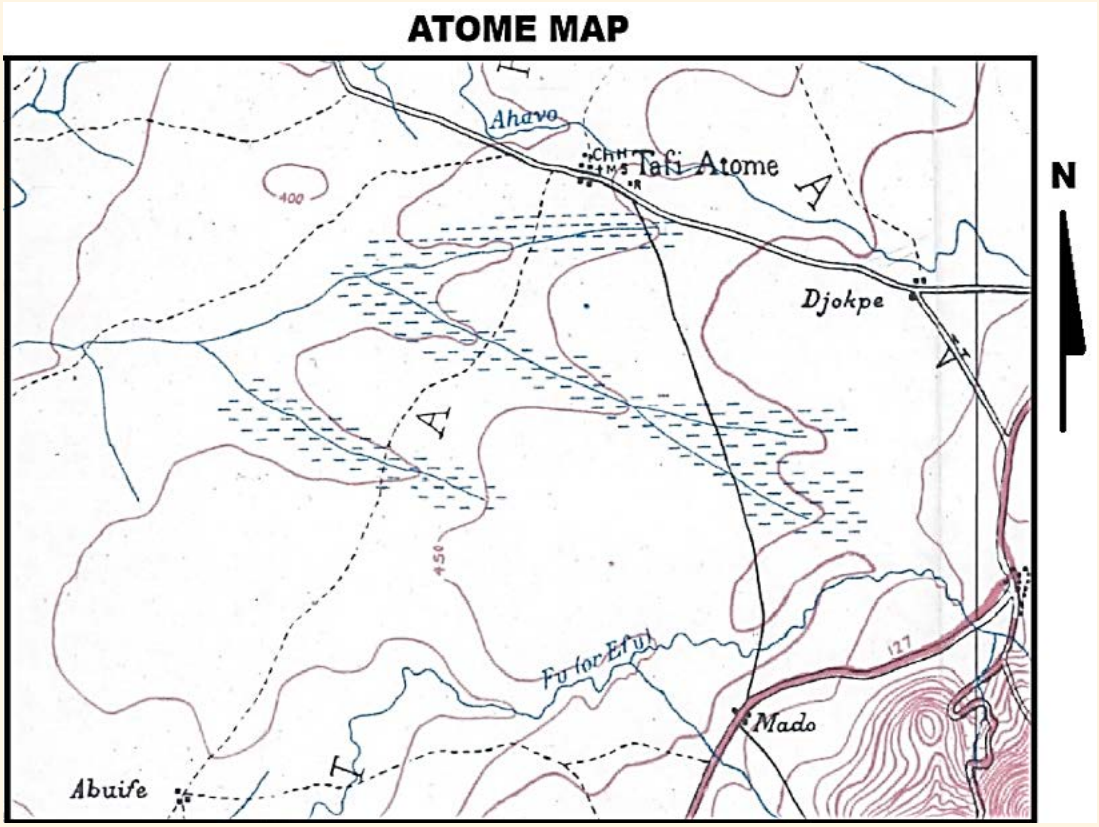


Figure 2.22: Atome Map

a. Determine the compass direction of Mado from Tafi Atome.

b. Find the bearing of Abuife from Djokpe.

Sectional Profile Drawing And Calculation Of Gradient

1. Define the vertical scale in the context of a cross-section drawing.
2. What does the horizontal scale represent on a map?
3. Explain the significance of labelling features on the cross-section and give examples of such features.
4. What does vertical exaggeration represent?
5. What is the definition of a gradient in map reading? Provide the formula for its calculation.
6. Compare the steepness of two slopes with gradients of 1 in 10 and 1 in 25.
7. Find the gradient of the slope along the line P—Q, using ABUSO COMMUNITY map below. Your answer should be in the form of a ratio to the nearest whole number.

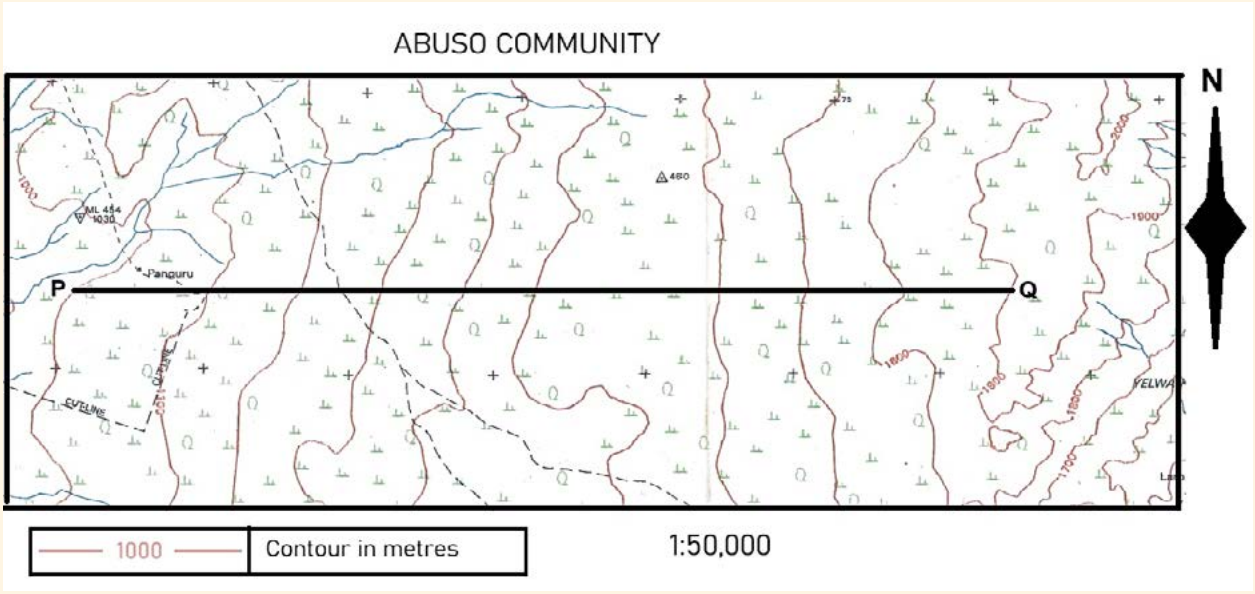


Figure 2.23: Abuso Community

Geography Year 2

SECTION

3

PHYSICAL SETTING OF WEST AFRICA AND AFRICA

HUMAN AND ENVIRONMENT

Physical Settings and People

Introduction

Welcome to Section Three! Your studies will focus on West Africa first then the entire continent. You learned about Ghana's relief, drainage, and climate in Year One, and now you will expand that knowledge to understand West Africa and Africa as a whole. In this section, you will cover such important factors such as location, size, political divisions, relief, drainage, climate, and vegetation, allowing you to compare Ghana's physical traits with the rest of Africa. This helps you understand the land, water bodies, climate, and plant life across the region. Let's get started!

Key Ideas

- Africa is divided into 54 recognised countries, each with its own government and borders. These political divisions are shaped by a mix of colonial history, cultural diversity, and natural geography. It is a continent full of rich contrasts and vibrant nations.
- Africa is the second largest continent on Earth.
- In terms of drainage, West Africa is dominated by the Niger River drainage system, while the Nile dominates that of the entire Africa
- The location of West Africa and Africa can be expressed in both absolute and relative terms.
- The physical characteristics of West Africa and Africa include relief, drainage, climate and vegetation.
- West Africa and Africa have both highlands and lowlands, dominated by Mount Kilimanjaro
- West Africa and Africa have diverse climate and plant life

LOCATION, SIZE AND POLITICAL DIVISIONS OF WEST AFRICA AND AFRICA

This work in part 1 is centred on the physical characteristics of West Africa and Africa. It covers the location, size and political divisions.

Location and Size of West Africa

Absolute location: West Africa, as the name implies is located on the western side of the African continent. It lies between latitude 4° and latitude 20° North of the Equator and extends from longitude 15° West to 18° East of the Prime Meridian.

Relative location: The sub-region is bounded by the following landmarks:

1. The Atlantic Ocean to the west.
2. Its southernmost point reaches the Gulf of Guinea, which is an extension of the Atlantic Ocean.
3. To the north, it is the northern boundary of Mauritania, Mali and Niger. West Africa also shares boundary with the Sahel and Sahara Desert in the north
4. On the east, West Africa is bounded by Lake Chad and the eastern boundaries of Niger and Nigeria. The eastern boundary is less clearly defined but separates West Africa from Central Africa.

Size: West Africa, a sub-region of the African continent covers about six million square kilometres, making it huge. It spans nearly 2,000 kilometres from the Sahara Desert in the north to the tropical Gulf of Guinea in the south. From west to east, it is about 3,000 kilometres from the Atlantic Ocean to Central Africa. Niger is the largest country with 1,267,000 square kilometres, and Nigeria is the most populated, with around 234 million people as of October 2024. For the latest data, check Worldometer.

Political Divisions of West Africa

Presently, 16 independent countries make up West Africa. Each country has its own unique system of governance. Due to the colonial background, some of the West African countries speak English, some speak French, others Portuguese. The countries, with their capitals, are listed below in **Table 3.1**.

Table 3.1: West African Countries and their capitals

French Speaking Countries	Capital City
1. **Senegal**	Dakar
2. **Côte d'Ivoire**	Yamoussoukro
3. **Guinea**	Conakry

4. Burkina Faso	Ouagadougou
5. Mali	Bamako
6. Niger	Niamey
7. Benin	Porto-Novo
8. Togo	Lomé
9. Mauritania	Nouakchott
English Speaking Countries	**Capital City**
10. Ghana	Accra
11. Nigeria	Abuja
12. Liberia	Monrovia
13. Sierra Leone	Freetown
14. The Gambia	Banjul
Portuguese Speaking Countries	**Capital City**
15. Guinea-Bissau	Bissau
16. Cape Verde (Cabo Verde)	Praia

Figure 3.1: West African countries with their boundaries and capital cities.

Location and Size of Africa

Absolute location: Africa's geographic location can be precisely defined by its absolute coordinates. The extreme north of the African continental mainland is Cape Ben Sekka in Tunisia, located on latitude 37°21' North of the Equator. Conversely, the southernmost point is Cape Agulhas in South Africa, located on latitude 34°51' South of the Equator, with the equatorial line intersecting the continent near its central region. It is also located on longitudes 17° West and 51° East of the Greenwich Meridian. If the surrounding island territories are included, the westernmost point becomes Ponta Cais dos Navios on the island of Boa Vista in Cabo Verde on longitude 22°54' West.

Relative location: In relative terms, Africa is bounded in the West by the North Atlantic Ocean, in the North by the Mediterranean Sea and Europe, in the East, it is bounded by the Indian Ocean and Asia and in the South by both the South Atlantic and Indian Oceans. It is the most tropical of all continents with about 43% of the entire continent lying between Tropics of Cancer and Capricorn (Dadson, 2021). The Equator cuts it almost into equal halves.

Size: Africa is the world's second-largest continent in terms of landmass after Asia. It covers about 30.3 million square kilometres which is approximately 20% of the Earth's total land surface. At its widest point, the African continent measures approximately 7,400 kilometres from Cabo Verde islands off the west coast to the Socotra Islands off the southern coast of the Arabian Peninsula. The continent's east-west expanse is around 7,000 kilometres from the Senegal-Mauritania border to the Somalia-Kenya border. This vast north-south expanse exceeds 8,000 kilometres. With the emergence of South Sudan as a severing nation, Algeria now remains the largest country in Africa while the Gambia is the smallest mainland country (Dadson, 2021).

Political Divisions of Africa

Africa comprises 54 countries. These countries are grouped regionally by the African Union, based on geographic proximity, historical ties, and cultural similarities. These regional divisions are:

1. **West Africa:** This region is home to 16 countries, known for its vibrant cultures and rainforests. Senegal, Nigeria, Ghana, and Côte d'Ivoire are some prominent examples. This region's economic community affiliation is the Economic Community of West African States (ECOWAS).
2. **North Africa:** There are five countries in North Africa, and these are Egypt, Algeria, Morocco, Tunisia, and Libya. These countries are characterised by the Sahara Desert and its proximity to the Mediterranean Sea. This region's economic community affiliation is the Arab Maghreb Union (AMU).
3. **Central Africa:** This central belt has 10 countries dominated by lush rainforests and the Congo River Basin. The Democratic Republic of Congo, Cameroon, Gabon, and the Central African Republic are some of the countries. This region's economic community affiliation is the Economic and Monetary Community of Central Africa (CEMAC).

4. **East Africa:** There are 13 countries in East Africa. The subregion is known for its Great Rift Valley, unique highlands, savannas, and diverse wildlife. Kenya, Ethiopia, Tanzania, Uganda, and Rwanda are some of the well-known countries. This region's economic community affiliation is the East African Community (EAC).
5. **Southern Africa:** Ten countries make up the Southern Africa subregion. South Africa, Namibia, Botswana, Zimbabwe, and Mozambique are some of the countries. The landscapes range from deserts to savannas and lavish coastal areas as well as. This region's economic community affiliation is the Southern African Development Community (SADC).

Figure 3.2: Political map of Africa.

Activity 3.1 Research and Data Collection of Position and Size of West Africa and Africa

For this activity, you will need an outline map of Africa, which shows the location of countries and their names

1. Use atlas maps or Google Earth to find the latitudinal and longitudinal extremities of both West Africa and Africa.

   Record the following as latitude and longitude coordinates on your map (remember that latitude always comes first):

   West Africa:

   Northernmost point: _____

   Southernmost point: _____

   Easternmost point: _____

   Westernmost point: _____

   Africa:

   Northernmost point: _____

   Southernmost point: _____

   Easternmost point: _____

   Westernmost point: _____

   a. List the countries that make up West Africa and draw the boundary of this sub-region on your map using a red marker.
   b. For Africa, mark on your map the major geographical features that define its boundaries (such as oceans and mountains).
   c. Measure the north-south stretch and east-west stretch for West Africa and Africa in kilometres or miles.
   d. Research and record the total land area of West Africa and Africa
      i. West Africa: _____
      ii. Africa: _____

2. Create a Comparison Table

Feature	Africa	West Africa
Latitudinal Extremities	North…… South……..	North…….. South……..
Longitudinal Extremities	East…… West……..	East…….. West……..
Total Area (in km²)	…….....	…….....
North-South Stretch (in km)	…….....	…….....
East-West Stretch (in km)	…….....	…….....
Any other observation related to position and size	…….....	…….....

Reflect on the differences and similarities between West Africa and Africa based on your findings. Consider factors such as size, location, and boundaries.

3. Assess yourself on the activity by considering the following questions:
   a. Did I accurately identify the extremities and boundaries of both regions?
   b. How confident am I in my measurements and calculations?
   c. What challenges did I face during this activity, and how did I overcome them?
4. Exchange your findings with a classmate for peer-reviewing by provide feedback on each other's work, focusing on:
   a. Clarity of information presented
   b. Accuracy of data
   c. Depth of analysis

Activity 3.2 Analysing Political Divisions of West Africa and Africa.

1. Use Google Earth or atlas maps and other resources to identify the countries within West Africa. For each country, note:
   a. Administrative regions (states, provinces, etc.)
   b. Official languages spoken
2. Identify the subregions of Africa (North, West, East, Central, Southern) and their common economic affiliations.
3. Write a brief comparison between West Africa and Africa, focusing on:

   a. The number of countries and regions in West Africa versus the total number of subregions in Africa.
   b. The diversity of official languages in West Africa compared to the languages spoken across Africa.
   c. Economic affiliations and how they differ or align between West Africa and other subregions.
4. Reflect on your findings by answering the following questions:
   a. What surprised you about the political divisions?
   b. Which country or region was most interesting to research, and why?
   c. How do the political divisions impact the culture and economy of the regions?
5. Write a short paragraph about what you learned through this activity. Consider:
   a. The importance of understanding political divisions in geography.
   b. How this knowledge might influence your view of West Africa and Africa as a whole.
6. Exchange your findings with a peer. Provide constructive feedback on each other's work by considering:
   a. Clarity and organisation of the information presented.
   b. Accuracy of the data regarding political divisions.
   c. Depth of comparison between West Africa and Africa.
7. Discuss your reflections and what you learned from each other's research.

Activity 3.3 Sketching the Political Divisions of West Africa and Africa

1. On a blank sheet, sketch the outline of West Africa.
   a. Label each country within West Africa, ensuring to include:
      i. Each country's name.
      ii. Administrative capital and other major cities (optional).
   b. Use different colours to differentiate between countries.
   c. Share your information with a friend.
2. On another sheet, sketch the outline of the entire African continent.
   a. Label the subregions of Africa, including:
      - Names of subregions (North, West, East, Central, Southern)
      - Major countries within each subregion.
   b. Again, use different colours to represent each subregion.
   c. Think about how the size of the outline maps you have drawn influence the amount of detail information that can be represented.
   d. Reflect on your sketches by answering the following questions:

- Did you accurately represent the borders and names of the countries?
- Are the subregions clearly labelled and differentiated?
- What techniques did you find helpful in creating your sketches?

e. Write a short paragraph reflecting on your experience with this activity
- What challenges did you face while sketching?
- How did this activity enhance your understanding of the political divisions in West Africa and Africa?
- What new insights did you gain about the geographical layout of these regions?

f. Pair up with a classmate and exchange your sketches.
- Provide constructive feedback based on:
- Clarity and accuracy of the political divisions.
- Creativity in the use of colours and layout.
- Overall presentation and organisation of information.

g. Discuss what you learned from each other's work and any areas for improvement.

3. Research and create a country profile for a West African nation include:
   a. Capital
   b. Population
   c. Language
   d. Currency
   e. Cultural facts
   f. Present your findings to your peers.

4. From the illustration below, create a map of West Africa, labelling countries, capitals, and major landmarks.

You are encouraged to include cultural symbols and artifacts (clothes) used in West Africa.

Figure 3.3: The Map of West Africa

5. Observe the entire Map of Africa and compare the size of West Africa to the entire African continent.
6. Research on Google Maps, National Geographic Maps, Blank maps (printable or digital), or Online encyclopaedias (e.g., Britannica, Wikipedia) and use information obtained to describe the geographical features, climate, and cultural differences among West African countries.
7. Locate West Africa and Africa on an interactive map (e.g., Google Maps, National Geographic) and identify its latitude and longitude.
8. Use a blank map of West Africa; Complete the map by adding:
   a. Country borders
   b. Major cities
   c. Rivers (e.g., Volta, Niger, Senegal)
   d. Mountain ranges (e.g., Fouta Djallon, Jos Plateau and Afadjato)
9. Complete online quizzes to assess understanding West Africa's global location
10. Sketch the outline map of West Africa. Label and locate:
    a. one English speaking country
    b. two French Speaking countries
    c. one Portuguese speaking country

Display your project on the Walls of the classrooms.

REFLIEF, DRAINAGE, CLIMATE AND VEGETATION OF WEST AFRICA AND AFRICA

In this part you will learn about the physical geography of West Africa and Africa including relief, drainage, climate and vegetation. The work you did in year 1 about the physical characteristics of Ghana will be helpful.

Relief of West Africa

Relief refers to the height of the land. West Africa has a number of important highland and lowland areas. The key features of its relief are:

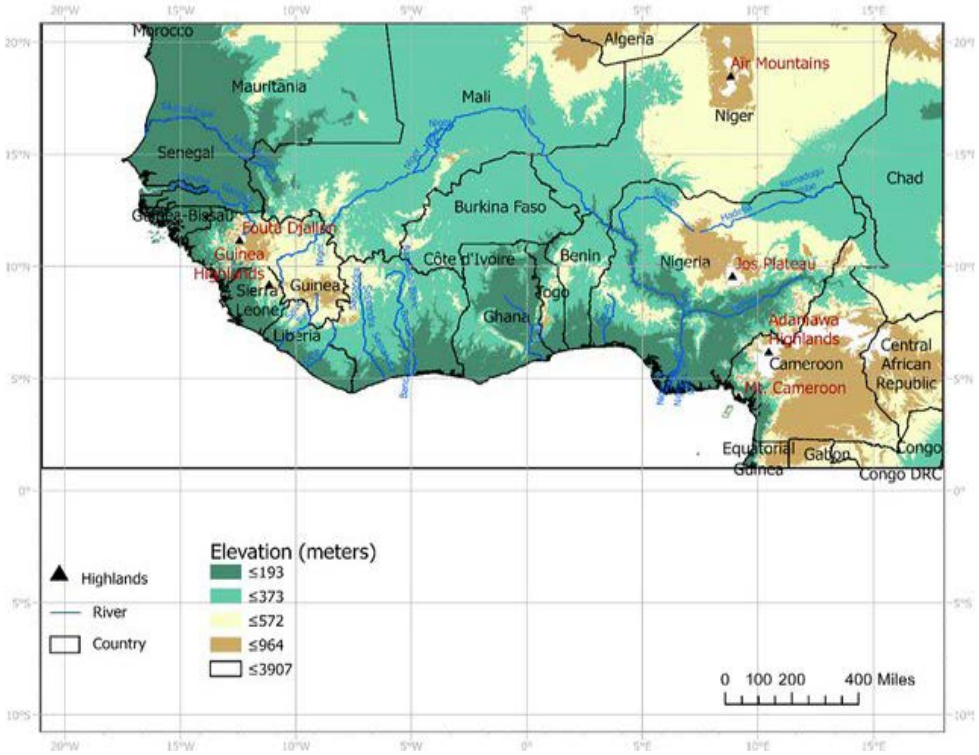


Figure 3.4: Relief of West Africa

The Lowlands

These are relatively low-lying areas below 300 metres above sea level. The lowlands can be divided into two categories:

a. Coastal Plains

i. Stretches along the western coast of Africa, bordering the Atlantic Ocean.

ii. It is low-lying and relatively flat terrain along the coastline.

iii. The coastal plains slope gradually from the inland areas towards the ocean.

iv. Most of the coastal countries in West Africa have some of their important cities located in coastal plains such as Accra, Lome, Freetown, and Monrovia among others

v. Some of the coastal plains have sandy beaches and coastal dunes. Examples can be found in Dakar, Cape Coast, Accra and Lagos, among others.

b. Inland lowland and Basins

i. Located in countries such as Mali, Niger, Nigeria and spans across the Sahel and inland savanna regions of West Africa.

ii. It covers vast, low-lying areas with relatively flat or gently sloping terrain.

iii. Some of these inland low-lying areas are surrounded by higher elevation landforms such as plateaux (flat areas) and inselbergs (isolated hills). Examples are the Savana belt from Northen Ghana to Burkina Fasso.

iv. Some inland plains are made of alluvial deposits (or sediments carried there by rivers) such as the Inland Niger Basin in Mali.

c. The Sahara Plains

i. The Sahara Plains is a huge flat area in West Africa that stretches from the Sahel region to the larger Sahara Desert.

ii. The Sahel is mainly flat, with most of the region lying between 200 and 400 meters (660 and 1,310 ft) in elevation.

iii. Several isolated plateaux and mountain ranges rise from the Sahel through the Sahara Desert, which is the world's largest hot desert.

iv. It stretches across countries such as Mauritania, Mali, Niger, and parts of Chad.

Highlands

The highlands in West Africa are mainly made of mountains, plateaux, ridges and escarpments. The interior uplands of West Africa are mostly composed of ancient rocks. Notable plateaux and highlands include:

The Fouta Djallon Plateau is located in Guinea. and extends into neighbouring countries such as Senegal, Guinea-Bissau, and Sierra Leone. It has an average elevation of around 1,500 metres above sea level. See **Figure 3.5**.

Figure 3.5: Parts of the Fouta Djallon mountains/plateaus

Jos Plateau: It is located in central Nigeria, specifically in Plateau State and has an average elevation of around 1,200 metres above sea level. It is an example of an extinct volcanic mountain.

Adamawa Highlands: It is located in north-eastern Nigeria and extends into parts of Cameroon and Chad. It has an average elevation of around 1,500 meters above sea level.

Drainage of West Africa

Drainage refers to the removal and storage of water from an area. It includes such water bodies as rivers, streams, lakes, lagoons and oceans. West Africa can boast of all these types of water bodies. Large rivers drain into the Atlantic Ocean. **Table 3.2** gives a list of some of the water bodies in West Africa.

Table 3.2: Some Waterbodies in West Africa and their location

Water body	Location/Country
1. River Niger	Nigeria
2. River Volta	Ghana
3. River Konkouri/Kolikoro	Guinea
4. River Sassandra	Cote d'Ivoire
5. River Gambia	Gambia
6. Lake Chad	Chad
7. Lake Volta	Ghana
8. Ebrei Lagoon	Cote d'Ivoire
9. Keta Lagoon	Ghana
10. Lagos Lagoon	Nigeria

Major Rivers in West Africa

West Africa is endowed with a number of rivers. Some of these rivers are shared between and among countries and are thus regarded as international or transborder rivers. These are shown in **Figure 3.6**.

1. **Niger River:** The Niger River is one of Africa's longest rivers, stretching over 4,100 kilometres. Originating in the Guinea Highlands in southeast Guinea, it flows through Mali, Niger, Benin, and finally Nigeria. The Niger River ultimately drains into the Gulf of Guinea.
2. **Senegal River:** The Senegal River spans about 1086 kilometres and serves as the border between Mauritania and Senegal. It eventually drains into the Atlantic Ocean.
3. **The Volta River:** This major river system originates from Burkina Faso and Ghana, eventually draining into the Gulf of Guinea. The Volta basin is home to Lake Volta, the largest artificial lake in the world by surface area.
4. **Gambia River:** The Gambia River is a significant river in West Africa that runs for about 1,120 kilometres through The Gambia and Senegal. It begins in the Fouta Djallon plateau in Guinea and flows westward to the Atlantic Ocean.

Figure 3.6: Some rivers in West Africa.

Major Lakes

While West Africa is not known for extensive natural lakes, there are some notable examples.

1. **Lake Chad**: It is located on the eastern periphery of the region. It is a large endorheic lake (having no outlet to the ocean) shared by several countries. However, due to climate change and water diversion, the lake has shrunk significantly.
2. **Lake Volta:** It is located in the southeastern part of Ghana. It is the largest human-made lake in the world. Covering 8,502 km^2, it is the biggest reservoir by surface area.

Major Lagoons

Lagoons are also prominent features along the West African coastline. Examples include the Ebrie Lagoon in Côte d'Ivoire, which is about 130 km (80 mi) long. The Lagos Lagoon in Nigeria and the Keta Lagoon in Ghana. These lagoons are critical for local fisheries, but some of them are threatened by pollution.

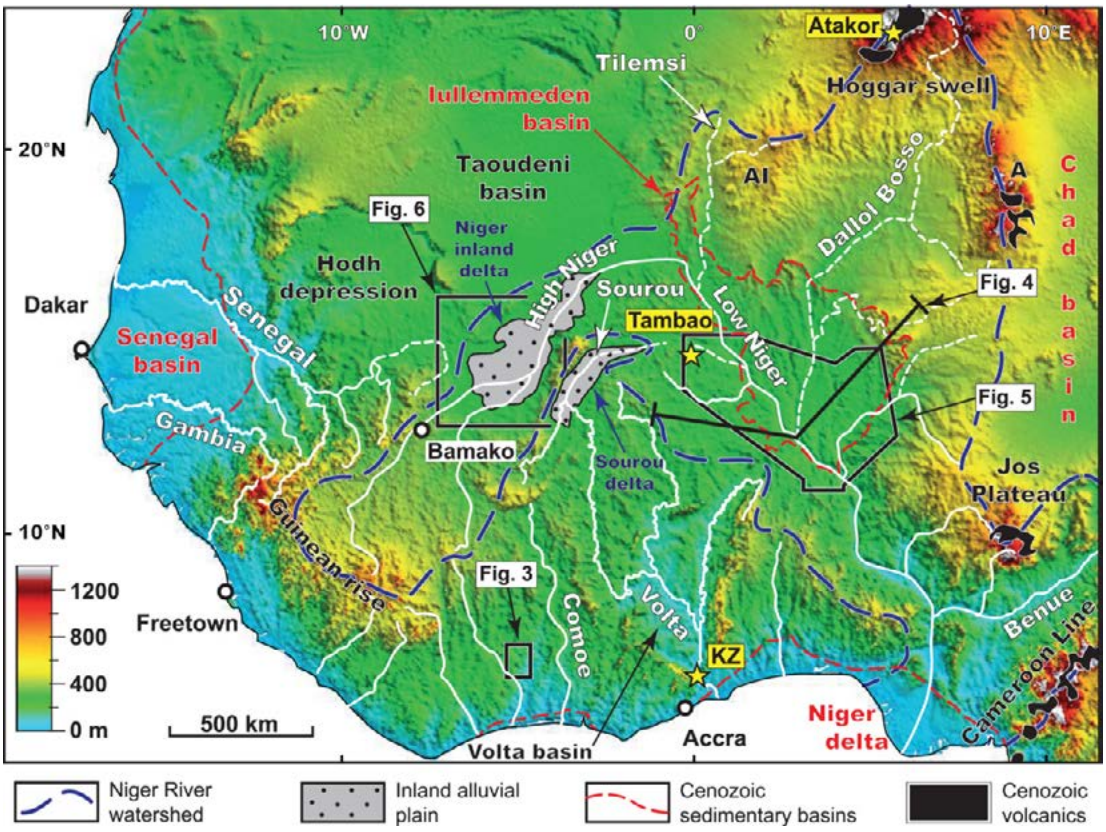


Figure 3.7: Major drainage features of West Africa (AGU Journals-Wiley)

Climate of West Africa

West Africa has a diverse climate. The climate in this region is primarily influenced by factors like latitude, proximity to the Atlantic Ocean, and atmospheric circulation patterns. Hope you remember your discussions on factors that influence climate in year 1. West Africa can be broadly divided into five major climatic regions, namely:

1. Tropical Wet (Equatorial) Climate
2. Tropical Monsoon Climate
3. Tropical Savanna/Continental Climate
4. Tropical Semi-Arid (Sahelian) Climate
5. Tropical Desert (Saharan) Climate

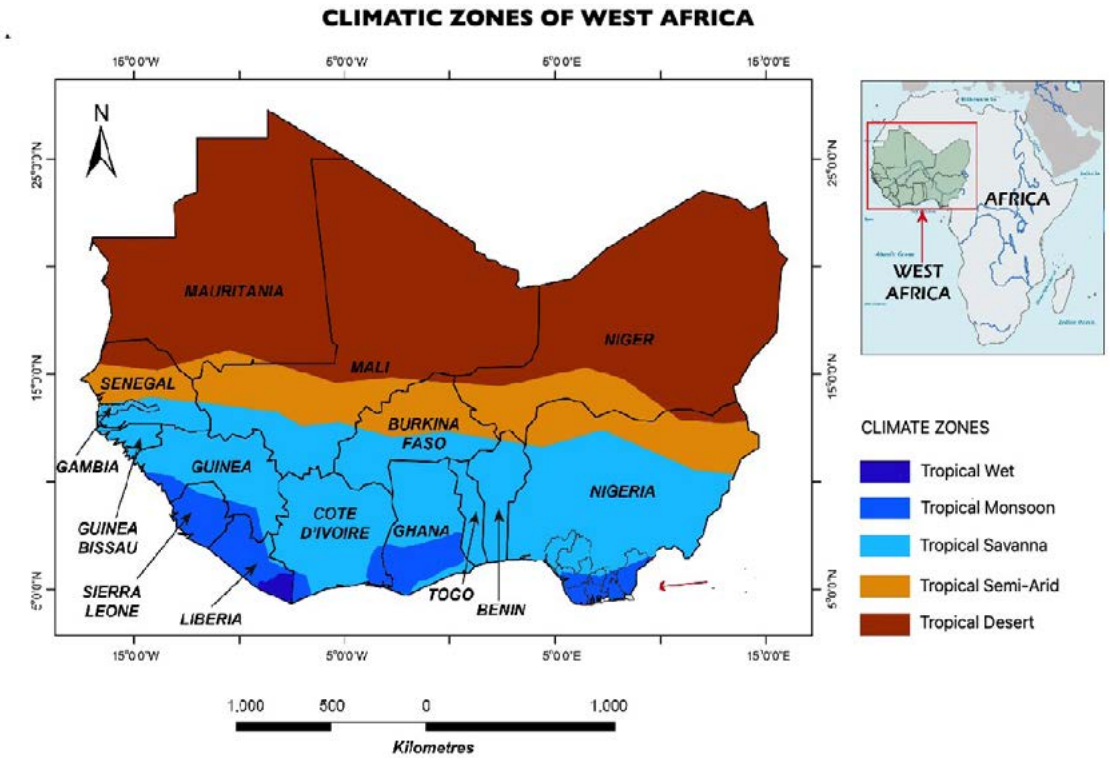


Figure 3.8 Climate Map of West Africa (Britannica)

1. Tropical Wet (Equatorial) Climate

Location: It is found along the south-eastern coast of Liberia, Côte d'Ivoire and Sierra Leone. A typical station is Monrovia.

Climatic Characteristics

a. The average annual temperature is typically high, ranging from 26°C to 30°C. The annual temperature range of about 3°C.
b. This region receives the highest annual rainfall in West Africa, often exceeding 2,500 mm.
c. It usually exhibits a double maxima or bimodal rainfall pattern.
d. This climate zone experiences extremely high humidity, typically exceeding 80% throughout the year, and often reaching close to 100% during peak rainfall periods.
e. Close to the Equator, the sun's rays hit the Earth's surface at a right angle (90 degrees), therefore are more concentrated, leading to intense surface heating.
f. In contrast, at higher latitudes, the sun's rays strike at a more oblique (slanted) angle, spreading the energy over a larger area, which means less surface heating.
g. It receives rains throughout the year and as a result, the dry season is not well marked.
h. It is mostly influenced by the tropical maritime air masses in most part of the year

2. Tropical Monsoon Climate

Location: It is primarily found in the coastal regions of countries such as Guinea, Sierra Leone, Liberia, Nigeria, and Ghana. Some typical stations for this climate are Conakry in Guinea, Freetown in Sierra Leone, and Axim in Ghana.

Climatic Characteristics

a. The zone experiences consistently high average temperatures throughout the year, often exceeding 25°C producing an annual range of typically falling between 10°C to 15°C.
b. This region experiences distinct wet and dry seasons.
c. It receives high annual rainfall which ranges from 1,800 mm to 2,000 mm.
d. It is mostly under the influence of the tropical maritime air masses or the southeast trade winds
e. Humidity remains high, often above 80%, even during the dry season.
f. Unlike equatorial regions with minimal day length variation, the tropical monsoon climate experiences more noticeable changes in daylight hours between the wet and dry seasons.

3. Tropical Savanna/Continental Climate

Location: This climate is typically found between the semi-arid Sahel to the north and the more humid Guinean climate to the south. The tropical savanna zone stretches across several countries, including southern Mali, Burkina Faso, northern Ghana, northern Nigeria, and parts of Senegal and Côte d'Ivoire. Typical stations include Kano, Nigeria and Ouagadougou, Burkina Faso.

Climatic Characteristics

a. The region experiences consistently warm to hot temperatures with an average monthly temperature typically between 20°C and 32°C.
b. The annual temperature ranges from 8°C to 12°C between the hottest and coldest months.
c. The region receives a moderate amount of rainfall, typically ranging between 600 and 1,600 mm.
d. This climate has a single concentrated wet season, occurring from May to September.
e. Humidity levels can reach 70% or higher during this period during the wet season and can drop to as low as 30% or lower during this period.
f. Throughout the year, the savanna region receives a significant amount of solar radiation due to its proximity to the equator.
g. It is mostly influenced by the tropical continental air masses

4. Tropical Semi-Arid (Sahelian) Climate

Location: The tropical semi-arid, or Sahelian, climate of West Africa is located just south of the Sahara Desert. It spans across several countries including Senegal, Mauritania, Mali, Burkina Faso, Niger, and northern Nigeria. This region forms a transitional zone between the arid Sahara to the north and the more humid savannas and forests to the south. It is a transitional zone. The temperatures are high Typical stations include Bamako, Mali and Nouakchott, Mauritania.

Climatic Characteristics

a. The Sahel experiences some of the hottest temperatures on Earth, with year-round averages exceeding 25°C and annual temperature range is relatively small, varying from 8°C to 12°C between the hottest and coldest months.
b. This region receives considerably less rain compared to wetter climates, averaging around 250 - 500 mm annually.
c. Rainfall can be highly unpredictable, with droughts a common occurrence. During the rainy season, rainfall can be sporadic and unevenly distributed.
d. Clear skies and minimal cloud cover allow for intense solar radiation in some areas.
e. The dry season mostly spans from October–May due to the influence from the tropical continental air masses. The harmattan is a very dry season that happens mostly between December and January. During this time, dry and dusty winds blow from the Sahara, making the air really dry and cool.
f. Relative humidity levels can drop to as low as 20% or even lower during this period. The short, wet season brings a temporary increase in humidity (about 40-50%).

5. Tropical Desert (Saharan) Climate

Location: It is primarily located in countries such as Mauritania, Mali, and Niger. It encompasses the vast expanse of the Sahara Desert, which is the largest hot desert in the world. Two typical stations within the Tropical Desert (Saharan) Climate of West Africa are Timbuktu in Mali and Agadez in Niger.

Climatic Characteristics

a. This region experiences extremely high average annual temperatures, often exceeding 28°C.
b. This climate zone experiences a significant daily temperature variation. Night time lows can drop considerably, sometimes reaching as low as 15°C.
c. This region receives very little rainfall, with annual averages typically falling below 250 mm.
d. The region therefore experiences long dry season with extreme harmattan winds in December and January.
e. The region's cloudless skies lead to direct exposure to intense sunshine throughout the year.
f. Humidity levels are consistently very low, typically falling below 30% and often even dipping below 20%.

Vegetation of West Africa

Vegetation describes the plant life in an area. There are several vegetational zones in West Africa. These vegetational zones provide unique characteristics that define the plant life forest landscape. They are affected by factors such rainfall, nature of the soil, time, and activities of humans, among others. The vegetational zones are:

1. Tropical Rainforest
2. Deciduous forest
3. Savanna vegetation
4. Sahel vegetation
5. Desert vegetation

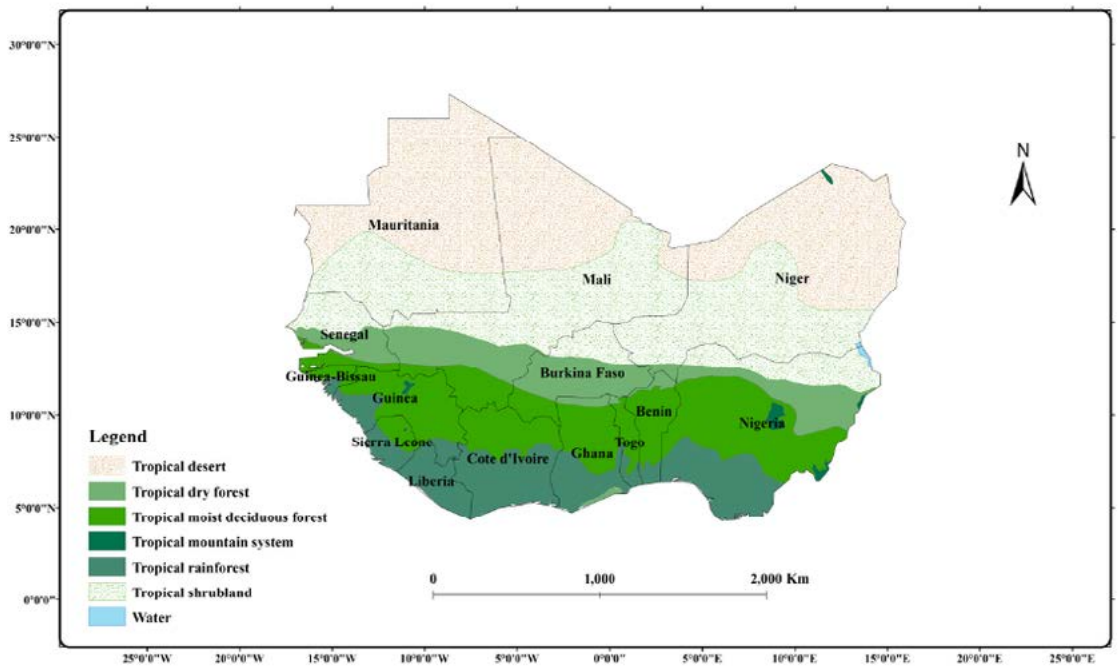


Figure 3.9: Vegetation zones of West Africa.

1. Tropical Rainforest Vegetation

a. This zone coincides with the Tropical Wet climatic region.
b. Multi layered canopy dominated by tall, emergent trees reaching heights of 45-60 metres (150-200 feet).
c. Extremely diverse tree species, with over 200 tree species per hectare.
d. Prominent presence of species such as mahogany, iroko, wawa and various hardwood and softwood trees.
e. The trees have thin bark
f. Abundant epiphytes (plants growing on other plants), lianas, and woody vines in the understory.
g. The trees have buttress roots with little undergrowth

2. Deciduous Forest Vegetation

a. The zone coincides with the Tropical monsoon climatic region.
b. Trees shed their leaves during the dry season.
c. Trees are generally shorter compared to tropical rainforests.
d. There is a diverse understory vegetation with shrubs and smaller plants.
e. Variety of tree species, including mahogany, iroko, African teak, silk cotton tree and waw exist.
f. Trees have thicker bark and often deep root systems to access water during the dry season.

3. Savanna Vegetation

a. This zone lies within the Tropical savanna/continental climatic region.
b. Dominated by tall grasses, which can grow up to several metres in height.
c. There are few trees and shrubs, often widely spaced apart.
d. Green and lush during the rainy season, dry and brown during the dry season.
e. Most plants are pyrophytes adapted to survive periodic fires.
f. The few trees found here are deciduous
g. Common plant species include Baobab, acacia, silk cotton tree and combretum.

4. Sahel Vegetation

a. This zone lies within the tropical semi-arid climatic region.
b. Most plants are pyrophytes adapted to survive periodic fires.
c. Most plants are xerophytes adapted to survive extreme drought conditions.
d. Presence of thorny shrubs and bushes to reduce water loss and protect against herbivores.
e. Dominated by hardy grasses that can survive with little water.
f. Many plants have shallow root systems to quickly absorb moisture.
g. The grass remains dormant in the dry season and sprot in the wet season.

5. Desert Vegetation

a. This zone coincides with the Tropical desert climatic region.
b. There are very few plants due to extreme arid conditions.
c. Low-growing shrubs and bushes to minimise water loss.
d. Most plants are xerophytes adapted to survive extreme drought conditions.
e. There are other plants like ephemeral (plants that grow, flower, and die quickly after rainfall) that grow within this vegetative belt.
f. Plants with deep root systems to access underground water also exist in this belt.
g. Hardy grasses that can survive with minimal water are found in the Sahara vegetation.

Relief of Africa

The African landscape is made of highlands and lowlands. The highlands are mainly concentrated in the eastern side while the lowlands are mostly found in the Sahelian, parts of the central and along the coast. These relief mostly define the landscape of a particular area in Africa. The highlands and lowlands are discussed below.

The Highlands

1. **The Ethiopian Highlands:** These are located in Ethiopia and extends for several kilometres to include the Semien Mountains and the Bale Mountains. It is 4,000 metres high. It is a rugged and undulating terrain with deep valleys and mountains.
2. **Kenya Highlands:** Found in Kenya, this region includes the central highlands around Nairobi and Mount Kenya (5,199 metres high), Africa's second-highest peak.
3. **Atlas Mountains:** This is an example of a young fold mountain and located primarily in Morocco, Algeria, and Tunisia. The Atlas Mountains is the longest mountain range in North Africa that extends for some 2,500km across north-western Africa. It is a series of ranges with diverse terrain with canyons and ravines. The highest peak is 4,167m Toubkal, which lies within Morocco's Toubkal National Park
4. **Mount Kilimanjaro:** Located in north-eastern Tanzania, close to the Kenyan border. Its highest peak ascends to 5,895 metres above sea level, making it the highest mountain in Africa. It is an example of an extinct volcano.
5. **The Drakensberg Mountain Range:** Located in Eastern South Africa, along the border with Lesotho and extends roughly from northeast to southwest. It has a maximum elevation of 3,482 metres. Thus is an example of old fold mountains.
6. **Mount Cameroon:** Located near the Gulf of Guinea in the Southwest Region of Cameroon. It stands at approximately 4,040 metres, making it the highest mountain in West Africa. It is an example of an active volcanic mountain.

Lowlands

1. **Nile Delta:** Located in Egypt, the Nile Delta is one of the world's largest river deltas. It is a low-lying area formed by the Nile River as it empties into the Mediterranean Sea. The Nile delta has a long history of being fertile for agricultural activities.
2. **Niger Delta:** Situated in Nigeria, the Niger Delta is another significant river delta in Africa. It is formed by the Niger River as it flows into the Gulf of Guinea. The delta region is known for its biodiversity, oil reserves, and mangrove forests.
3. **Lake Chad Basin:** The Lake Chad Basin is one of the low-lying areas in Africa. It is a large, shallow, and low-lying area in central Africa, spanning parts of Chad, Niger, Nigeria, and Cameroon. Lake Chad has been observed to be shrinking in recent decades due to climate change and human activities.

4. **The Congo Basin:** It is one of the largest and most important low-lying areas in Africa. It is located in the central part of Africa, encompassing parts of countries, including the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic, Cameroon, Gabon, Equatorial Guinea, and Angola. The plain is covered by tropical rainforest. It covers approximately 3.7 million square kilometres, making it the second-largest rainforest in the world after the Amazon Rainforest.
5. **Okavango Delta:** Located in Botswana, the Okavango Delta is a unique inland delta and wetland system. It is a low-lying area where the Okavango River spreads out and forms a maze of channels, lagoons, and islands, supporting a diverse array of wildlife.
6. **Sudd:** The Sudd is a vast swampy region in South Sudan, situated in the floodplain of the White Nile. It is one of the largest wetlands in Africa, characterised by low-lying plains that flood seasonally, influencing the region's hydrology and ecology.
7. **Sahara Desert:** While primarily known for its arid and desert landscapes, the Sahara also includes extensive areas of flat and sandy plains known as ergs. These are vast stretches of sand dunes and interdune sand flats that cover much of North Africa. The Sahara covers large parts of Algeria, Chad, Egypt, Libya, Mali, Mauritania, Niger, Western Sahara and Sudan, and parts of southern Morocco and Tunisia. It covers 9 million square kilometres (3,500,000 square miles), which constitute about 31% of the African continent. Though the Sahara has some mountain peaks, most of it is a low-lying plateau area with an average elevation of 500m
8. **Serengeti Plains:** Located in Tanzania, the Serengeti Plains are part of the broader Serengeti ecosystem and are famous for their grasslands. These plains support a diverse array of wildlife, including the annual migration of millions of wildebeest and other herbivores.
9. **Savannah Plains:** Savannahs cover large parts of Africa, characterised by grasslands with scattered trees and bushes. These plains are found in regions such as East Africa (example, Maasai Mara in Kenya, Kruger National Park in South Africa), Southern Africa, and parts of West Africa. Including northern Ghana, Burkina Fasso, Northern Nigeria, Mali and Niger.
10. **Sudanese Plains:** Also known as the Sahel region, this transitional zone between the Sahara Desert and the savannah of West Africa consists of semi-arid plains with sparse vegetation and seasonal rivers.
11. **Kalahari Desert:** Although technically a desert, the Kalahari includes vast plains with scrubby vegetation and occasional dunes. It spans Botswana, Namibia, and South Africa.

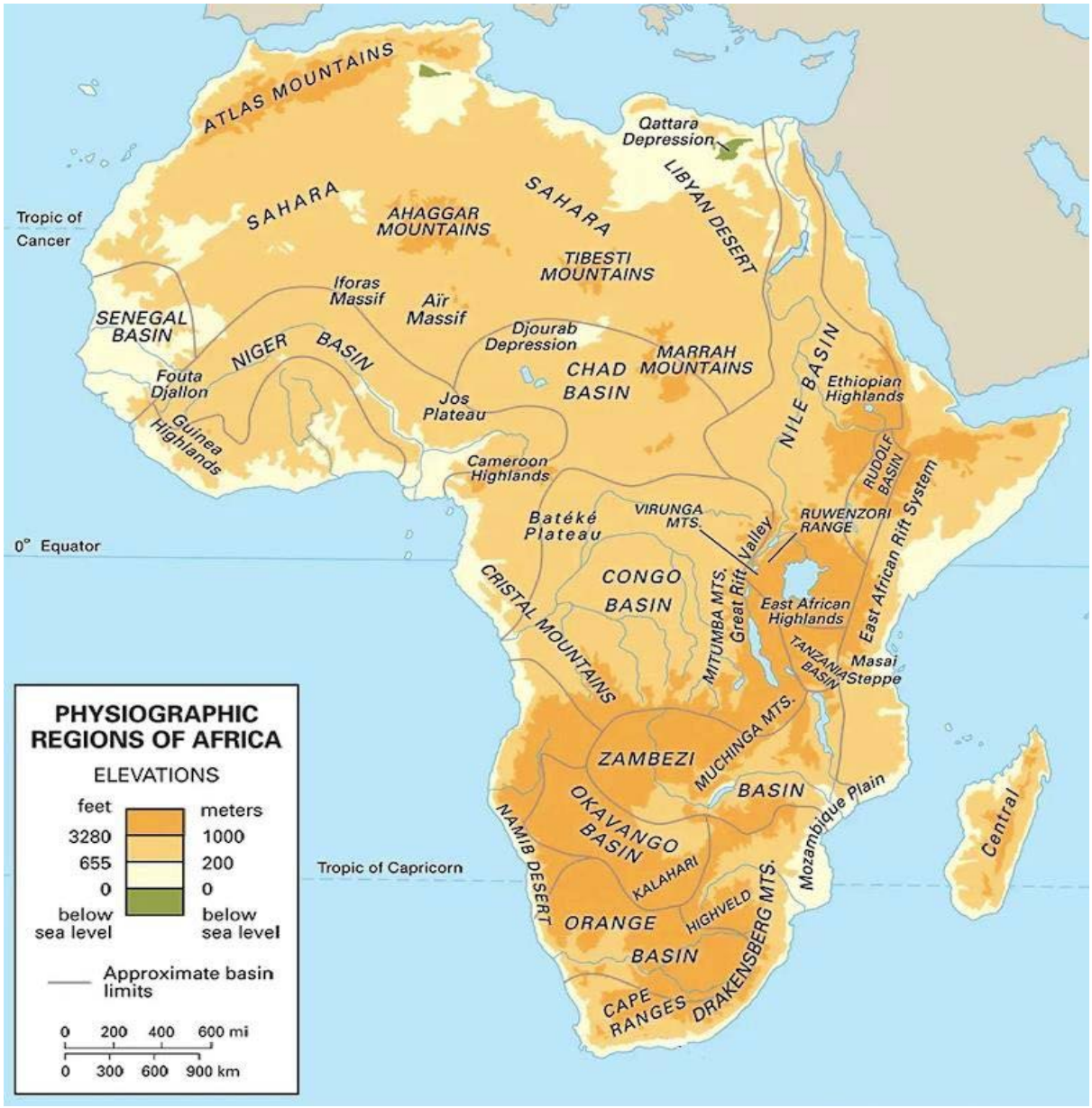


Figure 3.10: Relief and Drainage of Africa

Drainage of Africa

Drainage refers to the removal and storage of water from an area. It includes such water bodies as rivers, streams, lakes, lagoons and oceans. A drainage basin refers to an area of land in which all flowing surface water converges to a single point, such as a river mouth, or flows into another body of water.

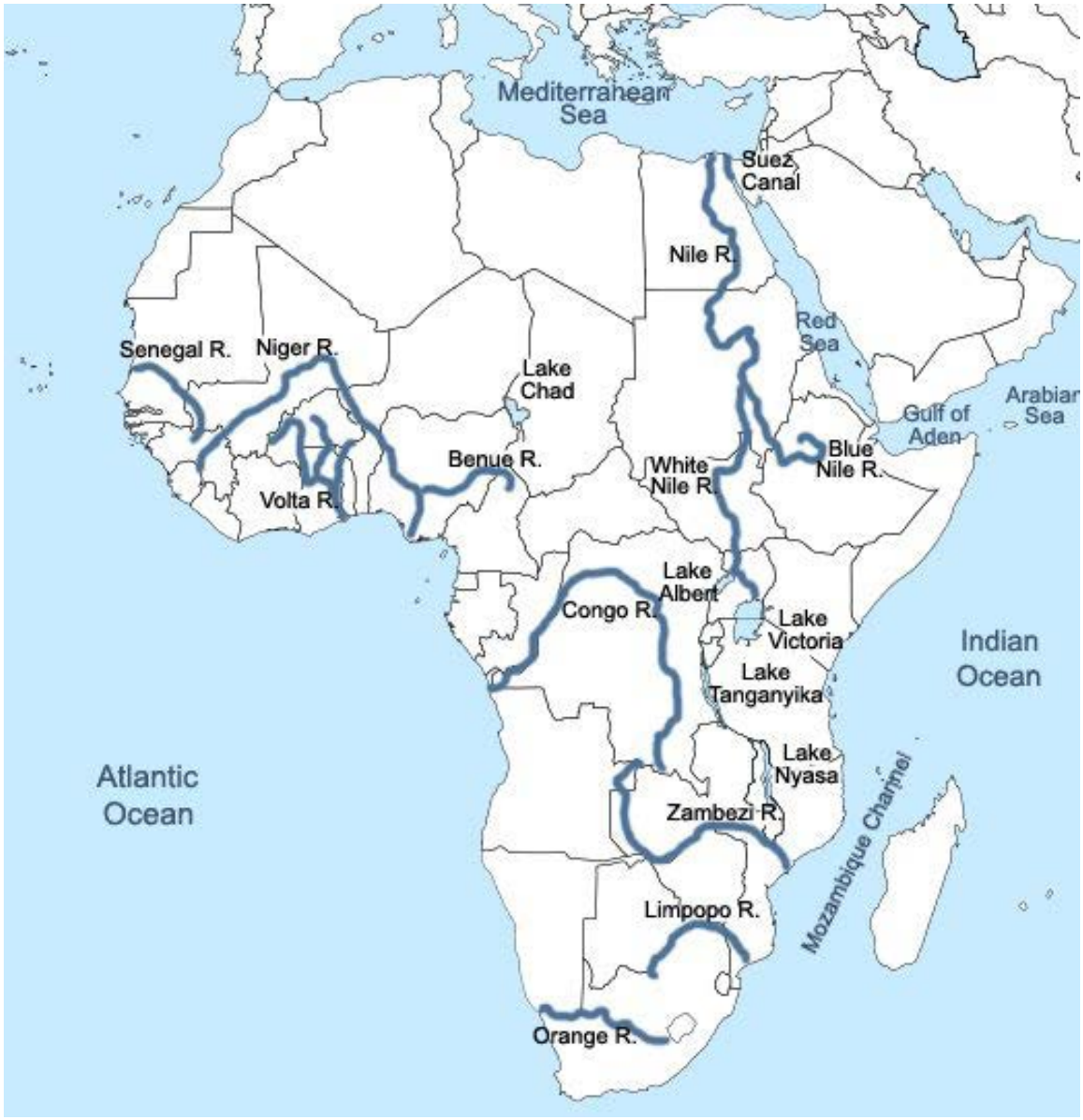


Figure 3.11: Drainage of Africa.

Africa has a number of large drainage basins. Water from these basins reaches the Atlantic Ocean in the west, the Indian Ocean in the east and the Mediterranean Sea in the north via complex river systems.

Major Drainage Basins in Africa

1. **Nile Basin:** The Nile River is one of the longest rivers in the world, flowing northwards through north-eastern Africa reaching the Mediterranean at Cairo in Egypt. It drains an area estimated at 1,293,000 square miles (3,349,000 square kilometres). Its basin includes parts of Tanzania, Burundi, Rwanda, the Democratic Republic of the Congo, Kenya, Uganda, South Sudan, Ethiopia, Sudan, and the cultivated part of Egypt. The Nile is regarded as the longest river on Earth, running nearly 6,700 kilometres from its source in Lake Victoria to its mouth in the Mediterranean.

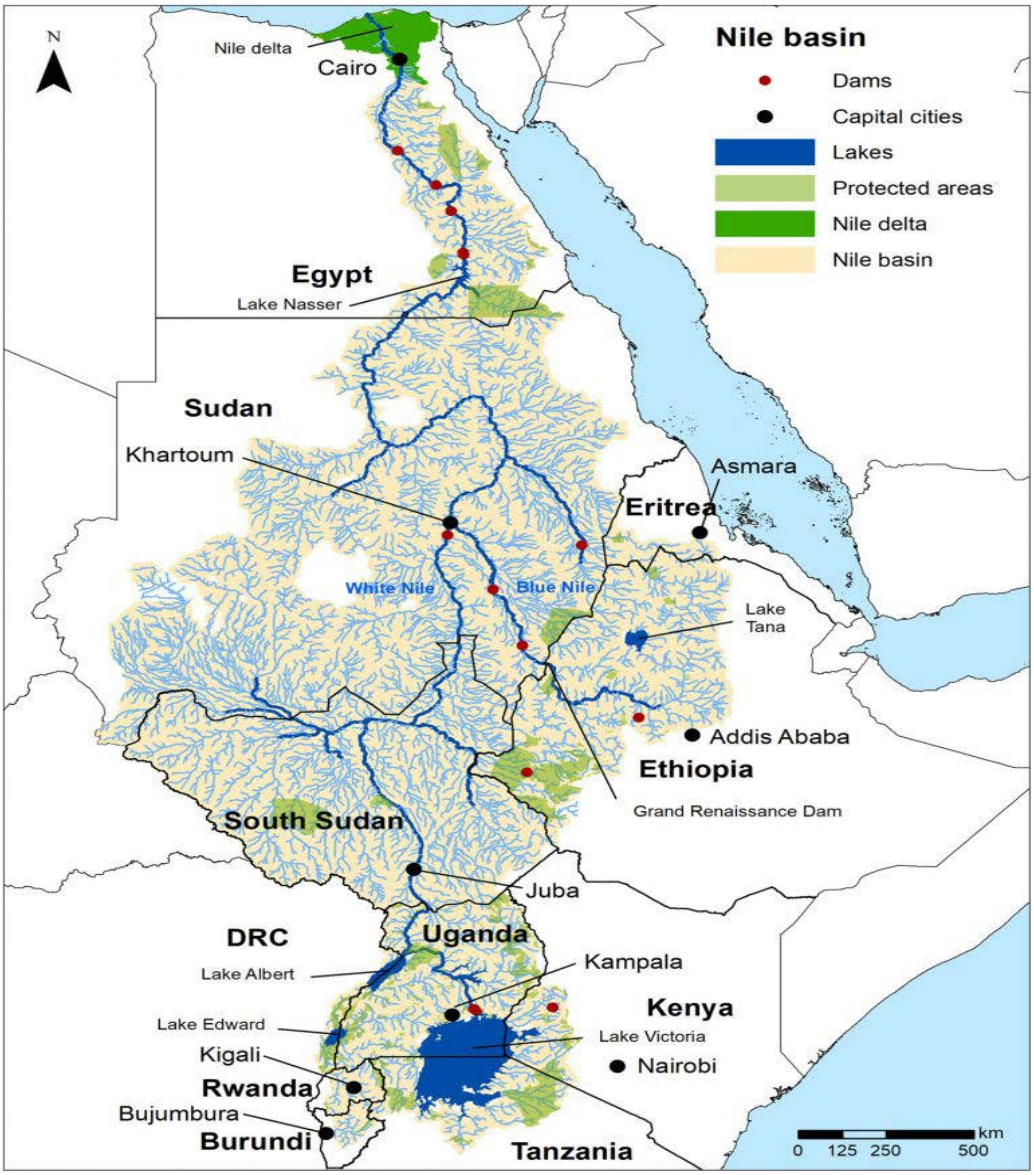


Figure 3.12: The Nile drainage basin.

2. **Zambezi River Basin:** The Zambezi Basin, spanning approximately 1.39 million square kilometres across eight countries, contains the Zambezi River, Africa's fourth-longest river. Notable for diverse ecosystems and rich wildlife, the basin includes landmarks like Victoria Falls and Lake Kariba. It supports agriculture, fisheries, and hydroelectric power from the Kariba and Cahora Bassa dams. Key challenges include deforestation, pollution, and climate change impacts.
3. **Congo Basin:** Also known as the Congo River Basin, it is the second-largest river basin in the world by area, covering about 3.7 million square kilometres in Central Africa. The Congo River and its tributaries flow through countries such as the Democratic Republic of Congo, Republic of Congo, Central African Republic, Angola, Zambia, and Tanzania.
4. **Niger Basin:** The Niger River Basin spans several countries in West Africa, including Guinea, Mali, Niger, Benin, Nigeria, and Burkina Faso.

Other Major River Basins in Africa

1. **The Orange River:** It with a length of approximately 2,200 kilometres, traverses the countries of Lesotho, South Africa, and Namibia. It is a vital watercourse in southern Africa. Notably, the river is home to Augrabies Falls. Its source is located in the Drakensberg Mountain range and empties into the Atlantic Ocean on the west coast of South Africa.

2. **The Limpopo River:** It spans approximately 1,750 kilometres and traverses the countries of Botswana, South Africa, Zimbabwe, and Mozambique. The river, like the Zambezi River, also drains into the Indian Ocean coast of Mozambique.

Major lakes in Africa

Africa has some of the world's most significant lakes, each with unique characteristics, ecological and economic value. These lakes play vital roles in shaping and changing the continent's topography, climate, and biodiversity. Some of the lakes are natural while others are humanmade. Some of these lakes are discussed below:

1. **Lake Victoria**: Located in the East African Rift Valley system, Lake Victoria is the largest lake on the continent and the second-largest freshwater lake in the world by surface area, covering approximately 68,800 square kilometres. It is bordered by three countries: Tanzania, Uganda, and Kenya. Lake Victoria is a crucial resource for fishing, transportation, and supporting the livelihoods of millions of people in the region. It is a shallow, tropical lake with an average depth of about 40 metres.

Figure 3.13: Aerial photograph of Lake Victoria

2. **Lake Tanganyika:** It stretches along the borders of Tanzania, the Democratic Republic of Congo, Burundi, and Zambia, Lake Tanganyika is the second-largest lake in Africa by surface area and the second-deepest lake in the world. It covers approximately 32,900 square kilometres and reaches depths of over 1,470 metres. This rift valley lake is known for its extraordinary biodiversity, hosting numerous endemic species of fish and other aquatic life.

3. **Lake Malawi:** Lake Malawi, also known as Lake Nyasa, is located between Malawi, Mozambique, and Tanzania. It covers an area of about 29,500 square kilometres and has a maximum depth of approximately 706 metres. This rift valley lake is renowned for its high species diversity, particularly its cichlid fish population, making it a key location for scientific research and ecological studies.
4. **Lake Turkana:** Lake Turkana, the world's largest permanent desert lake, lies primarily in Kenya, with its northern tip extending into Ethiopia. It spans around 6,405 square kilometres and has a maximum depth of about 109 metres. The lake is an important resource for the semi-arid region, supporting local fishing communities and providing water for livestock. It is an alkaline lake, which influences its unique ecosystem.
5. **Lake Albert:** It is located on the border between Uganda and the Democratic Republic of Congo, Lake Albert covers approximately 5,300 square kilometres. It is part of the Albertine Rift, the western branch of the East African Rift. Lake Albert plays a vital role in regional hydrology, connecting the Victoria Nile to the Albert Nile, and supports local fishing and agricultural activities.
6. **Lake Chad:** Lake Chad is a historically significant lake located in the Sahel region, bordered by Chad, Cameroon, Nigeria, and Niger. Its surface area varies significantly with seasonal rainfall, but it can cover up to 25,000 square kilometres during periods of high water. Lake Chad is a shallow, endorheic lake, meaning it has no outlet to the sea, and its size fluctuates due to climatic changes and human activities. It is crucial for local agriculture, fishing, and water supply.
7. **Lake Kivu:** Lake Kivu is situated on the border between Rwanda and the Democratic Republic of Congo, covering an area of about 2,700 square kilometres. This rift valley lake is notable for its significant methane gas reserves, which are harnessed for energy production. It has a maximum depth of around 485 metres and supports diverse fish species and local fisheries. It is an example of volcanic lake.

Major lagoons in Africa

The African continent is distinguished by the presence of a multitude of lagoons. They are:

1. **Ebrie Lagoon:** It is located in Côte d'Ivoire, Ebrie Lagoon is one of the largest lagoons in West Africa. It covers an area of approximately 566 square kilometres. This lagoon is situated near the economic capital, Abidjan, making it crucial for fishing, transportation, and as a habitat for diverse aquatic species. Its proximity to urban areas has also led to challenges such as pollution and habitat degradation.
2. **Lagos Lagoon:** Lagos Lagoon is a significant water body in Nigeria, situated in the city of Lagos, one of the largest and most populous cities in Africa. It spans an area of about 635 square kilometres. This lagoon is integral to the city's economy, supporting activities like fishing, sand dredging, and transportation. The lagoon also faces environmental pressures due to urbanisation and industrial activities.

3. **Aby Lagoon:** Aby Lagoon, located in south-eastern Côte d›Ivoire, covers an area of approximately 424 square kilometres. It is part of a complex system of lagoons and estuaries, playing a vital role in the region›s biodiversity. The lagoon supports local fishing communities and serves as a habitat for various bird species, making it important for both the economy and the environment.
4. **Keta Lagoon:** Keta Lagoon is located in the Volta Region of Ghana, along the eastern coast near the border with Togo. It is the largest lagoon in Ghana, covering an area of approximately 300 square kilometres.

Figure 3.14: Parts of Keta lagoon in Ghana (google.com)

Characteristics of African rivers

1. **Seasonal Variability**: Most rivers in Africa, like many others elsewhere, experience seasonal changes between the wet and dry seasons. During the wet season, most of these rivers increase in volume and overflow their banks. In the dry season, the volume decreases due to a high rate of evaporation and low rainfall. This is characteristic of many rivers in Africa, including Niger, Nile, Vota, the Limpopo and Zambesi.
2. **Intermittent flow**. Some African rivers have seasonal flows. They disappear in the dry season and flow again in the wet season. Examples are Rivier Tana in Kenya, the Ruvu in Tanzania, Benue in Nigeria. In Ghana, due to climate change and illegal mining in river bodies, a number of our rivers have become or are becoming intermittent, examples are Birin, Afram, Ochi, and Bonsa.
3. **Perennial in nature**: Some of the rivers in Africa are perennial rivers. This means these rivers maintain their volumes and flow throughout the year. This condition is associated with major rivers, and most especially those that flow in a humid equatorial climate. Examples are the Congo River, Nile, Zambesi and Limpopo.

4. **Develop large Deltas**: Some of the major rivers in Africa have developed deltas at their mouths where they enter the sea. This is due to the large sediments they carry along
5. **Presence of rapids and waterfalls**: Some of the rivers have rapids and waterfalls along their channel. Rapids are rocks that are exposed within the flow of rivers, while waterfalls are the steep flow or fall of river along a rock surface. These serve as obstacles to the flow of the river. Examples are the Victoria Falls on the Zambezi River is one of the biggest in the world, as well as the Blue Nile Falls on the Nile River in Ethiopia. The Congo River, for instance, has a number of rapids and falls.
6. **Presence of floating vegetation**: Some African rivers have floating vegetation within their channels. This plays a crucial role in the river ecosystems. These plants, suspended on the water and float freely on the surface. Examples of floating plants are duckweed, mosquito fern, water hyacinth, and watermeal. Most rivers in Africa have some sort of floating vegetation.

Climate of Africa

Africa is a continent with diverse climatic regions, each influenced by its latitude, proximity to the ocean, and geographical features. The climatic regions are:

1. Wet equatorial

Location: This climatic zone is located between latitudes 5°N and 5°S of the equator. Countries that are located in this climatic zone include Gabon, Congo, the Democratic Republic of Congo, and parts of Uganda and Kenya. A typical weather station is Kisangani.

Climatic Characteristics

a. Average annual temperature is around 24°C to 30°C.
b. Annual range of temperature is typically very small, usually between 2°C to 3°C.
c. High annual rainfall, usually exceeding 2500 mm, with no distinct dry season.
d. Rainfall is heavy and mainly convectional which often comes in the afternoon and generally accompanied by lightning and thunder.
e. Relative humidity is always high exceeding 80%.
f. It is mostly under the influence pf maritime winds

2. Tropical Monsoon Climate

Location: The tropical monsoon climatic zone is primarily found along the coastal regions of West Africa, extending from approximately 5°N to 10°N in terms of latitude. A typical station is Freetown in Sierra Leone.

Climatic Characteristics

a. Temperature is consistently high throughout the year, averaging around 25°C to 30°C.

b. The annual temperature range of the tropical monsoon climate in Africa varies between 5°C to 7°C
c. There is high annual rainfall, between 1500mm to 2000mm, characterised by distinct wet and dry seasons. This is driven by the seasonal shifts of the Intertropical Convergence Zone (ITCZ) and the monsoon winds.
d. Rainfall can be very heavy, often in the late afternoon or early evening occurring in the form of intense thunderstorms.
e. Relative humidity is high especially during the wet season, often exceeding 80%.
f. It is mostly under the influence of the maritime winds

3. Tropical Savanna or Continental Climate

Location: This climatic zone is typically found between latitude 5° and 15° north and south of the equator. It covers countries such as Nigeria, and Chad in the northern hemisphere and Tanzania and Zambia in the southern hemisphere. Two typical stations are N'djamena and Lusaka.

Climatic characteristics

a. The zone is characterised by high temperatures throughout the year. Average temperatures typically range from 20°C to 30°C.
b. During the wet season, which corresponds to summer in the respective hemisphere (for instance, June to September in the Northern Hemisphere and December to March in the Southern Hemisphere), temperatures are generally higher and more consistent due to increased cloud cover and humidity.
c. Rainfall is highly seasonal, characterised by alternating wet and dry seasons.
d. During the wet season, there is significant rainfall, often in the form of intense thunderstorms and occasional cyclones in coastal areas.
e. In the Northern Hemisphere, the wet season spans from May to October, while in the Southern Hemisphere, it occurs from November to April. On the other hand, in the Northern Hemisphere, the dry season generally lasts from November to April, and in the Southern Hemisphere, from May to October.
f. The annual rainfall varies from 500 mm to 1,500 mm with higher amounts closer to the equator and decreasing amounts toward the margins of this climatic zone.
g. In the wet Season, relative humidity often ranges from 70% to 90% while in the dry season it typically drops to 40% to 60%.

4. Semi-arid Climate

Location: The semi-arid climatic zone is located between latitude 10° to 20° north and south of the equator. Examples of semi-arid regions in Africa include the Sahel in northern Africa and parts of southern Africa, such as the Kalahari Desert region. A typical weather station is Luanda and Bamako.

Climatic Characteristics

a. This zone experiences some of the hottest temperatures on Earth, with year-round averages exceeding 25°C and annual temperature range varying from 8°C to 12°C between the hottest and coldest months.

b. The average annual temperature typically ranges between 20°C to 30°C.
c. This region receives considerably less rain compared to wetter climates, averaging around 250-500 mm annually.
d. In the northern hemisphere (Sahel region) the Wet Season typically occurs during the summer months (June to September) while the dry Season extends from October to May, with very little to no rainfall. In the southern hemisphere, which is Kalahari and Namib desert region, the wet Season generally occurs from November to March while extending from April to October, with little to no rainfall.
e. Rainfall can be highly unpredictable, with droughts a common occurrence. During the rainy season, rainfall can be sporadic and unevenly distributed.
f. Relative humidity levels can drop to as low as 20% or even lower during this period. The short, wet season brings a temporary increase in humidity (about 40-50%).
g. The dry conditions in the Namib and Kalahari Desert can partly be attributed to the cold Benguela current

5. Desert Climate

Location: The desert climatic zone is located between latitude 20° to 30° north and south of the equator. It mostly covers the Sahara Desert in the northern hemisphere and the Kalahari and Namib deserts in the southern hemisphere. Countries that are located in these zones include Egypt, Libya, and Morocco in the northern hemisphere and Namibia in the southern hemisphere. Typical weather stations are Tripoli and Windhoek.

Climatic Characteristics

a. Temperature differences between day and night can be large, often exceeding 40°C during day and drooping to as low as 0°C.
b. The average annual temperature ranges from 20°C to 30°C in the Sahara region and 15°C to 25°C in the Kalahari and Namib deserts.
c. Annual rainfall is extremely low, often less than 250 mm per year.
d. Rainfall is highly unpredictable and irregular, with long periods of drought punctuated by occasional, brief, and intense rain showers or thunderstorms.
e. Rainfall is concentrated in short, irregular bursts during specific seasons, often during the summer months in the northern hemisphere (June to September) and winter months in the southern hemisphere (December to March).
f. Rainfall events are often localised and sporadic, leading to highly variable amounts of precipitation over small distances.
g. High rates of evaporation due to intense sunlight and low humidity levels further contribute to the arid conditions.
h. Mostly under the influence of dry winds

6. Mediterranean Climate

Location: The Mediterranean climatic zone is primarily located along the northern and southern coastlines of the continent, spanning latitudes roughly between 30° and 40° both north and south of the equator. In northern Africa, it includes coastal regions of countries such as Morocco, Algeria, Tunisia, and Libya. In southern Africa, it encompasses the southwestern coast of South Africa, including areas around Cape Town.

Climatic Characteristics

a. Winter temperatures are generally mild, with average temperatures ranging from 10°C to 20°C.
b. Summers are hot and dry, with average temperatures ranging from 25°C to 35°C or higher.
c. Coastal areas experience milder temperatures due to the moderating influence of the Mediterranean Sea or Atlantic Ocean.
d. Rainfall primarily occurs during the winter months (November to March) in the northern hemisphere while in the southern hemisphere, it occurs May to September.
e. The total annual rainfall ranges from 200 mm to 600 mm in northern Africa and from 500 mm to 1,000 mm in southern Africa.
f. Higher relative humidity, often ranging from 70% to 90% during wet season and from 60% to 80% during the dry season.

Montane or Mountain Climate

Location: The mountain or montane climatic zone in Africa found in mountainous and high elevated regions. They are mostly found around the Ethiopian highlands, Kenyan highlands, Drakensberg, and the Atlas Mountains, Cameroon and Togo Atakora mountains. It can be found in countries such as Kenya, Tanzania, Ethiopia, Lesotho, and South Africa.

Climatic Characteristics

a. Mountainous regions generally receive higher annual precipitation compared to the surrounding lowlands.
b. Annual rainfall totals in mountainous areas can range from 1,000 mm to over 2,000 mm, depending on the specific location and elevation.
c. Rainfall is mostly orographic and convectional in nature.
d. The regions experience a distinct wet season, often corresponding to the summer months, when moisture-laden air masses are prevalent.
e. Higher elevations generally receive more precipitation, as the orographic effect is most pronounced at the higher slopes.
f. The rain shadow effect can create drier conditions on the leeward side of the mountains, leading to distinct precipitation patterns across the landscape.
g. Relative humidity varies with elevation and seasons in these regions.

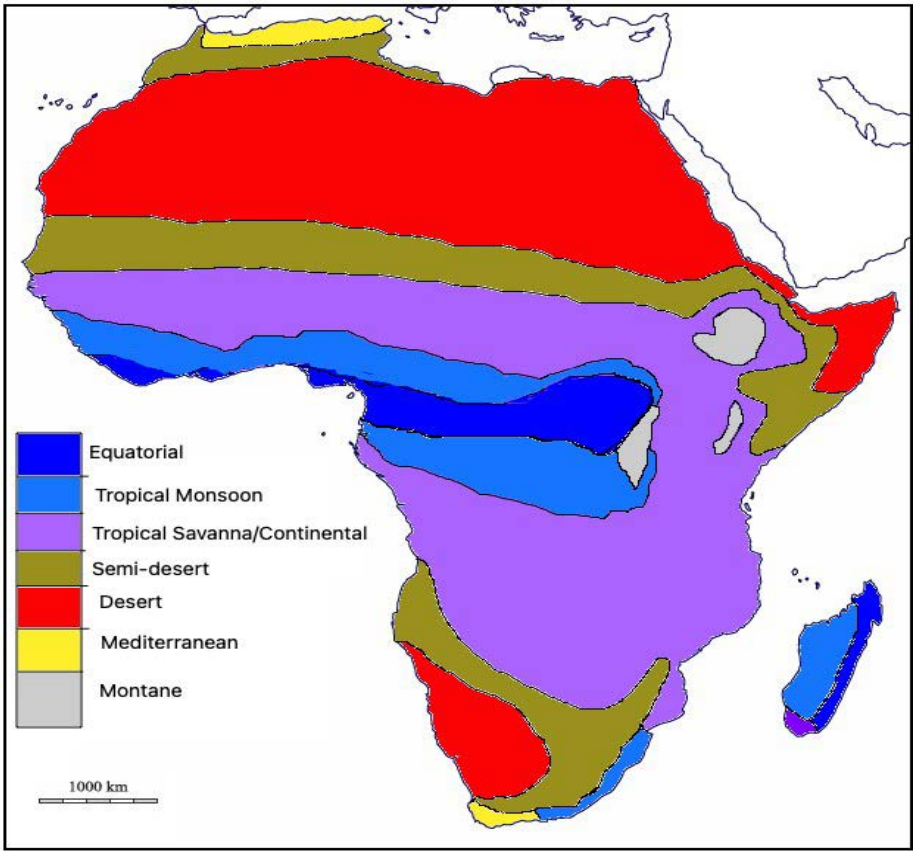


Figure 3.15: Climate zones of Africa.

Vegetation of Africa

Africa has diverse plant life, ranging from thick rainforest, through savanna to desert plant species. The vegetation types found in Africa include the tropical rainforest, deciduous forest, savanna and desert. The types and their respective characteristics are discussed below.

1. Tropical rainforest vegetation

Location: Found on the tropical equatorial or wet equatorial climate, mainly in the Congo basin.

Vegetation Characteristics

a. It features a diverse array of closely parked forest trees and other plants species.
b. The forest is structured into three layers, which is the upper layer or emergent, middle layer and lower layer.
c. Most of the tall trees have buttress roots.
d. Some of the trees in the middle- and lower-layers form canopy
e. there are subsidiary plants such as ferns, lianas, epiphytes, herbaceous and saprophytes. Hope you remember the meanings of these terminologies in your lessons on forest vegetation in Ghana and West Africa.

f. The tallest trees in the upper layer can reach the height of 60m.
g. Due to high temperatures and consistent rainfall, almost all trees are broad-leaved and evergreen, allowing year-round growth.
h. Shedding of leaves, flowering and fruiting occurs at the same time among the different plants.
i. The dense canopy formed by tall tree leaves blocks most light at ground level, limiting undergrowth.
j. Common tree species include mahogany, iroko, ebony, Okoume, African walnut, and various palm trees.

Figure 3.16: Parts of Congo rainforest vegetation.

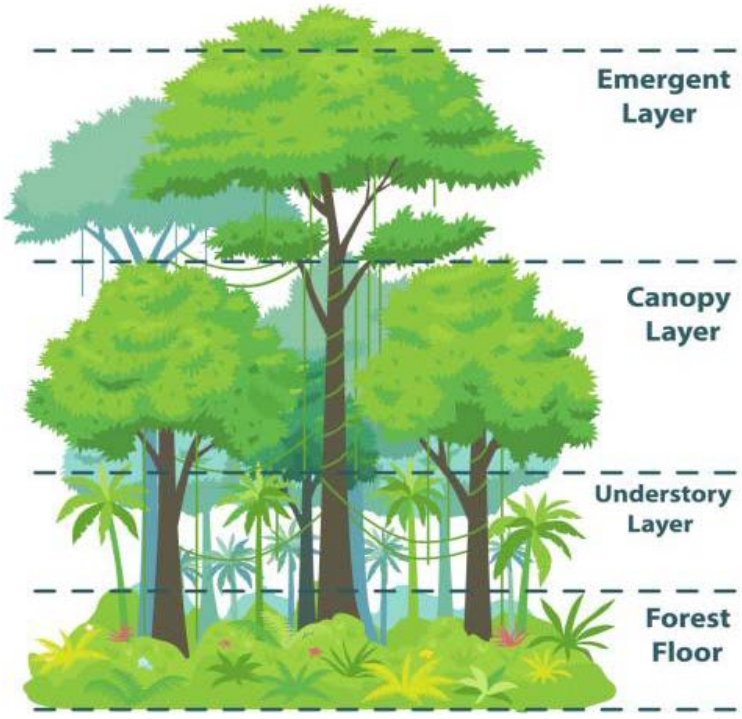


Figure 3.17: Tree layers in tropical rainforest.

2. Deciduous Forest Vegetation

Location: This zone coincides with the Tropical Monsoon climate.

Vegetation Characteristics

a. Most of the trees are deciduous, losing their leaves in the hot, dry season.
b. This forest is more open, allowing direct sunlight, with heavy rains to reach the ground, thus promoting the growth of other plant species. There is therefore dense undergrowth.
c. The trees are tall, often as high as 30 metres.
d. The undergrowth includes shrubs, grasses, and ferns that thrive in the shade of taller trees.
e. These forests have a diverse range of tree species, including mahogany, teak, African rosewood, and ebony.

3. Savanna Vegetation

Location: This zone coincides with the tropical Savanna/Continental climatic zone.

Vegetation Characteristics

a. Dominated by tall grasses, which can grow up to several metres in height.
b. There are few trees and shrubs, often widely spaced apart.
c. Green and lush during the rainy season, dry and brown during the dry season.
d. The plants are pyrophytes adapted to survive periodic fires.
e. Common plant species include Baobab, acacia and combretum.
f. The trees are mostly deciduous in nature

Figure 3.18: Parts of Savanna vegetation in Africa

4. Steppe Vegetation

Location: This zone coincides with the Semi-arid climate

Vegetation characteristics

a. Plants found in this zone are pyrophytes adapted to survive periodic fires.
b. Majority of the plants are xerophytes adapted to survive extreme drought conditions.
c. Presence of thorny shrubs and bushes to reduce water loss and protect against herbivores.
d. Dominated by hardy grasses that can survive with little water.
e. Many plants have shallow root systems to quickly absorb moisture.

Figure 3.19: Steppe grassland vegetation.

5. Desert Vegetation

Location: This zone coincides with the Desert climate, mostly found in North Africa as well as Namibia and Botswana.

Vegetation Characteristics

a. There are very few plants due to extreme arid conditions.
b. Low-growing shrubs and bushes to minimise water loss.
c. Most plants are xerophytes adapted to survive extreme drought conditions.
d. There are other plants like ephemeral (plants that grow, flower, and die quickly after rainfall) that grow within this vegetative belt.
e. Plants with deep root systems to access underground water also exist in this belt.
f. Hardy grasses that can survive with minimal water are found in the Sahara vegetation.

Figure 3.20: Sahara Desert vegetation.

6. Mediterranean Vegetation

Location: This zone coincides with the Mediterranean climate.

Vegetation Characteristics

a. Mediterranean vegetation includes many drought-resistant (xerophytes) plants such as evergreen shrubs, cork oak, and olive trees, which are adapted to dry summers.
b. Plants often have small, hard leaves (sclerophyllous) that reduce water loss and withstand harsh, sunny conditions.
c. Vegetation shows rapid growth during the mild, wet winters and goes dormant during the hot, dry summers.
d. The region is home to a diverse range of plant species, including aromatic herbs like thyme, rosemary, and lavender, which thrive in the dry climate.
e. Many plants have adapted to periodic wildfires (pyrophytes), with some species requiring fire for their seeds to germinate and others having thick bark to protect against fire damage.

Figure 3.21: Mediterranean vegetation

7. Montane Vegetation

Location: This zone coincides with the Montane climate.

Vegetation Characteristics

a. They are characterised by dense forests with tall, evergreen trees that thrive in cooler, moist conditions.
b. These areas often have a diverse understory of shrubs, ferns, and mosses due to the high humidity and regular cloud cover.
c. Bamboo thickets are common in some montane regions, particularly in East Africa, providing important habitats for various wildlife species.
d. Grasslands and heathlands can be found at higher elevations, where the temperature drops, and tree growth is limited.
e. Montane zones support a wide range of endemic plant species adapted to the unique climatic conditions and elevation. Examples are giant lobelia and giant groundsel.
f. Mountain vegetation exhibits vast differences in plant species between different elevations as well as the windward and leeward side of the mountain.

Figure 3.22: Vegetation on Mount Cameroon (Global National Parks)

Activity 3.4 Exploring the Characteristics of Relief, Drainage, Climate, and Vegetation of West Africa and Africa

***Note**: This activity can be done individually or a mixed gender/mixed-ability groups of not more than five members.*

1. Use atlas maps or online resources to gather information about West Africa and Africa on:
   a. **Relief**: Identify major landforms (mountains, plateaus, plains) and their characteristics.
   b. **Drainage**: Identify major rivers, lakes and lagoons and describe their characteristics.
   c. **Climate**: Identify climate zones and describe their characteristics.
   d. **Vegetation**: Identify vegetation zones and their characteristics.

2. Share your findings with a classmate or a friend in class.
3. Discuss how these characteristics interact. For example:
   a. How does the relief influence drainage patterns?
   b. What impact does climate have on vegetation types?
4. Create a visual representation (poster or digital slide) that summarises your findings. Include:
   a. Maps showing relief and drainage.
   b. Charts or graphs illustrating climate data (temperature, rainfall).
   c. Images or illustrations of vegetation types.
5. Ensure each characteristic is clearly labelled and organised.
6. If done in a group, reflect on your contributions to the group by answering these questions:
   a. Did you effectively communicate your findings?
   b. How well did you collaborate with your group members?
   c. What did you learn from researching your assigned characteristic?
7. Write a short paragraph reflecting on the overall activity:
   a. What insights did you gain about West Africa's geography?
   b. How do the relief, drainage, climate, and vegetation influence each other?
   c. What surprised you during your research and discussions?
8. Present your work or group's work to the class.
9. After each presentation, provide constructive feedback to your peers. Focus on:
   a. Clarity and completeness of the information presented.
   b. Creativity in the visual representation.
   c. Engagement and teamwork evident during the presentation.

Activity 3.5 Sketching the Physical Elements of West Africa and Africa

This activity can be done individually or in pairs.

1. Gather information on the following physical elements of West Africa and Africa:
   a. Relief: Major landforms such as mountains, plateaux, and plains and their locations.
   b. Drainage: Major rivers, lakes, and drainage basins and their location
   c. Climate: Climatic zones and their locations.
   d. Vegetation: Vegetation zones and their locations.
2. Use video documentaries from the internet, maps, and atlases to help visualise and understand these elements.

3. On a large sheet of blank paper, sketch the outlines of West Africa and Africa (Four each).
4. On the sketched maps (West Africa and Africa), locate and name
   a. major landforms using appropriate symbols
   b. major rivers and lakes using appropriate colours
   c. the different climatic zones using appropriate colours or shadings
   d. the vegetation zones
5. Consider adding marginal information (such as title, key and compass direction) to your map.
6. After completing the sketches, reflect individually by answering these questions:
   a. Did you accurately represent the physical elements in your sketches?
   b. How well did you and your partner collaborate during the activity?
   c. What challenges did you encounter while gathering information or sketching?
7. Exchange map sketches with a classmate or another pair in the class.
8. Provide constructive feedback focusing on:
   a. Clarity and accuracy of the physical elements represented.
   b. Creativity and organisation of the sketches.
   c. Overall presentation and ease of understanding.
9. Write a short paragraph reflecting on your overall experience:
   a. What new insights did you gain about the physical geography of West Africa and Africa?
   b. How do the relief, drainage, climate, and vegetation interact in shaping the environment?
   c. What surprised you during this activity?

Activity 3.6 Compare and contrast the relief, drainage, climate, and vegetation of West Africa with Ghana.

This activity is for discussion. Your teacher will put you into small groups and give you one of the following areas to research and discuss. You will present your findings to the class.

1. How do the mountains and highlands in Ghana compare to those in other parts of West Africa?

   Prompt: *Have you noticed how Ghana has highlands like the Akwapim-Togo range? Now compare that with the Fouta Djallon highlands in Guinea. How do these regions differ in terms of their height and terrain?*

2. What are the key differences in river systems and drainage patterns between Ghana and other West African countries?

   Prompt: *Think about the Volta River in Ghana. Now picture the Niger River. Can you see the differences in how these rivers impact agriculture and transport in their respective countries?*

3. How does the distribution of savannahs in Ghana differ from their distribution in other parts of West Africa?

   Prompt: *Ghana's got its vast stretches of savannah, right? How does this compare with the savannahs you find spread across West Africa, like in Burkina Faso or Mali?*

4. In what ways does the rainfall pattern in Ghana differ from the rainfall patterns in neighbouring West African countries?

   Prompt: *Ghana's rainy season is pretty distinct. How does this pattern change as you move westward into countries like Côte d'Ivoire or Liberia?*

5. How do the coastal and inland climatic conditions in Ghana compare to those in other West African nations?

   Prompt: *You have discovered that the coastal climate in Accra differs from the inland areas like Tamale. How does this comparison hold up in other West African countries along the coast and inland?*

6. What similarities and differences exist in the types of forests found in Ghana and those in other parts of West Africa?

   Prompt: *Ghana's got its tropical rainforests. Ever wondered how these compare with the forests in Sierra Leone or Liberia? What similarities and differences can you spot?*

7. How does the vegetation cover in Ghana's national parks compare with the vegetation cover in national parks across West Africa?

   Prompt: *Consider Mole National Park's vegetation in Ghana. How does the plant life there compare with what you might find in national parks across West Africa, say in Senegal's Niokolo-Koba National Park?*

Activity 3.7 Compare and contrast the relief, drainage, climate, and vegetation of Africa with Ghana.

You should **complete this activity on your own** but share the outcome with the class. Choose one of the following areas and **create a large poster** which highlights the vibrant and stimulating differences and similarities of your chosen topic (relief, drainage, climate or vegetation) over the African continent with that of Ghana. Make sure you include some incredible facts and figures on your poster for example – the River Nile, at 6,650km the longest river in the world, Lake Volta at 8,502 square kilometres, biggest artificial lake in Africa.

1. **Mountains and Highlands**: Prompt: Have you noticed how Ghana has highlands like the Akwapim-Togo range? Now compare that with the Atlas Mountains in North Africa or the Drakensberg Mountains in Southern Africa. How do these regions differ in terms of their height and terrain?
2. **River Systems**: Prompt: Think about the Volta River in Ghana. Now picture the Nile River in Egypt or the Congo River in Central Africa. Can you see the differences in how these rivers impact agriculture and transport in their respective regions?
3. **Savannah Distribution**: Prompt: Ghana's got its vast stretches of savannah, right? How does this compare with the savannahs you find in East Africa, like in Kenya and Tanzania, or in Southern Africa, like in Botswana?
4. **Rainfall Patterns**: Prompt: Ghana's rainy season is pretty distinct. How does this pattern change as you move across different parts of Africa, such as the rainforests in Central Africa or the arid regions in Northern Africa?
5. **Coastal vs Inland Climate**: Prompt: You have discovered that the coastal climate in Accra differs from the inland areas like Tamale. How does this comparison hold up in other African countries along the coast, such as Nigeria, versus inland countries like Chad.
6. **Forest Types**: Prompt: Ghana's got its tropical rainforests. Ever wondered how these compare with the rainforests in the Congo Basin or the Mediterranean forests in North Africa? What similarities and differences can you spot?
7. **Vegetation in National Parks**: Prompt: Consider Mole National Park's vegetation in Ghana. How does the plant life there compare with what you might find in national parks across Africa, like the Serengeti in Tanzania or Kruger National Park in South Africa?

Review Questions

Location, Size And Political Divisions of West Africa And Africa

1. What is Africa's rank in terms of landmass among the world's continents?
2. What percentage of the Earth's total land surface does Africa cover?
3. What is the extent of Africa's north-south expanse?
4. What are the easternmost and westernmost points of the African continental landmass?
5. What is the significance of Africa's location across both the Northern and Southern Hemispheres?
6. How many countries make up the African continent?
7. What are the five regional divisions of Africa, as grouped by the African Union?
8. Which countries are part of West Africa, and what is its economic community affiliation?
9. What are the characteristics of North Africa, and what is its economic community affiliation?
10. Which regional division includes the countries of Kenya, Ethiopia, and Tanzania?
11. How does Africa's geographic location influence its climate and economy?
12. What are the implications of Africa's strategic location across both hemispheres?
13. How do the regional divisions of Africa reflect cultural and historical ties?
14. What are the benefits and challenges of economic community affiliations in Africa?
15. How does Africa's diversity in geography, culture, and economy impact its development?

Relief, Drainage, Climate And Vegetation Of West Africa And Africa

1. What are the major highlands and lowlands found in West Africa?
2. Name two major rivers in Africa and describe their significance.
3. How does the relief of West Africa influence its drainage patterns?
4. Describe the typical climate zones found in West Africa. What factors contribute to these climatic conditions?
5. Compare and contrast the vegetation types found in West Africa with those in other subregions of Africa. What environmental factors contribute to these differences?
6. Analyse the impact of climate change on the vegetation zones of West Africa. What changes might occur in the future?

7. Evaluate how the interplay of relief, drainage, climate, and vegetation affects human activities (such as agriculture or urbanisation) in West Africa.
8. Develop a strategy to address the environmental challenges posed by the climatic zones in West Africa. What approaches could be taken to mitigate these challenges?

SECTION

4

MANUFACTURING INDUSTRIES IN GHANA

HUMAN AND ENVIRONMENT

Economic Activities

Introduction

In this section, you will learn about Ghana's manufacturing industries, which are important for the country's economy. You will find out where these industries are located, identify the key ones, and understand what role they play in providing jobs and helping the economy grow. You will also explore how these industries help bring new technologies to Ghana. However, you will also learn about the challenges these industries face, like poor infrastructure (bad roads and factories), lack of money for expansion, and competition from cheaper imported goods. To better understand these topics, you will participate in discussions, conduct research, and create presentations. This hands-on approach will help you appreciate the complexity of manufacturing in Ghana and its significance for the country's overall development. By the end, you will have the knowledge and skills to analyse how these industries affect the lives of people in Ghana.

Key Ideas

- Manufacturing industries are classified into small-scale and large-scale manufacturing companies
- Some of the reasons that accounted for the concentration of Manufacturing Industries in some parts of the country are proximity to raw materials and nearness to markets
- There are several challenges facing manufacturing industries and some of these challenges include poor infrastructure and limited access to money.

MANUFACTURING INDUSTRIES IN GHANA

Meaning of Manufacturing: it is the process of turning raw materials into finished products that people can use or eat. This can be done using machines or by using physical or chemical methods. Manufacturing is really important because it helps a country's economy by making different kinds of products instead of just relying on natural resources, like crops and minerals. This makes the economy stronger and more stable. In Ghana, manufacturing includes many different activities, from small businesses making things by hand to large factories producing goods on a big scale. These manufacturing activities help create jobs and support the country's growth by providing a variety of products for people to use.

Part 1 - The Distribution of Manufacturing Industries in Ghana

Ghana's manufacturing sector is especially important for its economic growth, making up about 10% of its GDP. GDP stands for Gross Domestic Product, which is the total value of all goods and services produced in a country. However, manufacturing is not evenly spread out across Ghana. Some areas have more factories than others, and this is caused by different geographic, economic, and government factors.

Historically, the areas near the coast, like Greater Accra and the Western regions, have been the main centres for manufacturing because they have good infrastructure, are close to ports, and have access to many customers. These regions produce things like food products, clothing, and metals. On the other hand, the northern regions do not have as many factories and mostly focus on processing agricultural products and natural resources.

To help, the government has started projects like industrial parks and special economic zones to encourage more balanced manufacturing across the country. They are also working to improve roads and energy supplies in less developed regions. However, there is still a challenge for leaders to address the differences in manufacturing across different areas of Ghana.

Types of Manufacturing Industries in Ghana

The following are the types of Manufacturing industries in Ghana;

Ghana's manufacturing sector can be split or divided into two main types: small-scale manufacturing and large-scale manufacturing. Small-scale manufacturing includes smaller businesses that make products, often by hand or with little machinery. These can be things like handmade goods like wooden furniture or local food products. On the other hand, large-scale manufacturing involves bigger factories that produce goods in large quantities using advanced machines. This can include items like clothing, electronics, or processed foods. Both types of manufacturing are important for the economy.

Characteristics of Small-scale Manufacturing Industries in Ghana

The following are the characteristics of Small-scale manufacturing industries in Ghana

1. **Few Workers**: Small-scale manufacturing industries usually have a small number of employees, often not more than a few dozen workers or not more than 12 workers.
2. **Common Locations**: These industries can be found all over Ghana, especially in rural areas and small towns like Swedru, HO, and Mampong among others just outside the cities.
3. **Low Energy Use**: They typically use less power for their work, often relying on sources like firewood, charcoal, or liquefied petroleum gas (LPG) for energy.
4. **Small Production Capacity**: The amounts of products they can make is generally small compared to larger factories example pure water manufacturing companies.
5. **Local Employment**: Many of the workers in these industries are family members, friends, or people from the local community.
6. **Unskilled Labour**: They mostly hire workers who may not have special training or skills for manufacturing.
7. **Less Investment Needed**: Small-scale industries usually do not require a lot of money to set up and run compared to larger factories.
8. **Using Local Techniques**: They often use traditional methods and simple machines, like a cassava grater or a hydraulic press for making palm oil. These local technologies help them produce goods effectively.

Examples of Small-scale Manufacturing Industries in Ghana

The following examples of some small-scale manufacturing industries in Ghana

1. **Food Processing and Beverages**

   Examples under food processing and beverages

   a. **Palm Oil Processing:** Small-scale palm oil mills producing palm oil for cooking and other uses.
   b. **Gari Production**: Processing raw cassava into finished products like gari.
   c. **Soobolo processing**: Local leaves and fruits such as lemon grass, hibiscus leaves, galbanum (Prɛkɛsɛ), cloves (pɛprɛ), ginger, and pineapples.
   d. **Honey Production**: Beekeeping and processing honey for local consumption and export.

Figure 4.1: Palm oil and gari processing using simple machines

2. **Textile and Cosmetics Production**

   Examples under textiles and cosmetics

   a. Kente Weaving: Artisanal production of kente cloth, a traditional Ghanaian textile.

Figure 4.2: Kente Weaving

   b. Tie and Dye: Small businesses producing tie-dyed fabrics and batik for local and export markets.

Figure 4.3: Tie and Dye production

c. Soap making: Local production of indigenous soap such as alata samena.

Figure 4.4: Alata samina

Visit the link below to watch a video on alata samena production https://youtu.be/lKKv6RPAO1c.

d. Shea Butter Production: Processing of shea nuts into shea butter, which is often done by women's cooperative associations in northern Ghana.

Figure 4.5: Shea butter production

3. **Woodworking and Furniture Making**

   Examples of woodworking and furniture-making

   a. Carpentry Workshops: Produce furniture such as chairs, tables, and cabinets from local timber.
   b. Wood Carving: Crafting wooden artifacts, sculptures, and souvenirs for tourists and local markets.

Figure 4.6: Wood Carving

4. **Crafts and Handicrafts**

   Examples:

   a. **Bead Making:** Creating beads from recycled glass and other materials for jewellery and decoration.

Figure 4.7: Bead Making

b. **Basket Weaving:** Producing baskets, mats, and other woven products from local materials like straw and reeds.

Figure 4.8: Basket Weaving

c. **Pottery and Ceramics:** Crafting clay pots, vases, and decorative items.

Figure 4.9: Pottery and Ceramics

General Characteristics of Large-scale Manufacturing Industries in Ghana

The following are the general characteristics of Large-scale manufacturing industries in Ghana

1. Located in Big Cities: Large-scale manufacturing industries are mostly found in major urban areas like Accra, Tema, Kumasi, Tamale and Takoradi.
2. Many Employees: These industries hire a lot of workers, often several hundred or even thousands.
3. Use of Modern Technology: They rely on advanced technology and have skilled workers, such as engineers, technicians, and managers, to help run their operations.
4. High Power Needs: Large-scale industries use a lot of energy for production, getting power from sources like hydroelectric dams, thermal plants, and coal.
5. Requires Significant Investment: They need a lot of money to start and operate, which is why we say they are "capital intensive."
6. High Production Output: These industries produce a large amount of goods, and the cost of making each product is low because they have so many workers and use efficient processes.

Examples of Large-scale Manufacturing Industries in Ghana

1. **Food and Beverage Processing:** This industry focuses on turning agricultural products into food and drinks. It includes processing items like cocoa, palm oil, fruits, and fish. Some well-known products from this sector are chocolate, fruit juices, canned fish, and alcoholic drinks. Examples of companies in this field are Cocoa Processing Company, Blue Skies Company Ltd, and Guinness Ghana Breweries.

Figure 4.10: A beverage factory

2. **Textile and Apparel:** This sector is all about making fabrics and clothing, including traditional outfits like kente cloth. It mixes modern techniques with old-fashioned weaving and dyeing methods. Some popular companies here are Akosombo Textiles Limited, Printex, and Ghana Textiles Printing Company Ltd, also known as GTP.

Figure 4.11: Printex manufacturing

3. **Chemical and Pharmaceuticals:** This industry produces important items like chemicals for factories, fertilisers for farming, paints, and medicines. It plays a key role in helping agriculture and healthcare. Examples of companies in this area include Ghana Chemicals and Tobinco Pharmaceuticals Limited.

Figure 4.12: Drug manufacturing company

4. **Building Materials:** This sector makes products like cement, bricks, roofing materials, and steel. These materials are important for building houses and other structures, helping to develop the country's infrastructure. Companies like Ghacem, Diamond Cement Ghana Limited, and B5 Plus Limited are involved in this industry.

Figure 4.13: Cement Manufacturing Company

5. **Automotive and Electronics Assembly:** This is about putting together vehicles and electronic devices. Although this sector is still growing, it is getting more investment and support from the government. Examples include companies like Kantanka Automobile, Toyota Ghana, and Samsung Electronics.

Figure 4.14: Vehicle assemblage in Accra

Reasons for the Concentration of Manufacturing Industries in Some Parts of the Country

1. **Proximity to Raw Materials:** Factories like to be close to the materials they need to make their products. This helps them save money on transportation and ensures they have a steady supply. For example, GHACEM and the Tema Oil Refinery are in Tema because they get their raw materials shipped through the Tema harbour.
2. **Access to Markets:** Many industries a set up in cities with lots of people, like Accra and Kumasi. Being near a large number of potential customers makes it easier for businesses to sell their products and reduces the cost of delivering them.
3. **Availability of Infrastructure**: Areas with good facilities like roads, ports, electricity, and water supply attract more factories. For example, Tema has a busy port and special industrial areas, making it an important centre for manufacturing.
4. **Skilled Labour Force:** Factories need workers who have the right skills and education. Places with many schools and universities, such as Accra and Kumasi, provide a steady number of trained workers for these industries.
5. **Government Policies and Incentives:** The government can help industries by creating rules that make it easier for them to operate. This includes things like tax breaks (which lower their taxes) and creating industrial zones where businesses can grow. These efforts aim to attract investment and support industrial development.
6. **Historical and Economic Factors:** Some areas have a history of being industrialised, which gives them an advantage. They have established networks and experience that attract new industries looking for a place to set up.

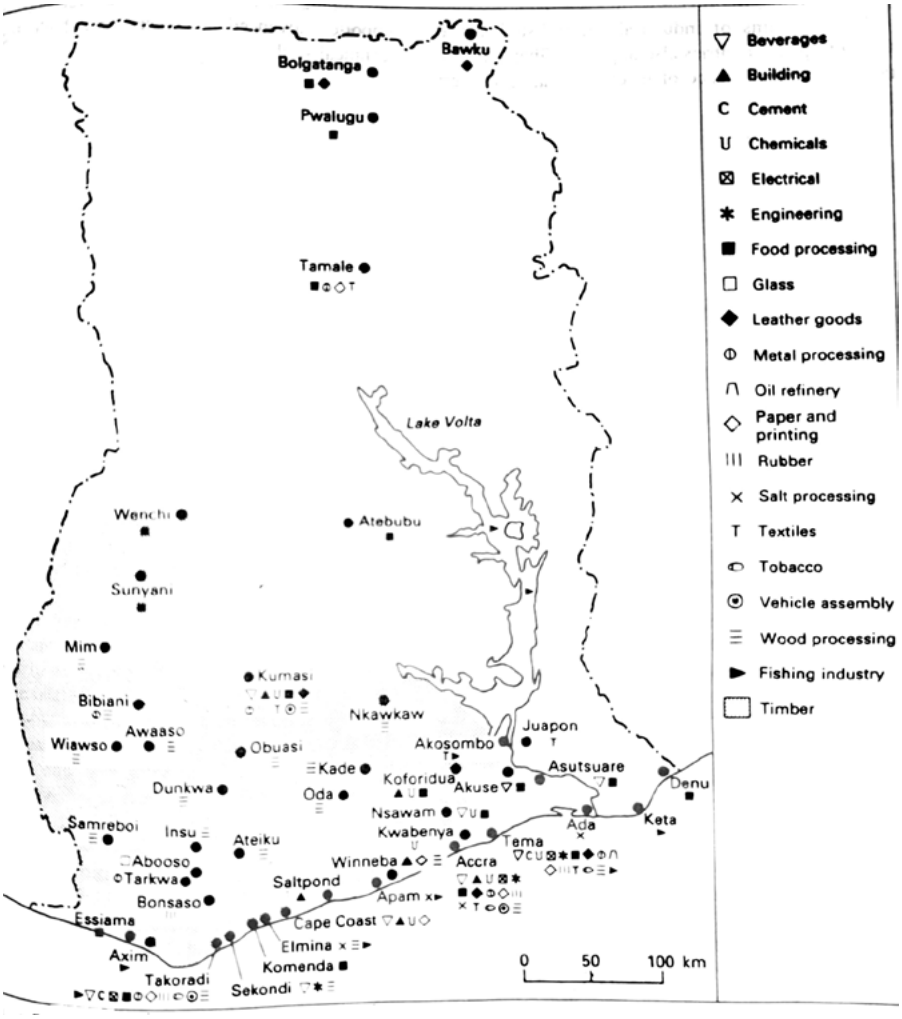


Figure 4.15: Distribution of Manufacturing industries in Ghana (Dickson & Acheampong, 1991)

Activity 4.1: Manufacturing Industries in Ghana

1. Use your internet device to watch videos and pictures that showcase some finished or semi-finished products made in Ghana. While watching the videos and surfing the pictures, perform the following activities
   a. Identify the things that go into making this product and the type of industry.
   b. Describe the characteristics of such an industry.
   c. Explain the reasons for the concentration of such an industry in the locality.
   d. Share your information with a friend in class

   If you cannot access the video or online materials, check your school or local library or look for an internet café near your home.

2. Create a KWL chart in your notebook or on a digital device. Use the sample below to guide you in creating the chart.

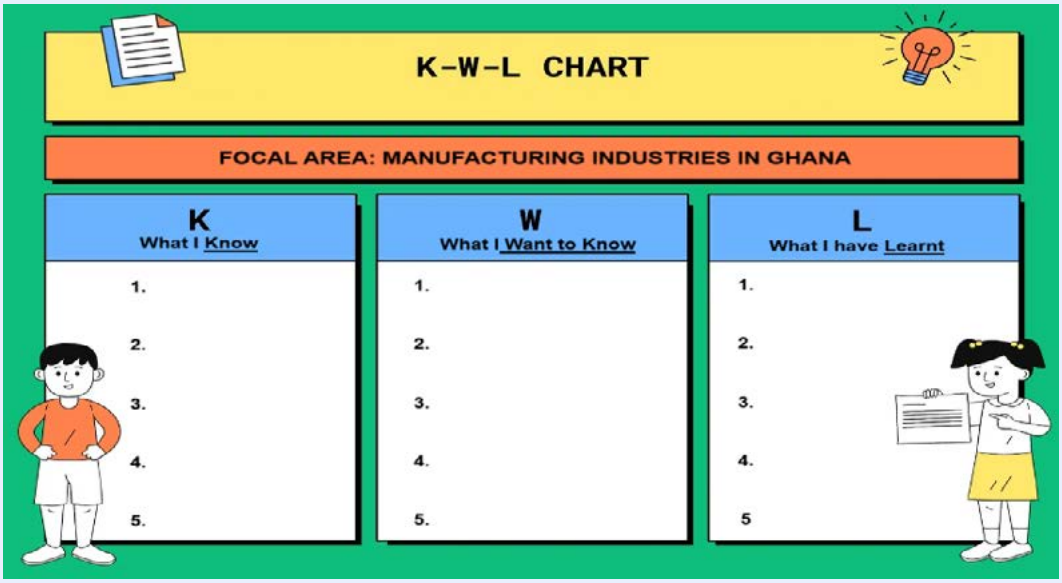


Figure 4.16: Sample KWL chart

a. Write whatever you know about manufacturing industries in Ghana in the '**What I Know**' section. Example: I know that Ghana has many manufacturing industries in Accra.
b. List what you want to learn about the manufacturing industries in Ghana in the '**What I Want to know**' section.
c. Example: I want to know about how chocolate is made.
d. Share your information with a friend in class

3. Use digital maps (like Google Map), Atlas, school or community library and other online materials to explore any one of the following manufacturing industries listed below.

Food processing
Oil refinery
Salt processing
Vehicle assembly
Wood processing
Textiles processing
Metal processing
Building materials
Wood processing
Chemicals and pharmaceutical
Leather goods

Record the following information for your chosen industry:

a. Describe the type of the industry?
b. Identify the location of such industry and why it is concentrated in such area
c. Explain the characteristics of the industry?
d. After your research, organise the information into a poster and share your findings with a friend in class. You may use your digital device to create digital poster.

4. Draw an outline map of Ghana in your notebook or a large paper
   a. On the map, accurately plot the locations of some manufacturing industries in Ghana. You may use atlas or Google Map to guide you.
   b. Add decorative elements like border line, a compass rose and key to describe the symbols used on the map.
   c. Share your findings with a friend or classmate.
5. Visit a local industry (e.g., basket weaving, Kente/smock weaving, gari processing, palm oil processing, pottery making, etc.) or a large industry (e.g. textiles making, car assemblage, foods and beverages, chemical and pharmaceutical factories, etc.) in your community, town or city and perform the following activities.
   a. Explain the type of industry located in your community.
   b. Identity the characteristics of such industry located in your community.
   c. Describe the reasons for the concentration of such industry in your community.

If a local industry visit is not possible, you can undertake the following:

6. Visit the links below to watch videos on different manufacturing activities.
   a. https://youtu.be/HEOjb5ZJEVI
   b. https://youtu.be/YDhnu_xhEJ0 -

   c. Supplement the video viewing with online articles or resources from your school or community library on the types and characteristics of manufacturing industries. Now share your thoughts and ideas on the types and characteristics of manufacturing industries with a friend.
   d. Use the knowledge gained from your research on the types and characteristics of manufacturing Industries in Ghana to complete the **Table 4.1**.

Table 4.1: Types of manufacturing industries

THEME	TYPES OF MANUFACTURING INDUSTRIES	
	SMALL SCALE	LARGE SCALE
Number of employees	Has fewer employees	a……
Physical size	occupies a smaller area	b……
Production capacity	c……	produces in bulk
Ownership	d……	Mostly owned by corporations or companies.
Technology	Uses simple technology	e……
Market Reach	primarily serves the local market	f……
Investment	g……	h……
Examples in Ghana	Gari making i…… j……	Ghana Brewery Ltd k…… l……

IMPORTANCE AND CHALLENGES OF MANUFACTURING INDUSTRIES IN GHANA

Importance of Manufacturing Industries in Ghana

The following are the importance of manufacturing industries in Ghana:

1. **Economic Growth and Variety:** Manufacturing industries help Ghana make more money by producing goods, which adds to the country›s wealth (called GDP). This is important because it means Ghana does not have to rely only on farming and mining. By making more things, Ghana can better protect itself from problems that come from global markets, like price changes.
2. **Job Creation:** Manufacturing industries create many types of jobs. Some jobs require special skills, while others do not need much training. This means more people can find work, lowering the unemployment rate and helping families earn more money.

3. **Value Addition to Products:** Manufacturing takes raw materials, like cocoa and minerals, and turns them into finished products. These products can be sold for higher prices around the world. By doing this, Ghana earns more money from exports and improves its balance of trade.
4. **Building Infrastructure:** To support manufacturing, Ghana needs to develop things like roads, electricity, clean water, and communication systems. This means that as manufacturing grows, so do the basic services needed for people to live better lives.
5. **Government Revenue:** Manufacturing industries help the government earn money through taxes and fees. This money can be used to support schools, hospitals, and other public services that benefit everyone.
6. **Better Living Standards:** Manufacturing produces many consumer goods that people need, making these products more accessible. When workers earn good salaries in manufacturing, it raises their household incomes and helps fight poverty.

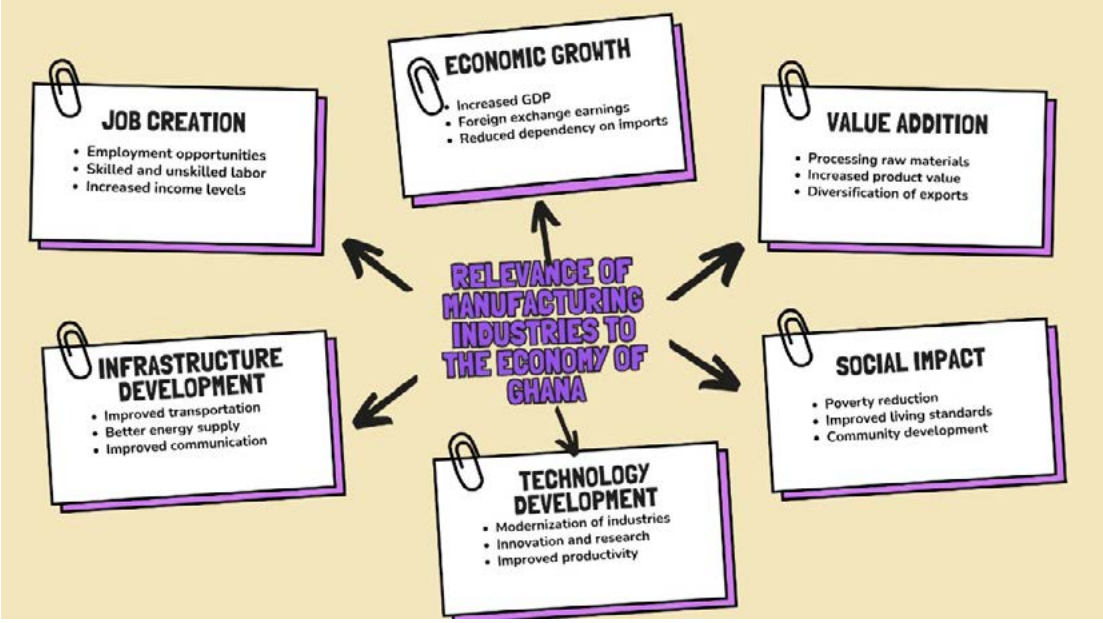


Figure 4.17: Relevance of Manufacturing Industries to the Economy Ghana

Challenges Faced by Manufacturing Industries in Ghana

The following are the challenges facing manufacturing industries in Ghana:

1. **Poor Infrastructure**: Many factories struggle because of problems like frequent power outages and bad roads. These issues make it harder to operate smoothly and increase costs.
2. **Limited Access to Money**: High interest rates can make getting loans tough for manufacturers. Small businesses, in particular, find it difficult to get funding because banks often require collateral that they do not have.

3. **Lack of Skilled Workers**: There are not enough workers with the technical skills needed for modern manufacturing. Also, not enough training programs are available to help current workers improve their skills.
4. **High Production Costs**: The prices of raw materials can change a lot, making it expensive to produce goods. Dependence on imported materials and machines also raises costs and makes businesses vulnerable to currency changes.
5. **Market Access and Competition**: Ghana's smaller market makes it hard for factories to produce on a big scale. Additionally, cheaper imported goods can compete with locally made products, which hurts sales.
6. **Outdated Technology**: Many manufacturing companies use old technology, which makes them less efficient. They also do not invest enough in research and development, limiting their ability to create new products and improve processes.

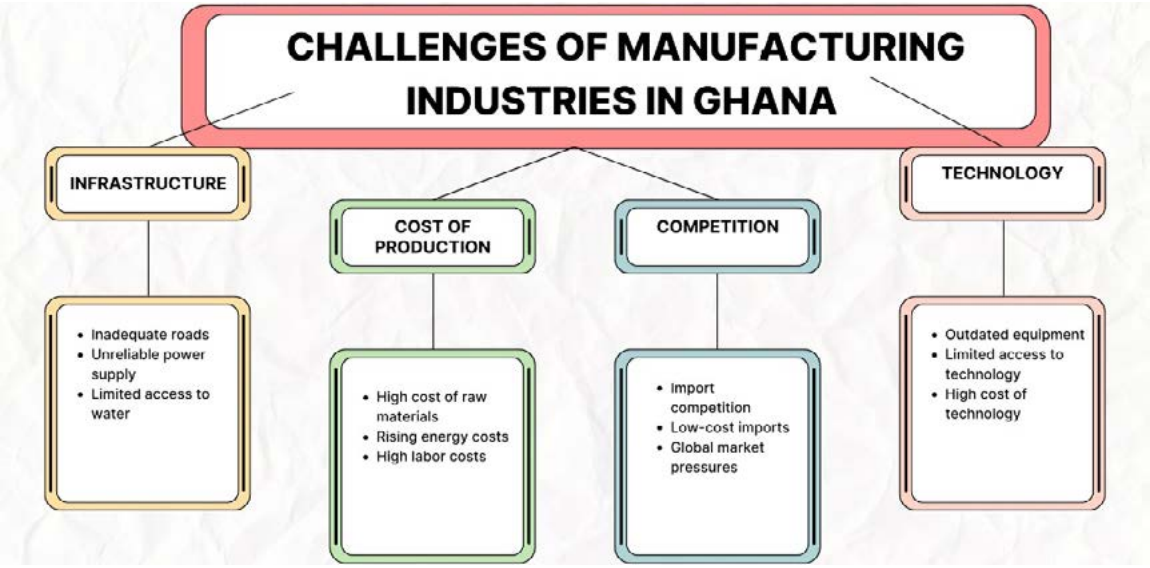


Figure 4.18: Challenges of manufacturing industries of Ghana

Solutions to the Challenges faced by Manufacturing Industries in Ghana

The solutions to the challenges are as follows:

1. **Better Infrastructure**
   a. **Use Renewable Energy**: Invest in sources like solar, wind, and hydropower to have more reliable electricity.
   b. **Improve Roads**: Upgrade roads and transportation systems to help move goods more easily.
   c. **Team Up**: Encourage partnerships between the government and businesses to fund these infrastructure projects.

2. **Easier Access to Money**
   a. **Lower Interest Rates**: Push for lower interest rates and better loan options, especially for small businesses.
   b. **Microfinance and Grants**: Provide access to smaller loans and government funding specifically for small and medium businesses.
   c. **Support for Loans**: Create programs that help small businesses get loans by reducing risks for banks.

3. **More Skilled Workers**
   a. **Training Programs**: Develop training programs to improve the skills of current workers.
   b. **Technical Education**: Promote technical and vocational schools to prepare more students for jobs in manufacturing.
   c. **Apprenticeships**: Encourage hands-on training programs that let students learn directly in factories.

4. **Lower Production Costs**
   a. **Use Local Materials**: Encourage the use of materials from Ghana to reduce reliance on imports and avoid price changes.
   b. **Buy Together**: Promote group buying among manufacturers to get better prices on materials.
   c. **Improve Efficiency**: Use techniques that make production more efficient and cost-effective.

5. **Access to Markets and Competition**
   a. **Explore New Markets**: To increase production, look for new places to sell products, both in Ghana and abroad.
   b. **Focus on Quality**: Improve the quality of locally made products to compete better with imports.
   c. **Protect Local Industries**: Advocate for government support, like tariffs (taxes on imports) to help local businesses.

6. **Upgrade Technology**
   a. **Invest in New Tech**: Encourage businesses to invest in modern technology and equipment, such as solar, wind, and hydroelectric power, to reduce dependence on unreliable electricity grids and improve efficiency.
   b. **Collaboration to boost infrastructure**: partnering with businesses can help fund the necessary road infrastructure to boost production
   c. **Research and Development**: Promote spending on research to create new products and improve processes.

Activity 4.2 Importance and challenges of manufacturing industries in Ghana

1. How do manufacturing industry in your locality contribute to the development of infrastructure?
2. What are the challenges faced by the local industry in your community
   a. Provide possible solutions to the challenges faced by your local industry
   b. Share your view with the opinion leader within your community
3. Create a mind map showing the following on manufacturing industries in your community.
   a. Importance of manufacturing industry to your locality
   b. Challenges faced by this local industry
   c. Solutions to the challenges faced by this local industry
4. Design a mind map to show connections between challenges faced by manufacturing industries in your locality and the suggested solutions.
5. Share your information with a friend in class.

Review Questions

The Distribution of Manufacturing Industries in Ghana

1. What are some types of manufacturing industries found in Ghana?
2. What are the characteristics of small-scale manufacturing industries in Ghana?
3. What are some of the main products made in large-scale textile industries in Ghana?
4. Name two large-scale beverage manufacturing company in Ghana.
5. What factors contribute to the concentration of industries in urban areas of Ghana?
6. How do small-scale industries benefit local communities?
7. Choose one type of manufacturing industry and explain its production process.
8. Discuss the impact of infrastructure on the location of manufacturing industries in Ghana.
9. Draw a map of Ghana. On the map locate and name
    a. one food and beverage processing industry
    b. vehicle assemblage industry
    c. one oil refinery industry
    d. one metal processing industry
    e. one textile manufacturing industry

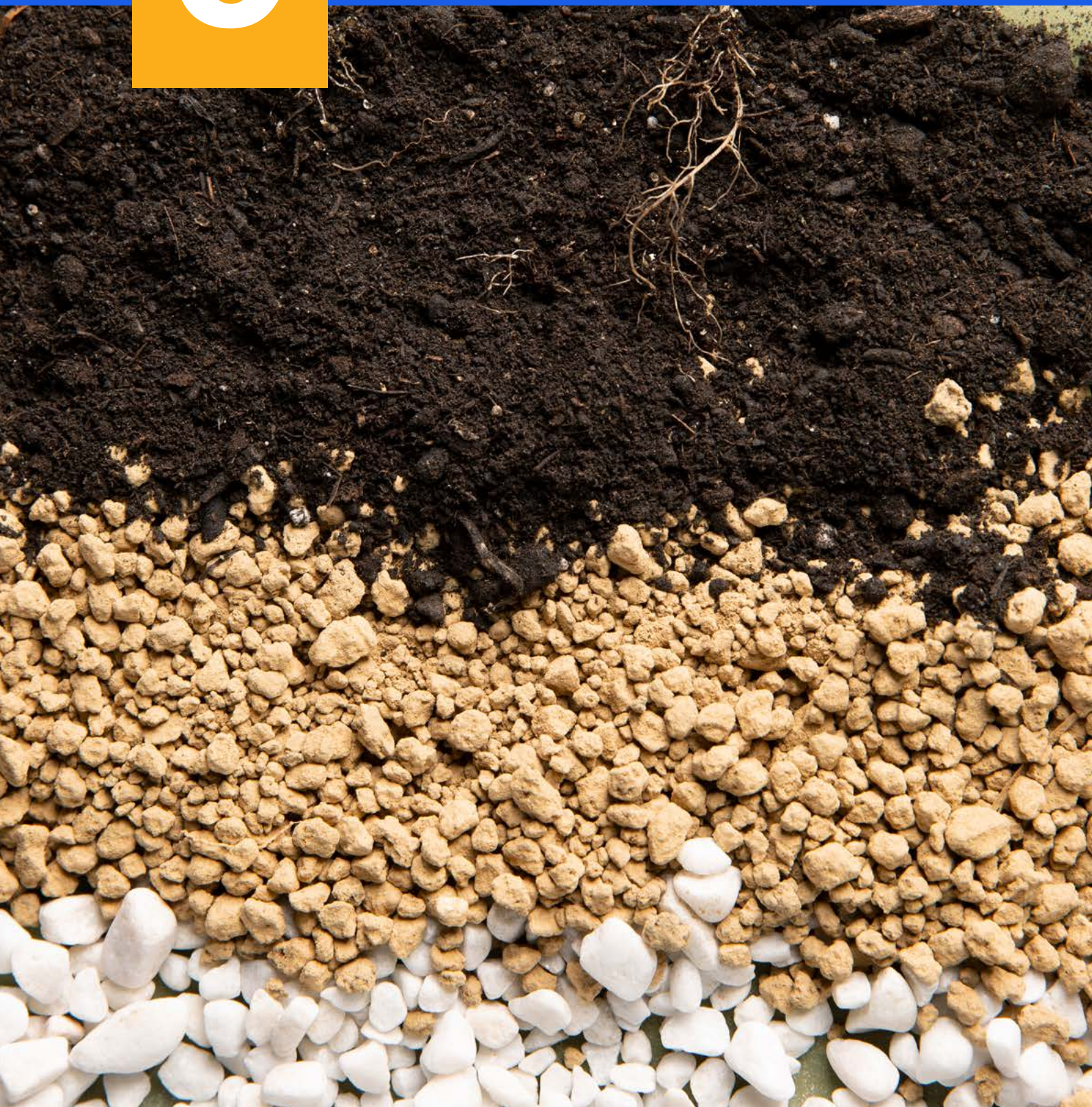
Importance and Challenges of Manufacturing Industries in Ghana

1. What are some key contributions of manufacturing industries to the economy of Ghana?
2. Explain three challenges that manufacturing industries in Ghana might face.
3. Outline three challenges facing manufacturing industries in Ghana, analyse one major challenge in detail. Discuss its implications for the industry and the economy.
4. Propose two feasible solutions to the challenges faced by manufacturing industries in Ghana. Justify your reasoning for each solution based on your research.

Geography Year 2

SECTION 5

SOIL FORMATION



THE EARTH'S AND ITS NEIGHBOURHOODS

Rocks, Weathering, Soils and Mass Wasting

Introduction

Soil is the vital, living skin of our planet, a foundation for all terrestrial life. At its most basic, soil is a complex mixture of minerals, organic matter, water, and air, each playing a critical role in its function. This section delves into the intricate world beneath our feet, beginning with a clear definition of soil and an exploration of its essential components. We will examine the vertical structure of soil, known as the soil profile, revealing the distinct layers that form over time through a variety of processes.

Understanding how soil comes to be is crucial, so we will investigate the key factors that govern its formation, from climate and parent material to the organisms that inhabit it. Our focus will then shift to a detailed study of three primary soil types: clay, loam, and sandy soils, exploring their unique properties and characteristics. Building on your previous work on the distribution of soil types across Ghana, this exploration will highlight the profound importance of soils to human civilization, from agriculture and construction to filtering our water. This journey into the ground will underscore why protecting this invaluable resource is essential for a sustainable future.

Key Ideas

- Clay, loamy and sandy soil are three soil types
- Soil is a mixture of minerals, organic matter (known as humus which is dead and decaying plants), living organisms, water, air and nutrients.
- Soil is a thin layer of loose material found on the surface of the Earth.
- Soils are classified broadly into types based on their physical and chemical properties.
- Soils support plant growth and their role in food production is critical in sustaining life on Earth.
- The formation of soils is influenced by climate, vegetation, topography, organisms and time.
- The vertical sectional view of soil is called a soil profile and is divided into layers called horizons.

SOILS

Definition of Soil

Soil can be defined as the unconsolidated mineral and organic materials on the surface of the Earth that serve as a medium for plant growth. Soils form part of the numerous resources like rocks, minerals, and water found on the surface of the lithosphere. Check you understand the term 'lithosphere' from the first lessons in year 2. Because of the role it plays in plant growth, soil is a natural resource essential for sustaining life on Earth.

Composition of Soil

Soil is a mixture of different components. There are five components to the mixture and these are:

1. **Mineral Particles:** These are the parts that form the **texture** of soils – how it feels when you rub it between your fingers. They are the product of physical, biological and chemical weathering of rocks. They help to group soils into three types - **sand, silt, and clay,** based on **particle size**. The mineral sand is the largest particle size, followed by silt, and then the smallest clay.
2. **Organic Matter:** This refers to **plant and animal remains** that decompose as part of the formation of the soil. It also includes kitchen waste created by humans which can be added to improve soil fertility. The organic matter is also known as **humus** which adds nutrients to the soil, thus making it fertile to support plant growth.
3. **Water:** Soils also retain or contain water, **found mainly between the solid parts if the soil**. Soil water is essential for the survival of plants and soil organisms. Without it, the soil cannot support crops and vegetation.
4. **Air:** The **air fills the gaps between soil particles not occupied by water**. It means that in the wet season, soils retain more water but in the dry season, soils retain more air. Soil air is essential for the transpiration and respiration of plant roots and soil microorganisms.
5. **Living Organisms:** Soils contain a variety of organisms. These organisms play very important roles in the supply and distribution of nutrients, decomposition of organic matter, maintenance of soil texture and structure and the proper functioning of the soils. Examples of soil microorganisms are bacteria, fungi, earthworms, eelworms, termites, insects, and other fauna that live in the soil.

Figure 5.1: Soil living organisms.

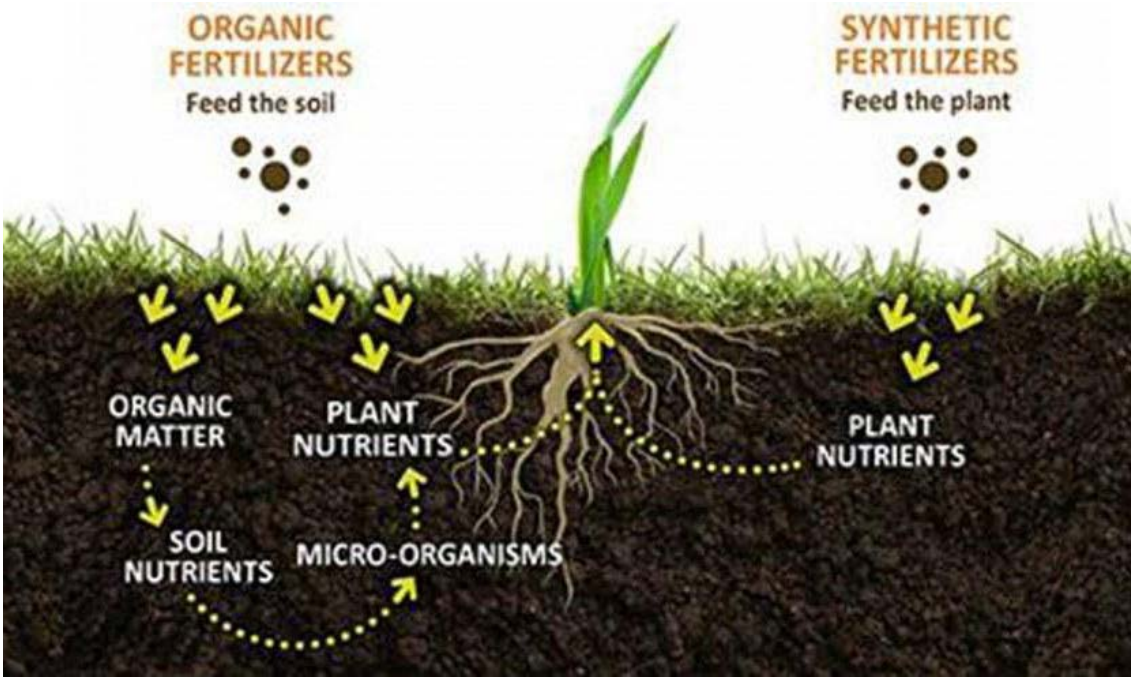


Figure 5.2: Organic matter in soils.

Soil Profile

When you dig deep into the soil, you will likely see different layers or zones with distinctive characteristics. These layers or zones are known as **horizons**. A number of horizons is called a soil profile. A soil profile is defined as the vertical sectional view of soil from the top or surface to the bottom layer or bedrock. The term bedrock is often referred to as the parent material of the soil because that is the main source

of the mineral component of a soil. A sandy rock will produce a sandy soil. A shale will produce a clay soil. See **Figure 5.3**. Each horizon or layer has distinct physical and chemical characteristics. It helps, among other things, to know whether the soil is young or old. The horizons or layers are discussed below:

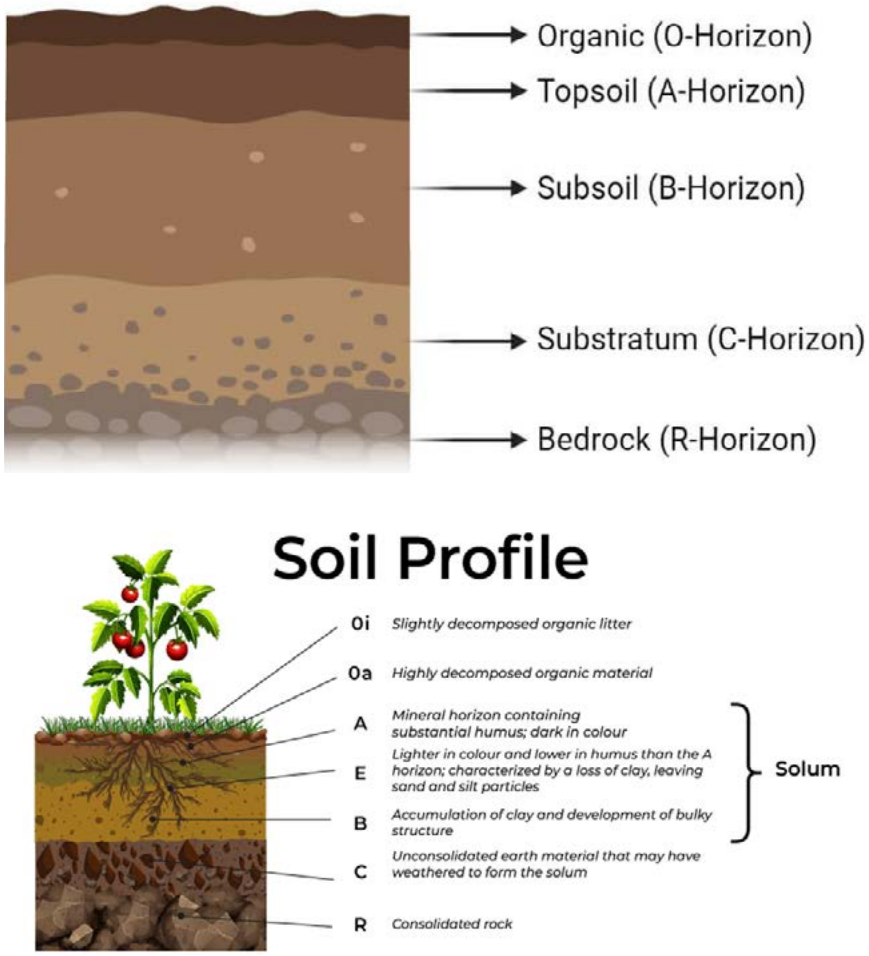


Figure 5.3: Soil profile.

1. **O Horizon:** This is the topmost or surface layer, also called the organic horizon. It mainly consists of decomposed organic matter, including dead and fallen leaves and other plant remains. This layer or O horizon enriches the soil with nutrients and contributes to its fertility.

2. **A Horizon:** The A horizon is often referred to as the topsoil. It is composed of rich dark organic matter due to the activities of soil microorganisms which help the decomposition of organic matter. It is characterised by a dark colour due to the presence of organic matter. Due to the presence of many readily available nutrients, this layer is crucial for plant root development and healthy growth.

3. **E Horizon:** The E horizon, also known as the **eluviation** horizon, is typically found in soils with good drainage. It is lighter in colour than the A horizon and is characterised by a loss of materials like minerals and organic matter. **Eluviation** is a term which simply means the picking up of clay, iron and organic matter by soil

water which moves them down the soil profile. It is important to understand that **leaching** is also the transport of materials down the soil profile by water but in this case, they are the dissolving in the water - soluble salts, and key nutrients like nitrogen and potassium.

4. **B Horizon:** The B horizon, commonly known as the subsoil, has soluble minerals and nutrients that have been **leached** from the upper layers. It often displays a reddish or yellowish colour due to the accumulation of leached materials – iron salts in this case. The B horizon can vary in thickness and composition depending on the specific type of soil.
5. **C Horizon:** The C horizon is the layer of weathered **parent material or bedrock** from which the soil has formed. It consists of partially weathered rock fragments and has little organic matter content.
6. **R Horizon:** The R horizon, also known as bedrock, is the non-weathered solid rock beneath the soil layers. It serves as the foundation from which the soil is derived but is not considered a part of the soil profile.

Factors of Soil Formation

The formation of soils does not occur within a short period. Soils need more time to develop as they go through processes. These processes are influenced by a number of factors. These are discussed below.

a. **Climate:** Hope you remember your discussions on climate and weather elements. These weather and climatic elements have some influence on the formation of soils. Therefore, the climatic conditions of a place are determined by temperature, precipitation, wind, and humidity among them. These play an essential role in soil formation. Temperature influences the rate of weathering. Precipitation and humidity determine and regulate the amount of water and movements of nutrients and minerals within the various zones or profiles of the soil. The rate of evaporation, the wetness or dryness of the soil is determined by the amount of moisture in the soil. This also helps the functioning of the soil organism and the rate of decomposition in the formation of the soil. Humid climate soils have higher organic matter due to dense vegetation and high rainfall but suffer from leaching (removal of dissolved nutrients) and this affects fertility - southern part of Ghana, including the Ashanti and Western regions. Dry climate soils are low in organic matter, with high mineral content and less leaching, which can lead to low nutrient content and a build-up of hard layers which make farming difficult – northern Ghana.

b. **Parent Material:** This defines the type of materials that make up the soil. A sandy parent material will produce a sandy soil, and a shale will produce a clay soil. The minerals, texture, the physical and chemical composition of the parent material largely determine the level of fertility and other characteristics of the resulting soil. Volcanic rocks produce soils that are very fertile because they contain many elements that provide plant nutrients as they are weathered. Sandy rocks produce soils that are not very fertile because sand (quartz) is

difficult to break down, has only two elements, and large particles help to drain water and any nutrients quickly, making it difficult for plants to get what they need to grow.

c. **Organisms:** The presence and activity of living organisms help the decomposition within the soil and the nutrient content. The organisms are plants, animals, fungi, and bacteria. These significantly promote the formation of soil. Plant roots, for example, can physically and chemically cause weathering of parent material, while decomposing organic matter adds nutrients and alters soil structure. Burrowing animals mix and aerate the soil, while microorganisms drive crucial biogeochemical processes that add soil components essential for plant growth.

d. **Relief:** The topography or relief of the land also impacts soil formation. Do you remember your lesson on the relief of Ghana and Africa? The nature of the land, be it steep slope, gentle or undulating will impact the formation of soils in the area. For example, steep slopes are prone to increased erosion, limiting soil depth, while gentle slopes and depressions tend to accumulate weathered materials. Soils along a steep slope are well drained as against those found in gentle and low-lying areas. Aspect, which is the direction a slope faces concerning the Sun, can influence soil moisture and temperature, leading to variations in soil characteristics even within a small geographic area.

e. **Time:** Soil formation takes a long time, like building a masterpiece from scratch. Imagine starting with just rocks. Over many, many years, these rocks break down and mix with organic material from plants and animals. The youngest soils are quite simple, but as time passes, they become more complex with layers that have different characteristics. This process involves the accumulation of organic matter, leaching of minerals, and the development of distinct horizons (layers). Eventually, after a long period, you get mature and productive soil that can support plant life effectively.

Activity 5.1 Discovering the Meaning of Soil

Working with a partner

1. Take a moment to think about the question: "What is soil, and why do you think it's important?" Discuss your thoughts with a partner
2. Use your devices to search for information about soil.
3. As you gather information, take notes on significant points, interesting facts, and new terminology related to soil.
4. After completing your research, take a few minutes to think individually about what you believe to be the meaning.
5. Write down your thoughts on chart paper or a digital document. You can use bullet points, mind maps, or diagrams—whatever method you prefer.

Organise yourselves into groups of no more than five for the rest of the activities

1. In your groups, take turns sharing your findings from the first five tasks in this activity.
2. Work together to create a poster or digital presentation that summarises your group's understanding of soil.

Working on your own

1. Spend a few minutes writing in your journal. Respond to the following prompts:
   a. How did I feel about sharing my ideas with others?
   b. What key takeaway about soil surprised me the most?
   c. How can I apply what I learned about soil to my understanding of the environment?

Activity 5.2 Exploring the Composition of Soil through Hands-on Activity.

Your teacher will provide you with some samples of soil in school. If you are working at home, choose an undisturbed area, remove the growing plants or gently part them and take some soil from about 3cm down and store it in a plastic bag. Choose an area which is not being used to grow things! Working on your own:

1. Think about what you already know about what makes up soil. Consider the different components that make up soil: mineral particles, organic matter, water, air, and living organisms.
2. Examine soil samples and identify their composition. Use hand lenses, glass dishes and brushes to observe and categorise what you find. Use your hands and a bit of water to feel the soil by rubbing it together between your fingers. Sand feels gritty, silt feels smooth and silky when wet, clay is sticky when wet.
3. Record the colours you see, and any living organisms you may find.
4. Use a chart, paper or table to document and organise your observations, noting the different components you identify. Consider:
   a. Mineral Particles: Look for sand, silt, and clay.
   b. Organic Matter: Identify decaying leaves, roots, or organisms.
   c. Water and Air: Discuss how to determine moisture levels.
   d. Living Organisms: Record any worms, insects, or microorganisms you see.

   For the remainder of this activity, organise yourselves into groups of no more than five. If working at home, share your findings with someone from your family.

5. In your groups share and summarise your findings and present to the class.
6. Assess your participation, contribution, and collaboration during the activity. Reflect on questions like:
    a. What did I learn about soil composition today?
    b. How well did I work with my peers?
    c. What role did I find most challenging, and why?

Working on your own

1. Write a brief reflection in your journal addressing:
    a. Your feelings about working on this task with your classmates.
    b. What surprised you the most about the soil you examined?
    c. How can you apply what you learned to your understanding the importance of soil to other parts of the environment.
2. Share one new insight you gained from this experience with a partner. Discuss how understanding soil helps people appreciate our environment.

Activity 5.3 Soil Profile

Your teacher will put you into small groups for this activity.

1. As a group share some thoughts about the images of soil profiles provided below. Discuss the following questions in your group:
    a. O Horizon: How does decomposition influence this layer? How does organic matter contribute to soil fertility?
    b. A Horizon: What makes this layer darker? Why is it important for plant growth?
    c. E Horizon: What materials are eluviated or leached away from this layer, and how does it affect soil quality? Why might this horizon be less fertile than the A horizon?
    d. B Horizon: How does this layer differ from the ones above? What might it be made of?
    e. C Horizon: What can you say about this layer? How might it affect plant roots?
    f. R Horizon: What is this bottom layer? Why do you think it is significant?

Figure 5.4: Soil profiles

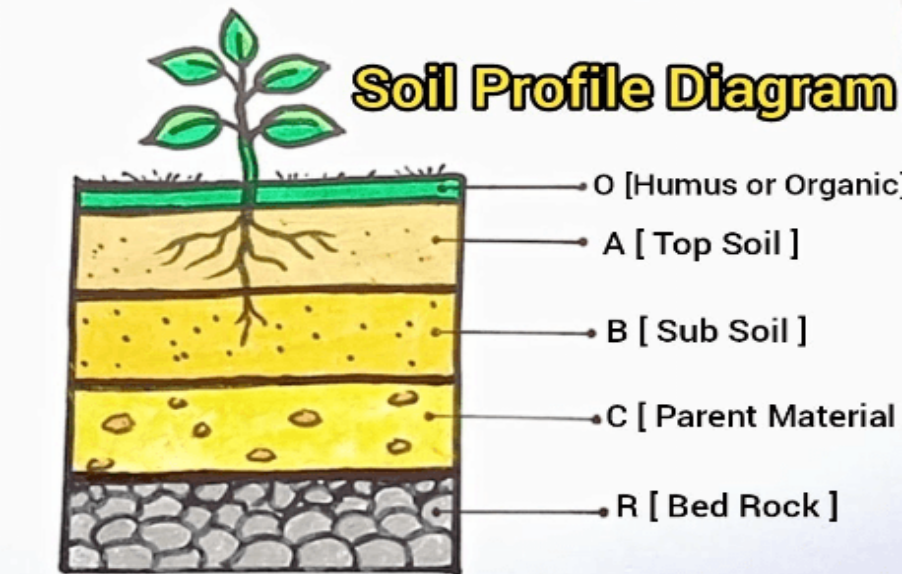


Figure 5.5: Sample soil profile

Activity 5.4 Factors of Soil Formation Observation

Choose three or five locations with different soil types (e.g., garden, park, forest, farm). With a friend organise a field trip to your chosen locations and perform the following activities. Take care to inform a responsible adult where you are going and how long you are going to be away for. Take care to avoid areas where there might be heavy traffic, water or other dangerous places. Ask permission to examine the soil at your chosen locations if necessary. It is a good idea to discuss your plans with your teacher before you go.

1. Parent Material:
   Determine the underlying rock or any other parent material like river sediment. Note how it influences soil colour and texture.
2. Climate:
   a. Find out how rainfall and temperature affect soil moisture in each location.
   b. Note how vegetation responds to climate conditions.
3. Topography:
   a. Observe how slope and elevation might affect soil erosion.
   b. Note how water flows through the landscape.
4. Biological Organisms:
   a. Observe plant roots and microorganisms.
   b. Note how they contribute to soil fertility.
5. Recognise any organic matter (decaying plants, animals).

Record your findings and present them to the class.

TYPES AND IMPORTANCE OF SOILS

The following part of this section deals with soil types and the importance of soil both economically and environmentally.

Types of Soils

Soils are classified based on their physical and chemical properties. In this section you will learn about how particle size can be used to classify soil. In terms of size **sand** has the largest particles, **silt** has medium-sized particles, and **clay** has the smallest particles. Sand particles are about the size of a grain of sugar, silt particles are like bread flour, and clay particles are very small, forming fine dust when dry. The main types of soil based purely on the mix of particle sizes are clay soil, loamy, and sandy soils. A loam is a type of soil which has an equal mix of sand, silt and clay. These are shown in **Figure 5.6**.

Figure 5.6: The three main types of soils based on size of particles.

Clay Soils

Clay soils are a type of soil that feels sticky when wet and the average particle size is very fine.

Characteristics of Clay Soils

1. **Particle Size:** Clay soils have very fine particles, less than 0.002 millimetres in diameter.
2. **Texture:** They have a smooth and sticky texture when wet and harden when dry. This means that clay soils get wet easily and also dry up easily.
3. **Water Retention:** Due to the smallness of the particles, clay soils have high water-holding capacity. They also tend to cover large surface areas.
4. **Drainage:** Clay soils are poorly drained. This is due to the small nature and tightly packed organisation of their particles which does not allow water to pass through them easily. This easily leads to waterlogging because permeability is slow.
5. **Nutrient Holding:** Clay soils can absorb and hold onto essential minerals and nutrients. As a result, they have high nutrient retention.
6. **Structure:** They are compact and dense, with low porosity and aeration.
7. **Distribution:** They are mostly found in low-lying waterlogged areas

Advantages of Clay Soils

1. High nutrient content makes clay soils fertile
2. Good water retention benefits plants during dry periods.
3. The rich nutrient and high-water retention capacity make clay soils ideal for the cultivation of water and nutrient-demanding crops such as wheat, rice, sugar cane and barley.

Limitations of Clay Soils

1. Poor drainage can lead to waterlogging thus making it unsuitable for cultivating root crops such as cocoyam, cassava and yam.
2. Difficult to work in both the dry and wet seasons due to its heavy and sticky nature, especially when wet and hard during the dry season.

Loamy Soils

Loamy soil refers to a type of soil that is a mixture of equal parts of sand, silt and clay. They are known for their ideal texture and composition for plant growth. If you want to make a loamy soil, just mix the topsoil with organic matter.

Characteristics of Loamy Soils

1. **Particle Size:** They have a wide range of particles from clay size (0.002mm) to sand size (2.0mm) Loamy soils are a balanced mixture of sand, silt, and clay particles.
2. **Texture:** Soft, crumbly texture that is easy to work with.
3. **Water Retention:** Due to relatively larger particles, loamy soils have moderate water-holding capacity, providing good moisture availability for plants.
4. **Drainage:** Good drainage with adequate aeration, reducing the risk of water-logging.
5. **Nutrient Holding:** Sufficient nutrient retention, combining the advantages of clay and sandy soils. They are ideal for growing crops due to rich organic matter content.
6. **Structure:** Well-structured, with good porosity (plenty of spaces) and aeration (air easily passes through).

Advantages of Loamy Soils

1. Ideal for most agricultural purposes due to its balanced properties.
2. Easy to work with and provides a stable environment for plant roots.
3. It has the perfect soil texture for plant growth and thus supports a wide variety of crops and plants.

Disadvantages of Loamy Soils

1. Require regular management to maintain fertility and structure.
2. May be subject to erosion if not properly managed.
3. The good drainage properties of loamy soils can sometimes lead to the leaching of nutrients, especially in areas with heavy rainfall or when too much water is applied (irrigation).

Sandy Soils

The sandy type of soil is characterised by a high proportion of sand particles (between 65% and 85%) and a low proportion of clay and silt particles.

Characteristics of Sandy Soils

1. **Particle Size:** Sandy soils have large particles, ranging from 0.05 to 2 millimetres in diameter.
2. **Texture:** Gritty and coarse texture that feels rough to the touch.
3. **Water Retention:** Low water-holding capacity. Sandy soils allow water to pass through them easily, leading to quick drainage and drying.
4. **Drainage:** Good drainage, with high permeability and low water retention.
5. **Nutrient Holding:** Poor nutrient retention due to the large particle size and low surface area.
6. **Structure:** Loose and well-aerated, with high porosity.

Advantages of Sandy Soils

1. Light and easy to work with, making it simpler to till, plant, and weed.
2. Good drainage reduces the risk of waterlogging and root diseases.
3. Suitable for plants that prefer well-drained conditions, such as root crops and certain vegetables.

Disadvantages of Sandy Soils

1. Require frequent watering and fertilisation due to low water and nutrient retention.
2. Susceptible to erosion and leaching of nutrients.

In **Table 5.1** is the soil type and properties at a glance. This is based on **particle size, texture, water retention, drainage, nutrient holding** and **structure.**

Hope you can identify these and use them to strike the differences among them.

Table 5.1: Properties of soil types

Soil type	Properties
Sand	Large particles, ranging from 0.05 to 2 millimetres in diameter Gritty and coarse Low water-holding capacity leading to quick drainage and drying out. Excellent drainage, with high permeability and low water retention. Poor nutrient retention due to the large particle size which gives the soil greater porosity and hence water moves down the profile quicker picking up and removing nutrients. Loose and well-aerated, with high porosity.
Loam	Balanced mixture of sand, silt, and clay particles. Soft and crumbly. Moderate water-holding capacity, providing good moisture availability for plants. Good drainage with adequate aeration, reducing the risk of waterlogging. Sufficient nutrient retention, combining the advantages of clay and sandy soils Well-structured, with good porosity and aeration.
Clay	Fine particles, less than 0.002 millimetres in diameter. Smooth and sticky when wet and hard when dry. High water-holding capacity. Poor drainage, leading to waterlogging and slow permeability High nutrient retention, as clay particles can adsorb and hold onto essential minerals and nutrients. Often compact and dense, with low porosity and aeration.

Importance of Soils

1. **Supports vegetation growth:** Soils give plants an anchor for their roots, store water and essential minerals, house beneficial microorganisms that break down organic matter and make nutrients available to plants. Without healthy soil, plant life would struggle to survive.
2. **Helps food production:** Soils are used to cultivate of crops for food. This helps to ensure the growing human population can be fed. Farmers cultivate a variety of crops. The survival and productivity of these crops depends on fertile soils.
3. **For visually appealing and manufactured products:** Soils, especially clay soils can be moulded to produce goods for sale or decoration. Clay soils are used for ceramic products such as bowls, plates and cups. Important for making souvenirs for areas with a tourist industry.
4. **Water Filtration and Regulation:** Soil acts as a natural filter, cleaning water as it percolates through the different layers. It removes pollutants and contaminants, helping to purify groundwater supplies. Healthy soil also plays a crucial role in regulating water flow, preventing floods, and reducing erosion.
5. **Climate Change Prevention:** Soils store a massive amount of carbon, acting as a significant carbon sink for that produced by burning fossil fuels. Healthy soil practices that promote organic matter retention can help slow or prevent climate change by capturing atmospheric carbon dioxide and storing it in the soil.
6. **Habitat and Biodiversity:** Soil is teeming with life, from microscopic organisms like bacteria and fungi to larger creatures like earthworms and insects. This rich biodiversity is essential for maintaining healthy ecosystems. The diversity of soil life also contributes to soil fertility and decomposition processes.
7. **As building materials:** Soils serve as materials for the building and construction industry. Sandy soils, in particular, are mixed with cement and used to mould building blocks and prepare concrete and plastering of houses.

Activity 5.5 Experiential Activity on the Characteristics of the Types of Soil

1. Pair up with a classmate. If you have mobility challenges, pair up with a classmate who can assist with physical manipulation of the soil samples. The partner can describe the textures and characteristics while you share your observations verbally.
2. Your teacher will provide three containers of soil labelled Clay, Loam, and Sandy Soil. Begin by closely observing each container, noting the different colours and appearances of the soils. Then, start with one sample at a time, using your fingers to touch and manipulate the soil. Pay attention to its texture and moisture levels as well as the colour. As you engage with each type, discuss your observations with your partner, sharing insights about the

physical characteristics and how they might influence gardening. Finally, record your findings in the table below, including any interesting insights or questions that arise during your exploration.

Soil Sample	Texture: Is it smooth, gritty, or sticky?	Moisture: Is it dry, damp, or wet?	Colour: What colour is the soil? Is it uniform throughout or varied?	Shape: How does it hold together when compressed?	Any other interesting observations or questions?
Clay					
Loam					
Sandy					

Share your observations with your partner. Take turns to describe what you felt and noticed about each soil type. Acknowledge your partner's observations. Use open-ended questions like:

a. What did you find most interesting about the clay?
b. How did the loam feel different from the sandy soil?

3. After discussing with your partner, choose one soil type (Sandy, Loam or Clay) and create a joint summary of your observations. Write down three key points about that soil type, considering texture, moisture, and any other observations.
4. Reflect on your participation in the activity by ticking the boxes for each question:
   a. How well did I communicate my observations to my partner?
   b. How actively did I listen to my partner's observations?
   c. Did I contribute equally to our discussion?
5. Take a few minutes to reflect on the following prompts:
   a. What did I learn about the different types of soil?
   b. How did working with a partner enhance my understanding?
   c. What social skills did I practise during this activity

Activity 5.6 The Importance of Soils

1. Think quietly about the importance of soils. Consider the following prompts as you reflect:
   a. Why are soils important for the environment?
   b. How do soils impact plant and animal life?
   c. What roles do soils play in water conservation?
2. Write down at least five points that come to mind regarding the importance of soils in your notebook.
3. Find a partner, classmate, or friend to discuss your ideas.
4. Take turns sharing the points you wrote down. Each person should speak for a few minutes while the other listens attentively. Listen actively to your partner's points and ask questions if anything is unclear.
5. Exchange your list with your partner and provide feedback based on this checklist:
   a. Are the reasons clearly explained?
   b. Did they cover a variety of aspects, like environmental, agricultural, or ecological importance?
   c. Is there any additional information that could strengthen the points?
6. Take a few minutes to reflect on the activity. Write a short journal entry answering the following questions:
   a. What new insights did you gain from your partner?
   b. How did discussing with a partner help you to improve your understanding of the importance of soil?
   c. What skills did you use to communicate and work with your partner?

Review Questions

Soils

1. Describe the difference between mineral and organic soil components.
2. Explain the role of humus in soil composition.
3. Discuss the importance of soil composition to plant growth.
4. Explain to a friend in class the factors that contribute to soil formation in your environment.
5. What is the role of microorganisms in soil formation?

Types And Importance Of Soils

1. What are the primary functions of soil in your community?
2. Describe the difference between sandy and clay soil.
3. Explain how soil supports plant growth.
4. Describe the relationship between soil type and vegetation in your local ecosystem.
5. Do all the soil types support the same types of crops? Support your answer with reasons.
6. How do different soil types support various ecosystems?
7. Why is soil important for plant growth and water quality
8. Describe how soil filtration influences water quality in your community.

Geography Year 2

SECTION 6

WORLD CLIMATIC AND VEGETATION ZONES

THE EARTH AND ITS NEIGHBOURHOODS

The Earth Atmosphere

Introduction

In this section, you will find out what climate is, examine some of its important elements and explore the instruments used to measure them. You will discover the different types of precipitation, like rain, snow, sleet, and hail, and the mechanisms producing them. You will also look at the main climate zones on the surface of the Earth. Each zone has its unique climatic characteristics, weather patterns and type of vegetation. By the end of the section, you should be able to identify and locate these climate zones on a world map and explain how climate influences the vegetation in those areas. This will help you understand the important connection between climate and vegetation and how they work together to shape the landscape and determine the types of plants and ecosystems that thrive in different regions.

Key Ideas

- Climate plays an important part in what types of plants grow in each of the zones. Plants found in the Hot Tropical zone would not be found in the Cold Zone,
- Factors influencing climate include latitude, altitude, closeness to water, ocean currents, prevailing winds and mountain barriers.
- Precipitation is the technical term for rainfall and includes rain snow, hail, drizzle and sleet.
- Some of the elements of climate include temperature, humidity, wind and precipitation
- Special instruments like wet and dry bulb thermometers, anemometers, wind vanes, rain gauges are used to record the elements of climate at the same places over a long period of time.
- The surface of the Earth can be divided into five main climatic zones:
- The three main types of rainfall are convectional, orographic (or relief), and frontal (or cyclonic). The process of condensation is common to them all.

ELEMENTS OF CLIMATE

Climate is defined as the average weather conditions in a specific area over a long period, usually about 30 years or more. The elements of climate include:

1. Temperature
2. Humidity
3. Wind
4. Precipitation

Temperature

Temperature measures how hot or cold a place is. An instrument called a thermometer is used to measure it. Thermometers can show temperature in degrees Fahrenheit (°F) or degrees Celsius (°C).

When you take a temperature reading outside in the sun, it is usually higher because it measures how much heat the sun is giving off directly. This reading is called "temperature in the sun," and it is not used as a source of data for climate.

To provide temperature data for climate zone a number of different thermometers are used. These thermometers are kept in a special weather station called a Stevenson Screen, which protects them from direct sunlight and other influences so they can give accurate and consistent readings as shown in **Figure 6.1** and **Figure 6.2**.

Figure 6.1: Stevenson's Screen (Exterior)

Figure 6.2: Stevenson's Screen (Interior)

Inside the Stevenson Screen is a maximum thermometer, a minimum thermometer, and wet and dry bulb thermometers.

The maximum thermometer shows the highest temperature over a 24-hour period, while the minimum thermometer shows the lowest temperature over the same period. The wet and dry bulb thermometers work together to measure humidity, which indicates how much moisture is in the air, and the dew point temperature, which is when water starts to condense into droplets.

On climate maps, lines that connect places with the same temperature are called isotherms. These lines help to understand how temperature varies in different areas.

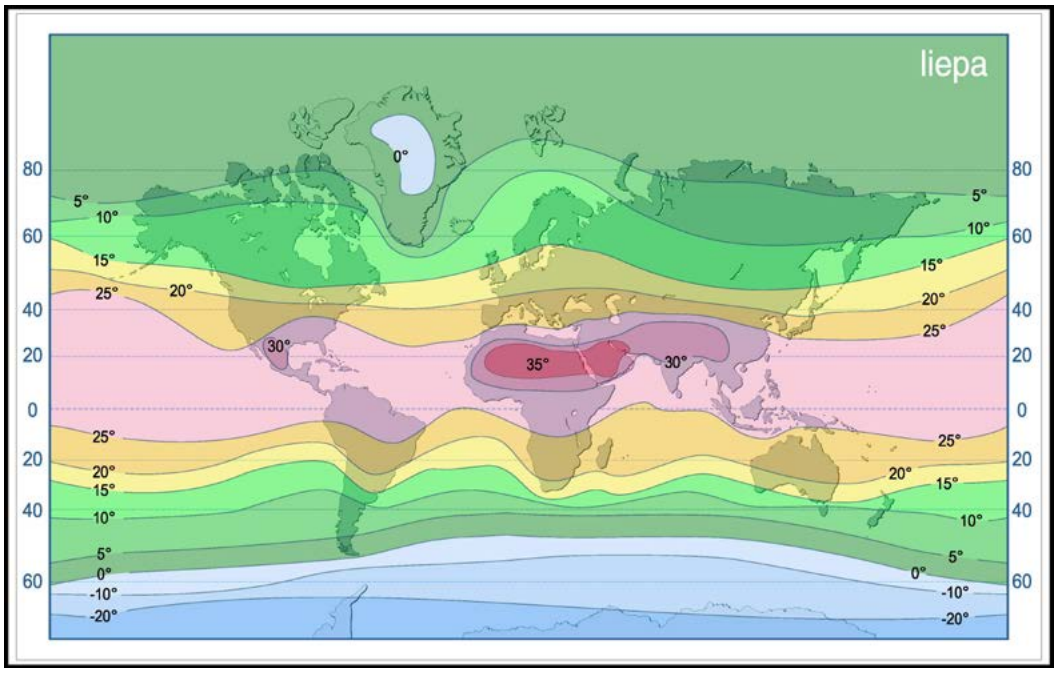


Figure 6.3: Global isotherms

Factors Influencing Temperature

The following are the factors influencing temperature

a. **Latitude:** Latitude is one of the main reasons why temperatures vary in different places. Areas closer to the equator get more direct sunlight, making them warmer as it happens in West Africa. In contrast, polar regions are colder because they receive sunlight at an angle, which spreads the heat over a larger area.
b. **Continentality:** The distance from large bodies of water, like oceans, also affects temperature. Oceans can store heat and keep temperatures more stable. Areas far from the ocean, like the middle of continents, can have much hotter summers and colder winters.
c. **Altitude:** Generally, as you go higher in the mountains (increased altitude), the temperature gets colder. This happens because there is less air pressure at higher elevations, which means the air cannot hold as much heat.
d. **Ocean Currents:** Ocean currents are like rivers of water in the ocean that can affect temperatures. Warm currents, like the Gulf Stream, bring heat from the equator to coastal areas further north, making those places warmer. Cold currents, like the Peru Current, can cool down coastal areas.
e. **Prevailing Winds:** The main wind patterns also help move heat around the globe. Warm winds can carry heat from warmer areas, raising temperatures in other regions. On the other hand, cold winds, like those from Siberia, can cool down places in eastern Asia.

Precipitation

The definition of precipitation is any type of water that falls from clouds to the ground, including rain, snow, sleet, and hail. Precipitation is measured using an instrument called a rain gauge, which tells you how much precipitation has fallen over a certain time. Rain gauges are usually set up next to a Stevenson Screen so scientists can collect information from different instruments simultaneously. A collection of recording instruments is often called a 'weather station'.

Factors that Influence Precipitation

The following are the factors that influence Precipitation

a. **Atmospheric Moisture:** For precipitation to happen, there needs to be enough moisture in the air. Warmer air can hold more water vapour, but once the air is cooled condensation occurs and water is released as droplets which form clouds, leading to precipitation. Oceans, seas, and big lakes are important because they release moisture into the air through a process called evaporation.
b. **Temperature:** The temperature of the air affects what kind of precipitation falls. When it is warm, rain is common, but when it is cold, snow or other frozen forms like sleet or hail might occur. If there is a big temperature difference between two air masses, it can help create precipitation through processes like

fronts (where warm and cold air masses meet), convection (warm air rising), or orographic lifting (air being forced to rise over mountains).So, the key processes that create precipitation involve the interaction of air masses and the cooling of air, resulting in condensation which leads to the formation of clouds and precipitation.

c. **Topography:** Mountains can affect precipitation too. When moist air is forced to rise over a mountain barrier, it cools down, condensation occurs and this can create precipitation on the windward side (where the air first meets the mountain). On the other side (the leeward side), there is often a "rain shadow,". This is because the air warms up as it moves to a lower altitude, can hold more moisture, so no rain falls.

d. **Atmospheric Pressure Systems:** Different atmospheric pressure systems play a big role in precipitation. Low-pressure systems are where air rises, which leads to cooling, condensation and the formation of clouds and more precipitation. On the other hand, high-pressure systems have sinking air, where air is warmed as it falls to lower levels and can hold more moisture, keeping skies clear and precipitation absent. Low-pressure systems can bring a lot of rain, while high-pressure systems tend to keep things dry.

e. **Wind Patterns:** Wind also affects where precipitation happens. Winds that blow from the ocean to land usually carry moist air, which can lead to more rain. In places where different wind patterns meet, like the Intertropical Convergence Zone (ITCZ), you often get lots of precipitation because the air rises and cools, condensation occurs creating clouds and rain.

Relative Humidity

Relative humidity is about how much water vapour is in the air. To understand it, you must compare the amount of water vapour in the air to the amount it could hold at a certain temperature.

For example, if the R.H. is 90% at a temperature of 26°C, the air has 90% of the maximum amount of water vapour it can hold. When the air cannot hold any more water vapour, it is said to be saturated, and the R.H. would be 100%. An instrument called a hygrometer is used to measure humidity. One type of hygrometer uses two thermometers as shown in **Figure 6.4**.

One of the thermometers used is called the wet bulb thermometer. Its bulb is covered with a special cloth that is saturated with water. A wet bulb thermometer measures the lowest temperature that can be reached by evaporative cooling. It reflects the temperature of air when it is saturated with moisture

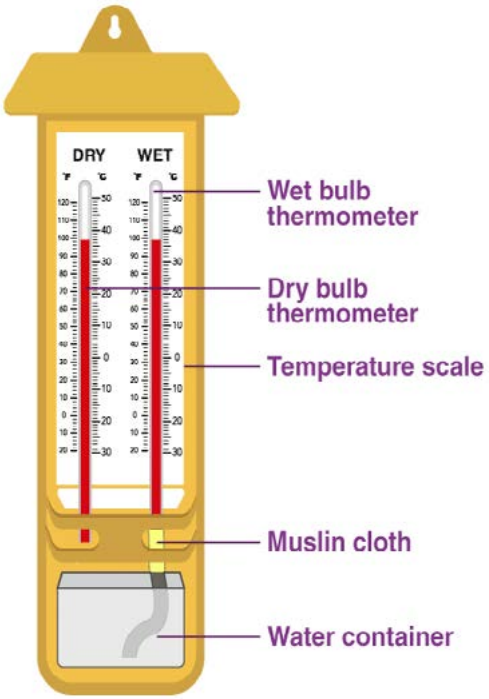


Figure 6.4: Hygrometer (Dry and Wet bulb thermometer)

due to evaporation. This is different from the dry-bulb temperature, which is the air temperature measured by a regular thermometer. The wet-bulb temperature gives an indication of the humidity level in the air and is used in calculating relative humidity. If there is a big difference between the two temperatures, it means the relative humidity is low. If the difference is small, it means the relative humidity is high, which means the air is close to holding as much water vapour as it can at that temperature.

Factors Influencing Humidity

The following factors influence humidity

a. **Temperature:** Temperature plays a big role in humidity levels. Warmer air can hold more water vapour than cooler air. So, when temperatures go up, the air can hold more moisture, which can raise the humidity.
b. **Water Bodies**: Being close to large bodies of water, like oceans, lakes, and rivers, can affect humidity. When water evaporates from these surfaces, it adds moisture to the air, making the humidity higher in those areas.
c. **Vegetation**: Plants also influence humidity. Through a process called transpiration, plants release water vapour into the air. Areas with lots of trees and plants usually have higher humidity because they constantly add moisture to the air.
d. **Wind Patterns and Circulation**: Wind patterns can change humidity levels too. Winds can carry moist air from the ocean onto land, which increases humidity. On the other hand, winds from dry areas, like deserts, can lower the humidity.
e. **Altitude**: The height above sea level, or altitude, affects humidity as well. At higher altitudes, the air usually has lower humidity. This is because of the cooling effect of altitude - the air cools because of the lower pressure higher up so it cannot hold as much moisture.

Wind

Wind is the movement of air that happens when air moves from places with high pressure to places with low pressure in the atmosphere. How fast the wind is blowing is measured in kilometres per hour (km/h) or metres per second (m/s). The direction of the wind uses the compass points or degrees. The wind direction is determined by considering where the wind is blowing from. For example, a southerly wind comes from the south. To measure how fast the wind is blowing a tool called an anemometer is used as shown in **Figure 6.6**, and to find out the direction, a wind vane is used as shown in **Figure 6.5**.

Figure 6.5: Wind Vane

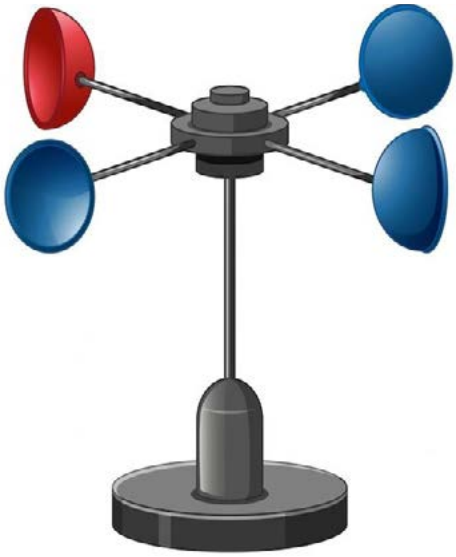


Figure 6.6: Anemometer

Factors that influence Wind Patterns

The factors influencing wind patterns include

a. **Pressure Gradients:** Wind is created by differences in atmospheric pressure, which are called pressure gradients. Wind moves from areas where the pressure is high to areas where the pressure is low. If there is a big pressure difference, the wind will blow strongly. These pressure differences often happen because the Earth's surface heats unevenly, which causes different air densities and pressures.
b. **Coriolis Effect:** The Coriolis effect is caused by the Earth spinning and affects the direction of the wind. In the Northern Hemisphere, wind gets pushed to

the right, while in the Southern Hemisphere, it veers to the left. This change in direction helps create large wind patterns like the trade winds and westerlies.

c. **Temperature Differences:** When different areas have different temperatures, it causes pressure differences that make the wind move. Warm air rises and creates low-pressure areas, while cooler air sinks, creating high-pressure areas. This process leads to local winds like sea breezes (from the ocean to land) and land breezes (from land to the ocean). Sea Breeze: During the day, land heats up faster than the sea. The warm air over the land rises, and cooler air from the sea moves in to replace it, creating a breeze. Can you describe what happens at night to create a breeze that blows from the land to the sea?

d. **Friction:** Wind slows down near the Earth›s surface due to friction, which comes from the ground's roughness. Things like mountains, forests, and buildings create more friction and slow down the wind. On smooth surfaces like oceans, there is less friction, so the wind can blow faster and more steadily.

Activity 6.1 Exploring the Four Elements of Climate through Research

1. Use books or search the internet to gather information about the four elements of climate (temperature, precipitation, humidity, wind). Find out:
   a. The definition of each element and the instruments used to measure it.
   b. The units used for each element.
   c. The average values for each element for southern and northern Ghana and four other **contrasting** areas in Africa.
   d. What a 'weather station' is, its purpose, and the climatic data collected there and how often it is recorded. Are there any weather stations in Ghana? Where are they?
2. Use your notes to create a visual presentation, such as an infographic, poster, or digital slideshow, which illustrates and explains each element of climate. In your presentation, include images, icons, graphs or maps. Pair up with a classmate to exchange and review each other's presentations. Use the following checklist:
   a. Are the definitions and other information clear?
   b. Does the presentation provide interesting or insightful examples?
   c. Are the visuals helpful for understanding the elements?

   Offer positive and respectful feedback, highlighting strengths and suggesting areas for improvement. Show empathy by acknowledging the effort your partner put into their work. After the peer review, assess your work using this checklist:
      i. Did I research each element thoroughly?
      ii. Are my explanations clear and informative?
      iii. Does my presentation effectively communicate key points?
      iv. Identify one area of strength and one area where you could improve.

5. Write a short reflection in your journal about the activity. Use these guiding questions:
    a. What new understanding did I gain from researching the elements of climate?
    b. How did peer feedback help improve my presentation?
    c. What skills did I practise through this research activity?

Activity 6.2 Sharing Perspectives on Factors Influencing Climate Elements

1. Conduct research using books or online resources to explore factors that influence the four elements of climate explored in **Activity 6.1**.
2. Write down your findings for each element in your notebook. Summarise each factor in a few sentences, explaining how it affects the climate element.
3. Create a presentation or visual summary that includes:
    a. Key factors influencing each element of climate.
    b. Your perspective or opinion on which factors you believe have the most significant impact and why.
    c. Visuals (charts, graphs, images) to support your findings.
4. Pair up with a classmate and share your perspectives on the factors influencing climate elements. Listen closely to your partner's points and ask questions to understand their viewpoint. Consider how their views might differ from yours or add new insights.
5. Work together to create a combined list that includes both of your views on each climate element.
6. Exchange your combined list with another pair for feedback. Use the following checklist for peer review:
    a. Are the factors clearly explained?
    b. Are there a variety of perspectives and examples?
    c. Are the explanations and ideas well-organised and understandable?
7. Provide constructive and respectful feedback on areas of strength and suggestions for improvement. Show empathy by recognising the effort both pairs put into their work.
8. After receiving peer feedback, use this checklist to assess your work:
    a. Did I clearly explain the factors influencing each element?
    b. Are my perspectives and explanations well-organised?
    c. Did I incorporate insights from my partner's ideas?
9. Identify one strength in your contribution and one area where you could improve.

10. Write a short reflection in your journal about this activity. Reflect on the following questions:
    a. What new perspectives did I gain from discussing with your partner?
    b. How did peer feedback help me think more deeply about the factors affecting climate elements?
    c. What skills did I practise, and how did they benefit my learning?
11. As a caretaker of nature, brainstorm and commit to one actionable step you can take to positively influence the climate of your community or town. Share your plans with a classmate or friend to foster a sense of collective responsibility and motivation.

FORMS OF PRECIPITATION

The water cycle begins with **evaporation**, where heat from the Sun causes water from oceans, rivers, lakes, and other bodies of water to turn into **water vapour**. This vapour rises into the atmosphere, where it cools and undergoes **condensation** to form clouds. When the droplets within the clouds combine and grow heavy enough, they fall back to the Earth as **precipitation**—in the form of rain, snow, sleet, or hail. The water falling to the ground eventually returns to the water bodies and the cycle begins again.

The following are the forms of precipitation.

1. **Rain:** Rain is the most common type of precipitation. It happens when water vapour in the atmosphere cools down and turns into liquid droplets. When these droplets become heavy enough, they fall to the ground, overcoming the air pushing against them.
2. **Drizzle:** Drizzle is a light kind of rain made up of very small droplets that fall steadily from the sky. It is different from regular rain because the drops are smaller and fall more gently. Drizzle can last for a long time and usually happens when it is cloudy or foggy outside.
3. **Snow:** Snow forms when water vapour in the air changes directly into ice crystals when it is really cold (below freezing). These ice crystals stick together to make snowflakes. The snowflakes will fall if the air stays cold down to the ground. Snow is most common in colder regions during winter and can pile up deeply, affecting nature and people's activities.
4. **Sleet:** Sleet, also known as ice pellets, happens when raindrops freeze into ice before they hit the ground. This usually occurs when there's warm air above freezing air near the surface. The raindrops melt in the warm air but freeze again when they pass through the cold air. Sleet can make the roads slippery and dangerous to drive on because it creates a layer of ice.
5. **Hail:** Hailstones are balls of ice that form during strong storms, especially those with powerful updrafts. These updrafts lift raindrops into really cold parts of the storm cloud where they freeze. Hailstones can get bigger as they move up and down within the cloud, collecting more layers of ice. They can come in various sizes, and big hailstones can damage buildings and crops.

Types of Rainfall

The following are the types of rainfall.

1. Convectional/Thermal Rainfall

This type of rainfall happens when warm, moist air rises, cools down, condensation occurs and clouds are formed, leading to rain.

Characteristics of Convectional Rainfall

a. It mainly occurs in tropical and equatorial areas near the equator.
b. It usually happens in the afternoon or early evening.
c. It is caused by the sun heating the Earth's surface and rapid evaporation.
d. Warm air moves upward quickly during this process.
e. Condensation creates towering clouds called cumulonimbus clouds.
f. The rain is often short but heavy.
g. This type of rainfall is often linked with thunderstorms and lightning.

Figure 6.7: An anvil-shaped cumulonimbus cloud

Formation of Convectional Rainfall

a. Convectional rainfall happens when the sun heats the Earth's surface, particularly in hot, humid places near the equator, where intense evaporation adds much moisture to the air.
b. The hot sun warms the air above the ground, and this air expands, causing it to rise quickly.
c. As the air rises, it cools, condensation occurs, and the water vapour in it changes into tiny water drops, forming towering clouds called cumulonimbus clouds (they have a similar shape to a metalwork anvil). The clouds spread out as the warmer air reaches higher altitudes, where they meet strong upper winds.
d. As more water vapour in these clouds turns into larger water droplets as they stick together.
e. Once these droplets get larger, they fall as rain, usually in short but heavy showers, often with thunderstorms.

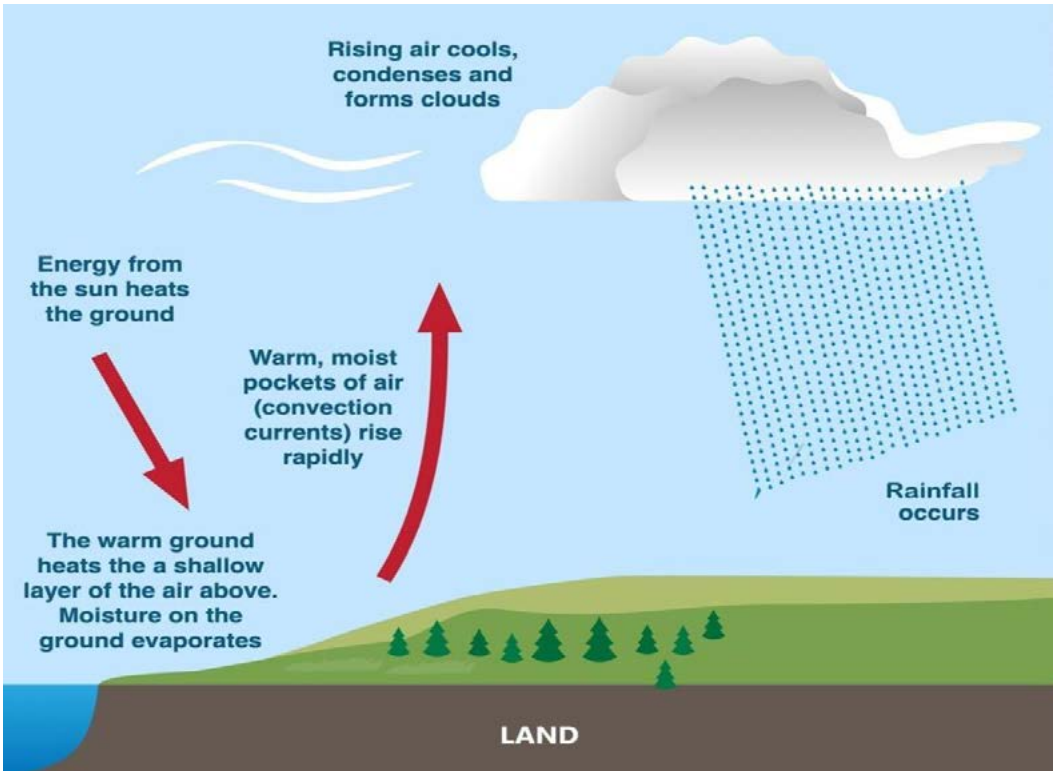


Figure 6.8: Formation of Convectional rainfall

2. Frontal/Cyclonic Rainfall

This type of rainfall happens in the middle latitudes when warm and cold air come together. The warm air gets pushed up over the cooler air, which causes clouds to form and leads to rain. The "front" is where these two air masses meet. The word "cyclonic" means that these rain systems usually spin; they turn in a counterclockwise direction in the northern part of the Earth and clockwise in the southern part. This spinning happens because of the Coriolis effect, which is how the Earth's rotation affects air movement.

Characteristics of Frontal Rainfall

a. Frontal rainfall happens when two air masses with different temperatures come together.
b. It is usually found in mid-latitude areas, where many countries are located.
c. The warm air mass gets pushed up over the colder air mass.
d. When the warm air rises, it cools down and forms clouds.
e. The amount of rain can range from drizzle to heavy downpours.
f. This kind of rainfall can last for a long time.
g. Weather fronts, called cold fronts and warm fronts, are the boundaries where these air masses meet.
h. Frontal rainfall is linked to changes in the weather, including shifts in temperature and wind direction.

Formation of Frontal Rainfall

a. Frontal rainfall happens when warm air meets cold air.
b. The lighter warm air gets pushed up by the cold air, which is heavier.
c. As the warm air rises it starts to cool down.
d. When the warm air cools enough, condensation occurs and water droplets form clouds.
e. When more water vapour condenses the droplets stick together, leading to precipitation.
f. This whole process is usually connected to weather fronts, like cold fronts and warm fronts.

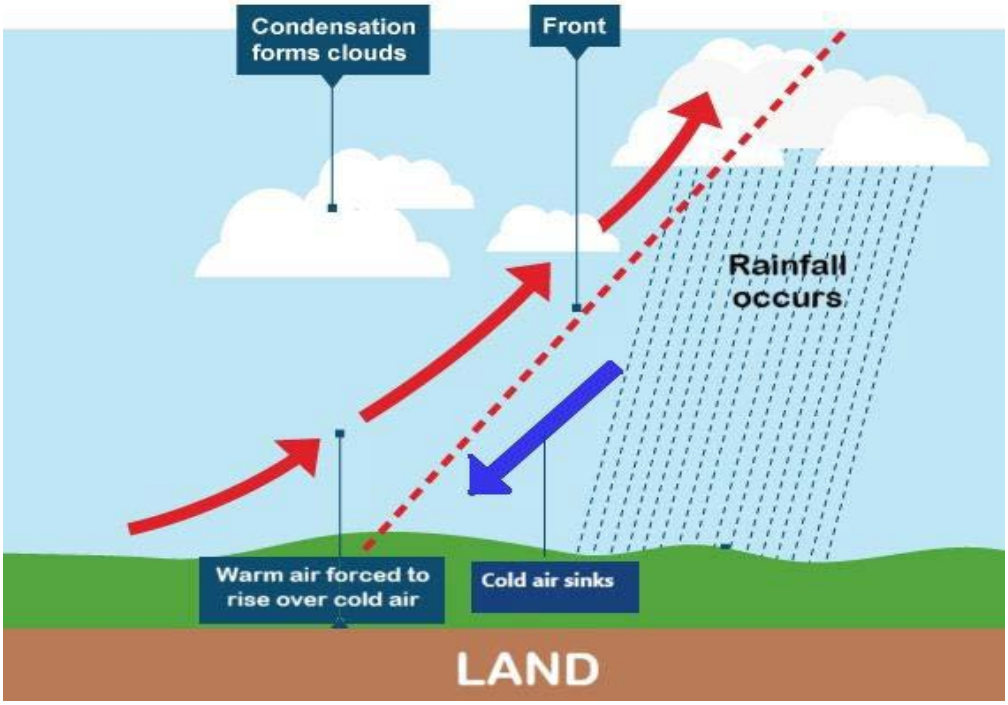


Figure 6.9: Cyclonic/Frontal Rainfall

3. Orographic or relief rainfall

This happens when moist air is pushed up over mountains or high land. As the air rises, it cools down, causing condensation and clouds form. This process leads to rain on the side of the mountain facing the wind, which is called the windward side.

Characteristics of Orographic Rainfall

a. Orographic rainfall happens when moist air hits mountains or highlands.
b. The direction the wind comes from and its origin, over water, is important.
c. A rain shadow is created on the other side of the mountain, the leeward side, because the air warms and can hold more moisture as it descends.
d. The mountain facing the wind is known as the windward side.

Formation of Orographic Rainfall

a. Orographic rainfall happens when moist air is pushed up over mountains or hills.
b. When moving air hits a mountain, it has to rise.
c. As the air goes up, it expands and cools down without losing or gaining heat from its surroundings, which makes it colder.
d. If the air keeps rising, it cools down to a point where water vapour starts to turn into liquid, causing condensation and forming clouds.
e. Clouds gather on the side of the mountain facing the wind because of this cooling and condensation.
f. The tiny water droplets in the clouds come together and fall as rain or snow on the windward slope.
g. On the other side of the mountain, known as the leeward side, the air that descends warms up again and becomes drier, leading to very little or no rain.

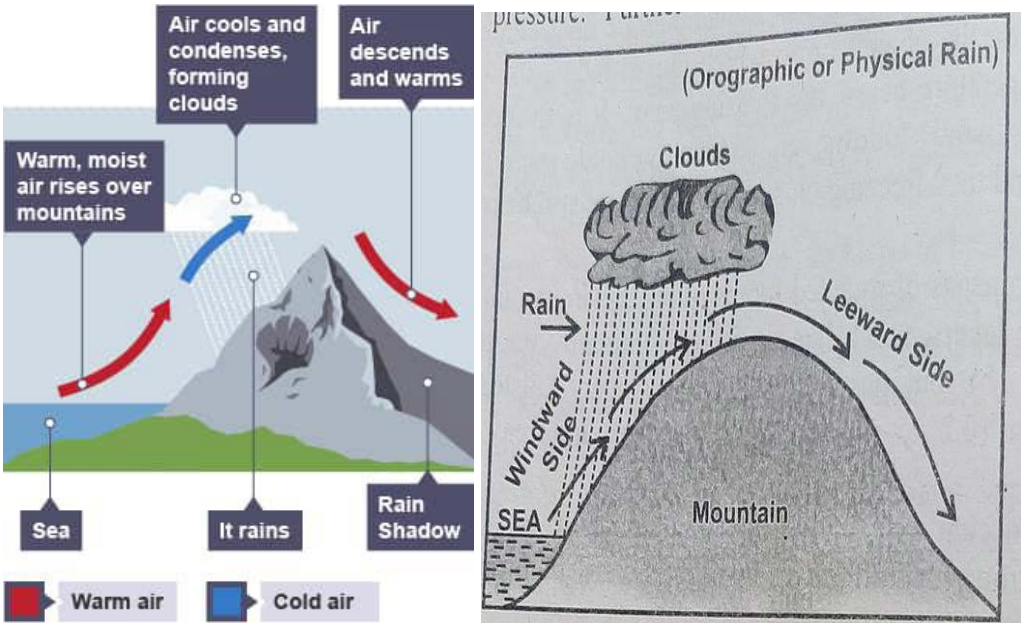


Figure 6.10: Formation of Orographic Rainfall

Activity 6.3 Investigating Forms of Precipitation

1. Note: This activity can be done individually or in small groups of no more than five. Use reliable sources, such as educational websites or textbooks, to research the forms of precipitation. For each form, take notes on:
   a. How it forms – makes sure you include the role of processes like heating by the sun, evaporation, cooling and condensation.
   b. Key characteristics – a diagram will help identify things like air movements, clouds, mountains.
   c. Where it mostly occurs – try and give an exact area or time of day/year.

2. Which of the forms of precipitation do you experience most often in your community or school?
3. How do these forms of precipitation experienced in your community or school affect the environment and daily life of the people of your community or school?
4. Using the information you have gathered from your research, create a visual representation (like an infographic or chart) that explains each form of precipitation. Include:
    a. Definitions and characteristics of each form of precipitation.
    b. Use images or diagrams to illustrate your findings
    c. Any personal reflections or observations about how different types of precipitation affect weather and the environment.
5. Share your visual representation with a classmate or in a group and discuss each form of precipitation.
6. Take turns explaining the forms of precipitation you researched. Listen carefully to your classmates or group members and ask questions to clarify any details you are not so sure about.
7. Use the following checklist to give feedback:
    a. Are the formation processes clear and accurate?
    b. Does the representation make the information easy to understand?
    c. Are the key facts and visuals engaging and informative?
8. Offer constructive feedback respectfully, showing appreciation for your partner's or any member of your group's work and suggesting areas for improvement if needed.
9. Use the following questions to assess your research and presentation:
    a. How effectively did I research and gather information on my form of precipitation?
    b. How well did I communicate my findings to my partner?
    c. What strengths did I demonstrate in my presentation, and what could I improve?
10. Write a short paragraph addressing the following prompts:
    a. What new knowledge did I gain about my chosen form of precipitation and its significance?
    b. How did discussing with a peer enhance my understanding of different precipitation types?
    c. What skills did I practice during this activity?
    d. How can I apply this knowledge in real-world contexts, such as understanding weather patterns or climate change?

Activity 6.4 Exploring the Types of Rainfall through Video Analysis and Discussion

1. Use your internet device to search and watch short educational videos that explain the following.
   a. Convectional Rainfall
   b. Frontal Rainfall
   c. Orographic Rainfall
2. As you watch each video, take notes on the following.
   a. Key points about the formation process of the rainfall type including the processes of evaporation and condensation.
   b. Distinctive and common characteristics
   c. Any maps or diagrams that illustrate the concepts
   d. Examples of regions where this rainfall occurs
3. Discuss your findings with a classmate or friend. Take turns discussing each type of rainfall, focusing on the following:
   a. Summarise the formation process and characteristics based on the video content.
   b. Discuss the type of rainfall that normally occurs in your community or school. Give reasons for your chosen type of rainfall.
4. Use prompts to guide the discussion, such as:
   a. What is the most interesting fact you learned about your rainfall type?
   b. How do different types of rainfall affect the environment?
5. After each member shares, give each other feedback, focusing on:
   a. Clarity of explanation
   b. Engagement during discussions
   c. Content accuracy and relevance of insights shared
6. In your notebook, write responses to the following questions:
   a. How well did I engage with the videos and understand the content?
   b. Did I contribute meaningfully to the group discussion?
   c. What feedback did I receive from my peers, and how can I use it for improvement?
7. Write a short paragraph addressing these prompts:
   a. What new insights did I gain about rainfall types and their significance?
   b. How did interacting with peers enhance my understanding of the subject?
   c. What 21st Century and socioemotional skills (like empathy, communication, teamwork) did I practice during this activity?
8. How can I apply the knowledge gained about rainfall to real-world situations, such as weather predictions or climate awareness?

WORLD CLIMATIC ZONES AND THE ASSOCIATED VEGETATION

There are FIVE climatic zones

1. Hot Tropical
2. Warm Temperate
3. Cool Temperate
4. Cold
5. Alpine

In this part of Section 6 you will learn about each of the main climatic zones, study some of their climatic variations and the type of vegetation that has developed in response to the climatic variations experienced in that zone.

The definition of each climate type is based on data collected from a number of **WEATHER STATIONS** located within each zone. A weather station for climatic zone purposes is a facility equipped with instruments and sensors to measure and record various atmospheric conditions. These conditions include temperature, humidity, wind speed and direction, precipitation, barometric pressure, and solar radiation. If you remember the **definition of climate** from the start of this section then you will understand that data recorded over the year **should not change significantly** over a long period of time, usually over 30 years. Weather stations are important because they can record long term changes happening to climate as a result of human activity.

Hot Tropical Zone

Location: The Hot Tropical Zone is located between the latitudes of approximately 23.5° North (Tropic of Cancer) and 23.5° South (Tropic of Capricorn) of the Equator. This region experiences consistently warm temperatures and significant rainfall throughout the year, typical of tropical climates.

Climate Type variations within the Hot Tropical Zone

Variation 1 - The Wet Equatorial Region: Hot, humid, a lot of rain all year round promotes rapid and dense vegetation growth. Found in the Amazon Basin in South America and the Congo Basin in Africa. You can also find wet equatorial zones in the coastal regions of West Africa, as well as in countries like Malaysia, Myanmar, Cambodia, Vietnam, and many islands in Indonesia and New Guinea. The wet equatorial climate area in Ghana is primarily found in the south-western region, near the coast.

Climatic Characteristics

1. It rains throughout the entire year, with total rainfall between 2,000 mm and 3,000 mm.
2. The average temperature is quite warm, around 29°C.

3. The temperature does not vary during the year, usually only by no more than 3°C.
4. This region is very humid, with humidity levels between 80% and 90%.
5. A common weather station in this area is in Kisangani.

Associated Vegetation and Characteristics

Tropical Rainforest Vegetation

1. In the rainforest, trees grow in different layers.
2. The trees are evergreen, meaning they stay green all year and have broad leaves.
3. The leaves of the trees create a thick cover called a canopy that shades the area below.
4. Common types of trees in this region include mahogany, ebony, rosewood, ironwood, and greenheart. You can also find palm trees and tree ferns.

Variation 2 - Tropical Monsoon Climate

Location: The Tropical Monsoon climate is found in areas from south-eastern and eastern Asia down to northern Australia. In eastern Asia, this climate includes wet summers and dry winters. This Hot Tropical zone climate variation has a seasonal rainfall caused by the shifting of wind patterns due to differences in temperature between the ocean and land, leading to heavy rains during certain seasons.

Climatic Characteristics

1. Rainfall: It gets a lot of rain in the summer, with total annual rainfall around 1,700 mm.
2. Temperature: The average temperature is warm, around 27°C, with a small temperature change throughout the year of about 5°C.
3. Humidity: The air is quite humid, with humidity levels between 70% and 80%.
4. Typical Locations: Some places that experience this climate are Mumbai in India and Darwin in Australia.

Associated Vegetation and Characteristics

Tropical Monsoon Forest

In the Tropical Monsoon Forest, you will find fewer types of trees compared to rainforests. Here are some key points about these forests:

1. Tree Species: There are fewer tree species, and most of the trees are deciduous, which means they lose their leaves during the dry season.
2. Height of Trees: The trees can be quite tall, often reaching heights of up to 30 meters.
3. Common Trees: Trees you might find include teak (especially in countries like Burma, Thailand, Cambodia, Laos, and East Java), bamboo (also in Thailand, Cambodia, Laos, and Vietnam), Sal, sandalwood, and climbing plants called lianas. In East Java and northern Australia, you can also find acacia, eucalyptus, and casuarina trees.

Variation 3 - Tropical Marine Climate

Location: This climate is typically found in coastal areas and islands in the Hot Tropical zone. The Tropical Marine climate is mainly found in lowland areas of Central America, the West Indies, coastal regions of Brazil and East Africa, as well as Madagascar, northeast Australia, and the Philippines.

Climatic Characteristics

1. Rainfall: This area gets a lot of rain in the summer and less rain in the winter. The total annual rainfall is between 1,100 mm and 1,500 mm.
2. Temperature: The average temperature is fairly warm, around 26°C, with a small temperature change throughout the year of about 8°C.
3. Humidity: The humidity is quite high, ranging from 70% to 85%.
4. Typical Locations: Some cities that experience this climate include Havana in Cuba and Durban in South Africa.

Associated Vegetation

Tropical Rainforest
In the Tropical Marine climate, you will find a variety of plants that have adapted to the warm temperatures and high humidity. Here are some key types of vegetation and their characteristics:

1. Rainforests: These forests are dense and filled with tall trees. The trees have broad leaves that help them catch sunlight.
2. Mangrove Trees: Mangroves grow in coastal areas where saltwater meets freshwater. They have special roots that can withstand salt and help protect coastlines from erosion.
3. Coastal Plants: You will find shrubs and grasses that are adapted to sandy soils and salty air. These plants often have tough leaves to survive the harsh coastal conditions.
4. Palm Trees: Many palm trees thrive in this climate. They have tall, slender trunks and large fronds (the leaves) that provide shade and habitat for animals.
5. Fruit Trees: Tropical Marine regions are home to many fruit-bearing trees, such as coconuts, mangoes, and bananas. These trees thrive in warm, humid conditions and are important for both wildlife and people.

Variation 4 - Tropical Continental Climate (Sudan Type)

Location: The Tropical Continental climate, also known as the Sudan type, is found in several regions around the world, including Sudan in north-eastern Africa, West Africa, particularly in countries like Mali, Niger, and Nigeria, Parts of East Africa, such as Kenya and Uganda, North-eastern India Northern and Australia.

Climatic Characteristics

In areas with a Tropical Continental climate, you can expect the following

1. Rainfall: Most of the rain falls in the summer, with very little rain during the winter. The total annual rainfall is about 750 mm.
2. Temperature: The average temperature is quite high, around 30°C. The temperature can vary by about 15°C throughout the year.
3. Humidity: The humidity levels are generally low, ranging from 40% to 60%.
4. Typical Locations: Some cities that experience this climate include Kayes in Mali and Bulawayo in Zimbabwe.

Vegetation and Characteristics

Savanna (Tropical Grassland) Vegetation
The vegetation in this climate includes Savanna, which is a type of tropical grassland. Here are some important features of Savanna vegetation:

1. Tall Grasses: The savanna is dominated by tall grasses, which can grow up to 2 metres high.
2. Grass Growth: The grasses grow in compact tufts, which means they clump together rather than spreading out.
3. Deciduous Trees: The trees in the savanna are deciduous, meaning they lose their leaves during the dry season.
4. Transition to Desert: As you get closer to hot desert areas, the vegetation changes to smaller, scrub-like plants, such as mallee and mulga in Australia.
5. Different Names: Tropical grasslands are known by different names depending on where they are located. For example, they are called Campos in Brazil, Llanos in the Guiana Highlands, and Savanna in Africa and Australia.

Variation 5 - Tropical Desert Climate (Saharan and Mid-Latitude Types)

Location: The Tropical Desert climate, which includes types like the Saharan Desert and mid-latitude deserts, is found in very dry regions around the world. Here are some key locations where this climate is well-developed:

1. Sahara Desert in Africa: The largest hot desert in the world.
2. Arabian Desert in the Middle East: Another major desert known for its extreme dryness.
3. Kalahari Desert in Southern Africa: A large semi-arid sandy area that gets a bit more rain than typical deserts.

Other important deserts with this climate include the;

4. Thar Desert in India and Pakistan: Known for its hot temperatures and sandy landscapes and the Great Victoria Desert in Australia: The largest desert in Australia, also characterised by its dry conditions.

Climatic Characteristics

In areas with a desert climate, the conditions are extremely dry, and rainfall is very rare. Here are some key features:

1. Rainfall: It only rains once every two or three years, but when it does rain, it comes down in heavy downpours. The total annual rainfall is around 200 mm.
2. Temperature: The temperature is very high all year, with an average temperature of about 30°C. During the hottest months, it can even exceed 40°C
3. Temperature Range: The annual temperature can vary by about 25°C from the coolest to the hottest times of the year.
4. Humidity: The humidity is very low, typically between 10% and 30%. This means the air is very dry.
5. Typical Location: One place you can find this desert climate is in Salah, Algeria.

Vegetation and Characteristics

Desert Vegetation and Shrub
The vegetation in desert areas is unique and adapted to survive in extreme conditions

1. Sparse Vegetation: Only small areas may be completely bare; most areas have some plant life.
2. Xerophytes: Most plants are called xerophytes, which are specially adapted to conserve water.
3. Ephemerals: Many plants are ephemerals, meaning they quickly grow and reproduce after rain, but they will not be seen again until it rains again.
4. Dormant Seeds: Some plants produce seeds that can stay dormant (inactive) for years until the right conditions occur, like a bit of rain.
5. Common Plants: The most common types of plants in this desert are cacti, thorn bushes, and coarse grasses, all of which help them survive the lack of water.

Warm Temperate Zone

Location: The Warm Temperate Zone is generally located between the latitudes of approximately 23.5° and 40° in both the Northern and Southern Hemispheres. This zone experiences mild to warm temperatures and distinct seasons, making it ideal for a variety of vegetation and human activities.

Climate Type variations within the Warm Temperate Zone

Variation 1 - Western Margin (Mediterranean type)

Location: The Mediterranean climate takes its name from regions close to the Mediterranean Sea but similar climatic conditions can be found in other parts of the world. Here are some key locations where this climate occurs:

1. Nearby the Mediterranean Sea: Countries like Spain, Italy, and Greece have this climate.

2. Southwest Africa: Areas like parts of South Africa experience this climate.
3. Central Chile: The middle part of Chile has a Mediterranean climate.
4. Central California: Areas like Los Angeles and the surrounding regions in California have this climate.
5. Southwest to Southern Australia: Regions from Adelaide to Melbourne in Australia also have a Mediterranean climate.

Climatic Characteristics

1. Rainfall: It gets about 900 mm of rain each year, with most rain falling during the winter months, while summers are quite dry.
2. Temperature: The average temperature is low, around 17°C. This means it is cooler compared to other climates.
3. Temperature Range: The temperature can change by about 12°C between the coolest and warmest times of the year.
4. Humidity: The humidity is pretty high, ranging from 60% to 80%. This means the air feels moist and can be a bit sticky.
5. Typical Locations: You can find this climate in places like Sacramento in California and Perth in Australia.

Vegetation and Characteristics

Mediterranean Evergreen Forest
In the Mediterranean Evergreen Forest, you will find a unique group of plants that are well-adapted to the dry climate. Here are some important features:

1. Evergreen Trees: The forest is mainly made up of evergreen broadleaf trees like oaks, olives, and laurels. These trees keep their leaves all year round.
2. Water-Saving Leaves: Many of the plants have tough, leathery leaves that help them conserve water during the dry season. This type of leaf is called sclerophyllous.
3. Evergreen Shrubs: You will also find many evergreen shrubs that are often aromatic (they smell good) and can tolerate dry conditions.
4. Different Names for Shrubs: The shrub vegetation in this forest is referred to as maquis in France and chaparral in California.
5. Coniferous Trees: In some drier areas or at higher elevations, you might see coniferous trees, like pines and cypresses.
6. Canopy Cover: The thick canopy created by the dominant trees can limit the growth of smaller plants (understory) beneath them in some areas.

Variation 2 - Central Continental Climate (Steppe Type)

Location: The Central Continental climate, also known as the Steppe type, can be found mostly in the southern parts of the world including prominent places like the Murray-Darling Lowlands in Australia and the High Veldt in Africa. In the United States, you can find it in western Oklahoma, Texas, and northern Mexico.

Climatic Characteristics

1. Rainfall: It usually receives light rain during the summer, but winters are very dry with little to no rainfall, often just as snow. Overall, the total annual rainfall is around 200 mm to 500 mm.
2. Temperature: The average temperature is generally very low, often below 0°C.
3. Temperature Range: The temperature swings a lot, often more than 45°C between the hottest and coldest times of the year.
4. Humidity: Humidity is usually low, especially in winter months.
5. Typical Locations: Examples of places with this climate include Bourke in Australia and San Antonio in Texas.

Vegetation and Characteristics

Steppe or Temperate Grassland

The Steppe climate is known for its grasslands, which have some unique features:

1. Almost Treeless: These grasslands are mostly without trees, making them very different from tropical grasslands.
2. Shorter Grasses: The grasses in this climate are generally shorter than those found in tropical areas.
3. Summer Heat: In the summer, the grass can get scorched by the heat, causing most of it to die off by fall. However, the roots survive, and the grass will come back in spring.
4. Transition Zones: The temperate grasslands gradually change into coniferous forests in the north and semi-desert scrub in the south.
5. Names Around the World: This type of biome has different names in different parts of the world. It is called steppe in Eurasia, prairie in North America, pampas in Argentina, veldt in South Africa, and down in Australia.

Variation 3 - Eastern Margin Climate (China Type)

Location: The Eastern Margin climate, also known as the China type, is found in several places, including the Canadian prairies, specifically in Alberta, Saskatchewan, and Manitoba. It is also present in the central and Midwestern United States, as well as parts of eastern Europe and western Russia.

Climatic Characteristics

1. Rainfall: This climate has high summer rainfall, often with heavy monsoon rains, while winters are generally dry with very little rain. Overall, total annual rainfall is between 1000 mm and 2000 mm.
2. Temperature: The average temperature is relatively low, usually ranging from 15°C to 25°C.
3. Temperature Range: The temperature does not change drastically throughout the year, with a moderate annual range of around 15°C.

4. Humidity: Humidity levels are generally high, staying around 70% to 80% all year long.
5. Typical Locations: Examples of cities in this climate include New Orleans in the U.S. and Sydney in Australia.

Vegetation and Characteristics

Temperate Evergreen Forest
In the Eastern Margin climate, you will find the Temperate Evergreen Forest, which has some interesting characteristics:

1. Tree Types: This forest is a mix of evergreen broadleaf trees (trees that keep their leaves all year) and deciduous hardwood trees (trees that lose their leaves in fall).
2. Conifers: You may also see coniferous trees like pines and cypresses, especially in mountainous areas.
3. Dense Understory: The forest has a thick understory, which means many plants are growing underneath the trees, including ferns, lianas (vines), and bamboo.
4. Other Tree Species: Some other trees found in this forest include Camphor laurel and Chinese oak.

COOL TEMPERATE ZONE

The Cool Temperate zone is generally located between the latitudes of 40° and 60° in both the Northern and Southern Hemispheres. This zone experiences moderate to cool temperatures with distinct seasons, including cold winters and mild to warm summers.

Climate Type variations within the Cool Temperate Zone

Variation 1 -Western Margin Climate (British Type)

Location: The Western Margin climate, also known as the British type, is found in some cool, moist regions around the world Locations as well as places like north-western Europe, coastal British Columbia in Canada, the coast of southern Chile, Tasmania in Australia, and the South Island of New Zealand.

Climatic characteristics

1. Rainfall: This region experiences moderate rainfall throughout the year. Autumn is usually the wettest season, and sometimes it even snows.
2. Annual Rainfall: The total amount of rain in a year ranges from about 500 mm to 1500 mm.
3. Temperature: The average annual temperature is generally between 8°C and 15°C.

4. Temperature Range: Temperature changes throughout the year are usually moderate, with variations of about 13°C.
5. Humidity: Humidity in this climate is relatively high, often around 70% to 80%.
6. Typical Cities: Examples of cities in this climate include Valencia (in Europe) and Hobart (in Tasmania).

Vegetation and Characteristics

Temperate Deciduous Forest

In the Western Margin climate, you will find the Temperate Deciduous Forest, which is full of unique features:

1. Tree Types: This forest is mainly dominated by deciduous broadleaf trees. These are trees that lose their leaves in the autumn to save energy during the cold winter months.
2. Seasonal Changes: In the summer, the trees have lush green leaves, which change to vibrant reds, oranges, and yellows in the fall before all the leaves fall off in winter.
3. Conifers at Higher Elevations: In higher areas, you will find more coniferous trees like pines, spruces, and firs.
4. Common Deciduous Trees: Some of the common deciduous trees in this forest include oak, beech, and elm. In North America, you might also see hickory and maple trees, while cedar and spruce trees appear more at higher elevations.

Variation 2 - Central Continental Climate (Siberian Type)

Location: The Central Continental climate, also known as the Siberian type, is found in some very cold areas of the world and covers the central and southern regions of Russia (especially western Siberia, the Gobi Desert), much of Canada (from Alaska eastward), and parts of northern Europe, including Scandinavia and northern Russia.

Climate Characteristics

1. Rainfall: In the summer, there is moderate rainfall that often comes with thunderstorms. However, there is very little rain in the winter, although there can be a lot of snowfall.
2. Annual Rainfall: The total amount of rain and snow each year ranges from about 150 mm to 500 mm.
3. Temperature: The average temperature for the year is very low, usually between -5°C and 5°C. That means it can often be below freezing!
4. Temperature Range: The temperature changes a lot between seasons, with a range of about 45°C throughout the year. This means summers can be much warmer, while winters are very cold.
5. Humidity: The air is usually quite dry, especially in the winter months.
6. Typical Places: Cities like Verkhoyansk in Russia and Dawson in Canada are examples of areas with this climate.

Vegetation and Characteristics

Evergreen Coniferous Forest

In the Central Continental climate, you will find the Evergreen Coniferous Forest, also known as the taiga.

1. Tree Types: These forests are dominated by coniferous trees, which are evergreen trees that keep their needles all year round. Common types include pine, spruce, fir, and larch.
2. Tree Adaptations: The trees have needle-like leaves that help them lose less water during the cold winters. Their cone-shaped branches also help shed snow easily, so the branches do not get weighed down.
3. Understory: Because the conifer trees are so tall and dense, they block a lot of sunlight, which means there is not much growth under the trees. You might find some mosses, lichens, and cold-adapted shrubs, but not a lot of other plants.

Variation 3 - Eastern Margin Climate (Laurentian Type)

Location: The Eastern Margin climate, also known as the Laurentian type, can be found in several regions around the world. This includes eastern Canada (like Newfoundland and Labrador), the north-eastern United States (especially New England), eastern Siberia in Russia, northern China, Korea, and Hokkaido in Japan.

Climatic Characteristics

1. Rainfall: Summers typically bring moderate rainfall, often with thunderstorms. In winter, it gets cold, and there's significant snowfall.
2. Annual Rainfall: A year's total amount of rain and snow usually ranges from 750 mm to 1500 mm.
3. Temperature: The average temperature throughout the year ranges from 5°C to 15°C.
4. Temperature Range: The temperatures can vary quite a bit, with an annual range of about 25°C, meaning that summers can be quite warm, while winters are chilly.
5. Humidity: Humidity levels are relatively high, ranging from 60% to 80% all year round.
6. Typical Cities: Places like Montreal in Canada and Bahia Blanca in Argentina are examples of locations with this climate.

Vegetation and Characteristics

Mixed Forest

In the Eastern Margin climate, you will find a Mixed Forest, which is a blend of different types of trees:

- Tree Types: The forest is dominated by coniferous trees (which are evergreen) and deciduous broadleaf trees. This means you will see a mix of needle-leaved trees and trees that lose their leaves in the fall.

Coniferous Trees

1. Species: Common coniferous trees include spruce, fir, larch, and pine, especially in the northern areas where it is colder.
2. Adaptations: These trees are well adapted to survive the cold winters. They have needle-like leaves to reduce water loss and a cone shape to easily shed snow.

Deciduous Trees:

1. Species: As you move further south, you can find more deciduous trees like oak, beech, maple, and birch. These trees are better suited for areas where winters are not as harsh.
2. Seasonal Changes: In the summer, these forests are lush and green, and in autumn, they showcase beautiful colours like red, orange, and yellow before the trees become bare in winter.

Cold Zone

The Cold Zone is located between latitude 65°-90° North and South of the equator. There are no variations of climate within this zone.

Polar Climate

Location: The Polar Climate is found in some of the coldest places on Earth, including Greenland, the interior of Iceland, and Antarctica. The polar climate, found in the Arctic and Antarctic regions, is characterised by extremely low temperatures, minimal precipitation, long winters with continuous darkness, short cool summers with continuous daylight, and extensive ice and snow cover. Vegetation is sparse, limited to tundra plants like mosses and lichens due to the harsh conditions and permafrost. These regions experience very low humidity and are often considered deserts because of the limited precipitation.

Climate Characteristics

1. Summers: Summers are very cold and dry, with occasional snow or light rain, but they are not warm like summers in other parts of the world.
2. Winters: Winters are extremely cold and usually dry as well, with very little precipitation. Most of the precipitation that does fall is snow.
3. Blizzards: Frequent blizzards can happen, which are strong snowstorms with high winds that can limit visibility and create dangerous conditions.
4. Annual Rainfall: The total amount of precipitation (rain and snow combined) is very low, typically less than 250 mm each year. That is a lot less than most other climates.
5. Temperature: This climate has the coldest temperatures, with average annual temperatures ranging from about -20°C to -40°C.
6. Temperature Range: The temperature can vary greatly throughout the year, with an annual range of about 35°C, which means that summers can be a lot warmer than winters, but still very cold compared to other places.

7. Humidity: Humidity is generally low—often below 50%. This is because cold air cannot hold as much moisture as warmer air, so it feels drier.
8. Typical Weather Station: A typical place to experience this climate is Inuvik in Canada.

Vegetation and Characteristics

Tundra, Mosses, and Lichens Vegetation
Due to the extreme cold and short growing seasons, the types of plants that can grow in a polar climate are quite limited:

1. Plant Life: Vegetation in polar regions is mostly low-growing tundra plants. This includes mosses, lichens, grasses, sedges, and small shrubs. These plants have adapted to survive in harsh conditions.
2. Frozen Ground: Much of the ground is permanently frozen, a layer known as permafrost. This means that many plant roots cannot grow very deeply, which limits the types of plants that can thrive there.

Alpine Zone

This climate is named after a range of European mountains called the **ALPS**. Although there are variations in Alpine climate with altitude these are based in small differences in temperature. The term Montane climate is used when referring to 'Alpine' climate just to show that other parts of the world with high mountains share the **same climatic and vegetation characteristics**.

Alpine climate typically occurs at **altitudes ranging from about 1,000 to 3,500 metres (3,300 to 11,500 feet) above sea level.** These elevations can vary slightly depending on the specific mountain range and latitude, but this range generally captures the zone where Alpine climate conditions prevail, including cooler temperatures, increased precipitation, and distinct vegetation adapted to high altitudes.

Montane Climate

Location: The Montane climate is found in mountainous regions all around the world, no matter where they are located. You can find montane climates in the Himalayas in Asia, the Andes in South America, the Rocky Mountains in North America, the Alps in Europe, and even in the mountains of Africa and Oceania.

Climatic Characteristics

1. Precipitation: As you go higher up in the mountains, the amount of precipitation (rain and snow) generally increases because the air gets cooler. However, if you go too high, the air becomes thin (rarefied), and precipitation can decrease.
2. Annual Rainfall: The total amount of rainfall in a montane climate can vary significantly depending on the specific location and height of the mountain.
3. Temperature: The air in montane regions is usually cool, and the temperatures do not change much from day to night, leading to low daily temperature variation.
4. Humidity: Humidity levels can vary widely, without a consistent pattern throughout the year.

Vegetation and Characteristics

In montane climates, you will find a variety of plants that change depending on the altitude:

1. Types of Plants: The forests can be made up of broadleaf trees or coniferous trees (which have needles and cones), depending on the latitude (how far north or south you are) and local conditions.
2. Tree Growth: As you climb higher up the mountain, the trees become shorter and less dense. Conifer trees like pines and firs are more common at higher elevations because they can tolerate colder temperatures.
3. Krummholz: At very high altitudes, you will encounter trees in a stunted, shrubby form called krummholz, which are specially adapted to survive the harsh conditions found at those elevations.

Typical Weather Stations:

- Typical locations where you can experience a montane climate include Pike's Peak in the Rockies and Quito in Ecuador, which is situated high in the Andes.

Activity 6.5 Exploring World Climate Zones and associated Vegetation through Digital Learning

Note: *This activity can be done individually or in groups of not more than five learners.*

1. Research and watch a series of short videos, review images and investigate books or online resources that illustrate and explore different climate zones and their associated vegetation. As you go through each climate zone, take notes on:
   a. the climate types in each zone, their location and typical weather stations as well as their associated vegetation.
   b. the characteristics (such as temperature, precipitation and relative humidity) of each climate type
   c. the characteristics of the vegetation (such as appearance, common plant species and plant adaptations) associated with each climate type.
2. Now, complete **Tables 6.1** and **6.2** to organise your information for easy comparison as you share your findings with a classmate. Add as much detail as possible. Use a digital form of presentation like a spreadsheet or make a table in a word processor document.

Table 6.1 is to be used to identify locations (weather stations or towns) and vegetation for each climate type in the second column.

Table 6.1

Climate Zone	Climate Types	Location (typical weather station or a named town)	Vegetation Type
Hot Tropical	Wet Equatorial	a…… (……)	b…… ……
	Tropical Monsoon	Southeastern Asia (Delhi)	Tropical Monsoon Forest
	Tropical Continental (Sudan type)	c…… (……)	d…… ……
	Hot Tropical Desert	Sahara Desert (Tamanrasset) Arabian desert (Dubai)	Hot desert vegetation and shrub
Warm Temperate AND Cool Temperate	Western Margin (Mediterranean type)	e…… (……)	…… ……
	Western Margin (British type)	g…… (……)	h…… ……
	Central Continental (Steppe type)	i…… (……)	j…… ……
	Central Continental (Siberian type)	k…… (……)	l…… ……
	Eastern Margin (China type)	Southeastern China (Shanghai) Southeastern U.S.A. (New Orleans)	Temperate Evergreen Forest
	Eastern Margin (Laurentian type)	m…… (……)	n…… ……
	Cold Temperate Desert	Gobi Desert (Ulaanbaatar)	Cold desert vegetation and shrub
Polar	Polar	o…… (……)	p…… ……
Alpine	Montane	the Himalayas (Leh) q…… (……)	Alpine pastures, conifers and ferns

Table 6.2 is to be used to identify climate characteristics, vegetation type and plants and their adaptations.

Table 6.2

Climate Type	Climate Characteristics	Vegetation Type	Typical plants and any adaptations they have developed in response to climate
Wet Equatorial	…… ……	…… ……	…… ……
Tropical Monsoon	**Temperature** It is warm throughout the year Mean annual temperature usually ranges from 25°C to 27°C The annual temperature range is relatively small, usually between 5°C to 10°C **Precipitation** The precipitation is rainfall throughout the year. Rainfall is mostly convectional often associated with thunderstorms Characterised by distinct wet and dry seasons Heavy summer rain and dry winter Total annual rainfall is around 1700mm **Relative humidity** In wet season, relative humidity is generally high, often between 80-90%. In dry season, relative humidity drops, typically ranging between 60-70%.	Tropical Monsoon Forest	There are fewer types of tree species compared to tropical rainforests. Most of the trees are deciduous, meaning they lose their leaves in the dry season. Trees in these forests are tall, often reaching up to 30 metres. Common tree species include teak, bamboo, Sal, sandalwood, lianas, and acacia.
Tropical Continental (Sudan type)	…… ……	…… ……	…… ……

Climate Type	Climate Characteristics	Vegetation Type	Typical plants and any adaptations they have developed in response to climate
Western Margin (Mediterranean type)	....	....	....
Western Margin (British type)	....	....	....
Central Continental (Steppe type)	....	....	
Central Continental (Siberian type)	....	....	....
Eastern Margin (China type)	**Temperature** It is characterised by warm summers and cool winters Mean annual temperature generally ranges from 15°C to 20°C, varying with latitude and altitude. Mean annual temperature generally falls between 15°C and 25°C. Annual temperature range is quite distinct, varying between 15°C and 20°C. **Precipitation** Rain is the primary form of precipitation, with thunderstorms or typhoons common in summer. Occasionally, snow occurs in winter, especially in areas at higher latitudes, but it is typically light.	Temperate Evergreen Forest	The trees in temperate evergreen forests are mostly tall and thick with evergreen leaves (leaves that stay green all year). These forests have a dense canopy (top layer of trees) that blocks sunlight from reaching the ground. The understory (lower layer of plants) is made up of shrubs, ferns, and small trees.

Climate Type	Climate Characteristics	Vegetation Type	Typical plants and any adaptations they have developed in response to climate
	The total annual precipitation ranges from 1000 to 2000 mm. **Relative humidity** High relative humidity in summer (around 70-90%) Low relative humidity in winter (40-60%)		Common trees in this forest include oak, pine, and fir trees. Some areas also have holly and cedar trees. The forest is lush and green, with plants that can survive in cool, moist conditions.
Eastern Margin (Laurentian type)	…… ……	……. …….	…… ……
Hot Tropical Desert	**Temperature** It is characterised by extremely hot summers and cooler winters The mean annual temperature typically ranges from 20°C to 30°C The annual temperature range can be quite large, often exceeding 25°C **Precipitation** Form of precipitation is rainfall Rain is very rare and usually occurs in the form of short, heavy showers or thunderstorms. Annual rainfall in hot deserts is usually less than 250 mm	Hot desert vegetation and shrub	Plants in hot deserts are often small and spread out to save water. Many have thick, waxy leaves or spines instead of leaves to reduce water loss. Deep roots help them reach underground water, while shallow roots quickly soak up rain from the surface. Some plants, like cacti, can store water in their thick stems. Desert shrubs are usually short and tough to survive the dry and hot conditions.
Polar	…… ……	……. …….	…… ……

Climate Type	Climate Characteristics	Vegetation Type	Typical plants and any adaptations they have developed in response to climate
Montane	**Temperature** It is characterised by Mild to warm temperatures at lower elevations and cooler temperatures at higher elevations during summers. Winters are generally cold, often below freezing point, particularly at higher elevations. Mean annual temperature is typically between 0°C and 10°C, varying significantly with altitude. The annual temperature range can vary widely, often exceeding 20°C depending on the specific altitude. **Precipitation** Rain is the main form of precipitation at lower altitudes, while snow occurs at higher elevations. Precipitation is often heavy and frequent, especially in the summer months, and may include thunderstorms. At higher altitudes, snowfall can be heavy in the winter, and the snow may persist into the spring. The annual precipitation varies greatly depending on altitude, but it generally ranges from 1000 to 2500 mm. In some mountainous regions, precipitation can be even higher, particularly on windward sides that face moist air.	Alpine pastures, conifers and ferns	The plants here are usually low-growing and hardly surviving the harsh conditions. The grasses in alpine pastures are short and can grow in rocky soil. Conifer trees, like pines and spruces, are common in higher areas, with needle-like leaves that help them survive the cold. Ferns are also found in some alpine regions, with their fronds (leafy parts) growing close to the ground. The plants here are adapted to cool, windy conditions with short growing seasons.

Climate Type	Climate Characteristics	Vegetation Type	Typical plants and any adaptations they have developed in response to climate
	Relative humidity Relative humidity varies across seasons and elevations. Relative humidity is relatively high at higher elevations compared to lower elevations. In summer, relative humidity is relatively high as compared to winter seasons		

1. Use a 2 circle Venn diagram to compare and contrast each of the following:
   a. Tropical climate with temperate climate
   b. Tropical rainforest with temperate coniferous forest
   c. Forest vegetation with grassland vegetation
2. Pair up with a classmate or join a small group to review each other's completed tables (**Table 6.1** and **6.2**) and Venn diagrams comparing climate and vegetation types. Take turns presenting your findings on each climate zone, its characteristics, and associated vegetation. Use a peer review checklist to guide your feedback. Consider the following questions:
   a. Are the climate characteristics accurately described?
   b. Are the locations and examples for each climate zone correctly identified?
   c. Is the associated vegetation and its characteristics clearly explained?
   d. Do the Venn diagrams effectively compare and contrast the selected climate zones or vegetation types?

   Give words of encouragement to your friend for the work done.
3. Show empathy and respect by acknowledging the effort your peers put into their work and valuing diverse perspectives.
4. Revisit your completed tables and diagrams after the peer review.
5. Write a short reflection in your journal about this activity. Consider these questions:
   a. What new understanding did I gain about world climate zones and their associated vegetation?
   b. How did peer feedback help improve my understanding or presentation of the material?
   c. To what extent did I practice active listening and respectful dialogue?

6. Reflect on any challenges you faced (e.g., organising information, understanding complex climate characteristics) and how you worked through them.
7. Identify one SEL skill you feel more confident in after this activity and describe how you can continue to develop it in future group activities.

Activity 6.6 Designing Posters on Vegetation in Climatic Zones

1. Select one of the five major climate zones (Tropical, Temperate, Desert, Polar, or Montane) that interests you most.
2. Research to collect information on the following:
   a. Identify the vegetation type (e.g., rainforest, coniferous, grassland, alpine) in your chosen climate zone and decide which one you will design the poster for.
   b. How have plants adapted to the specific conditions of the zone (e.g., they might tolerate drought, and survive in very cold weather)?
   c. What are the distinctive characteristics of the selected vegetation? (e.g., leaf shape, roots, growth patterns)?
3. Collect some pictures and infographics to use in your poster.
4. Sketch out a basic layout for your poster, including:
   a. Title: Think of a catchy title for your poster.
   b. Images: Use good-quality pictures of plants and landscapes.
   c. Text: Write short, clear text to describe the vegetation and how it adapts to the climate.
5. Colour scheme: Pick colours that match your theme and make your poster attractive.
6. Use tools like Canva or Google Slides (or draw by hand) to create your poster. Include different visuals like images, diagrams, and charts to make it interesting.
7. Write a brief introduction and conclusion to your poster that highlights the importance of understanding climate zones and their vegetation.
8. Show your poster to a classmate and ask for feedback on:
   a. How clear and organised the information is.
   b. How creative and visually appealing it looks.
   c. How accurate the information is.
9. Give each other kind and helpful feedback. Suggest ways to improve the clarity, detail, or creativity of the poster. Show respect for your classmate's work and creativity.
10. Put up your posters around the room like a gallery.
11. Walk around to view each poster. Leave a sticky note with a positive comment and one helpful suggestion for each poster.

12. In your notebook, write answers to these questions:
    a. How well did I explain the features of the vegetation in my poster?
    b. Did I use visuals well to help others understand?
    c. What were my strengths, and what could I improve for next time?
13. Write a short paragraph answering these questions:
    a. What new things did I learn about climate zones and vegetation?
    b. How did working with others help me learn better?
    c. How could you use this knowledge to help with real-world issues?

Review Questions

Elements of Climate

1. What instrument is used to measure temperature in climate studies?
2. Name the four elements of climate.
3. What are lines joining places of equal temperature on a climate map called?
4. What is the **primary** cause of global temperature variation?
5. How does proximity to large water bodies affect temperature?
6. Explain the 'rain shadow effect' found in areas which have coastal mountains.
7. Describe the relationship between the temperature and relative humidity of air.
8. How do atmospheric pressure systems influence precipitation?
9. Compare and contrast the impact of warm and cold ocean currents on coastal temperatures. Use examples in your answer.
10. Analyse how wind patterns affect humidity levels in coastal and inland regions.
11. Explain how altitude affects both temperature and humidity.
12. Evaluate the significance of the Coriolis effect on global wind patterns.

Forms of Precipitation

1. State five forms of precipitation.
2. Name the three types of rainfall.
3. What instrument is used to measure rainfall?
4. What cloud type is often associated with convectional rainfall?
5. How does sleet form?
6. Describe the characteristics of orographic rainfall.
7. Compare and contrast the formation of convectional and frontal rainfall.
8. Analyse the impact of elevation on the type and amount of precipitation in orographic rainfall.
9. Evaluate the risks associated with hail formation during thunderstorms.
10. How do different air mass interactions lead to the formation of precipitation in frontal rainfall?

World Climate Zones And Associated Vegetation

1. Mention five major world climate zones
2. Name two types of natural vegetation associated with the Hot Tropical Zone.
3. Which vegetation type is commonly found in the Mediterranean climate?
4. How does the climate of the Tropical Desert differ from the Steppe climate in terms of rainfall?
5. Explain the main characteristics of vegetation in the Polar Zone.
6. Describe the role of humidity in determining the vegetation of the Tropical Monsoon climate.
7. How does altitude affect vegetation in the Montane climate?
8. How do human activities interact with vegetation in the Warm Temperate Zone?

Geography Year 2

SECTION 7

EMERGING TECHNOLOGIES AND MAPPING OF GEOSPATIAL DATA

NAVIGATING OUR ENVIRONMENT

Geospatial Data Collection, Representation, and Interpretation

Introduction

This section deals with the methods of geospatial data collection. It covers information on traditional, modern digital methods and emerging technologies for data collection. You will understand and acquire the skills of using traditional methods such as chain and compass surveying, the use of geospatial methods such as remote sensing, GPS (Global Position System) GIS (Geographical Information System) and, the use of mobile Apps and emerging technologies such as drones and Artificial Intelligence (AI). If you have used a mobile phone to check how long journey will take or order a pizza delivery to your home you will have used geospatial data. The world has moved from traditional ways of gathering geospatial data to collecting it using digital devices. In this section you find out how modern digital devices are used to collect geospatial data and keep pace with the digital and technological direction of the world.

Key Ideas

- Apart from these, there are also emerging techniques such as Geo Artificial Intelligence, Unmanned Aerial Vehicles or Drones and Light Detection and Ranging (LiDAR) among others
- Geospatial data is beneficial to urban planning, environmental monitoring and disaster detection and management.
- Geospatial data is information that describes objects, events or other features with a location on or near the surface of the Earth. This data is often represented in terms of coordinates (latitude and longitude) and can include information about natural features (such as rivers and mountains), human-caused structures (like buildings and roads), and various environmental conditions (such as land use and weather patterns).
- The methods of collecting geospatial data are both traditional and modern.

METHODS OF COLLECTING GEOSPATIAL DATA

Meaning of Geospatial Data

Geospatial data is information that describes objects, events or other features with a location on or near the surface of the Earth. Geospatial data is also called georeferenced data or information, as well as geodata and geoinformation. It is simply geographic data or information. The information or data is related to a specific location on the Earth's surface and is often represented in two dimensions (2D) or three dimensions (3D). This type of data is typically associated with coordinates, such as latitudes and longitudes, making it essential for a variety of applications that require understanding geographical locations, relationships, and patterns.

Areas Where Geospatial Data Can Be Applied

Geospatial data can be applied in many fields. These include:

a. Urban planning
b. Monitoring the environment
c. Management of disasters and risks
d. Tracking the spread of diseases
e. Monitor the location and distribution of natural resources
f. Business and marketing
g. Telecommunications

The application of geospatial data within the seven areas named above are explained by assessing the importance and application of geospatial data to them:

1. For planning purposes: Geospatial data are used by planners for planning purposes. For example, urban planners utilise geospatial data to inform decisions on land use, population distribution and location of settlements.
2. Mapping: One of the most common uses of geospatial data is making a map of the area being described. This helps to visualise the area that the data describes. For example, you can use geospatial data to map out your community.
3. Environmental Monitoring: In environmental science, geospatial data assists in tracking changes in ecosystems, monitoring biodiversity and assessing the impact of climate change. It helps researchers identify areas of concern and develop conservation strategies.
4. Risk assessment: Geospatial data is used to monitor and assess risks such as natural disasters, epidemics and impending dangers. It allows for efficient mapping of areas at risk from natural disasters such as floods, earthquakes, and wildfires, thus allowing for emergency risk preparedness.
5. Site Selection: Geospatial data helps to select appropriate sites for the location of facilities and projects. For example, if the government wants to build a facility in your community, geospatial data can be used to select an appropriate site for such a facility.

6. Helps marketing of products: It is used to monitor marketing channels and locate customers. This involves analysing your existing marketing points and finding out which ones are most effective at acquiring customers and increasing your market share.
7. Communication network planning: Geospatial data can be used by communication network operators to ensure that an existing or new telecommunications network or service meets the needs of the customer or subscriber and operator.
8. Helps business people to make investment decisions: Geospatial data is used to conduct investment research. This involves the use of geospatial devices to make detailed examination and analysis of various financial instruments, markets, and trends to aid investors in making investment decisions. It also contributes to a business's competitive advantage.

Methods of Collecting Geospatial Data

The methods for collecting geospatial data are both traditional and modern.

The Surveying Method

Surveying is the technique of determining the relative positions of points on the Earth's surface. It can be used to determine the location of any point, object or boundary of land. For example, in the building industry, surveying helps to determine land boundaries, establish property ownership and preparation of maps. Surveying also makes use of distances and directions which help to determine the horizontal positions of these points. Surveying can use latitude and longitude coordinates, or land might be divided, using a grid system to help identify features like areas of forest, lakes, flat land, or slopes. The techniques or methods of surveying can be categorised into traditional and modern.

Traditional Surveying Techniques

Traditional surveying methods are also referred to as conventional methods of surveying. These methods often use manual equipment which can be cumbersome and slow to use and record the results. The traditional surveying techniques are outlined below.

1. Chain Surveying: Involves measuring distances with a chain. It is straightforward but limited by terrain and obstructions. In the absence of the chain, surveyors may use the Tape. Hope you have seen a chain and tape measure before, ask your teacher to show you one if they can.
2. Compass Surveying: Uses a magnetic compass to determine angles and directions. This method helps in plotting the layout of an area.
3. Levelling: Levelling is a technique to determine the vertical position or height of different points below, on or above the ground. It is mostly used in the construction or the building industry.

Traditional or Conventional Surveying Instruments or Equipment

These are listed below;

1. The chain: For measuring distances, which is linear measurement
2. The Tape: For measuring distances, which is linear measurement
3. Theodolite: An optical instrument for measuring angles in horizontal and vertical planes.
4. Total Station: A versatile instrument that integrates the capabilities of a theodolite and electronic distance measuring (EDM) technology, allowing for precise location data.
5. Levelling staff: For measuring height or elevation
6. Prismatic compass: For measuring angles

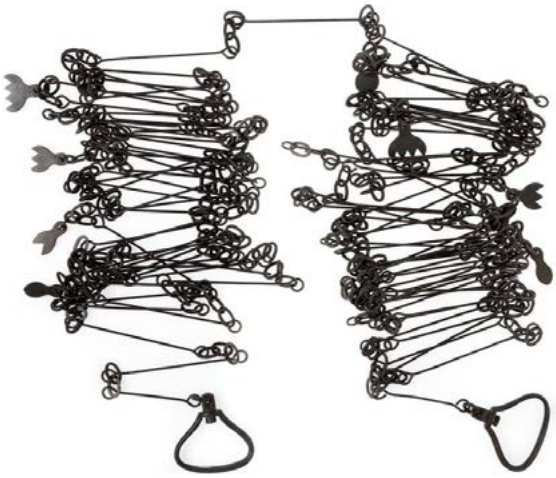


Figure 7.1: The Chain

Figure 7.2: Tape Measure

Figure 7.3: Theodolite

Figure 7.4: Total Station

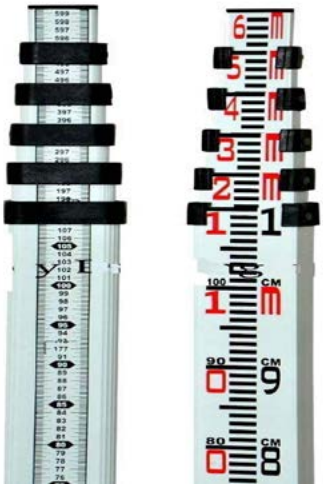


Figure 7.5: Levelling Staff

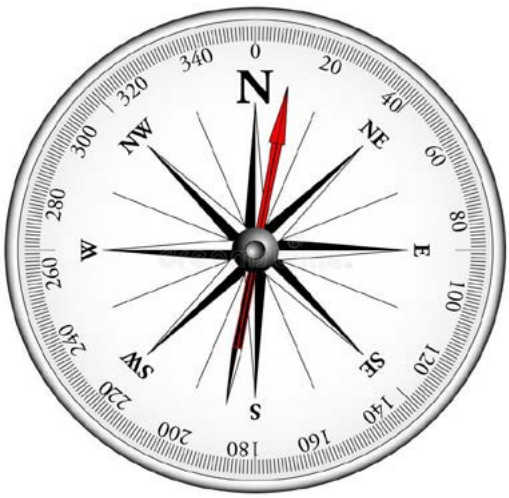


Figure 7.6: Prismatic Compass

Steps involved in the surveying process

Step 1: Preparation and Planning: Defining goals, methods, and equipment needed for the survey. This also includes a reconnaissance survey, which is sometimes the surveyor will visit the site before the actual survey or field work begins. Why do you think a reconnaissance survey is important?

Step 2: Fieldwork and Data Collection: Taking measurements on-site using the chosen techniques and instruments. It also includes gathering and recording measurements systematically.

Step 3: Data Analysis: This involves the use of data analysis techniques such as percentages and averages to make meaning from the data gathered during the field survey.

Step 4: Preparation of the Final Map and Report: the final map and reports are derived from the data and analysis. The results from the analysis are presented as a map or a written report.

Modern Surveying Methods

Modern survey methods are also referred to as digital survey methods. It is the use of digital devices to take measurements. It can increase the speed at which a survey can be completed. These are outlined below.

Remote Sensing Method

Remote sensing involves getting data about the Earth's surface from a distance, typically using satellites or aircraft. It operates on the principle of detecting reflected or emitted electromagnetic energy from various surfaces. This is known as Radar (which stands for Radio Detection and Ranging). Find out more about what Radar is and how it works. It is useful because it involves identifying, observing, and measuring an object without coming into direct contact with it.

Types of Remote Sensing

a. Active Remote Sensing: This method uses machine generated energy (e.g., electromagnetic waves) and measures the response from the Earth's surface.
b. Passive Remote Sensing: This type relies on naturally occurring energy, primarily sunlight, to collect data (e.g., photographic images).

Electromagnetic Spectrum in Remote Sensing

The electromagnetic spectrum is like a rainbow that includes all types of light and radiation including that which you cannot see with your eyes. It ranges from very tiny waves like gamma rays to very long waves like radio waves. The Sun's energy travels in waves, and satellites or sensors use these waves to gather information.

Key Parts of the Electromagnetic Spectrum in Remote Sensing

a. Visible Light: This is the light you can see with your eyes when the Sun shines. It is used to make colour images of the Earth, like photos taken by satellites. It is the only part of the spectrum to visible to human eyes.
b. Near-Infrared (NIR): This part of the spectrum is just beyond what you can see. Healthy plants reflect a lot of NIR light, so it is used to check how healthy plants and forests are.
c. Shortwave Infrared (SWIR): SWIR can show things that are not visible in regular light, like the moisture content in plants and soil.
d. Thermal Infrared (TIR): TIR is used to measure heat. It helps you see how hot or cold different parts of the Earth's surface are, which is useful for things like detecting forest fires or checking city temperatures.
e. Microwaves: These can see through clouds and are used in radar systems to measure things like the Earth's surface shape, soil moisture, and even ice thickness.

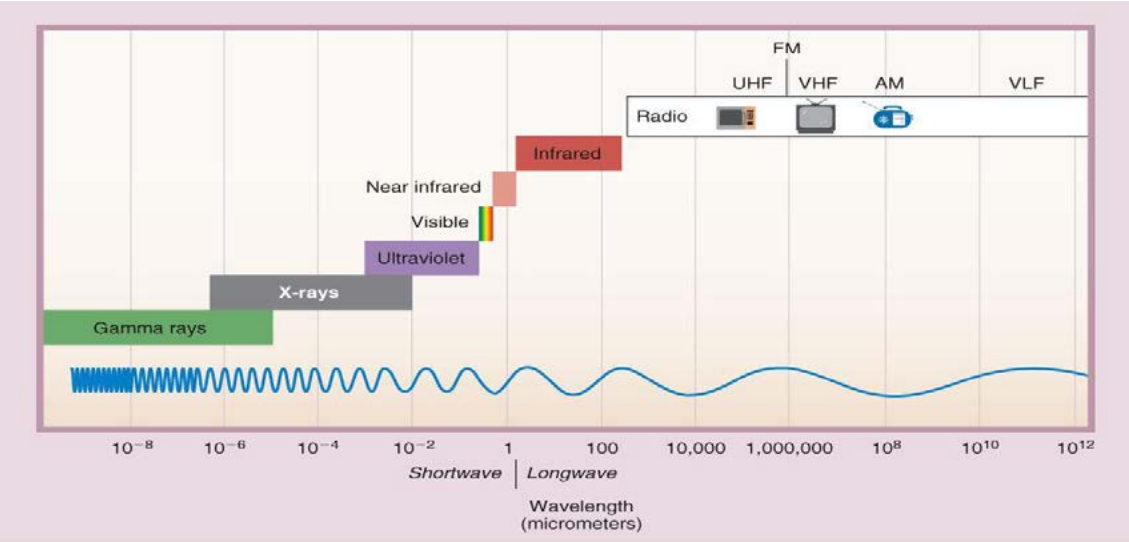


Figure 7.7: The spectrum of electromagnetic radiation

Remote Sensing Platform and Sensors

a. Satellites: A satellite is a body or object that orbits or goes around another body in space. Remote sensing satellites are sensors that detect energy being reflected from the Earth. Examples are Landsat, Envisat and WorldView satellites. These help to provide large-scale views and regularly monitor changes over time.

b. Aircraft: Aircraft detection helps to locate regions and classify objects in those regions. This is also called aerial remote sensing. It is the method of continuously obtaining photographs of the earth's surface from the sky by using cameras mounted on aircraft. It offers detailed imagery for smaller areas.

c. Drones: This is also called Unmanned Aerial Vehicle (UAV) remote sensing. This technology allows for data gathering from multiple aerial photos taken at different times along a pre-set route. It has increasingly become popular due to its flexibility and ability to capture high-resolution data.

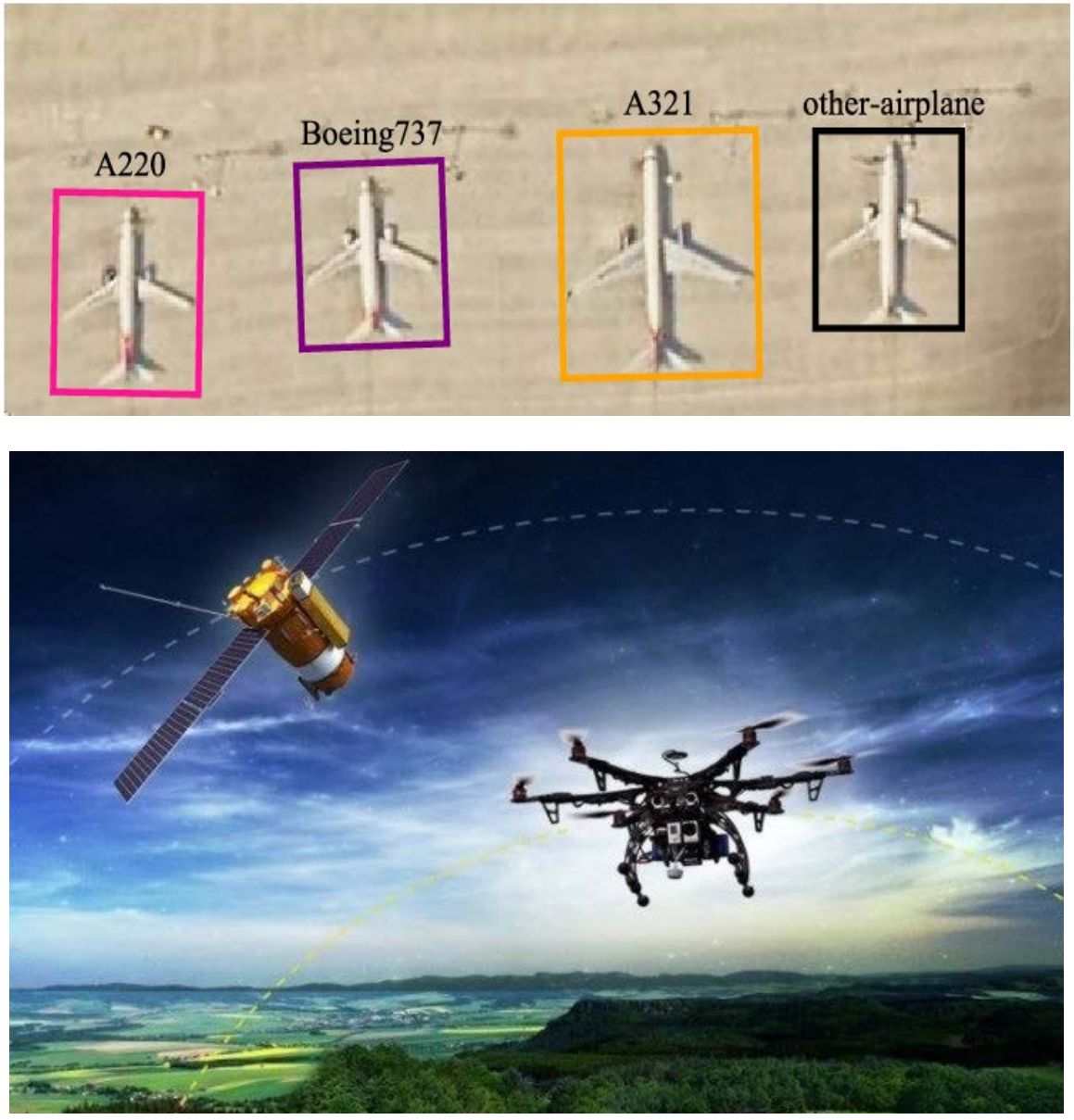


Figure 7.8: The use of Aircrafts, Satellites and Drones in remote sensing

Areas where Remote Sensing application is needed

Remote sensing is applied in every aspect of human life. Here are some examples:

a. Used in agriculture where farmers can use it for crop identification and monitor crop health
b. It is used in forestry to assess forest and vegetation cover
c. For climate monitoring to track changes in weather patterns and environments.
d. It is used in business and marketing for production forecasting
e. For disaster and risk assessment, damage control and management
f. Soil mapping and moisture estimation
g. For water resource mapping

Geographic Information Systems (GIS)

A Geographic Information System (GIS) is a tool for gathering, managing, and analysing spatial data. Unlike remote sensing, which focuses on data collection through techniques like aerial and satellite surveys, GIS uses software to analyse this collected data. Simply put, remote sensing gathers the data, while GIS analyses it.

Key Components of GIS

The major components in GIS are:

a. Hardware: Computers and servers where GIS software runs.
b. Software: Programs used for mapping and analysis. Examples include Aeronautical Reconnaissance Coverage Geographic Information System (ArcGIS) and Quantum Geographic Information System (QGIS).
c. Data: Geographic data, both spatial and attribute.
d. People: Specialists who manage and analyse the data, popularly called GIS specialists. Hope you will also learn hard to become a GIS specialist.
e. Methods: Techniques used to analyse and visualise the data. This is called GIS data input techniques such as digitising and automatic scanning.

Types of data in GIS

There are two primary types of data in GIS. Hope you remember these from one of your lessons in Year One? These are:

a. Vector Data: Represents data using points, lines, and polygons (e.g., cities, roads, lakes).
b. Raster Data: Represents data in a grid format, suitable for continuous data such as elevation or temperature. You can refer to your reading material in Year One for details, including illustrative diagrams.

Functions of GIS

a. Data Input: Collecting and entering data into the system.
b. Data Management: Organising and storing data for easy access.
c. Data Analysis: Interpreting data to uncover patterns and relationships.
d. Data Output: Presenting results in the form of maps, reports, or visualisations.

Areas where GIS can be applied

a. GIS can be applied in the following areas
b. Mapping & navigation
c. Telecommunications services
d. Community development and planning
e. Public health
f. Agriculture
g. Disaster management
h. Risk assessment
i. Environmental impact analysis

Importance of GIS Application

The benefits of GIS include improved communication, efficiency, management, and decision-making. Some of these are listed below.

a. GIS helps to understand and visualise geospatial or geographical information or data:
b. It helps to facilitate planning and decision-making
c. GIS enhances emergency response and management of disasters and risks
d. It helps improve environmental management
e. It enhances business operations and marketing.
f. It helps improve communication
g. Helps to track the trend of events and phenomena

Global Position System (GPS) Method

Global Positioning System (GPS) is a satellite-based navigation system that provides location and time information anywhere on Earth. It works with signals from satellites orbiting the Earth. These satellites connect with receivers on the ground and can pinpoint the exact location of the receivers. GPS is a system of satellites that can identify a user's coordinates (which are usually latitudes and longitudes) on Earth and altitude through the use of a device called a receiver.

Components of GPS

Has the following components

a. Satellites: A network of at least 24 satellites orbit the Earth.
b. Control Stations: Ground stations that manage the satellites and ensure their accuracy.
c. Receivers: Devices that use satellite signals to determine the user's location.

Types of GPS

There are three basic types of GPS. These are:

a. Personal GPS: These are GPS devices used by the general public for personal activities such as navigating to a destination or helping locate themselves. GPS devices for personal use are the most common type of receiver and are used around the world. An example is the use of a smartphone, handheld device, or one integrated into a car to find a location.
b. Commercial GPS: These are GPS devices used by companies, businesses and institutions. For example, a delivery or haulage company may use GPS to help track its vehicles.
c. Military GPS: This is used by the military in its operations. It will interest you to know that GPS was originally developed by the United States of America's military for its own use but now it is being used by the public.

GPS devices may be the standard type, which offers basic positioning services or the differential type which improves accuracy by linking to fixed ground reference stations to correct signal errors.

How GPS Works

GPS satellites orbit the Earth in precise paths, completing their journey roughly twice a day. They determine location by measuring the time it takes for signals to travel from the satellites to GPS receivers on the ground. By using triangulation, GPS receivers calculate a user's exact location. This involves comparing signals from at least four satellites to pinpoint the precise position by determining the distance from each satellite.

Accuracy and Limitation of GPS

GPS can provide accurate positioning within a few metres. It gives high precision in terms of location; however, signals can be affected by factors such as atmospheric conditions, obstructions like buildings, and multipath effects where signals bounce off surfaces. It is not possible to receive GPS signal in a deep underground mine or parts of a subway system. Many remote areas of the world are not covered by satellites, some parts of the Pacific and polar latitudes for example.

Other uses of GPS

As well as giving users an exact global position GPS can also be used:

a. in navigation. Points on a journey from one location to another .
b. for tracking. Used to monitor objects or personal movement.
c. for mapping. For creating maps of different places and activities. You can use GPS devices to create a map of your community.
d. To give an accurate time. Each GPS satellite carries highly accurate atomic clocks, and the system's ability to synchronise these clocks allows it to provide precise time data.

Similarities between the traditional and modern methods of collecting geospatial data

In terms of similarities:

a. Data collected by each method can be integrated to create comprehensive geospatial data sets.
b. All these methods can be used for spatial analysis and mapping.
c. All the methods can be improved subject to technological advancements.

Differences between the traditional and modern methods of collecting geospatial data

The following table shows differences in methods of collecting geospatial data in terms of scale and coverage, accuracy, and precision, how data is collected and applications of collected data:

Table 7.1: Differences among the Methods of Geospatial Data Collection

Attribute	Tradition Surveying	GPS	Remote Sensing	GIS
Scale or Coverage	suitable for small areas	provides point-based data globally	covers large areas	integrates multiple scales, local to global
Accuracy and Precision	offers the highest precision	varies in accuracy based on the system used	less precise but offers broad coverage	accuracy and precision are highly dependent on the quality of the input data
Method of Data Collection	requires human physical presence to take direct measurement	relies on satellite signals	collects data remotely, often from satellites, ships, or aircraft	utilises and analyses various geospatial data

Attribute	Tradition Surveying	GPS	Remote Sensing	GIS
Areas of Application	Identifying boundaries in construction and civil engineering	Local and global navigation and data collection	environmental monitoring and large-scale mapping.	supports complex spatial analyses and decision-making processes

Activity 7.1 Reviewing the Methods of Collecting Geospatial Data

1. Divide yourselves into pairs for this activity. In a tabular form, outline the differences between Traditional Surveying, Remote Sensing, GIS and GPS under the following headings:
   a. Scale or Coverage
   b. Accuracy and Precision
   c. Method of Data Collection
   d. Areas of Application
2. Research and watch short videos or examine pictures and diagrams about Surveying, Remote Sensing, GIS, and GPS. Take brief notes on:
   a. How data is collected.
   b. Advantages and limitations.
   c. Applications in real-world scenarios.
3. Discuss your findings. Share your ideas and help each other to understand the concepts better. Use respectful communication and active listening to ensure all voices are heard. Provide constructive feedback by highlighting the strengths of each other's work and suggesting ways to make the work better.
4. Now observe, with your partner, the pictures below. You will have to find out what some of them are by researching or asking your teacher for help.

Name of tool	Geospatial data they can collect
A:	
B:	
C:	
D:	
E:	
F:	
G:	
H:	
I:	

1. Provide the names of the tools and indicate the geospatial data they can collect in the table below.
   a. Discuss the advantages and disadvantages of using:
      - tool A
      - tool E
   b. Given the options of tool A and tool F, which would you select for a geospatial survey of your school compound? Justify your answer with three reasons.

Consider the views of other people by accepting different opinions and working towards a common goal.

2. Review your notes, table, and group discussions. Use the following checklist:
   a. Did I accurately describe the methods and tools?
   b. Did I contribute meaningfully to the group discussion?
   c. Is my comparison table clear and complete?

   Identify one thing you did well and one thing you could improve.
3. Write a short reflection in your notebook answering these questions:
   a. What did I learn about geospatial data collection methods and tools?
   b. How did working with my group help me understand the focal area better?
   c. What SEL skills did I practise, and how did they help?
   d. How can I apply what I learnt to solve real-world problems?

Activity 7.2 Comparing the Similarities and Differences between Geospatial Data Collection Methods. Divide yourselves into pairs for this activity.

1. Go over your notes on the four methods: surveying, remote sensing, GIS, and GPS. For each method, reflect on the following questions:
   a. What are the advantages?
   b. What are the limitations?
   c. What kind of data does it collect?
   d. What are some real-world uses?
2. Find a partner for this activity. Take turns sharing your notes and discussing:
   a. Similarities between the methods
   b. Differences between the methods
   c. How can methods be combined for better results

   Value your partner's contributions, even if they differ from yours. Feel free to express your ideas in the way that feels most comfortable for you, whether that is through drawing, writing or speaking.
3. Create a Venn diagram together on chart paper or in your shared document to visually represent the similarities and differences you discussed. Join with another pair to form a group of four.
   a. Present your Venn diagram to the other pair and discuss your findings.
   b. Provide constructive feedback and discuss any additional insights you gain from each other. Encourage everyone in your group to share their thoughts and ensure that all voices are heard.
4. Take a moment to reflect on your participation by answering these questions in your notes:

a. What was the most surprising thing I learned about geospatial data methods?
b. What did I learn from my partner's or group members' perspective?
c. How did my partner's and group's input enhance my understanding of geospatial data methods?
d. How can I apply this knowledge in real-world situations?
e. How effectively did I contribute to my pair's and group's discussions?
f. Did I listen actively and respectfully to my partner and members of the group?

COLLECTION AND MAPPING OF GEOSPATIAL DATA

This part of Section 7 deals with the collecting and mapping of geospatial data. The collection and mapping of geospatial data is essential in areas like urban planning, environmental monitoring, and disaster management. With advancements in technology and growing concerns for environmental destruction and change, collecting and mapping geospatial data has become a priority. This data provides humans with a means of monitoring and managing some of these environmental issues.

Applications (Apps) for Collecting Geospatial Data

1. **aQField:** Open-source app for Android used for mapping, photo-taking, and custom forms. Works with QGIS.
2. **SW Maps:** Collects and manages data points, lines, and polygons. Works offline.
3. **OpenStreetMap:** Adds and edits maps with points of interest, paths, and other data.
4. **Field Mapper:** Open-source app for customizable field data collection.
5. **Google Maps:** Provides maps, satellite views, and street views for navigation and simple data collection.
6. **ArcGIS Collector:** Captures data in the field, integrates with ArcGIS Online.

You might like to explore each of these Apps online to get a better understanding of what each one offers.

Software for Data Mapping

1. **QGIS:** An open-source GIS software for mapping and analysing spatial data.
2. **Google Earth Pro:** Allows users to create, view, and analyse maps using satellite imagery and other geospatial data.
3. **ArcGIS:** A comprehensive GIS software suite used for mapping, spatial analysis, and managing geographic data.
4. **OpenStreetMap:** Can contribute by adding and editing geographic information, such as roads, trails, buildings, and landmarks, to improve the map.

Strengths and weaknesses of using mobile apps, GPS devices, and GIS software.

The use of geospatial software and devices to collect data may have the following strengths and weaknesses, as shown in **Table 7.2.**

Table 7.2: Strengths and weaknesses of using mobile apps, GPS devices, and GIS software for collecting geospatial data

Software	Strengths	Weakness
Mobile app	These are easy to use Widely available on smartphones Data is real-time They are cost-effective Requires little training to use.	They are not as accurate as GPS Drain smartphone batteries quickly There are risks with data privacy and security.
GPS Devices	These are highly accurate providing precise and reliable data Devices are built to withstand harsh environmental conditions Can be used in the most rugged of terrain.	They cost much more than mobile apps May need special training Are limited to collecting location data only.
GIS Software	GIS software uses a range of complex spatial data It provides complex mapping and visual representations at all scales.	The cost of GIS software and access to data is high Maintenance is required in terms of updates and licensing Significant training and expertise are needed to use it effectively Existing servers and computers must be powerful enough to run it.

Procedures to Collect and Map Geospatial Data

Step 1: Planning your data collection exercise

Planning involves the following:

a. Define the types and purpose of your data collection, whether primary or secondary data. For example, mapping trees or buildings in your school compound or community – primary data or using an existing map – secondary data.

b. Choose the appropriate tools and apps based on your needs and available resources.

Step 2: Collecting Data with Mobile Apps

a. Install the chosen mobile app (e.g., Google Maps, ArcGIS Collector) on your smartphone or tablet.
b. Create a new project or survey within the app.
c. Go to the field and start collecting data points by marking locations, taking photos, and adding notes or attributes (e.g., tree species, pothole size).
d. Save and synchronise your data with the app's cloud service or export it for further analysis.

Step 3: Mapping Data with Computer Software

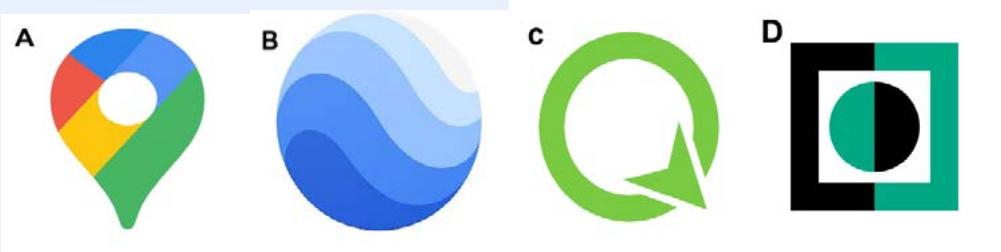
a. Install GIS software (e.g., QGIS, ArcGIS) on your computer.
b. Import the collected data from your mobile app into the GIS software.
c. Create layers for different types of data (e.g., trees, roads, buildings).
d. Use various tools in the GIS software to analyse and visualise the data (e.g., creating maps and performing spatial analysis).
e. Creating models and designs.

Step 4: Publicity

Making your maps and findings known to the public for intended use.

Activity 7.3 Collecting and Mapping Geospatial Data Using Smartphones and Computer Software

1. Install a geospatial app like Google Maps (**A**), Google Earth (**B**), QField (**C**) or Mergin Maps (**D**).



Identify a small area on your school compound or local community for data collection.

2. Think about what types of data you want to collect.

Examples include:

a. Land use (residential, commercial, agricultural, recreational)
b. Infrastructure (schools, bus stops, playgrounds, power lines, sewage systems)
c. Environmental features (trees, animals, ponds, streams, hills, valleys, plains)

3. Write down what you will observe and record for each point of interest (e.g., type of land use, condition of infrastructure, number of trees).
4. Using your smartphone or tablet geospatial App (like Google Earth), navigate to your chosen area and:
    a. Use the GPS feature to mark the locations of your points of interest.
    b. Take photos or notes about each point based on your checklist.
    c. If using mapping apps, enter the data directly into the app for each location.

Be aware of your surroundings and prioritise safety while exploring outdoor locations. In addition, follow local guidelines and respect private property while collecting data.

5. Use a tool like Google My Maps, ArcGIS Online, or any other mapping software to create a visual representation of your findings. Include photos and notes for context.
6. Share your map and findings in pairs or in small groups.. In turns, discuss:
    a. What did you discover about your chosen area?
    b. How does your data reflect the characteristics of the community?
7. Review your map and process. Use this checklist:
    a. Did I collect accurate and meaningful data?
    b. Is my map clear, organised, and easy to understand?
    c. Did I use the app effectively?

Identify one thing you did well and one area where you could improve next time.

8. Write a short reflection in your journal. Consider the following questions:
    a. What did I learn about collecting and mapping geospatial data?
    b. What challenges did I face, and how did I overcome them?
    c. How did presenting and reviewing with peers improve my work?
    d. How can I apply these skills in real-world situations?

EMERGING TECHNOLOGIES FOR GEOSPATIAL DATA COLLECTION

Drones and Unmanned Aerial Vehicles (UAVs)

Drones have revolutionised geospatial data collection, providing an efficient and cost-effective method for capturing high-resolution aerial imagery and data. Equipped with cameras and advanced sensors, drones can cover large areas quickly, capturing detailed data that was previously difficult or time-consuming to obtain through traditional methods.

Figure 7.9: Drone or UAV

Advantages of Drones

a. Rapid Data Acquisition: Drones can capture images and data over vast areas within a short period.
b. High Resolution: The images obtained from drones offer many details, making it ideal for applications in mapping and environmental monitoring.
c. Flexibility: Drones can be deployed in various environments, including urban areas, forests, and inaccessible terrains. A drone can reach and capture images and footage from angles and heights that would be impossible or impractical for a human operator.
d. Safety: It is very safe to operate drones, due to their flexibility and portability
e. Accuracy: Has a high level of accuracy
f. Cost efficiency: It is comparatively and relatively less costly to acquire and operate a drone.

Areas of application and benefits of drones

Drone can be applied and are beneficial in the following areas.

a. For Military and emergency services: Drones are used for search and rescue operations. This is because they can provide an aerial view of a disaster zone.
b. Agriculture: In agriculture, drones monitor crops, assess plants' health, and spray pesticides and fertilizers.
c. Movie or filmmaking and entertainment industry: In the entertainment industry, drones have revolutionised how filmmakers can capture footage, scenes and events.
d. For use during sporting and recreational activities: Drones can be used to monitor and record recreational and sporting activities such as football, swimming and athletics to make sure rules are followed. Sometimes drones are used to capture certain activities, events and scenes during football matches, athletics and other sporting and recreational activities.
e. Drones are used in the construction industry: Drones are used to survey and map land, establish boundaries and applied in various aspects associated with the building and construction industry.

Disadvantages of drones

a. There are concerns about their potential impact on privacy and safety.
b. Drones are not good in strong winds, rain, and snow, which can affect their performance.
c. Some drones are high cost, having expensive features like high resolution cameras.
d. Most drones have a short flight time due to limited battery capacity, which restricts their operational range.
e. They can be used for harmful purposes, such as spying or delivering loads which hurt people.
f. Many countries now regulate drone flying, and many have strict laws and licensing requirements which limit where and how drones can be used.

LiDAR (Light Detection and Ranging)

LiDAR technology utilises laser beams to measure distances and create detailed, three-dimensional representations of the Earth's surface. This technology has found extensive applications in forestry, urban planning, and infrastructure development. It is simply the use of light to capture information or data. In a LiDAR system, light is emitted from a rapidly firing laser. That is why it is sometimes also referred to as active laser scanning. The reflected light energy then returns to the LiDAR sensor where it is recorded as data. It works like a scanner or camera on some mobile phones. Use the link below to watch a video on how LiDAR works.

https://youtu.be/m7SXoFv6Sdc.

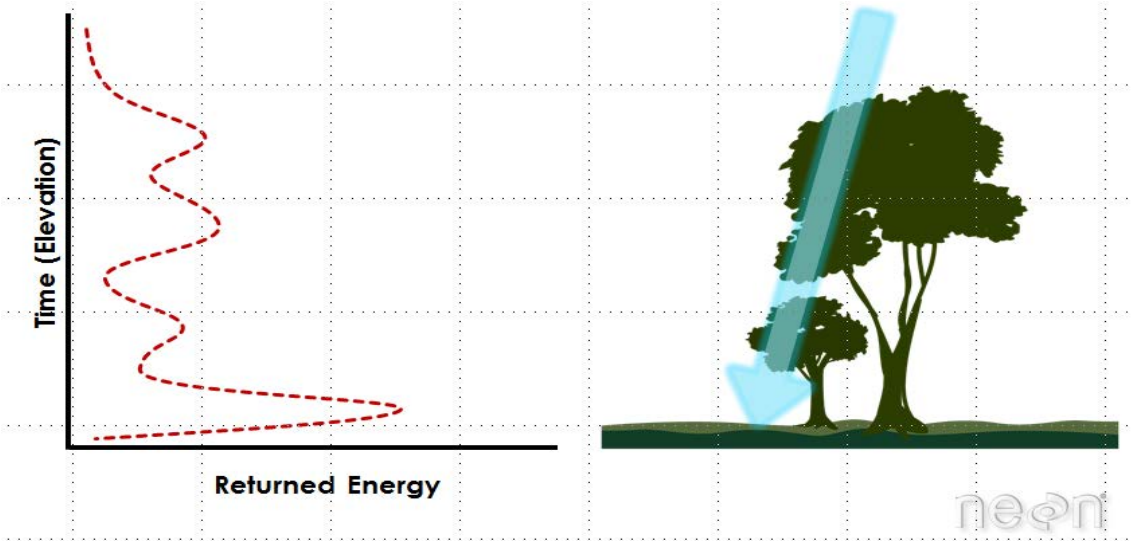


Figure 7.10: LiDAR waveform returned from two trees and the ground (NEON)

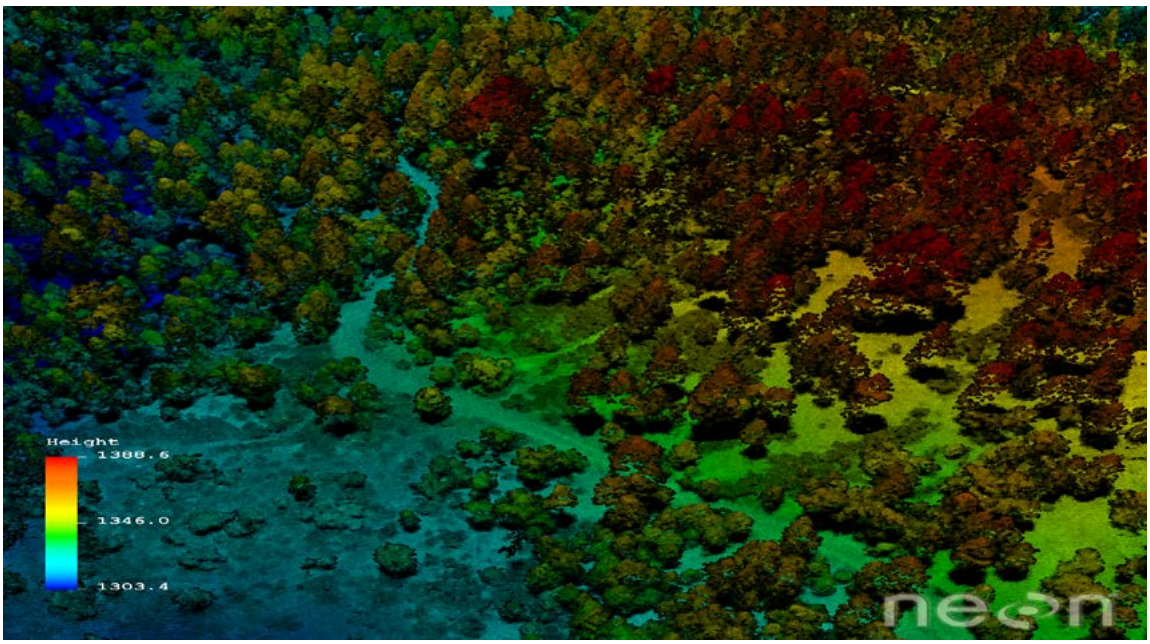


Figure 7.11: LiDAR data, showing vegetation height or structure. (the National Ecological Observatory Network's Airborne Observation Platform (NEON AOP).

Advantages of LiDAR

There are a number of advantages of LiDAR:

a. High accuracy and precision: LiDAR can achieve sub-meter accuracy, making it invaluable for detailed topographical mapping. It can generate high-resolution images and maps. It can also distinguish between objects and detect smaller objects using shorter wavelengths.
b. Capable of seeing through vegetation and canopy: Unlike traditional aerial photography, LiDAR can penetrate tree canopies, providing valuable data on forest structure and biomass. For example, LiDAR can see through vegetation to provide precise images of what's underneath.
c. Rapid Data Processing (Speed): Advanced algorithms allow for quick processing of LiDAR data, generating insights promptly. LiDAR sensors are fast, receiving data from laser pulses at a high rate.
d. Data integration: LiDAR can be integrated with other data sources to simplify and automate complex data analysis and processing.
e. Capable of 3D scanning: LiDAR can produce 3D scans of objects by measuring their distance and detecting differences in reflectivity.
f. Cost savings: LiDAR can help reduce costs associated with exploration in the field by improving accuracy and faster data acquisition.

Disadvantages of LiDAR

Light Detection and Ranging (LiDAR) has some disadvantages. Some of these are:

a. LiDAR equipment and maintenance can be expensive.
b. LiDAR is sensitive to atmospheric interference from rain, snow, and fog, which can scatter, absorb, or reflect its beams.
c. LiDAR has a limited range compared to radar in some scenarios.
d. The accuracy of LiDAR is dependent on the quality and calibration of the system's components.
e. LiDAR is complex and requires a deep understanding of the technology and skills to process the data.
f. LiDAR data is not coloured, making it difficult to interpret without overlaying RGB photos. (RGB stands for Red, Green, and Blue, which are the primary colours of light. In the context of photos and digital imaging, RGB refers to a colour model used to create a broad array of colours by combining different intensities of these three primary colours)

Application and benefits of LiDAR

LiDAR is of great benefit and can be applied in the following areas.

a. Information about the environment, especially forestry: LiDAR is used in autonomous vehicles to provide detailed information about the environment, especially detecting vegetation cover and changes in areas such as canopy height, canopy cover, vertical forest structure and species identification.

b. Agriculture: LiDAR data can help predict crop yields more accurately.
c. Energy: LiDAR data is used in the energy sector for site selection, assessment, and monitoring.
d. Aerial Inspection: LiDAR is used in airborne inspections to detect and track aerial activities and events, including weather and climatic activities and air pollution.
e. Survey and mapping in land management: it is also used in land management and administration, including detecting and managing land-based environmental activities such as mining and quarrying.
f. Robotics: LiDAR technology assists robots to navigate their surroundings by providing object perception, object identification. LiDAR sensors provide information about the robot's surroundings such as walls, doors, people and other objects to avoid collision.
g. Autonomous Vehicles: LiDAR is capable of tracking obstacles and vehicles to maintain safe distances. It makes autonomous or self-driving vehicles to identify road signs, traffic signals, and road markings. This technology is paramount in ensuring the safe and effective operation of autonomous vehicles.
h. Used to assess hazards: It is used to monitor and assess hazards such as lava flows, landslides, tsunamis, and floods.
i. For geologic mapping: It is used to map out terrain, including relief and geological settings of an area.
j. For watershed and river management: surveys: Used to demarcate waterbodies, including drainage basins and watersheds.

Mobile Mapping Systems

Mobile Mapping Systems (MMS) integrate multiple data collection technologies, including GPS, cameras, and LiDAR, into a single platform mounted on vehicles. In MMS, devices that collect geographic data have sensors that are mounted on mobile platforms, such as cars, boats, or airplanes. This technology provides a comprehensive approach to data collection for applications like urban planning and infrastructure assessment.

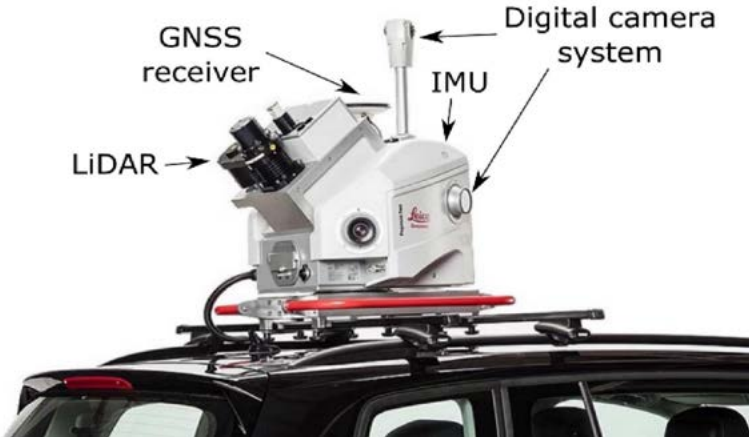


Figure 7.12: Mobile Mapping Systems with sensors and devices mounted on a vehicle (MDPI)

Advantages of Mobile Mapping Systems

These are some of the advantages of using mobile mapping for surveying

a. Comprehensive Data Capture: The combination of various sensors allows for the collection of diverse data types, from high-resolution images to detailed 3D models.
b. Higher accuracy and resolution: It has a high level of accuracy due to the higher resolution of some of the sensors.
c. Efficiency: Mobile mapping systems can cover large areas rapidly, saving time and resources compared to traditional survey methods.
d. Faster and safer data collection: Many mobile mapping systems can process data in real time, facilitating immediate analysis and decision-making. Mobile mapping can be up to 40 times faster than traditional static scanning tools.
e. Easier and more flexible data processing: Due to the multiple use of sensors, it is easier to process data. It has flexibility due to the use of multiple devices.
f. Can capture data anywhere: Mobile scanners can be operated remotely, making it possible to survey and map inaccessible, dangerous, or hostile environments. Mobile mapping can operate in various weather and lighting conditions and can even collect data indoors or underground.

Disadvantages

The accuracy of mobile mapping data is highly dependent on the quality of the sensors and the environment in which it is collected. For example, GPS signals can be obstructed in urban environments or dense forests, leading to reduced accuracy.

Areas of application and benefits

a. Spatial Understanding. Maps provide a visual representation of space, allowing an understanding of the layout and relationships between different geographic features.
b. Used for Navigation and route-finding
c. For planning, analysis and decision-making, such as urban, municipal and town planning
d. Can be used to preserve historical and cultural artifacts
e. For environmental awareness on pollution, degradation and climate change.
f. For making maps

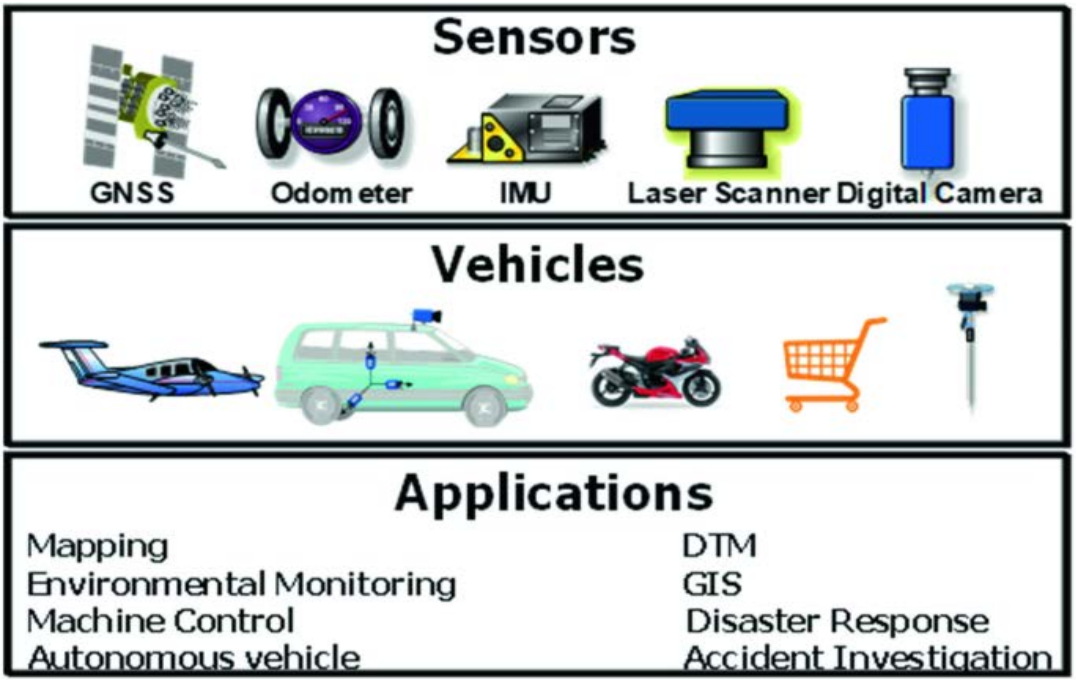


Figure 7.13: Application and benefits of mobile mapping systems (Springer Links)

Internet of Things (IoT) and Sensor Networks

The Internet of Things (IoT) is a network of physical objects that are connected to the Internet and can exchange data with other devices and systems. In other words, The Internet of Things (IoT) involves the interconnection of devices and sensors that collect and exchange data. It enables real-time geospatial data collection from a network of sensors deployed in various environments, from urban areas to remote locations.

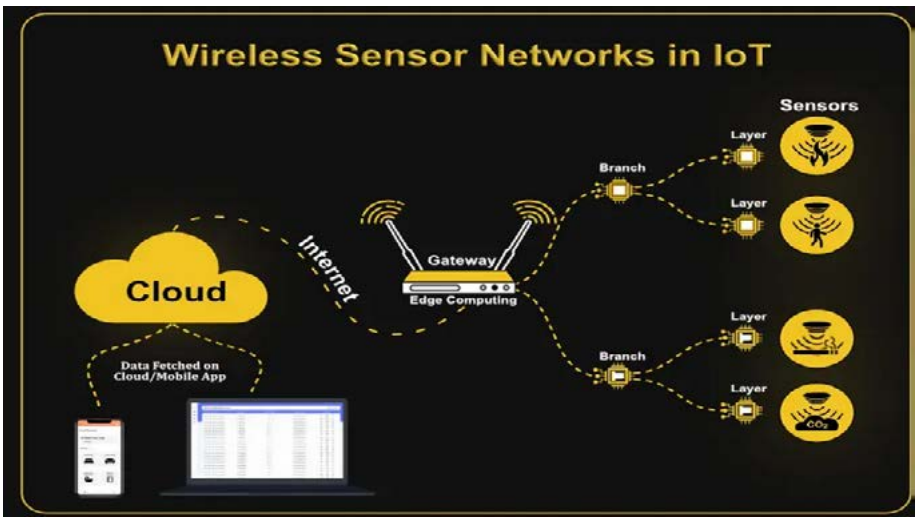


Figure 7.14: Wireless Sensor Networks in IoT. WSN is a self-organizing network formed of a large number of sensor nodes. Using their simple computing power, these sensor nodes sense the environment in the network.

Advantages of IoT

The following are some of the advantages of IoT

a. Real-Time Monitoring: IoT sensors can provide continuous monitoring of environmental conditions, infrastructure health, and other geospatial factors.
b. Data Integration: The ability to integrate data from various sensors offers a comprehensive view of geographical phenomena, enhancing situational awareness.
c. Costs: Low cost as using sensors to collect data is much lower than using humans.
d. Reliability. Sensors are accurate and reliable, making fewer mistakes.
e. Efficient operation management: It is very efficient due to the combination of different networks.

Disadvantages of IoT

The major disadvantages are security issues, privacy concerns, increased unemployment, the complexity of the system, and high chances of the entire system getting corrupted for example.

Application and benefits of IoT

The following are the benefits and areas where IoT can be applied

a. Used in traffic systems
b. The Internet enables local communities, regions and, nations to develop
c. It can be used to attract, retain and, expand job-creating in businesses and institutions
d. It also improves the productivity and profitability of large, small and home-based businesses
e. For market survey and allows them to compete in local, national and global markets
f. It enhanced data collection and helps improved security

Geospatial Artificial Intelligence (GeoAI)

GeoAI combines geospatial data with artificial intelligence (AI) and machine learning algorithms to analyse complex datasets and generate actionable insights. This technology is particularly useful in applications such as predictive modelling, urban planning, and disaster response. It simply combines artificial intelligence (AI) with geospatial data, science, and technology to analyse data and solve real-world problems:

Advantages of GeoAI

a. Helps Identify Relationships in Spatial Data: GeoAI **can spot patterns and connections in maps and geographic data** that might be missed by humans using traditional methods.
b. Provides Detailed Location Information: It gives **precise details about where things are**, like exact coordinates (latitude and longitude).
c. Can Help Determine the Probability of Disasters: GeoAI can **predict the chances of natural disasters** like floods or earthquakes by analysing past and current data.
d. Can be used in a number of geography related areas: The tools and methods used **can be tailored to fit specific fields**, like city planning or environmental studies.
e. Software Packages are available for a range of tasks: Different tasks **have specialised GeoAI software**, similar to how various apps serve different purposes on your phone.
f. Involves Low Cost: Many **GeoAI tools and data sources are affordable**, making them accessible to more people and organizations.
g. Automation of Routine Data Analysis Tasks: **GeoAI can automate repetitive tasks**, allowing experts to spend more time on important decisions.

Disadvantages of GeoAI

a. Low Resolution Data: this type of **low-cost data often lacks detail**, affecting AI accuracy.
b. High Costs: **powerful computers are needed** to deal with big data sets, which are expensive.
c. Privacy Issues: one of the main concerns with AI - **data privacy**, sharing might be done without your knowledge, and information could be used by others to their advantage.
d. Complexity: **Requires special skills** so users need to be highly trained in to use it properly.
e. Data Quality: AI **depends on good data**; bad data leads to wrong results.
f. Regulations: **Legal and ethical challenges** can result in costly courtroom visits.
g. Maintenance: Needs **regular updates and servicing** by qualified technical staff.
h. Integration: **Hard to fit into existing digital systems**

Application and benefits

Can be used in the following areas

a. Environmental monitoring
b. Transportation

c. Urban planning
d. Data analysis
e. Emergency management
f. Spatial modelling
g. Agriculture
h. Academic research
i. Forecasting and prediction.

Activity 7.4 Exploring Emerging Technologies for Geospatial data through Digital Learning

1. Research and watch videos or examine pictures and diagrams of the following technologies:
   a. Drones and Unmanned Aerial Vehicles (UAVs)
   b. LiDAR (Light Detection and Ranging)
   c. IoT (Internet of Things) Systems
   d. GeoAI (Geospatial Artificial Intelligence)
2. Take notes on each technology, focusing on:
   a. How it works: Describe the basic principles behind each technology.
   b. Applications: Note how the technology is used in various fields such as urban planning, agriculture, or disaster management.
   c. Advantages and Challenges: Identify the benefits and limitations of each technology.
3. Use your notes to create a simple infographic or chart comparing the technologies. Your infographic should include:
   a. Brief descriptions of how each technology works.
   b. Real-world applications for each technology.
   c. Icons, images, or diagrams that make your infographic visually appealing and informative.
4. Pair up with a classmate and exchange your infographics. Take turns explaining your work, highlighting how each technology functions and its applications in real-world scenarios. Engage in a respectful discussion; appreciate and respect your partner's ideas. Practice active listening and building on each other's thoughts.
5. Use the Peer Review Checklist to provide feedback on your partner's infographic. Consider the following:
   a. Are the descriptions accurate and easy to understand?
   b. Does the infographic compare the technologies?
   c. Are visuals used effectively to enhance understanding?

6. After the peer review session, take time for self-assessment using the following prompts:
   a. How well I you understand the technologies?
   b. What did I find most interesting or surprising about these technologies?
   c. How effectively did I communicate my findings in my infographic?
7. Write about your thoughts on:
   a. How these emerging technologies can be applied to solve real-world problems.
   b. Reflect on your collaboration experience: What did you learn from your partner during the explanation and review process?
   c. Identify one area where you felt you excelled and one area where you can improve in future collaborative activities

Review Questions

Methods of Collecting Geospatial Data

1. What is geospatial data?
2. Name two traditional surveying techniques.
3. What are the three main components of GPS?
4. How is the electromagnetic spectrum used in remote sensing?
5. Explain one similarity between traditional surveying and GIS.
6. What role does GIS play in urban planning?
7. Compare the applications of remote sensing and GPS in environmental monitoring.
8. Evaluate the advantages of modern surveying methods like remote sensing over traditional surveying techniques.
9. How can combining multiple geospatial data collection methods improve decision-making?

Collection and Mapping of Geospatial Data

1. For what is geospatial data used?
2. Name two mobile apps used for collecting geospatial data.
3. What does GIS stand for?
4. Describe one advantage and one disadvantage of using mobile apps for collecting geospatial data.
5. How can OpenStreetMap contribute to geospatial data collection?
6. What is the first step to take when planning for data collection?
7. Compare and contrast the use of GPS devices and GIS software in geospatial data collection.
8. Explain the process of importing data from a mobile app into GIS software and why this step is important.
9. Analyse how advancements in technology have impacted the collection and mapping of geospatial data.

Emerging Technologies For Geospatial Data Collection

1. What are drones used for in geospatial data collection?
2. What does LiDAR stand for and what is its primary function?
3. Explain one key benefit of using mobile mapping systems for data collection.
4. How does the Internet of Things (IoT) enhance geospatial data collection?
5. Compare the data acquisition capabilities of drones and LiDAR technology.
6. Discuss how Geospatial Artificial Intelligence (GeoAI) integrates with geospatial data collection and its potential impact on decision-making.

Geography Year 2

SECTION 8

LAND DEGRADATION IN GHANA

HUMAN AND THE ENVIRONMENT

Environmental Degradation

Introduction

In this section, you will learn about land degradation and soil pollution in Ghana. You will explore the causes of these environmental problems, their effects and how they can be fixed. You will discover that human activities like mining, cutting down trees, building cities, and farming can harm the land and soil. You will also find out that plants can absorb soil pollutants, which can then enter the food chain and harm people's health. Therefore, it is important to understand how to take care of your land to keep it healthy. By the end of this section, you will understand the challenges land degradation and soil pollution present to people in Ghana, and how local communities are affected. This knowledge will help you think about how effective current laws are in protecting lands and soil and suggest some smart solutions of your own to tackle these environmental problems.

Key Ideas

- Land degradation affects the environment. Deforestation, water pollution, climate change, reduced habitat biodiversity, soil erosion, and desertification can be caused by a combination of natural processes and human activities.
- Land degradation refers to the decline in land quality and agricultural productivity due to various factors, including natural processes and human activities.
- Soil pollution affects the environment. Soil fertility reduction, contamination of local water sources, loss of fish, plant and animals, erosion leading to sedimentation of water bodies can all be caused by misuse of the soil.
- Soil pollution refers to the presence of toxic chemicals, contaminants, or pollutants in the soil.
- The socio-economic effects of land degradation are serious for Ghana because a bug percentage of people are employed in farming and local people rely on growing their own produce to survive.
- The socio-economic effects of soil pollution have a negative impact on people, affecting health and ability to work, reducing agricultural productivity, making farms unprofitable, causing migration which leads to uncontrolled city growth.
- Toxic chemicals taken up by plants grown by farmers and local people and can enter the human food chain and cause illness.

LAND DEGRADATION IN GHANA

Meaning of Land Degradation

Land degradation refers to the decline in land quality and productivity due to various factors, including natural processes and human activities.

This problem affects the health of the soil, water supplies, and the variety of plants and animals in an area. In Ghana, land degradation is a serious issue because it threatens food security, people's jobs, and the overall economic development of the country. It is important to understand what causes land degradation, how it affects people, and what can be done to fix it. Knowing this information can help make better laws and plans to protect Ghana's land and improve how people use it.

Causes of Land Degradation

The following causes contribute to land degradation in Ghana.

1. **Indiscriminate Lumbering:** This is cutting down trees without considering the future. If more trees are cut down than are plated then Ghana will soon run out of this valuable natural resource. The high demand for timber, both for local use and export, has caused a lot of trees to be cut down in Ghana. From 1990 to 2015, the country lost about 2.5 million hectares of forest. When trees are removed, the soil becomes exposed to wind and water, which can wash away the topsoil that is important for growing crops.
2. **Mining Activities:** Both legal and illegal mining (known as galamsey)damage the land. Mining can lead to soil erosion, pollute water with harmful metals, and destroy natural habitats. For example, illegal mining has heavily affected the Atewa Range Forest Reserve, which is home to many plants and animals.
3. **Agricultural Practices:** Some farming methods, like shifting cultivation and overgrazing, can harm the soil. If farmers keep planting crops without giving the land a break, it can run out of nutrients, making it harder to grow food. In northern Ghana, overgrazing and poor farming practices have led to serious land degradation.
4. **Climate Change:** Changes in the weather, like more frequent droughts and floods, make land degradation worse. For example, in the Upper East Region, repeated droughts have led to less plant cover and more soil erosion.
5. **Urbanisation:** As cities grow and more people move in, there is more pressure on land. This often leads to farmland and forests being turned into homes and businesses. Cities like Accra and Kumasi have experienced significant changes in land use because of urbanisation.

Figure 8.1: Illegal mining activities resulting in land degradation

Environmental effects of land degradation in Ghana

The following are the environmental effects of land degradation in Ghana.

1. **Loss of Biodiversity**: The Atewa Range Forest Reserve is like a special home for many plants and animals, including some species that can only be found in that area, like the Atewa forest's unique frogs. However, illegal mining is causing a lot of damage. When the miners dig for gold, they destroy the homes of these animals and plants, which means some of them might disappear forever.

2. **Soil Erosion**: In the Upper East Region, farmers sometimes do not take care of the land properly. For example, if they do not plant trees after cutting them down, the rain can wash away the top layer of soil, which is rich in nutrients. This is a problem because, without that nutrient-rich topsoil, crops like maize and cassava cannot grow well. It also creates big holes called gullies, which make the land even worse over time.

3. **Desertification**: In the northern parts of Ghana, especially the Upper East and Upper West regions, the land is turning into desert. This happens when too many animals graze on grass and trees are cut down. For example, when farmers let their goats and cows eat all the plants, it leaves the soil exposed. Without plants to hold the soil, it can dry out and become like a desert, where it is hard to grow food.

4. **Water Pollution**: Illegal mining, especially small-scale mining known as "galamsey," is causing serious pollution in rivers in Ghana. For instance, rivers like the Pra and Ankobra are being contaminated with harmful substances like heavy metals from the mining process. This pollution harms fish and other animals that live in the water. It also makes the water unsafe for people to drink, which can lead to health problems.

5. **Climate Change**: Land degradation contributes to climate change by releasing carbon dioxide into the air. Trees and healthy soil help absorb carbon dioxide, so when they are damaged or removed, more greenhouse gases are left in the atmosphere, leading to global warming.
6. **Deforestation**: Cutting down trees for farming or logging reduces the number of forests in Ghana. Trees are important because they help keep the soil in place, provide homes for animals, and produce oxygen. When trees are removed, it can lead to more erosion and loss of wildlife.

Socio-Economic Impacts of Land Degradation in Ghana

The following are the Socio-Economic impacts of land degradation in Ghana.

1. **Reduced Agricultural Productivity**: In the Upper East Region, problems like soil erosion and the loss of soil nutrients mean that farmers cannot grow as many crops as they used to. For example, if a farmer normally grows 100 bags of maize a year, they might only produce 50 bags now because the soil is not healthy anymore. This makes it hard for families to have enough food and earn money, forcing some farmers to leave their land or use farming methods that are not good for the environment.
2. **Increased Poverty**: In most rural communities in Ghana, the people rely on farming for their livelihood. When land becomes less productive due to degradation, farmers earn less money. For instance, if a farmer used to make enough money to provide for their family but now struggles to sell enough crops, they may fall into poverty. This lack of income makes it difficult for families to pay for school or improve their farming practices, creating a cycle of poverty.
3. **Migration and Urbanisation**: When farmers cannot produce enough crops because of land degradation, many people leave their rural homes to find better opportunities in cities. For example, someone from a farming village might move to Accra or Kumasi in search of work. As more people move to the cities, there is more pressure on things like housing, schools, and health services. This can lead to overcrowded areas and informal settlements, which often have poor living conditions.
4. **Loss of Livelihoods**: Some communities, especially those near the Atewa Range Forest, rely on the resources the land provides, such as wood for building and plants for food. When land degradation occurs, these resources become scarce. For instance, if people cannot find enough timber due to deforestation, they may lose their jobs in logging or ecotourism. This economic hardship can affect everyone in the community, making it harder for families to support themselves.
5. **Health Problems**: In areas affected by mining, like the Western Region, water pollution from land degradation can cause serious health issues. For example, if the rivers are contaminated with harmful chemicals, people who drink that water might get sick with diseases like diarrhoea or skin infections. These health problems increase the cost of healthcare for families and lower their quality of life.

Strategies for dealing with Land Degradation in Ghana

The following strategies can help reduce land degradation in Ghana.

1. **Afforestation and Reforestation Projects**: The government runs a program called the Ghana Forest Plantation Development Programme, which aims to bring life back to damaged forest areas by planting new trees. For example, they might plant native tree species to help the environment. This process improves the soil quality, prevents erosion, and helps animals and plants thrive again. An organisation called A Rocha Ghana also helps plant trees in places like the Atewa Range Forest Reserve, helping restore this key area.

2. **Promotion of Sustainable Agricultural Practices**: Sustainable agricultural practices are methods of farming that aim to meet current food needs without harming the environment or using up resources for future generations. The Ministry of Food and Agriculture (MoFA) encourages farmers to use good farming methods that protect the land, such as rotating crops (growing different crops in a field each year) and planting cover crops (growing plants that protect the soil between harvests). These methods help keep the soil healthy and reduce erosion—a farmer might grow maize one season and beans the next to improve the soil. Non-Governmental Organisations (NGOs) like the Savanna Agricultural Research Institute (SARI) provide training and resources to farmers in Northern Ghana, teaching them these important techniques.

3. **Soil and Water Conservation Techniques**: A project called the Ghana Environmental Management Project (GEMP) focuses on protecting soil and water. Techniques like contour ploughing (ploughing along the curves of the land to stop the natural flow of water down a slope) and building check dams (small barriers to slow down water) help stop soil erosion and keep water available for crops. These methods are especially useful in the Upper East and Upper West regions.

4. **Community-Based Natural Resource Management**: The Community Resource Management Areas (CREMAs) initiative helps local communities take charge of their natural resources. It is supported by the Wildlife Division of the Forestry Commission and NGOs like the Nature Conservation Research Centre (NCRC). Getting locals involved in planning how to use and protect their land, increases their sense of responsibility—like planting trees or protecting wildlife in their areas.

5. **Integrated Water Resources Management (IWRM)**: The Water Resources Commission (WRC) works to manage and protect water resources smartly. This means they look at how land and water work together and make plans that help both. For example, they might create rules on how much water farmers can use to prevent overuse. Organisations like WaterAid Ghana work with the government to make sure these strategies are used effectively, which helps reduce land degradation caused by poor water management.

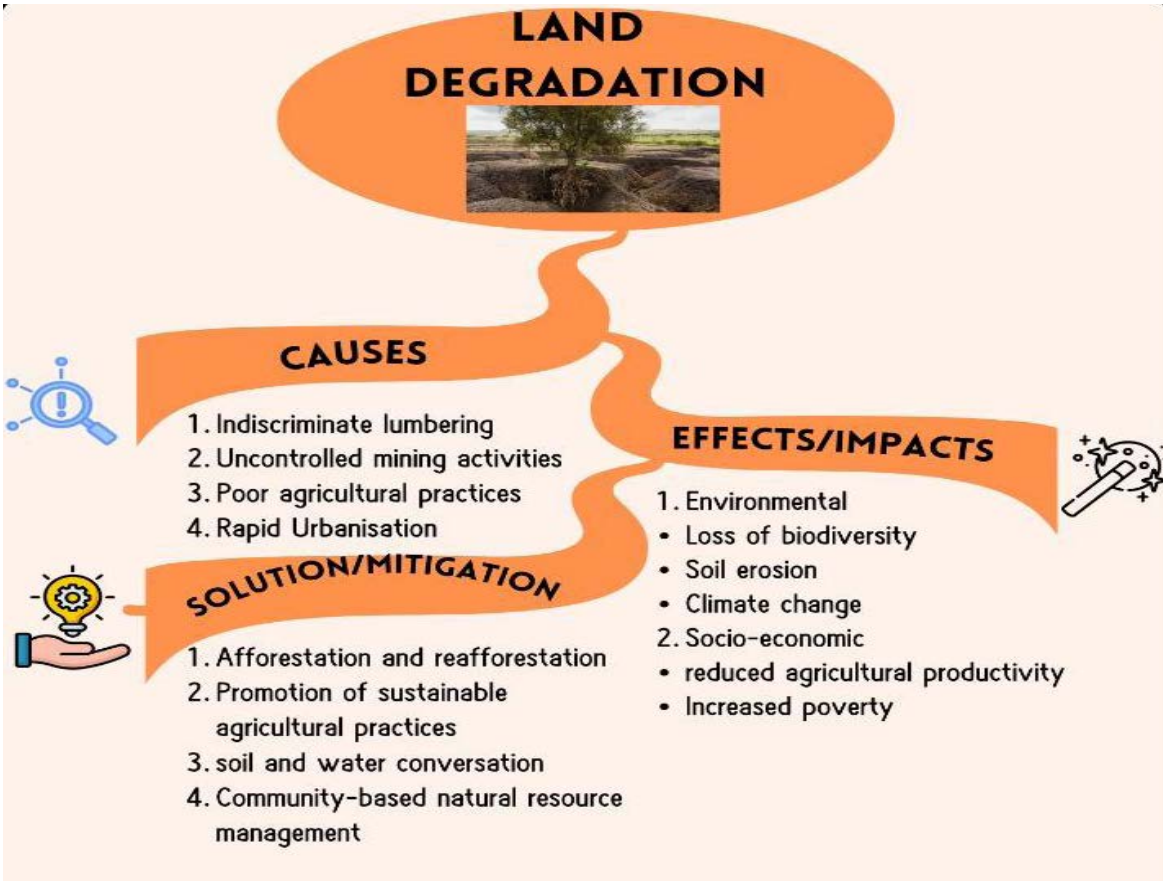
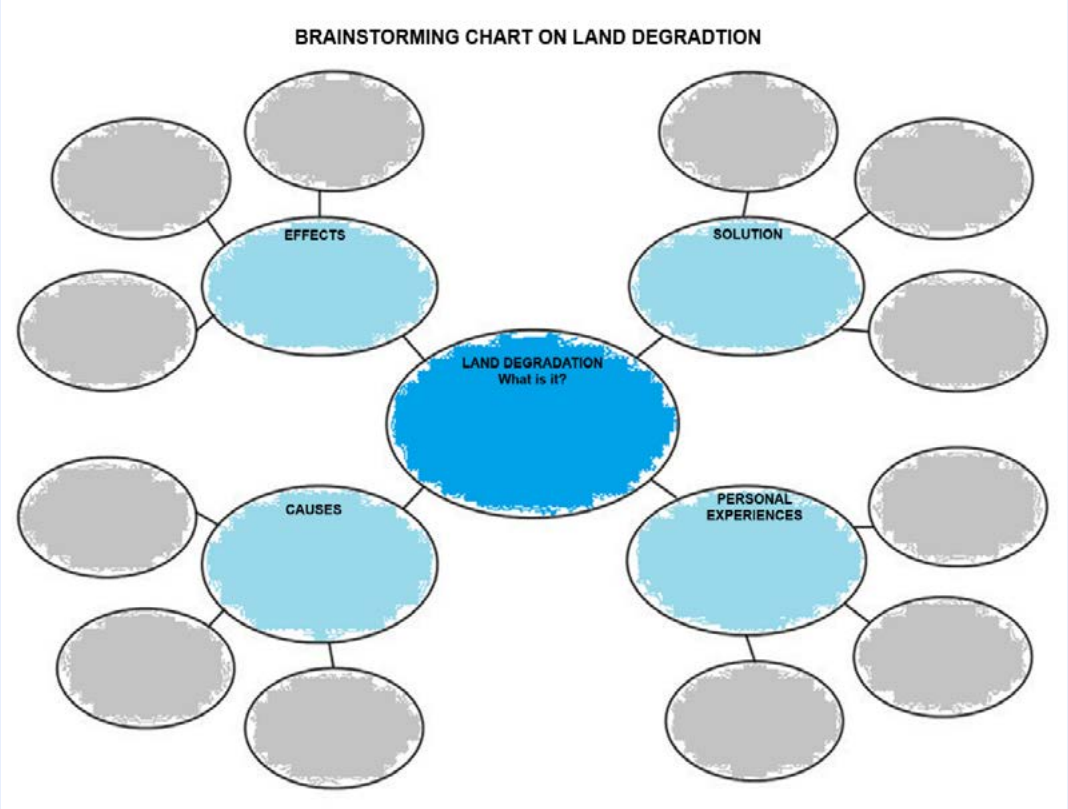


Figure 8.2: Concept Mapping on Land Degradation (Writers' construct, 2024)

Activity 8.1 Land degradation

1. Start by thinking about what land degradation means to you. Keep in mind how this concept might look different depending on where you live or your cultural background.
2. Take a moment to think about the following questions on your own:
   a. What causes land degradation?
   b. What are the environmental and socio-economic effects of land degradation? Have you seen or experienced land degradation in your community or elsewhere? Write down what you experienced or saw.
   c. What can individuals, the government and organisations do to tackle the effects of land degradation?
3. Your teacher will provide you with a Brainstorming Chart like the like the one below or you could make your own. Share your thoughts from question 2 with others by writing them on sticky notes and placing them on the relevant sections of the Brainstorming Chart. Write clearly and include specific examples.



4. Organise yourselves into small groups of no more than five. Have a discussion about the brainstorming chart. Use these guiding questions:
   a. What common themes did you notice in your ideas about causes and effects of land degradation?
   b. How do different cultural or geographical contexts shape our understanding of this issue?
   c. Which solutions stood out to you, and why should people consider them?

   Share how land degradation has impacted your community. Respect different viewpoints and experiences.

5. Reflect, individually, on your participation in this activity by considering:
   a. How effectively did I share my ideas and experiences?
   b. Did I listen actively to my peers? How can I improve in this area?
   c. What did I learn about land degradation that was new to me?

6. In your reflection journal, respond to these questions:
   a. How does land degradation affect my community or cultural heritage?
   b. Why do I think it is important to address land degradation locally and globally?
   c. What personal actions can I take to help combat this issue?

   Take your time to think critically and express your feelings about what you learned.

Activity 8.2 Exploring Mining and Mining Machinery through Video Documentary and Group Presentation.

Revise the work you did on "Mining in Ghana" in Year 1. Make sure you know the types of machines, methods used for both legal and illegal mining and the impact each one has on the land and surrounding environment (water bodies, ecosystems and humans). Consider how mining companies could be made legally responsible for controlling pollution during mining and putting back the land to how it was before they started. Why is illegal mining common in Ghana? Think about the meaning of the word galamsey. How you would make illegal miners responsible for cleaning up after their activities.

1. Watch the following documentary which lasts for about 15 minutes. It is pretty shocking so be prepared to hear and see some things which might upset you. Focus on the environmental destruction and the scale at which it is taking place. Make a note of the different machines that are being used in the mining activities. How does the use of machines affect the process of land degradation.

The price of gold: Chinese mining in Ghana documentary | Guardian Investigations

   a. Make notes on the documentary and then organise them into a series of points.
   b. Tell a friend or someone at home about what you have learned from the documentary.
   c. Decide with your friend what could be done to slow down land degradation caused by mining.
   d. Watch the clip below which lasts for three minutes. It describes the fight by environmentalists to protect the rainforest in Ghana and prevent large scale land degradation as a result of bauxite (the ore of aluminium) mining. You could research how bauxite is mined to give you an idea of just how destructive the process is.

Mining in Ghana: Environmentalists fight to stop deforestation

   a. Make notes on the clip and then organise them into a series of points.
   b. Tell a friend or someone at home about what you have learned from the clip.
   c. Decide with your friend if the Ghanaian government has made progress in protecting the forest and stopping land degradation that will result if they allow the mining of bauxite.

2. Organise yourselves into small groups of no more than five. Remember to assume a role (e.g., note-taker, presenter, facilitator) in the group to ensure that you actively participate. Be respectful and offer positive suggestions while you take turns sharing your ideas. Practice positive communication and active listening.

Below are sample pictures that show some machines being used for mining in Ghana.

a. Match the pictures with the following machines: bulldozer, excavator, river dredger, dumper truck.
b. Explain how using each of these machines causes land degradation in Ghana?
c. Research on modern technologies that are used in mining in Ghana. Look for online articles or credible sources to gather in-depth information.

Organise your findings in a clear, structured manner. Engage in a respectful discussion by covering:

a. What each type of machinery is used for
b. Are any of the machines environmentally friendly?
c. Which machinery is likely to cause the most environmental damage and why?
d. What would need to be done to put back the land after heavy machines have worked on it?
e. Are there any modern technologies that could be used instead of heavy machines for mining in Ghana?

Work together to summarise your group's findings and prepare a brief presentation (5-10 minutes) in either digital format (e.g., slides) or traditional format (e.g., poster) by highlighting the machinery, its functions, and its impacts on the environment. Ensure everyone practices their role and contributes to the

presentation. Use peer feedback to refine your delivery. Present your group's findings to the entire class. Be prepared to answer questions from your classmates by offering positive and informative responses.

After all presentations, provide respectful and constructive feedback to other groups. Focus on:

a. What you learnt from their presentation.
b. Suggestions for improvement or additional thoughts related to their findings presented.

Individually, assess your contribution to the group using the following prompts:

i. How effectively did I communicate your ideas?
ii. Did I actively listen and support your teammates?
iii. What role did I play in the group, and how did it contribute to the overall success of the group's presentation?

Write a response to the following questions:

i. How did the discussion change or deepen your understanding of mining machinery and its environmental impact?
ii. What modern technology impressed you the most, and why do you think it is important for sustainable mining practices?
iii. How can you apply the collaboration and communication skills developed during this activity in future projects?

SOIL POLLUTION IN GHANA

Meaning of Soil Pollution

Soil pollution refers to the presence of toxic chemicals, contaminants, or pollutants in the soil, which adversely affect its quality and health. This pollution can come from human activities, such as factories releasing toxic waste, farmers using too many chemicals on their crops, or people throwing trash in the wrong places. It is important to study soil pollution in Ghana because it can hurt our ability to grow food, pollute our water, affect people's health, and damage the environment. To tackle this problem, the area where the pollution is coming from should be identified to understand its future impacts so preventive solutions can be planned and undertaken.

Causes of Soil Pollution

The following are the causes of soil pollution in Ghana.

1. **Industrial Activities**: Gold mining releases toxic metals like mercury, lead, and cadmium which are used to separate out raw gold into the soil. For example, in Obuasi, where gold mining happens, these heavy metals can seep into the ground and contaminate soil and water sources. Other industries, such as those making

electronics or batteries, can also release harmful substances into the soil. In places like Takoradi, the nearby oil refineries can lead to soil pollution through improper disposal of waste from the refining process.

2. **Agricultural Practices**: Many farmers use chemical fertilisers, pesticides, and herbicides to help their crops grow faster and protect them from pests. However, using too many of these chemicals can harm the soil. For instance, in the Western and Ashanti regions, cocoa farmers often use high amounts of pesticides, which can build up in the soil and make it unhealthy. Similarly, in Northern Ghana, the heavy use of fertilisers on rice farms has caused soil contamination, affecting the land's ability to grow crops.
3. **Improper Waste Disposal**: When people and businesses throw away their trash carelessly, it can lead to soil pollution. For example, in cities like Accra and Kumasi, there are not enough systems for collecting and processing waste, so garbage piles up in open areas, leaking harmful substances into the soil. In some neighbourhoods, people may even dump old car batteries or chemicals, which can contaminate the ground and even reach water supplies nearby.
4. **Oil Spillage**: Oil drilling and extraction can lead to spills that damage the land. In the Western Region, the Jubilee oil field is a site where oil spills have been reported. These spills can cause serious harm to the soil and surrounding plants. In addition, during oil transportation through pipelines, leaks can occur, spreading oil onto farmland and affecting crops.
5. **Urbanisation**: As cities expand quickly, they create more pollution from construction projects, vehicle exhausts, and careless waste disposal. In Accra, the rapid growth of the city means more buildings and roads, which can release pollutants into the soil from construction debris or car emissions. Poor waste management in these growing areas, such as not having enough bins or collection services, also contributes to soil contamination, especially in neighbourhoods around the city where trash is often dumped.

Environmental Effects of Soil Pollution in Ghana

The following constitute the environmental effects of soil pollution in Ghana.

1. **Loss of Soil Fertility**: In mining areas like Obuasi and Tarkwa, heavy metals from mining can make the soil unhealthy and reduce its fertility. This means that plants struggle to grow, leading to empty, barren land. As a result, farmers in these regions find it harder to grow crops, causing a decrease in food production. In other areas, like parts of the Eastern Region where farmers use too many chemicals, soil fertility can also decline, making it tough to cultivate healthy plants.
2. **Contamination of Water Bodies**: Soil pollution from mining often causes dangerous metals and chemicals to wash into nearby rivers and streams. For example, rivers like the Pra and Ankobra have been polluted by waste from mining activities, making the water unsafe for fish and other wildlife. This not only harms aquatic life, such as fish and frogs but also affects people who rely on these water

sources for drinking and fishing. In some areas, residents have reported having to find alternative water sources because their local rivers have become contaminated.

3. **Loss of Flora and Fauna**: The Atewa Range Forest Reserve is suffering due to illegal mining, which pollutes the soil and damages the habitats of many plants and animals. This pollution causes some plant species to die off and drives animals away from their homes, reducing the variety of life in the forest. Other regions, like the biodiversity hotspots in the Western Region, also see a decline in animal and plant species due to pollution, threatening ecosystems that rely on a variety of species to thrive.

4. **Disruption of Ecosystems**: In agricultural areas like the cocoa farms in the Western and Ashanti regions, the excessive use of chemical fertilisers and pesticides leads to an unhealthy buildup of these substances in the soil. This chemical overload can kill beneficial organisms that help keep the soil healthy, like earthworms and bacteria. Without these helpers, pests can multiply quickly because their natural predators are harmed by the chemicals, leading to more diseases and lower crop yields. This problem is not limited to cocoa farms; it also affects maize and rice farms across the country.

5. **Erosion and Sedimentation**: In regions like the Upper East and Upper West, soil pollution speeds up soil erosion. Polluted soil is often less stable, can wash away more easily with heavy rain, leading to increased sediment in rivers and streams. This sediment can harm fish habitats and water quality, making it difficult for aquatic life to survive. For example, when soil from these regions erodes into waterways, it can clog rivers, making it harder for fish to breathe and find food. Additionally, this sediment can carry pollutants that further affect the environment.

Socio-Economic Impact of Soil Pollution in Ghana

The following are some of the Socio-Economic Effects of Soil Pollution in Ghana

1. **Reduced Agricultural Productivity**: In farming communities that use a lot of chemical fertilisers and pesticides, the soil can become contaminated. For example, in areas like the Western Region, where cocoa is grown, farmers often have trouble producing healthy crops because the polluted soil does not support their growth. This leads to fewer crops being harvested, which means farmers earn less money. When families cannot earn enough from farming, it can lead to food shortages, making it hard for people to get the food they need.

2. **Economic Losses**: In places like the cocoa-growing regions of Ashanti and Western Ghana, soil pollution can lower the quality of the cocoa beans. When the beans are of poor quality, they sell for less money at the market. Farmers may find it difficult to sell their crops, which leads to less money coming in. Because of this, they might not be able to afford to buy new seeds or equipment, making it harder to improve their farms. This creates a cycle of financial problems for the farming families.

3. **Health Risks**: People living near industrial areas, especially those involved in mining like Obuasi, often face serious health problems because of the dust from contaminated soil. The dust can cause breathing issues or skin problems. In some cases, exposure to toxic substances can even lead to more severe health issues like cancer. This means families have to spend more money on healthcare and medicine, affecting their income and quality of life. For example, children in these areas might frequently miss school because of health problems.
4. **Loss of Livelihoods**: Communities that rely on natural resources, such as those in small-scale farming or artisanal mining, are greatly impacted by soil pollution. For instance, in areas where people mine for gold or farm for their living, contaminated soil can mean less land to grow crops or find resources. This pollution can lead to job losses, as there is not enough healthy land to support their work. Families may struggle to make ends meet, affecting their overall well-being and stability.
5. **Migration and Urbanisation**: When soil pollution makes farming difficult, some farmers might have to leave their lands and move to cities like Accra or Kumasi to find better jobs. This migration causes cities to become overcrowded, putting pressure on services like schools, hospitals, and roads. Many people live in informal settlements where conditions can be poor and jobs are hard to find. For example, as more people move to the city, the unemployment rate can increase because there are not enough jobs for everyone, making life even tougher for new arrivals.

Strategies to Reduce Soil Pollution in Ghana

1. **Proper Waste Disposal**: Keeping waste materials from the soil, like plastics and other trash. By using bins and encouraging recycling, prevents harmful chemicals in waste from entering into the soil and contaminating it.
2. **Regulation of Chemicals:** Controlling how agricultural chemicals, like pesticides and fertilisers, are used. Farmers should follow guidelines to reduce the amount of these chemicals, preventing excess use which is polluting the soil and waterways.
3. **Organic Farming:** Growing food without synthetic fertilisers and pesticides. Use natural compost and fertilising methods that enrich the soil without harmful chemicals, maintaining soil health and looking after the environment.
4. **Education and Awareness:** Teaching people about the effects of soil pollution and how to prevent it. When communities understand the importance of clean soil and ways to maintain it, they can change habits that contribute to pollution.
5. **Restoration Projects:** Efforts to clean up and reclaim polluted land. By removing contaminants and restoring plants, soil health can be improved and made safe for agriculture and wildlife again.

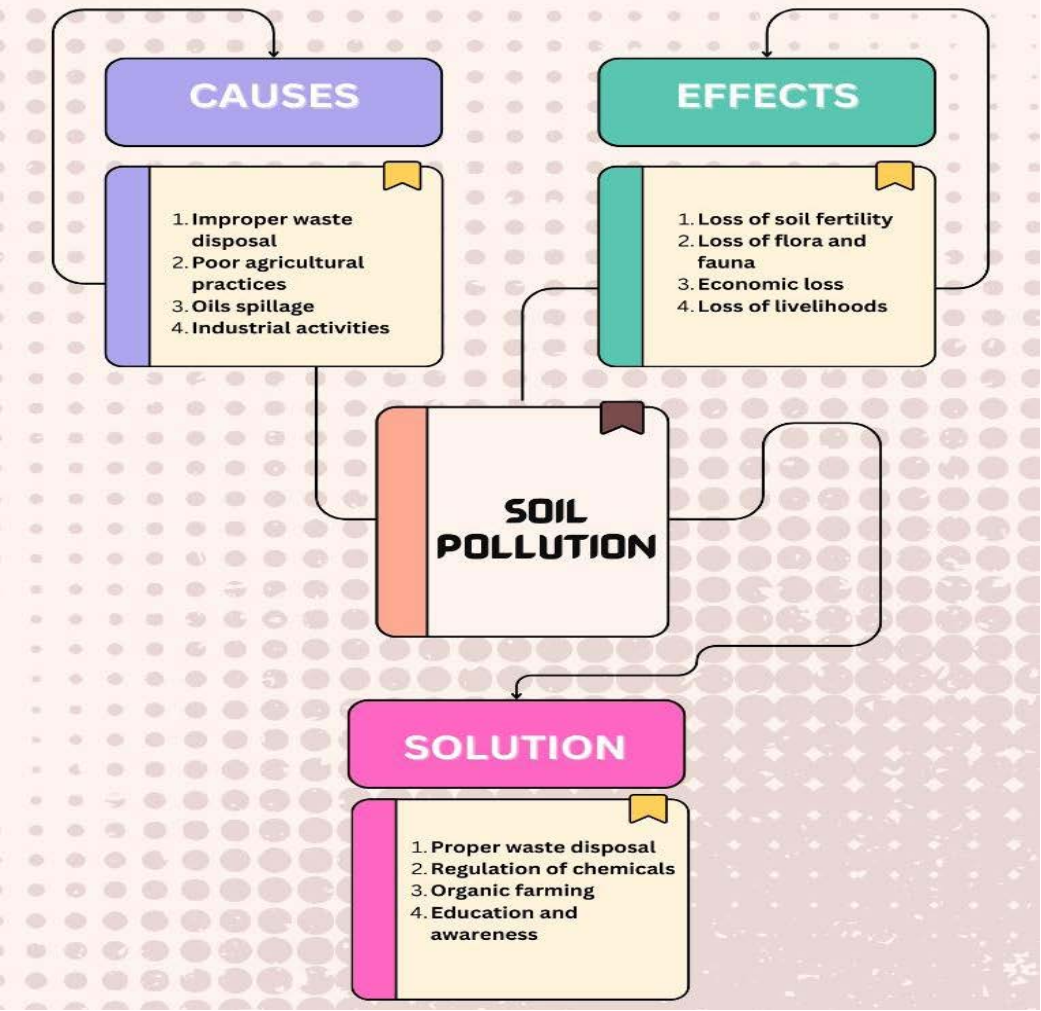


Figure 8.3: Concept Mapping on Soil Pollution (Writers' construct, 2024)

Activity 8.3 Understanding Soil Pollution - Causes, Effects and Solutions

1. Think about the term "soil pollution". How is it caused and what can be done to avoid it. Write your OWN ideas in your reflection journal.

   For the following activities, organise yourselves into groups of no more than five.

2. Each member of the group should use sticky notes to write down their ideas about what soil pollution is, what causes it and how it can be reduced or managed. Place them on a large chart paper or make a digital document. Once everyone has shared, work as a group to produce an agreed definition of soil pollution, the causes and solutions. Write your agreed definition, causes and solutions and add them to your chart.
3. While in your group, think independently about your community. What common activities or practices might contribute to soil pollution? Consider factors like waste disposal and agricultural practices. Write down your observations in your reflection journal.

4. Complete a survey of your school compound and record your observations of potential sources of soil pollution such as littering or waste disposal areas.
5. Share your findings with your group members. As a team, compile a comprehensive list of local causes of soil pollution on the chart paper or digital document. Discuss how each cause might impact different community members, ensuring everyone's voice is heard in this process.
6. As a group, discuss the impacts of soil pollution on humans and the local environment. Use the following prompts to guide your discussion:
   a. How can soil pollution affect health?
   b. What consequences does it have for wildlife and plants?
   c. In what ways does it impact your quality of life and community well-being?

   Write down the impacts you identify on sticky notes and add them to your chart.
7. Now that you have discussed the impacts, suggest potential remedies to ease soil pollution in your community. Consider both individual actions and community-wide initiatives. Record these solutions on your chart. Aim for practicality in proposing actions that everyone can take part in.
8. Find a partner from your group and exchange your completed charts. Review your partner's definitions, causes, impacts, and proposed remedies. Offer constructive feedback and suggestions for improvement. Focus on clarity and the practicality of the proposed solutions.
9. Reflect on the activity using these questions:
   a. How effectively did I participate in brainstorming and discussions?
   b. Did I listen actively to others? What can I improve?
   c. What key insights did I gain about soil pollution and its effects?

   Write your thoughts in your reflection journal.
10. In your reflection journal, answer the following questions:
    a. How seriously do I view the issue of soil pollution in my community, and why?
    b. What is one action I can take to help combat soil pollution locally?
    c. How can I share what I have learned with my community to raise awareness?

    Reflect on your emotions regarding current environmental issues and your role in addressing them.

Activity 8.4 Creating a Mind Map of Soil Pollution in Ghana

1. First, take some time to reflect on your findings on the causes, effects, and control measures of soil pollution in Ghana which you completed for Activity 1.
2. Using your research notes, create a mind map on a large sheet of paper or use a digital mind-mapping tool (like Mind Meister, Lucid chart or Canva). Include:
   a. Central Idea: "Soil Pollution in Ghana"
   b. Main Branches: Causes, Effects and Control
   c. Sub-branches: Specific points related to each main branch.

   Use colours and images to make your mind map visually engaging and easy to understand. You can use sticky notes for the ideas, organising them as you go.
3. Pair up with another learner and share your mind maps. Discuss each other's mind maps using the following guiding questions:
   a. Are the causes clear and specific to Ghana?
   b. Do the effects reflect the impact of soil pollution comprehensively?
   c. Are the control measures practical and relevant?

   Offer constructive feedback and note down suggestions for improvement.
4. Reflect on your participation in the activity using these questions:
   a. How effectively did I collaborate with my partner and group?
   b. What could I improve in my mind-mapping skills?
   c. What new understanding did I gain about soil pollution in Ghana?

   Jot down your responses in your reflection journal.
5. In your reflection journal, respond to the following prompts:
   a. How seriously do I view soil pollution as an issue in Ghana?
   b. What personal action can I take to raise awareness or contribute to solutions for soil pollution in my community?
   c. How can I use what I learned to help others understand the importance of controlling soil pollution?

Review Questions

Land Degradation in Ghana

1. What is land degradation?
2. List two causes of land degradation in Ghana.
3. What is the goal of the Ghana Forest Plantation Development Programme?
4. How does mining contribute to land degradation in Ghana?
5. Explain how urbanisation leads to land degradation in cities like Accra and Kumasi.
6. What role does the Ghana Environmental Management Project (GEMP) play in combating land degradation?
7. Compare the environmental effects of land degradation in the Upper East Region and the Atewa Range Forest Reserve.
8. Evaluate the socio-economic impact of land degradation on rural farmers in Northern Ghana.
9. In what way does community-based natural resource management (CREMAs) contribute to reducing land degradation in Ghana?

Soil Pollution in Ghana

1. What is soil pollution?
2. Name two major causes of soil pollution in Ghana.
3. Describe one strategy for reducing soil pollution that is active in Ghana?
4. How does illegal mining contribute to soil pollution in Ghana?
5. Explain one environmental effect of soil pollution in Ghana.
6. What role does the Ghana Environmental Protection Agency (EPA) play in reducing soil pollution?
7. Evaluate the socio-economic effects of soil pollution on farming communities in Ghana.
8. Suggest how afforestation and reforestation projects can help reduce soil pollution in Ghana.

Geography Year 2

SECTION 9

COMMON ENVIRONMENTAL HAZARDS AND DISASTERS IN GHANA

HUMAN AND ENVIRONMENT

Environmental Hazards and their Management

Introduction

In this section, you will explore three major environmental challenges in Ghana; floods, droughts, and fires. You will learn that climate change, poor land use practices, and few proper response services all contribute to the causes of these challenges . You will find out how these disasters impact communities, farming, and ecosystems. For example, floods can cause immediate damage and force people to leave their homes, while droughts and fires can lead to long-term problems like food shortages and economic struggles for families. By the end of the section, you will understand how these events are connected and how they affect people's livelihoods. You will also see why it is essential to have good management strategies in place to reduce the risks associated with floods, droughts, and fires to help protect communities and support sustainable development.

Key Ideas

- A drought is a lengthy period where rainfall is well below the expected average of the year.
- Droughts lead to many problems that affect both the environment and people.
- Fire disasters are categorised into urban fires and rural fires.
- Fire disasters refer to uncontrolled blazes that can occur in forests, grasslands, and even urban areas.
- Flood protection measures can be structural, for example building flood barriers or non-structural, for example educating people about proper waste management.
- Flooding is a natural disaster described as the covering by water of land that is normally dry.
- Rural fires are caused by bush clearance getting out of control, very dry conditions, human errors, cultural practices.
- Several areas in Ghana suffer from regular flooding, for example Greater Accra and the Volta Region.
- Some causes of droughts are climate variability, seasonal rainfall, deforestation, land degradation, and climate change.
- Strategies to reduce and prevent rural fires include making sure farmers follow sustainable farming practices, provide education and training, develop early warning systems and ensure that community fire management is strong.
- Strategies to reduce and prevent urban fires include educating people about fire safety, fire-proof buildings and well-trained firefighters.
- The causes of flooding can be heavy rainfall, river overflow, coastal storm surges, low lying flat land, climate change, deforestation, urbanisation, poor waste management and inadequate drainage systems.
- The impact of droughts can be lessened by introducing water conservation measures, sustainable farming techniques, water management schemes, planting trees and having government management policies.
- Urban fires are common in Ghana, caused by badly constructed or wooden buildings, electrical failures and human error.

FLOODS IN GHANA

Meaning of Flood

Flooding is a natural disaster that happens when water covers land that is usually dry. This occurs when rivers, streams, lakes, or oceans get too full and the water spills over their banks. Floods can last for a short time or a long time, with water levels changing over hours, days, weeks, or even months.

Causes of Flooding in Ghana

1. **Natural Causes**
   a. **Heavy Rainfall**: Ghana gets a lot of rain, especially during the rainy seasons from April to June and September to November. For example, in 2015 and 2020, Accra experienced heavy rains that caused many streets to flood because the drainage systems could not handle all the water.
   b. **River Overflow**: Major rivers like the Volta, Pra, and Ankobra can overflow during heavy rain. For instance, when the Volta River overflows, it can flood nearby towns, affecting homes and farmland.
   c. **Coastal Storm Surges**: In coastal areas like Elmina and Takoradi, flooding can happen due to storm surges during tropical storms and cyclones. These storms push ocean water inland, which can flood the land and disrupt the lives of people living there.
   d. **Topography**: The shape of the land in Ghana, with valleys and low-lying areas, can cause water to gather in some places. For example, during heavy rain, valleys can fill with water quickly, leading to floods in areas like the Northern Region.
   e. **Climate Change**: Changes in the Earth's climate are causing higher temperatures and different rainfall patterns in Ghana. This can lead to more intense and frequent floods. Coastal regions, like those around Accra, are particularly at risk of flooding from rising global sea levels and stronger storms which push water towards the coast.

2. **Human-Induced Causes of Flooding in Ghana**
   a. **Poor Drainage Systems**: Many cities in Ghana, like Accra and Kumasi, have drainage systems that are not well maintained. For example, when it rains heavily, clogged drains cannot carry water away properly, causing streets to flood. In Accra, flooded roads prevent cars from passing and can trap people in their homes.
   b. **Deforestation**: Cutting down trees for farming, logging, or building houses leads to fewer trees to protect soil and absorb rainfall. This means more water runs off the land instead of soaking in and being captured by trees. In the Upper East Region, for instance, deforestation has made the area more prone to flooding during heavy rains because there are fewer trees to help manage the water.

c. **Urbanisation**: As cities grow quickly, natural surfaces like soil and grass are often covered with asphalt and concrete for buildings and roads. These surfaces do not allow water to soak in, it runs off into drains which quickly fill and overflow. In Accra, this rapid urban growth has contributed to more frequent floods as drains cannot cope with extra water.

d. **Waste Management Issues**: Throwing trash, especially plastic and other debris, inappropriately can block drainage systems. For example, during a rainstorm, rubbish can clog the drains, causing water to back up and flood streets. This problem can create even more flooding in cities during heavy rains when the water has no place to go.

Figure 9.1: Chocked gutter likely to cause flood

Areas Prone to Flooding in Ghana

1. **Greater Accra Region**: Accra, the capital city of Ghana, often faces flooding, especially after heavy rains. This is because the city has grown quickly, and the drainage systems are not big enough to handle the large amounts of water running off hard surfaces. With many people living close together and not enough trees to soak up the excess water, areas that are lower in the city get flooded easily. For example, in June 2015, heavy rains caused serious flooding in Accra, which led to many deaths, property damage, and even a cholera outbreak.

2. **Northern Region**: This region sees a lot of flooding during the rainy season from May to October. Rivers like the White Volta can overflow when there is heavy rain. In 2018, strong rains caused major flooding that damaged homes and farmland, forcing many people to leave their houses.

3. **Volta Region**: The Volta River runs through this region which can flood when water is unwanted water is released from the Akosombo Dam. Seasonal flooding is also a common issue here. For example, in 2007 and again in 2023, heavy rains

made the river overflow, flooding many areas, displacing thousands of people, and damaging roads and buildings.

4. **Upper East Region**: The Upper East Region often experiences flash floods during intense rainfall, especially because of deforestation and poor land management. In 2009, very heavy rains caused flash floods that seriously affected many communities, damaging homes and other property.
5. **Western Region**: This region can flood from both storm surges along the coast and overflowing rivers. Rivers like the Tano and Ankobra can cause problems when it rains a lot. In 2010, the Ankobra River overflowed due to heavy rains, affecting agricultural lands and forcing people to leave their homes.
6. **Central Region**: The Central Region, which includes Cape Coast, is prone to coastal flooding. High tides and storm surges, made worse by rising sea levels, can cause flooding here. In 2011, Cape Coast and nearby areas experienced flooding that damaged properties and affected local businesses and tourism.

Figure 9.2: Map showing some flood-prone areas in Ghana (Manual Writers, 2024)

Measures for managing floods in Ghana

To manage flooding in Ghana, both structural and non-structural measures need to be used. The main ways to do this include:

1. Structural Measures

a. **Improved Drainage Systems**
   i. Upgrading and maintaining existing drainage systems: This means fixing old pipes and making sure they are clean and functional so that heavy rainwater can flow away quickly and so that it does not cause flooding.
   ii. Constructing new drainage systems: In places that often flood, like certain neighbourhoods or low-lying areas, engineers can build new pipes and channels to help direct rainwater away and keep homes and roads safe.

b. **Flood Barriers and Embankments**
   i. Building levees and floodwalls: These are like big hills made of dirt or walls made of concrete that raise the banks to stop water from rivers from spilling over into towns and fields during floods.
   ii. Constructing retention basins and reservoirs: Imagine big ponds or storage areas where extra rainwater can be held temporarily. This way, when there is a heavy downpour, the water does not rush into the streets but is stored safely until it can be released slowly.

c. **River Channelisation**
   i. Modifying river channels: Sometimes, rivers can overflow their channels if they are too narrow or bend too much. By straightening and widening these channels, engineers can help the water flow faster and prevent it from flooding nearby areas.
   ii. Dredging rivers: Silt and debris, like mud and trash, can block rivers. Dredging means using suction machines to take this material out, which helps keep the rivers clear so water can flow smoothly.

d. **Stormwater Management Systems**
   i. Implementing detention basins and retention ponds: These are specially designed areas that capture rainwater after storms, so it does not flood streets. They act like temporary pools for excess water.
   ii. Installing permeable pavements: Instead of regular concrete or asphalt, using special paving that allows water to seep through can help reduce puddles and flooding since rainwater can soak into the ground.

e. **Coastal Defences**
   i. **Constructing seawalls and groynes:** Seawalls are strong walls along coasts that stop ocean waves from flooding the land. Groynes extend into the water and help reduce the impact of waves and protect the beach from erosion. An example is the Keta Sea Defence wall constructed to prevent the sea from destroying the coast.

ii. **Building breakwaters:** These are barriers built in the water to protect coastal areas from rough waves and storm surges, acting like a shield to keep the land safe.

2. Non-Structural Measures

a. **Urban Planning and Land Use Management**

i. Enforcing strict zoning regulations: This means creating rules about where buildings can be built. For example, if an area is known to flood often, the government can make a rule that no houses or stores can be built there. This helps keep people safe from floods.

ii. Promoting green infrastructure: This refers to creating parks, wetlands, and green roofs (roofs with plants) in cities, which help absorb rainwater. For instance, a park can soak up rainwater instead of letting it run into the streets, reducing the chance of flooding.

b. **Reforestation and Afforestation**

i. Planting trees and restoring forests: Trees help hold the soil together and absorb a lot of water. By planting more trees or restoring damaged forests, foresters can make sure the land stays stable and can handle heavy rainfall without flooding.

ii. Protecting existing forests: It is important to take care of the forests that are still there and prevent cutting them down. Healthy forests act like sponges, soaking up rainwater and helping to control floods naturally.

c. **Waste Management**

i. Implementing effective waste management practices: This means having good systems for taking care of trash and recycling. If people throw away their garbage properly, it will not get washed into drains and block them, which can cause floods. For example, using bins for recycling and garbage helps keep the streets clean and the drains clear.

ii. Conducting regular clean-up campaigns: Organising community events where people go out to clean up parks and rivers can keep waterways free of trash. This way, when it rains, water can flow freely without being blocked by debris.

d. **Public Awareness and Education**

i. Educating communities: Teaching people about what causes floods and why it is important to throw away trash properly can help prevent floods. For example, local schools can have programs to explain this to students and their families.

ii. Promoting community-based flood preparedness: This means encouraging communities to create plans together for what to do during a flood, such as where to go for safety and how to help each other.

e. **Early Warning Systems**

i. Establishing and maintaining early warning systems: These are systems that help people know when a flood might happen so they can prepare. For example, if people predict heavy rain, these systems can send texts or alerts to let people know to be ready.

ii. Using technology: Using modern tools like weather satellites and special computers helps predict when floods may happen. This technology can show people living in areas which regularly flood how much rain is coming and where it might flood.

f. **Policy and Legislation**

i. Developing and enforcing policies: Governments create rules that help manage floods, like making sure areas at risk are not built on. For instance, there can be laws that protect flood-prone areas from new construction.

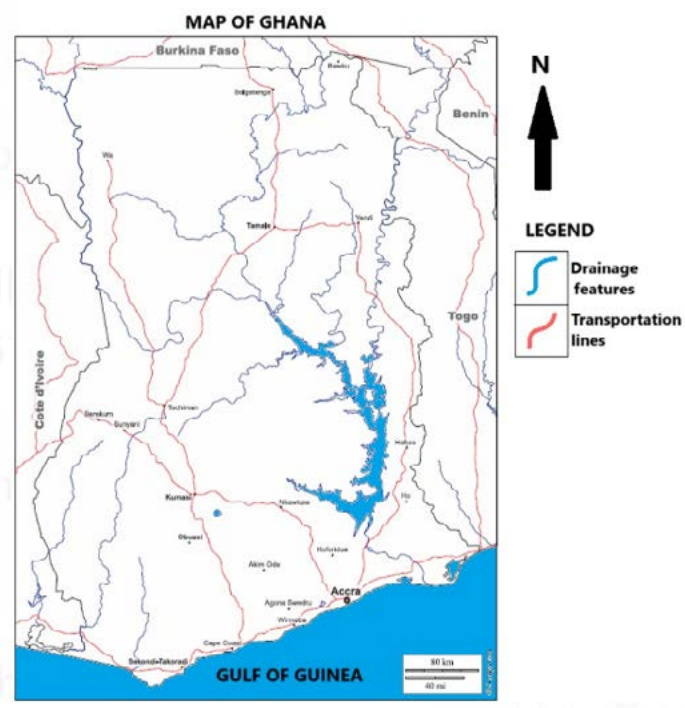
ii. Strengthening institutional capacity: This means giving organisations, like National Disaster Management Organisations (NADMO), the training and tools they need to handle flood risks better. For example, if workers learn more about floods and how to respond, they will be more effective in protecting communities.

Activity 9.1 Floods in Ghana

The pictures below show a flooded community in Greater Accra.

1. From the pictures above, describe the incidence of flooding in a community to a friend. What might have caused these communities to get flooded during the rainy seasons?
2. Watch the YouTube videos below and write a presentation on Floods in Ghana.
   a. https://youtu.be/-3pMRgQJfh0?si=nkl-MZ8vEOofmJ0n
   b. https://youtu.be/8OpNN2_7Ei4?si=Ok97Yd-2Fm4fsPd9
   c. https://youtu.be/Y6GNSqoNcyg?si=dqIvj5QusdPm1kUN
   d. https://youtu.be/hNMRTCarClY.

3. After watching the videos, identify ways by which members of your community can prepare for floods.



4. Discuss with a friend the causes and effects of floods on communities in Ghana.
5. As a personal project, investigate what would be important for flood preparedness: supply of fresh drinking water, protecting properties, emergency supplies and reinstating infrastructure (electricity, drinking water, roads and drains). .
6. Create a visual project (poster, drawing, or painting) illustrating:
   a. M your projects to the class.

7. Research local flood-prone areas and identify areas in your community that are prone to flooding.
8. Observe drainage systems in your community and note the condition of drains, gutters, and waterways in the area, discuss with your class members how you can develop a class project to create community awareness and measures to keep drains free from getting choked. Present to class.
9. Organise a local clean-up initiative: Clear drains and waterways to reduce flood risk.
10. Conduct a flood awareness campaign: Share information with neighbours and local businesses.
11. Collaborate with local authorities: Participate in flood preparedness and response planning.
12. Develop a community emergency plan: Work with neighbours to create a plan for flood response.
13. Share your learning: Teach others about flood risks and prevention strategies.

DROUGHT AND FIRES IN GHANA

Drought

A drought is a prolonged period where precipitation is well below the expected average, resulting in water shortages that can affect agriculture, ecosystems, and human activities.

A drought can lead to serious problems, such as:

a. Water shortages: There is not enough water for drinking, farming, or other everyday needs.
b. Impact on agriculture: Farmers struggle to grow crops because plants need water to survive. This can lead to less food production.
c. Effects on ecosystems: Animals and plants also need water to live. When it does not rain enough, it can harm them and the environment where they live..
d. Challenges for industry: Some businesses, like the **pure water (sachet water)** companies in Ghana, and those that need water to produce goods, can suffer during a drought.

In Ghana, drought can cause many problems, such as:

a. Loss of income: People who rely on farming may earn less money if their crops fail.
b. Limited drinking water: Communities may struggle to find enough clean water, which is essential for health.
c. Social and economic impacts: Drought can lead to food shortages, increased prices for food, and a decline in the quality of life for many people.

Causes of Drought in Ghana

The following are the causes of drought in Ghana

a. **Climate Variability**

   i. Ghana's climate can change a lot from year to year. Sometimes there might be a lot of rain in a year, while other years there might be very little. Global weather patterns, like El Niño and La Niña, can affect this.

   ii. For instance, during an El Niño event, sea temperatures in the Pacific Ocean rise, which can cause less rainfall in Ghana. As a result, regions that usually depend on regular rainfall for farming might receive significantly less water.

b. **Seasonal Rainfall Patterns**

   i. Ghana has two main seasons: the wet season, when it rains a lot, and the dry season when there is little to no rain. If the wet season starts late or does not rain as much as expected, it can lead to dry conditions.

   ii. For example, in the northern region of Ghana, if the rains come late, farmers who plant crops like millet or maize may find that their seeds do not get enough water to sprout and grow, leading to a failed harvest.

c. **Deforestation**

   i. Deforestation is when large areas of trees are cut down for things like farming, building houses, or making roads. This can change the local weather and reduce how much moisture is in the air.

   ii. When forests are cleared for farmland, the moisture that forests release into the air, which helps create rain, decreases. Without this moisture, the area can experience less rainfall, contributing to drought conditions.

d. **Overexploitation of Water Resources**

   i. As Ghana's population grows and more people farm for food, there is an increased need for water. This can lead to using too much water from rivers, lakes, and underground sources.

   ii. If farmers use lots of water to irrigate their crops without letting the rivers refill, those rivers can run dry. This means there is less water for everyone—farmers, homes, and animals.

e. **Land Degradation**

   i. Land degradation happens when land becomes less productive due to problems like soil erosion and bad farming practices. Poorly managed land cannot hold onto water well.

   ii. For example, if farmers do not practice crop rotation (changing the types of crops grown in a field each season), the soil can lose its nutrients and structure. This makes it harder for soil to retain water during dry periods, increasing the risk of drought.

f. **Climate Change**

i. Climate change is when changes in the Earth's climate—often caused by human activities—lead to more extreme weather conditions. This can include much longer droughts.

ii. For instance, in Ghana if climate change leads to higher average temperatures, it can increase evaporation rates. This means that even if it rains, more water is lost to the atmosphere, making droughts worse.

Figure 9.3: Drought in Ghana

Methods of Reducing the Effects of Drought in Ghana

To reduce the effects of drought in Ghana, everyone needs to use strategies that work together. This means focusing on rules and policies, using technology, getting the community involved, and practicing sustainable methods. Here are some ways people can help:

a. **Water Conservation Techniques**

i. **Rainwater Harvesting:** This is the collection and storage of rainwater so it can be used in times of shortage. For example, schools or homes can set up tanks or barrels to catch rainwater from their roofs. This way, even when it does not rain for a while, they still have water for drinking or watering plants.

ii. **Drip Irrigation:** This is a smart way to water crops without wasting water. Instead of spraying water everywhere, drip irrigation delivers small amounts of water directly to the roots of plants. For example, a farmer can use this method to make sure their tomato plants get just the right amount of water without letting it evaporate.

iii. **Soil Moisture Conservation:** Techniques like mulching (covering the soil with materials like straw), cover cropping (growing plants that help retain moisture

in the soil), and contour farming (ploughing along the shape of the land) can help keep the soil wet. For example, a farmer might use mulching to keep the soil cool and moist during a hot, dry season.

b. **Sustainable Agricultural Practices**
   i. **Crop Diversification:** This means planting different types of crops instead of just one. For example, a farmer might grow maize, beans, and cassava together. This way, if one crop suffers from drought, the others might still do well. Also, growing drought-resistant crops, like certain types of millet, can help during dry times.
   ii. **Agroforestry:** This is when farmers grow trees alongside their crops. Trees can help by providing shade, which keeps the ground cooler and can help the plants get more water. For example, a farmer might plant mango trees in their field to give shade to smaller crops underneath.
   iii. **Soil Management:** This includes practices like composting (using decayed organic matter to enrich the soil) and using less ploughing (reduced tillage) to help the soil hold more water. For instance, if farmers use compost, it can improve soil quality and help it retain moisture better.

c. **Improved Water Management**
   i. **Integrated Water Resources Management (IWRM):** This is a way to manage all water sources and uses carefully. For example, planning how to use rainwater, rivers, and groundwater together helps ensure there is enough water for everyone.
   ii. **Construction of Dams and Reservoirs**: Building dams helps to store rainwater during the wet season so that it can be used later when it is dry. For example, a dam can hold back water from rivers, giving towns access to water even in drought conditions.
   iii. **Monitoring and Early Warning Systems:** Setting up systems that track weather and rainfall patterns can help communities prepare for droughts. For example, if an alert says that rain will be less than usual, farmers can plan to plant drought-resistant crops and conserve water.

d. **Reforestation and Afforestation**

   Encouraging tree planting helps restore areas where trees have been cut down. For example, planting trees can improve the local climate, which can lead to better rainfall and protect the soil from being washed away.

e. **Community Awareness and Education**
   i. **Educating Local Communities:** Teaching people about how drought affects them and how they can help conserve water is important. For example, community workshops can show families how to save water at home and farm sustainably.
   ii. **Training Farmers:** Providing farmers with tips on sustainable practices and water management can help them better deal with droughts. Workshops can teach them how to use techniques like the ones mentioned above.

f. **Policy and Governance**
   i. **Developing Comprehensive Policies:** Governments can create rules and plans to manage drought risk. For example, they can establish a system for allocating water during dry times to make sure everyone gets what they need.
   ii. **Encouraging Collaboration:** Getting different groups to work together—like the government, local communities, non-profits, and international organisations—can create a strong plan to fight drought. For example, they can share resources and knowledge to support farmers better.

Fire Disasters in Ghana

Fire disasters refer to uncontrolled blazes that can occur in forests, grasslands, and even urban areas. In Ghana, like in many other developing countries, managing these fires can be challenging.

There are two main categories of fire disasters: urban fires and rural fires.

1. Urban fires happen in city areas where lots of people live close together. These fires can be caused by things like poor building conditions and social issues, such as poverty. For example, a fire in a crowded market can spread quickly because the buildings are so close together.
2. Rural fires occur in the countryside and are often related to farming practices, how land is managed, and natural conditions like dry weather. For instance, farmers may accidentally set a fire to clear their fields, and if it gets out of control, it can spread to nearby forests or grasslands.

Urban Fire Disasters

Urban fires are fires that happen in cities or towns. These fires usually involve buildings, cars, and other things in the area. They can spread quickly because there are a lot of flammable materials, like wood and paper, close together. For example, if one building catches fire, it can easily spread to nearby buildings, making the situation very dangerous.

Causes of Urban Fires in Ghana

a. **Inadequate Infrastructure:** Many buildings in Ghana are not built very well, and they often do not follow fire safety rules. For example, some buildings are made from materials that can easily catch fire, and they might not have proper fire escapes or alarms to warn people.
b. **Electrical Failures:** Fires can happen because of bad electrical wiring or using cheap electrical appliances that do not work properly. These faulty items can overheat and cause a fire.
c. **Human Activity:** Sometimes, people accidentally start fires by not throwing away flammable things properly or by being careless while cooking. For example, leaving food cooking unattended can lead to a fire.
d. **Economic Factors:** Because a lot of people in Ghana face poverty and unemployment, they might use unsafe ways to cook food or keep warm. This can put them at a higher risk of starting a fire.

Examples of Major Urban Fire Incidences in Ghana

The following are some examples of major urban fires in Ghana

1. **The Aboabo Market Fire (2009)**

   In April 2009, a devastating fire broke out at the Aboabo Market in Kumasi. The fire rapidly consumed numerous stalls and goods, leaving many traders without their livelihoods. It was reported that the fire was caused by an electrical fault. The incident highlighted vulnerabilities in market infrastructure and the importance of fire safety measures.

2. **The Accra Central Market Fire (2015)**

   On January 16, 2015, a significant fire engulfed the Accra Central Market, one of the busiest markets in the capital. The blaze destroyed a large section of the market, affecting thousands of vendors. Firefighters faced challenges in controlling the fire due to the market's congested layout. The incident raised concerns about fire safety standards in urban markets.

3. **The Kantamanto Market Fire (2012)**

   In June 2012, a massive fire broke out at the Kantamanto Market in Accra, which is famous for its second-hand clothing. The fire was believed to have started from an electrical spark and quickly spread throughout the market. Many shop owners lost their goods, and the incident emphasised the need for improved fire safety regulations in crowded areas.

4. **The 2016 Goil Gas Station Explosion**

   In October 2016, a gas explosion at a Goil filling station in the capital caused a major fire that impacted nearby buildings and vehicles. The explosion resulted in injuries and fatalities, and the incident underscored the necessity for strict safety measures in gas stations to prevent similar occurrences.

5. **The Kumasi Central Market Fire (2020)**

   In March 2020, a fire at the Kumasi Central Market caused substantial damage to many stalls. The fire allegedly started due to cooking activities using unsafe methods. It resulted in significant economic losses for many vendors and highlighted the urgency of fire safety awareness in some of Ghana's busiest markets.

6. **The Fire at the Ghana National Fire Service Headquarters (2020)**

   In December 2020, a fire occurred at the headquarters of the Ghana National Fire Service in Accra. The blaze reportedly started in the office area, leading to damage to important documents and equipment. Fortunately, there were no casualties, but it raised concerns about the safety protocols within organisations responsible for firefighting.

7. **The 2021 Fire Incident at Madina Market**

   In December 2021, a major fire disruption occurred at the Madina Market in Accra. The fire started in the evening and spread quickly, destroying several stalls and causing considerable economic loss. Firefighters worked through the night to control the flames, but many vendors lost their stock and livelihood.

These incidents reflect the critical need for improved fire safety and prevention measures in urban areas of Ghana, especially in markets and crowded settings where the risk of fire is heightened.

8. **Makola Market Fire in Accra, July 2019**

   The Makola Market Fire in Accra, which occurred in July 2019, was a significant fire disaster that impacted many traders and highlighted ongoing safety concerns in crowded market areas. The fire is believed to have been caused by an electrical fault, which ignited flammable materials in and around the stalls. Rapidly spreading through the market led to significant devastation.

Strategies to Reduce or Prevent Urban Fires

The following are strategies to reduce or prevent urban fires

a. Stronger Fire Safety Rules: Cities need to have strict rules about building safety and fire prevention. This means making sure buildings are built properly and checking them regularly to ensure they follow safety guidelines. If someone breaks these rules, there should be consequences.
b. Teach People About Fire Safety: Everyone should understand how to stay safe from fires. This includes teaching people about the importance of having smoke detectors and fire extinguishers in their homes. When people know how to prevent fires and what to do in case of a fire, they can protect themselves and their families better.
c. Better Firefighter Training and Equipment: Firefighters need to be well-trained and have the right tools to do their job effectively. This means providing them with good training, and better equipment, and making sure they can respond quickly when there is a fire. When firefighters are prepared, they can help reduce the damage caused by fires.
d. Community Fire Watch Programs: Communities can work together to keep an eye on things that might cause fires. By encouraging people to report any potential fire hazards, like broken electrical wires or unsafe cooking practices, a safer environment is the result. When everyone looks out for each other, it helps prevent fires before they start.

Rural Fires

Rural fires are fires that happen in the countryside, away from cities and towns. These usually occur in places like forests, grasslands, and farms. Because these areas often have a lot of dry plants and open land, fires can spread very fast. This can be dangerous for animals, plants, and even people living in those areas, as well as for crops and farms.

Causes of Rural Fires in Ghana

a. **Slash-and-Burn Agriculture**: This is when farmers clear land by burning it to make space for crops. For example, if a farmer wants to plant maize, they might burn the grass and bushes first. While this helps them grow more food, it can also cause big fires that get out of control and harm the environment.

b. **Natural Conditions**: During dry seasons or droughts, the land becomes very dry and can easily catch fire. For instance, if there has been little rain for a while, even a small spark from a campfire can spread quickly and create a large wildfire that destroys plants and animals.
c. **Unintentional Ignition**: Sometimes, farmers accidentally start fires when they are preparing their fields. For example, if they use a tool that creates sparks or if a fire meant for cooking gets too close to dry grass, it can lead to a fire that spreads beyond what they intended.
d. **Cultural Practices**: In some communities, people use fire as a traditional way to manage their land or control pests. For example, they might burn old crops to clear the field. However, if the fire is not carefully controlled, it can quickly grow into a larger wildfire that affects nearby areas.

Examples of Major Rural Fires Incidence in Ghana

a. Northern Region Bushfires (2020)
b. Bawku Fire Incident (2019)
c. Central Region Bushfires (2015)
d. Tongo Bushfires (2018)
e. Eastern Region Forest Fires (2021)
f. Western Region Cocoa Farm Fires (2022)
g. Visit the link below to watch a video on the effects of rural fires https://youtu.be/kInnv83Aabs.

Strategies to Reduce or Prevent Rural Fires

a. **Sustainable Agricultural Practices:** Farmers can use methods that do not rely on burning, which helps reduce the chances of fires. For example, instead of burning old crops, a farmer could practice agroforestry by planting trees alongside their crops, or they could practice crop rotation, where they grow different crops each season to keep the soil healthy. These methods keep the land productive without starting fires.
b. **Education and Training for Farmers**: Teaching farmers safe ways to clear land can help prevent accidental fires. For instance, workshops could show farmers how to use tools that do not create sparks and how to clear land by chopping plants instead of burning them. Learning about the dangers of fire can help farmers make safer choices.
c. **Early Warning Systems**: Setting up systems that keep track of weather conditions can help communities prepare for potential fires. For example, a warning system could alert people when it is very dry and windy, which are conditions that make fires more likely. This gives communities time to be cautious and make plans to protect their homes and farms.
d. **Community Engagement in Fire Management**: Getting the community involved in managing fire risks can make a big difference. For example, local groups can work together with government officials to monitor land for signs

of fire danger. They could organise community meetings to plan fire drills or clean-up days to remove dry brush that could catch fire, helping everyone stay safer.

Figure 9.4: Concept Mapping on Urban and Rural Fires (Writers' construct, 2024)

Activity 9.2 Drought and fire

1. Watch the videos and study the pictures below to explain what drought is to a friend in class.

   https://youtu.be/Iz3HQ18VwKQ?si=POJUIp9z9VwwaoGR.

Pictures showing Drought in Northern Ghana.

DROUGHT

2. From the picture above, in what ways has drought contributed to access to water in the community?
3. Observe the pictures above,
   a. How do changes in water levels affect local wildlife?
   b. What are the consequences of reduced water supply for agriculture and industry?
   c. How do temperature and precipitation changes impact local vegetation in your community?
   d. What role do seasonal variations play in drought occurrence?
4. Assess Community Vulnerability:
   a. Evaluate your community's preparedness for drought.
   b. Research local water management strategies and identify areas for improvement.
   c. Observe and record changes in your local environment.
   d. Engage with community members and experts to describe the climatic patterns over the years.

e. Develop practical solutions for protecting against drought
f. Share your information with the class in a whole-class discussion.

5. Explore Local Drought-Resistant Practices: Research and visit local farms, gardens, or parks that have and use drought-resistant strategies. Share your information with a friend.
6. Below is a picture of a Rural fire on a farm. Explain to a friend what activities of people or phenomena can cause rural fires and urban fires. Share your information with a friend.

7. Create a poster in class on Urban and Rural fire and describe to a friend the causes and effects of Rural and Urban fire in your community.

Review Questions

Floods in Ghana

1. How do the behaviours of members in your community contribute to flooding?
2. How do local weather patterns contribute to flooding in your area?
3. What are the potential consequences of flooding in your community?
4. How can I contribute to flood prevention and reduction efforts locally?
5. What are the most vulnerable areas in my community to flooding?

Drought and Fire in Ghana

1. What are the primary causes of drought and fire in your community?
2. Identify the most vulnerable populations to drought in your community (e.g., farmers, and low-income households).
3. How do local climate patterns and weather events contribute to drought and fire in Ghana?
4. Describe the economic impacts of drought and fire and fire on local agriculture, industry, and businesses.
5. How does drought affect water availability and quality for household use?
6. What are the social and health implications of drought and fire (e.g., food insecurity, mental health)?
7. What emergency measures can be taken during severe droughts?
8. Which of the following is the primary cause of drought in Ghana?
    a. Overexploitation of water resources
    b. Climate change
    c. Deforestation
9. What are some drought prevention methods and fire preventive measures that are being practiced in your community?

REFERENCES

1. Acheampong, R. A. (2018). Spatial Planning in Ghana. Springer Nature Switzerland AG.
2. Adu-Boahen, K., & Dadson, I. Y. (2015). General Synthesis of Soils and Biogeography. Cape Coast: University of Cape Coast Press
3. Agyeman, F. O., & Owusu, P. A. (2021). Urbanisation and its impact on soil pollution in Ghana. Journal of Urban Environmental Research, 30(1), 67-82.
4. Areas of Ghana. Environmental Science Journal, 25(4), 345-359.
5. Armah, F. A., Yawson, D. O., & Pappoe, A. N. M. (2010). Impact of floods on livelihoods and vulnerability in Ghana: A case study of the catchment areas of the Oti River. International Journal of Disaster Risk Reduction, 2(3), 56-65. https://doi.org/10.1016/j.ijdrr.2010.04.001.
6. Asante, K. A., & Ntow, W. J. (2019). Impact of industrial activities on soil pollution in mining
7. Bunnet R. B. And Okunrotifa P. (1999). General Geography in Diagrams for West Africa, 7th Ed. UK: Longman Group.
8. Bunnett, R, B., & Parihar, S.M. (2019). Physical Geography in Diagrams (4th ed). Pearson India 12.4.
9. Bunnett, R,B. (1997). General Geography in Diagrams (4th ed). Pearson Education 13.5.
10. Bunnett, R. B. (2014). General Geography in Diagrams, Pearson Education: Singapore
11. Campbell, J., & Shin, M. (2011). Essentials of geographic information systems. Saylor Foundation. https://open.umn.edu/opentextbooks/textbooks/67
12. Carver, S., Heywood, I. & Cornelius, S. (2006). An Introduction to Geographical Information Systems. Prentice Hall Series in Geographic Information Science. New Jersey: Prentice Hall.
13. Cengage Learning: City
14. Clarke K. C. (2001) (Eds). Getting Started with Geographic Information Systems. Prentice Hall Series in Geographic Information Science. New Jersey: Prentice Hall
15. Dadson I. Y. (2019). Understanding Climatology (3rd Ed). Ghana: University of Cape Coast Press.
16. Dadson I. Y. (2022) Integrated Human and Regional Geography, **Revised Edition**. Cape Coast: University of Cape Coast Press.
17. Dadson I.Y Adu-Boahen K., & Owusu B.A (2022). Essentials of Physical Geography. UCC
18. Dhir R. P. (2018). Drought Management and Desertification Control. Daya Publishing House
19. Dickson, K.B. & Acheampong P. K. (1991). Geography for Senior Secondary Schools.
20. Dickson, K.B. & Acheampong P. K. (1991). Geography for Senior Secondary Schools, Macmillan Press Education, 24(2), 118-130.
21. Ghana National Fire Service. (2021). Annual report on fire incidents in Ghana. Ghana National Fire Service. https://www.gnfs.gov.gh/annual-reports.
22. Ghute B. B. (2024). Flood Risk Management: Assessment and Strategy. Springer
23. Goh Cheng Leong. (1995). Certificate Physical and Human Geography (2nd ed). Oxford University Press.
24. https://dicf.unepgrid.ch/ghana/land
25. https://doi.org/10.1016/j.agrstud.2020.02.005
26. https://doi.org/10.1016/j.envsci.2019.04.002
27. https://doi.org/10.1016/j.urbanenvres.2021.01.007.
28. https://mettatec.com/what-is-lidar-technology-advantages-and-disadvantages/#:~:text=Similarly%2C%20the%20point%20cloud%20is,of%20equipment%2C%20installation%20and%20commissioning
29. Jordan D. S. (2023) Applied Geospatial Data Science with Python. Leverage geospatial data analysis and modelling to find unique solutions to environmental problems. Packt Publishing Ltd.

30. Kumi, E. (2023). Understanding drought and fire management in Ghana: Challenges and strategies. Environmental Science & Policy, 132, 45-58. https://doi.org/10.1016/j.envsci.2022.12.003.
31. Lettenmaier D. P. (2021) Global Drought and Flood: Observation, Modeling, and Prediction. American Geophysical Union
32. Macmillan Press: City
33. Mensah, J. K., & Boakye, R. (2020). Agricultural practices and soil contamination in Ghana's cocoa farms. Agricultural Studies Review, 18(2), 210-225.
34. Mettatec. (2023). What is LiDAR technology? Advantages and disadvantages.
35. Mishra, R. K. (2015). Mapping the knowledge topography: a critical appraisal of
36. National Geographic Society. (2024). GIS (geographic information system). National Geographic Education. https://education.nationalgeographic.org/resource/geographic-information-system-gis/7th-grade/
37. Nsiah-Gyabaah K. (1994) Environmental Degradation and Desertification in Ghana: A Study of the Upper West Region (Avebury Studies in Green Research) First Edition of Grace Ent: Kumasi
38. Oladokun V. O. (2023) Handbook of Flood Risk Management in Developing Countries. Routledge, Chapman & Hall, Incorporated
39. Osman K. T. (2013). Soil Degradation, Conservation and Remediation. Springer Netherlands.
40. Owusu Tawiah, H. (2021). Understanding Geography (Physical & Practical). Accra
41. Owusu, K., & Waylen, P. (2013). The changing rainfall regime in Ghana and its impacts on flood risk management. Journal of Hydrology, 14(4), 320-334. https://doi.org/10.1016/j.jhydro.2013.08.010.
42. Petersen, J., Sack, D., & Gabler, R. E. (2014). Fundamentals of Physical Geography.
43. Peterson, F. J, Sack, D & Gabler R. E (2011). Fundamentals of physical geography: Instructor Edition 2011 Brooks/Cole: Cengage Learning.
44. Pourabbas, Elaheh (2014) Geographical information systems: trends and technologies. 1st edition. Boca Raton: CRC Press
45. Press, Cape Coast.
46. Tsibu, B. (2022). Human and Regional Geography for Senior High Schools. Abundance of Grace Ent: Kumasi
47. Tumbulto, J. W., & Bannerman, R. R. (2012). Assessment of urban flooding and drainage in Accra, Ghana. Environmental Management Journal, 27(2), 112-125. https://doi.org/10.1016/j.envman.2012.03.004.
48. UCC Press, Cape Coast.
49. UN Environment Programme. (n.d.). Land / Ghana. Retrieved from
50. University Press.
51. University Press. 10.2. Petersen, J. F., Sack, D., & Gabler, R. E. (2011). Fundamentals of Physical Geography (2nd ed). Cengage Learning. 11.3.
52. World Bank. (2021, August 30). Ghana to reverse land degradation with World Bank support. Retrieved from https://www.worldbank.org/en/news/press-release/2021/08/30/ghana-to-reverseland-degradation-with-world-bank-support

GLOSSARY

WORD	MEANING
Algorithms:	procedures for solving mathematical problems. Simply, a step-by-step procedure for solving a problem.
Bedrock:	This is the solid rock layer beneath the soil surface.
Biodiversity:	different kinds of life found in an environment
Coarse sand:	refers to sand particles that are larger compared to fine or medium sand
Coniferous trees:	woody evergreen plants that have cones and needles rather than leaves
Contaminants:	are substances that make something impure or unclean by introducing harmful or undesirable elements.
Continentality:	refers to the effect that being in the interior of a continent has on a region's climate and weather patterns
Data privacy:	the protection of personal data from those who should not have access to it
Ecosystems:	are complex communities of living organisms (plants, animals, microorganisms) and their physical environment (soil, water, air) interacting as a system
El Nina:	refers to a periodic cooling of sea surface temperatures in the central and eastern Pacific Ocean.
El Niño:	is a climate phenomenon characterised by the periodic warming of sea surface temperatures in the central and eastern Pacific oceans.
Eluviation horizon:	Layer of soil where nutrients and organic materials are removed.
Ephemeral plants:	plants that have very short life cycles. They have very short periods of growth, only during favourable periods.
Geospatial:	data that relates to a specific geographical location.
Global warming:	the increasing world (global) temperatures due to the release of gases into the atmosphere.
Gritty sand:	refers to a type of sand with a noticeable rough texture, often characterised by a mixture of larger sand particles and possibly some tiny gravel.
Hardware:	the physical part of a computer that can be touched or seen. The opposite is **software.**

WORD	MEANING
Herbicides:	poisonous or toxic chemicals used to control or destroy unwanted weeds or vegetation.
High-resolution data:	data that has a large amount of detail and is primarily high-quality. The opposite is **low-resolution data.**
Illuviation horizon:	a layer of soil where nutrients and organic matter are deposited
Isothermal lines:	lines on maps joining places with equal temperatures.
Landscape:	refers to the visible features of an area of land, including its physical elements, landforms, vegetation, and how they are arranged.
Microorganisms:	Organisms that are too small that, they can only be seen through a microscope.
Non-Governmental Organisations (NGOs):	are non-profit organisations that operate independently of government control.
Northern Hemisphere:	the northern half of the globe/Earth.
Pesticides:	chemicals used to control or kill pests, including insects and rodents.
Reconnaissance survey:	initial visit to the area to be surveyed before the actual survey begins.
Robotics:	is the branch of technology that deals with the design, construction, operation, and use of robots.
Sedimentation:	the deposition of materials.
Sensors:	are devices or instruments that detect and measure physical properties or environmental changes.
Snowstorms:	heavy snowfall with strong winds.
Software:	refers to instructions or programs that tell a computer or device how to perform specific tasks.
Soil texture:	refers to the classification of soil based on the relative proportions of different soil particles, specifically sand, silt, and clay.
Southern Hemisphere:	the southern half of the globe/Earth.
Spectrum:	a band of colours produced by separating different lights by their different degrees of wavelengths. Used to classify things in terms of their positions on a scale between two extreme points.

WORD	MEANING
Synchronise:	means to cause two or more things to occur at the same time or rate, or to coordinate them in a way that they function together smoothly.
Synthetic fertilisers:	are man-made chemical substances used to enhance the growth of plants by providing essential nutrients.
The water-holding capacity of soils:	the ability of soils to contain or hold water against the force of gravity
Triangulation:	the tracing and measurements of a series or network of triangles in surveying.
Unconsolidated mineral:	loose or not compact or not dense
Weather station:	a place with a collection of weather instruments where weather information is recorded
Xerophytes plants:	plants that survive in dry environments. Simply, they are drought-resistant plants