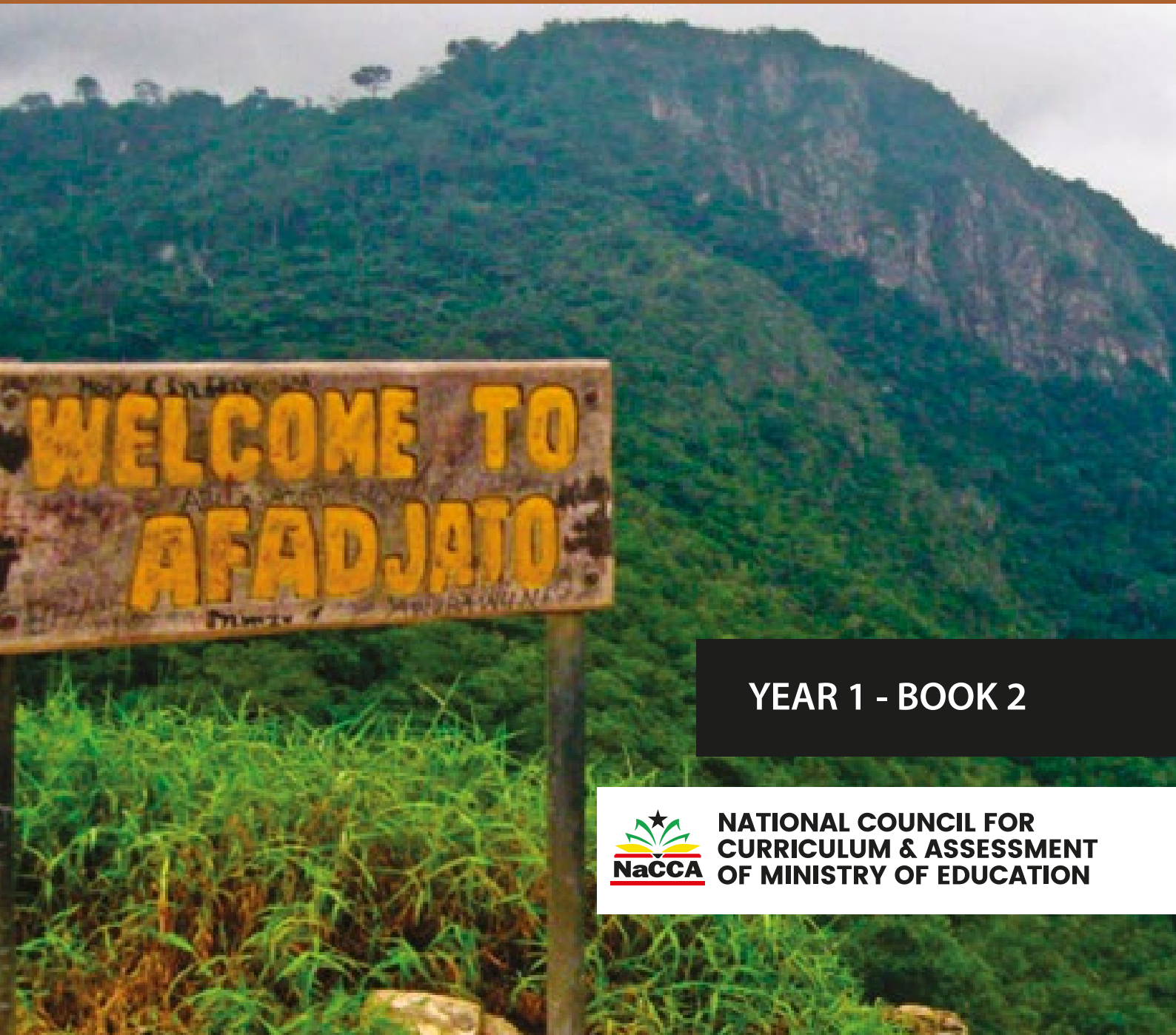**MINISTRY OF EDUCATION**

GEOGRAPHY
For Senior High Schools

TEACHER MANUAL

YEAR 1 - BOOK 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

NaCCA

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

Geography

For Senior High Schools

Teacher Manual

Year One – Book Two

**NATIONAL COUNCIL FOR
CURRICULUM & ASSESSMENT
OF MINISTRY OF EDUCATION**

NaCCA

GEOGRAPHY TEACHER MANUAL

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CONTENTS

INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS 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.

This Book Two of the Teacher Manual for Geography covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains information for the second 12 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- Foundational Knowledge: Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship

- Competencies: Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication

- Character Qualities: Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- Internal Assessment (30%) – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.

- External Assessment (70%) – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.

- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.

- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.

- Making provision for the needs of gifted and talented learners in schools.

Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Geography is:

Philosophy: All learners can be supported to develop their full potential in the geographical skills of space-time and human-environment interrelationships, build on contemporary and emerging technologies and competencies for further studies, the world of work and adult life.

Vision: Learners equipped with 21st Century skills and competencies in critical thinking and spatial analysis of the earth's physical and human patterns and processes to be interdisciplinary innovators, advance new world-changing discoveries in geospatial science and the interrelationship between the natural and the built-environment.

SUMMARY SCOPE AND SEQUENCE

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1.	The Earth and its Neighbourhoods	The Earth and its features	4	4	8	2	2	4	1	1	2
		Rocks, weathering, soils and mass wasting	1	1	3	1	1	2	1	1	3
		The earth's atmosphere	1	1	3	1	1	3	1	2	3
2.	Navigating the Environment	Maps: Their elements and analysis	2	2	4	1	2	4	1	1	3
		Geospatial data collection, representation and interpretation	1	1	2	1	1	3	1	1	2
3.	Human and Environment	Physical settings and people	1	1	3	1	1	2	2	2	5
		Economic activities	1	1	2	1	1	2	1	1	3
		Environmental degradation	1	1	2	1	1	2	1	1	3
		Environmental hazards and their management	1	1	2	1	1	2	1	1	2
Total			13	13	29	10	10	24	10	10	26

Overall Totals (SHS 1 – 3)

Content Standards	33
Learning Outcomes	33
Learning Indicators	79

SECTION 7: ROCKS AND PROCESSES OF WEATHERING

Strand: **The Earth and Its Neighbourhoods**

Sub-Strand: Rocks, Weathering, Soil and Mass Wasting

Learning Outcome: *Identify the three types of rocks and explain weathering processes*

Content Standard: Demonstrate knowledge in rocks formation and weathering processes

INTRODUCTION AND SECTION SUMMARY

Rocks, with their diverse types and formational processes, significantly shape the Earth's crust and offer valuable insights into its geological history. They serve various purposes, including resource availability, construction materials, and environmental conservation. Studying rock characteristics reveals their origins and properties. Investigating processes like igneous, sedimentary and metamorphic formation deepens our understanding of the dynamic crust. Recognising factors affecting weathering such as temperature, moisture, chemical composition and biological activity helps learners to grasp how rocks break down and transform.

The week(s) covered by the section is/are:

> *Week 13: Rocks: The Types, their Characteristics, Formational Processes and Importance*
>
> *Week 14: Rock Weathering and Its Processes*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Collaborative learning, achieved through small group brainstorming, and project-based learning, particularly via field tours or trips, are effective pedagogical strategies for teachers. Small group brainstorming encourages active participation, critical thinking and improved communication skills among learners. It facilitates idea exchange, knowledge building, and problem-solving. Project-based learning, outside the classroom, offers hands-on experiences that deepen learners' understanding, connect theory to practise, and enhance critical thinking and analytical abilities. Field tours provide exploration opportunities, foster curiosity and promote independence. Both approaches contribute significantly to active learning, deeper comprehension and essential skill development in learners.

ASSESSMENT SUMMARY

Group presentations, discussions and class exercises can be utilised as effective assessment strategies to evaluate learners' understanding of rocks and weathering processes. Teachers should use both formative and summative forms of assessment. Group presentations, discussions, and class exercises should be assessed both formatively and summatively, evaluating learners' abilities to examine complex weathering processes, predict future changes, and propose innovative solutions. These assessment strategies facilitate a comprehensive understanding of rocks and weathering processes while promoting critical thinking, analysis, and synthesis skills at progressively higher cognitive levels.

Week 13

Learning Indicator: *Discuss the three types of rocks, their characteristics, formational processes and their importance*

Theme or Focal Area: **Rocks Formation, Characteristics and Importance**

Meaning of Rocks

A rock is defined as the naturally occurring aggregate of solid substances that is made up of one or more minerals. A mineral is a naturally occurring aggregate of inorganic substances having an orderly atomic structure and a definite chemical composition and physical properties. Rocks represent the fundamental component of the Earth's crust. All rocks differ from one another in texture, structure, colour, permeability, mode of formation, and degree of resistance to denudation.

Types of Rocks

Rocks can be classified into three major types based on their origin or the mode of formation. They are igneous, sedimentary and metamorphic rocks.
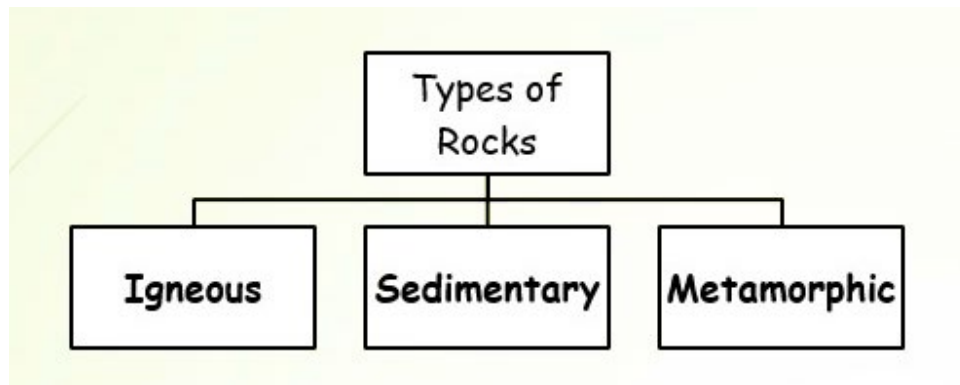
Igneous Rocks

The word igneous comes from the Latin word ***ignis*** which means **fire**. Igneous rocks are formed from molten rock (magma) that cools and solidifies in the earth's crust, near the earth's surface or on the surface of the earth's crust.

Characteristics/Description/Features of Igneous Rocks

1. They are crystalline in structure, i.e., they contain crystals.

2. They are non-stratified.

3. They do not contain fossils.

4. They are comparatively harder.

5. They are impervious.

6. They are resistant to weathering and erosion.

7. They are either acidic or basic.

Mode of Formation

1. Igneous rocks are formed by the cooling and solidification of molten rocks called magma, ejected from within the earth's crust.

2. The magma which results from high temperature and pressure, forces itself towards the earth's surface through cracks.

3. As magma moves towards the surface, it comes into contact with lower temperature, hence it cools and solidifies to form igneous rocks.

Types of Igneous Rocks

1. **Intrusive Igneous (Plutonic) Rocks:** These are rocks formed when the magma cools slowly and solidifies within the earth's crust. They are only exposed to the surface of the earth after a long period of denudation. Examples include granite, diorite and gabbro.

Granite   *Diorite*   *Gabbro*

2. **Extrusive Igneous (Volcanic) Rocks:** These are formed when magma on getting to the earth's surface (lava) cools and solidifies rapidly. These rocks have small crystals because of the rapid cooling of the magma. Examples include basalt, rhyolite, andesite, pumice, and obsidian.

Andesite   *Basalt*   *Obsidian*

Sedimentary Rocks

The word sedimentary is obtained from the Latin word, *sedimentum* which means *to settle down*. These are rocks formed from erosion, deposition, and lithification (compaction and cementation) of sediments obtained from a weathered material of a pre-existing rock or from biological processes.

Characteristics/Description/Features of Sedimentary Rocks

1. Sedimentary rocks are stratified, which means they are arranged in layers.

2. They may be coarse or fine grained depending upon the nature of materials deposited.

3. They are non-crystalline.

4. They may contain fossils.

5. They are comparatively softer.

6. They are less resistant to erosion.

7. They are permeable.

Mode of Formation

1. Sedimentary rocks are formed from sediments deposited either by water, wind or ice.

2. These sediments are deposited in layers or strata, i.e one on top of the other.

3. After a long period of time, they become hardened, through compaction and cementation to form sedimentary rocks.

4. The line between two strata is called the bedding plane.

Classification of Sedimentary Rocks

1. **Mechanically Formed Sedimentary (Clastic) Rocks**: They are derived from the sediments or fragments of pre-existing rocks. Sediments are transported and deposited in layers, with older ones at the bottom by the agents of erosion. The layers become compacted and cemented together. They can be categorised according to the *grain size* of the rock. *Argillaceous rocks* are *fine-grained* clastic rocks composed of clay. E.g., shale, mudstone and others. *Arenaceous rocks* are *medium-grained* clastic rocks composed of sand. E.g., sandstone, siltstone and others. *Rudaceous rocks* are *coarse-grained* clastic rocks composed of cobbles and pebbles embedded in clay or silt. E.g., conglomerate and breccia.

Shale   *Sandstone*   *Conglomerate*

2. **Organically Formed Sedimentary (Bioclastic Rocks):** These are rocks formed from compaction and cementation of the remains of living organisms. The plant remains form carbonaceous rocks such as coal, peat and petroleum while the remains of corals and shellfish result in the formation of Calcareous rocks such as chalk and limestone.

Shale   *Petroleum*   *Shelly limestone*

3. **Chemically Formed Sedimentary Rocks (Evaporites):** They are formed when mineral crystals are precipitated chemically from solution of a kind or another through the process of evaporation. They are usually formed in lakes and seas of high salinity. E.g., halite/rock salt (sodium chloride), rock gypsum (calcium sulphate), dolostone (calcium and magnesium carbonate-dolomite) and oolitic limestone.

Rock salt   *rock gypsum*   *oolitic limestone*

Metamorphic Rocks

They are rocks that are derived from pre-existing rocks (igneous or sedimentary) that have been physically or chemically changed usually by the application of intense heat, pressure and/or chemically active fluids.

Ultra-metamorphism refers to the process whereby metamorphic rocks undergo extreme temperatures and pressures, pushing them close to, but not exceeding, their melting point. It is essentially the most intense form of metamorphism. Examples of rocks formed by ultra-metamorphism include granulite and eclogite.

Characteristics/Description/Features of Metamorphic Rocks

1. They are comparatively harder and more resistant to erosion.

2. They are impervious.

3. They may be foliated or non-foliated.

4. They are more compact than their original rocks.

5. They do not contain fossils.

6. They may be stratified or non-stratified depending on the parent material.

7. They may be fine-grained or coarse grained.

Types of Metamorphic Rocks according to Mode of Formation

1. **Regional/Dynamic Metamorphism:** It is a type of metamorphism where rock minerals and texture are changed by intense pressure over a wide area or region. As the pressure rises with depth, the mineralogy and texture of the rock change dramatically. Rocks affected by regional metamorphism tend to show foliation because of the directed pressure (the parallel alignment of minerals). E.g., gneiss and schist.

Gneiss   *Schist*

2. **Contact/Thermal Metamorphism:** It is a type of metamorphism where rock minerals and texture are changed mainly by intense heat due to contact with magma. Igneous activity is accompanied by intense heat which affects nearby rocks. E.g., quartzite and slate.

White quartzite   *slate*

3. **Thermo-dynamic Metamorphism:** It is a type of metamorphism where rock minerals and texture are changed by the combination of heat and intense pressure.

4. **Metasomatism (Hydrothermal) Metamorphism:** It is the type of metamorphism where rock minerals are chemically changed as they come into contact with chemically active fluids (very hot liquid and gases). E.g., Skarn and serpentine.

Skarn   *Serpentine*

Examples Of Parent Rocks and Their Metamorphosed Forms

Parent Rock	Metamorphic Rock
Clay (S)	Slate
Shale (S)	Schist
Limestone/dolostone/gypsum (S)	Marble
Sandstone (S)	Quartzite
Coal (S)	Graphite
Basalt/gabbro (I)	Amphibolite
Conglomerate (S)	Meta-conglomerate
Slate (M)	Phyllite

Economic importance of rocks include;

1. Formation of soil through processes of weathering

2. Source of water. e.g. aquifer

3. Source of fertiliser. e.g., potash and phosphate rich rocks

4. Industrial raw materials e.g., gypsum and limestone.

5. Use as constructional materials, e.g., granite and basalt.

6. Can be carved into statues. e.g. limestone and marble

7. Use as ornaments, e.g., slate and obsidian.

8. Some rocks contain minerals. e.g., gold and diamond

Learning Tasks

1. In small groups based on people living in different relief areas, brainstorm on the different rock types and their formation.

2. Discuss the importance of rocks to your community/national development.

Pedagogical Exemplars

Collaborative learning:

Working in small groups *based on people living in geographical areas,* brainstorm on the different rock types and their formation.

1. Form small groups that consist of learners with diverse abilities. This ensures peer learning and allows for collaboration where learners can support and learn from one another.

2. Provide prompts or questions that cater to different levels of abilities. For learners approaching proficiency, focus on identifying basic rock types and their characteristics. For proficient learners, encourage analysis of the formation processes of different rock types. For highly proficient learners, challenge them to explore the geological significance, historical contexts, and potential applications of different rock types.

3. Offer graphic organisers or templates to support learners in organising their ideas during the brainstorming activity. These organisers can be adjusted to accommodate different levels of intellectual abilities and help learners structure their thoughts effectively.

4. Provide scaffolding materials such as reference books, diagrams, online resources, or visual aids that can be utilised at different levels of proficiency.

5. Guide the small groups through the brainstorming process by asking probing questions, encouraging participation from all group members, and providing additional explanations or examples when needed. Ensure that each learner's contribution is valued and respected.

6. Continuously monitor learners' progress through formative assessment and provide timely feedback that is specific to their individual abilities and areas for improvement.

Project-based learning:

In a field tour within the community, identify and discuss the importance of rocks to your community/ national development.

1. Provide pre-tour information that caters to different levels of intellectual abilities. For learners approaching proficiency (AP), focus on basic concepts and vocabulary related to rocks. For

proficient (P) and highly proficient (HP) learners, provide more in-depth information on the significance of rocks in community and national development.

2. During the field trip, AP learners can identify rock types, P learners can analyse the formations of rock types and HP learners can consider social and economic impacts. Offer note-taking templates adjusted to different levels of ability.

3. After the trip, form mixed ability groups for learners to share observations, insights, and questions related to the importance of rocks in community and national development. Provide scaffolding and prompts tailored to each group's learning abilities to foster meaningful conversations.

4. Allow learners to present the significance of rocks, considering their abilities. Accept simple short verbal or written statements from AP learners. P and AP learners can present in essay form to the whole class using traditional or digital styles

Learners should cooperate with each other and accept variations in the observations made during the field tour.

Alternatively, teachers can show picture/videos of rock types and the formational processes to reinforce the lesson.

Key Assessment

Level 1: Identify the rocks in the images below. (NB: *Teachers should provide physical examples of the images in class for learners to identify and give a reason for their selection*)

| *A* | *B* | *C* | *D* |

Level 2: Explain the difference between sedimentary and igneous rocks, including how they are formed.

Level 3: Prepare a presentation on the economic significance of rocks in a specific region or country. Highlight the major rock resources found in that area and discuss how they are utilised for economic purposes. Include examples of industries or sectors that have thrived due to the presence of these rocks.

Level 4: Critically analyse the environmental and social impacts of large-scale quarrying operations on local communities and ecosystems. Discuss the ethical considerations involved and propose strategies to mitigate the negative effects while meeting the demands for construction materials.

Week 14

1. *Explain weathering and the factors affecting its processes*

2. *Evaluate the three weathering processes (physical, chemical and biological weathering)*

Theme or Focal Area: **The Meaning and Factors Affecting Weathering**

Meaning of Weathering

Weathering is the physical disintegration or the chemical decomposition of rocks *in situ* (that means 'in the same place). Various agents contribute to weathering and eventually alter the landscape. They include water, acid, wind, temperature changes, plants and animals.

Weathering is one of the processes of **denudation** (lowering and levelling of the earth's surface) and its end result is **soil formation**. The remains of a weathered environment is called a **regolith**. The broken pieces of rocks collected at the base of the parent rock are called **talus** or **screes.**

Factors Affecting Weathering

1. Climatic conditions

2. Type of vegetation

3. Type of rock and mineral composition of the rock

4. Topography of the land

5. Action of plants and animals
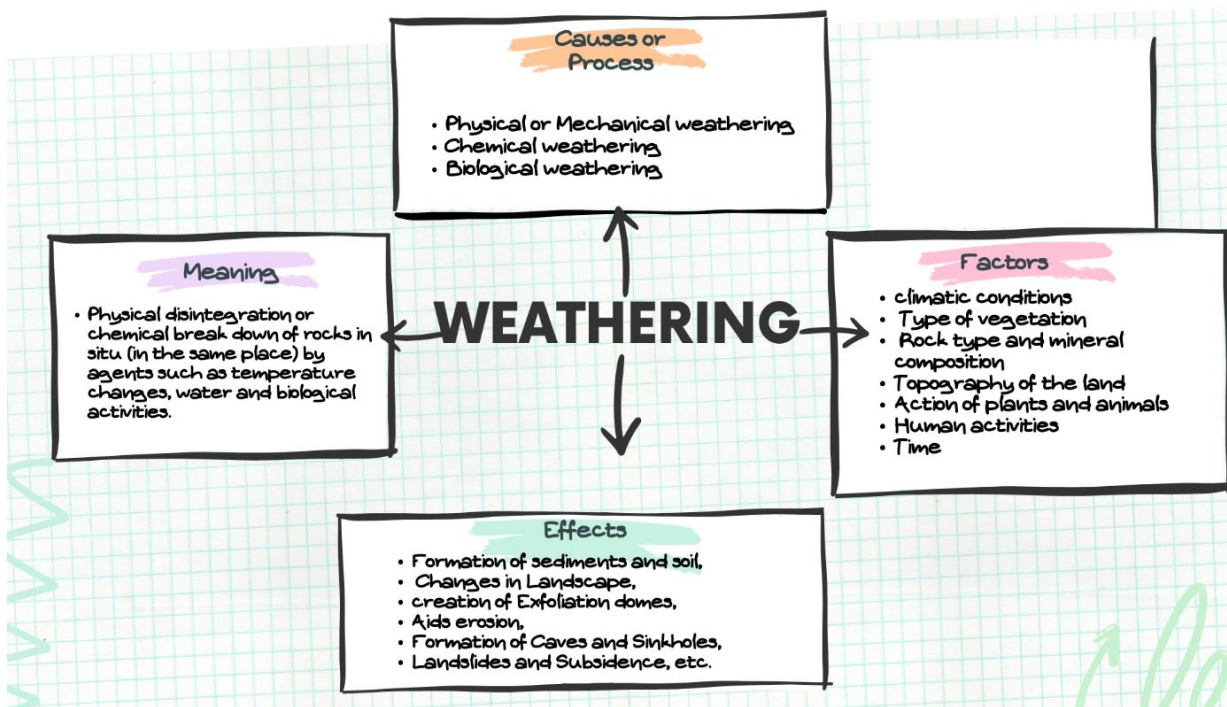
6. Human activities

7. Time

Fig. 14.1: *Sample Mind map of Rock Weathering*

Learning Tasks

1. Explain the term *weathering*.
2. Discuss factors affecting weathering processes.

Pedagogical Exemplars

Activity Based Learning:

Create a mind-map on weathering, covering its meaning, causes, effects and factors affecting it.

1. Provide step-by-step instructions for creating the mind-map, including a clear hierarchy of concepts and connections.

2. Break down the task into manageable parts for learners approaching proficiency, while allowing more flexibility for proficient and highly proficient learners to explore additional details and connections.

3. Provide a list of key vocabulary terms related to weathering and offer definitions or examples for learners approaching proficiency. Proficient and highly proficient learners can be encouraged to explore and add additional relevant vocabulary terms to their mind-map.

4. Encourage learners to work in mixed-ability pairs or groups to create their mind-maps. This allows for peer support and collaborative learning, where more proficient learners can assist those approaching proficiency while reinforcing their own understanding.

Learners should be self-reflecting and be confident.

Key Assessments

Level 1: List three factors that can accelerate the rate of weathering.

Level 2: Discuss how human activities affect weathering.

Theme or Focal Area 2: Processes of Weathering

Processes of Weathering

There are three processes of weathering and these are physical processes, chemical processes and biological processes.

Physical or Mechanical Weathering

Physical weathering is the breaking down or disintegration of rocks through physical processes without any change in the chemical composition of the rocks. These processes are mainly due to changes in temperature, action of plants and animals, as well as human activities. Examples of physical weathering processes are unloading, repeated temperature changes, repeated wetting and drying, frost action, and salt crystal growth.

1. **Unloading/ Pressure Release**
   a) When surface material is removed by erosion, the pressure on the underlying rock is reduced.
   b) This reduces the pressure on the mineral grains, allowing them to spread out more, thereby creating voids.
   c) As a result, the rock expands beyond its lithostatic pressure limit, and ultimately, fractures.

2. **Repeated temperature changes/Alternate heating and cooling**
   a) During the day in the desert, the rock is exposed to the intense heat of the sun.

b) The outer layer of the rock expands at a much faster rate than the cooler inner layer of the rock.

c) At nightfall the temperature drops quickly, causing the outer layers to contract faster than the inner layers, creating internal stress.

d) Repeating this stress over many months and years results in cracking and splitting of the rock.

e) This cracking and splitting cause the outer layer of rock to peel off uniformly in a process called **Exfoliation.** The individual minerals or grains may also break into granular mass in a process known as **Granular Disintegration**

f) In rocks, such as exposed batholith, the remains after the peeling off form a convex hill known as an **exfoliaon dome.**

Fig.14.2: *Half Dome in Yosemite National Park, USA*
(http://mntviews.blogspot.com, 2018)

3. **Repeated wetting and drying leading to the process of Slaking.**
   a) This is especially common in tropical areas where short rains saturate the rock and the hot sun dries it out quickly.
   b) It also happens in coastal areas where the rocks may dry out quickly due to sun and wind in the period between tides.
   c) When the rock is wet, the outer layer of the rock absorbs water and expands.
   d) When the rock is dry, moisture evaporates and the rock shrinks rapidly.
   e) When this process occurs repeatedly, the outer layer of the rock undergoes continuous stress and eventually fractures, causing it to disintegrate or crumble

4. **Frost Action/Freeze-thaw action/Ice wedging**
   a) In temperate climates, frost is a powerful force in the formation of rock fragments.
   b) Most rocks are composed of cracks, joints, or pores, which are then filled with rainwater or snowfall.
   c) When the temperature drops during the night or in the winter months, the water is able to freeze.
   d) When water freezes, it expands by one-tenth, which increases the stress in the cracks and pores.
   e) Repeated freezing and thawing of this kind will cause the original cracks to become deeper and wider, resulting in the breaking down of rock into angular fragments.
   f) It can also occur on high mountain peaks such as Mt Everest or Mt. Kilimanjaro.
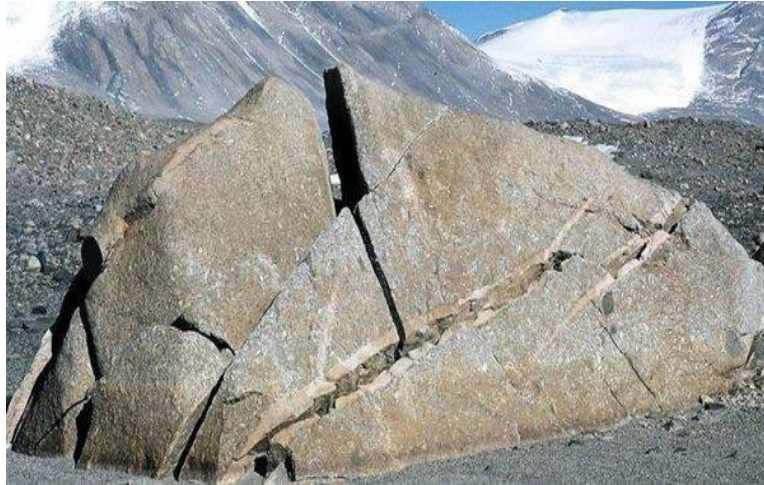
Fig. 14.4: *Frost Action*
(https://www.teacherspayteachers.com, 2023)

Salt Crystal Growth/Salt weathering/ Haloclasty

a)   In coastal and arid regions, crystals may grow in saline solutions through evaporation.

b)   Salt crystallising within the pores of rocks produces stress, which widens the pores, and this leads to granular disintegration.

c)   This process is known as salt weathering or '**haloclasty**.'

d)   When salt crystals formed within pores are heated, or saturated with water, they expand and exert pressure against the confining pore walls; this produces thermal stress or hydration stress respectively, both of which contribute to salt weathering.

Fig. 14.5: Haloclasty *(PockMarked Rock with Many Holes, 2007)*

Chemical Weathering

a)   Chemical weathering is the gradual decomposition of rocks due to exposure to air and water which alters the chemical composition of the rocks.

b)   Air and water contain small chemical elements that are sufficient to set up chemical reactions in the surface layers of exposed rocks.

c)   The processes of chemical weathering include dissolution, carbonation, oxidation, reduction, hydration, hydrolysis, and chelation.

Processes of Chemical weathering

1. **Dissolution**
    a) Dissolution is the process where rocks are dissolved by weak acids in rainwater
    b) In this process mineral compounds are slowly removed from solid bedrock through the combination of water and acid. The dissolved minerals are then carried away in liquid solution. Sedimentary rocks such as limestone, dolomite (Ashanti region of Ghana) and chalk are all subject to the process of dissolution. Their main component calcite ($CaCO_3$ or calcium carbonate) can dissolve in weak acid, producing calcium and bicarbonate ions according to the following equation:

    $CaCO_3 + H^+ + HCO_3^- \rightarrow Ca^{2+} + 2HCO_3^-$
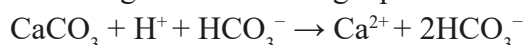
    The dissolving of carbonate rocks is known as 'carbonation'.

    c) Dissolution can produce large cave systems in calcareous rocks, especially in tropical areas where high temperatures accelerate the chemical process. The products of dissolution can build up in domestic water pipes and kettles as limescale.
    d) Examples of other rocks which can be dissolved through the action of water are halite (salt), and gypsum.

2. **Oxidation**
    a) Oxidation involves the reaction of iron minerals with oxygen in the presence of water.
    b) This process can cause a variety of changes to the mineral composition and physical properties of rocks, including discolouration, weakening, and fragmentation.
    c) One example of oxidation in action is the weathering of iron-bearing minerals such as pyrite, which can react with oxygen and water to form iron oxide minerals such as hematite and goethite.
    d) The chemical formula for oxidation weathering is given as $Fe + O_2 + H_2O \rightarrow Fe_2O_3 \bullet nH_2O$
    e) In the formula, iron (Fe) reacts with oxygen (O_2), often in the presence of water (H_2O), to form hydrated iron (III) oxide ($Fe_2O_3 \bullet nH_2O$), or rust.

   f)   This changes the rock from ferrous state to ferric state.

Pyrite (Ferrous State)   *Goethite (Ferric/Rusted State)*

3. **Hydrolysis**
    a) Hydrolysis is a process whereby hydrogen ions in water react with the ions in a mineral, breaking the mineral down into smaller, more soluble minerals.
    b) This process is often facilitated by the presence of acids, such as carbonic acid.
    c) One example of hydrolysis is the weathering of feldspars.
    d) Feldspars are common minerals in igneous rocks, and they can be weathered by hydrolysis.
    e) When feldspars come into contact with water, the water molecules react with the potassium, sodium and calcium ions in the feldspar, breaking the feldspar down into clay minerals, such as kaolinite.

Note that there are other chemical weathering processes such as chelation and reduction that the teacher can expose learners to.

Biological Weathering Processes

Biological weathering processes are those that involve the breakdown of rocks and minerals by living organisms through physical and chemical processes. There are several types of biological weathering processes:

1. **Root Wedging:** The roots of plants can grow into cracks in rocks and exert pressure on the surrounding material, causing the rock to break apart.
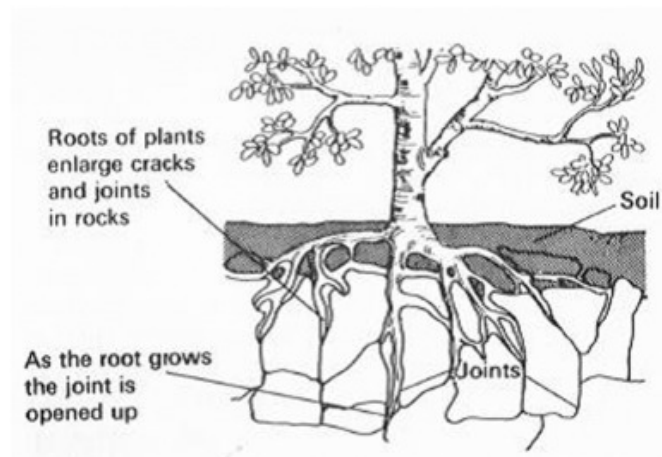
Fig. 14.8: *Root wedging process*

2. **Burrowing:** Animals such as rodents, earthworms, ants and termites burrow into soil and rocks, disrupting their structure and providing the opportunity for chemical weathering to take place.

Fig. 14.9: *Burrowing insects*

3. **Biodegradation:** This process involves the breakdown of rocks and minerals by microorganisms such as bacteria and fungi. These organisms secrete enzymes that can break down organic compounds in the rocks and minerals, leading to their decomposition.

Fig. 14.10: *Biodegradation activity by fungi*

4. **Lichen and moss growth:** Lichens and mosses are organisms that grow on rocks and minerals. As they grow, they can secrete acids that can break down the rocks and minerals, leading to their decomposition.

Fig. 14.11: *Moss (green) and lichens (white) growth*

5. **Biomineralisation:** Many organisms, such as molluscs and corals, are capable of extracting calcium minerals from their environment and using them to build their shells and skeletons. This can lead to the dissolution of minerals from rocks.

Learning Tasks

1. Discuss the types of weathering processes.

2. In mixed ability groups, embark on a field tour around the school compound or neighbourhood to observe the types of weathering and weathering processes in the environment and make presentations with pictorial evidence.

Pedagogical Exemplars

Talk for learning:

Using questions and answers, discuss the types of weathering processes, ensuring all participants are involved.

1. Begin by assessing learners' prior knowledge and understanding of weathering processes.

2. Tailor questions to match the cognitive abilities of learners. For approaching proficiency learners, provide simple questions that focus on identifying and describing the types of weathering processes. For proficient learners, ask questions that require deeper analysis, such as explaining the causes and effects of each type. Highly proficient learners can be challenged with more complex questions that require critical thinking and synthesis.

3. Provide scaffolding strategies to support learners at different levels. This can include visual aids, graphic organisers, or sentence starters to help learners organise their thoughts and responses.

4. Arrange learners in small groups or pairs based on their abilities. This allows for peer support, collaborative learning, and the opportunity to engage in discussions at an appropriate level.

5. Provide one-on-one support or additional resources for learners who may require extra assistance or extension activities for highly proficient learners who need further challenges.

6. Continuously monitor and assess learners' progress through formative assessment strategies such as observations, quizzes, or exit tickets. Use the feedback gathered to adjust instruction and provide timely support as needed.

Experiential Learning:

In mixed ability groups, embark on a field tour around the school compound or neighbourhood to observe the types of weathering and weathering processes in the environment and make presentations and/or a written field report.

1. Before the tour, provide an overview of weathering processes and their significance before the tour to establish foundational knowledge.

2. Conduct pre-tour discussions or activities that activate prior knowledge and generate questions or hypotheses about weathering processes.

3. During the field tour, divide learners into small groups based on their abilities, ensuring that each group has a mix of skills and strengths. Assign peer helpers to support learners who may require extra assistance during the tour.

4. Offer field guides or checklists to assist learners in identifying and documenting different types of weathering processes.

5. Encourage learners to record their observations using a variety of methods, such as sketches, photographs, or written notes.

6. During the presentation or field report, preferably in mixed ability groups, accept varied presentation formats, such as oral presentations, PowerPoint presentations or written reports

7. Provide opportunities for peer feedback and revision to enhance the quality of the final presentation or report.

8. Facilitate post-tour discussions to encourage learners to reflect on their observations and findings, connecting them to the concepts of weathering processes.

Alternatively, where the weathering processes might not be common within the community, teachers are encouraged to provide video presentations of the weathering processes.

Key Assessment

Level 1: List one example of each of the following:

   a) physical (mechanical) weathering

   b) chemical weathering

   c) biological weathering process.

Level 2: Create three stage-related labelled diagrams to explain the biological weathering process based on the action of tree roots which can lead to the mechanical breakdown of rocks.

Level 3: Explain the role oxygen in water plays in the discolouration, weakening and fragmentation of iron-bearing rocks.

Level 4: Evaluate the importance and interaction of each of the processes of weathering.

Section Review

Weeks 13 and 14 focused on rocks and weathering processes. Learners explored the characteristics of different rock types and delved into the mechanisms and effects of weathering. The sections of the weeks employed learner-centred pedagogies like collaborative learning and exploratory learning to promote active learner engagement, critical thinking, and self-confidence among learners. Class exercises, discussions, and projects served as both formative and summative assessment forms, enabling learners to apply their knowledge, participate in group activities, and demonstrate their understanding of rocks and weathering. The section incorporated differentiated content and assessment strategies to accommodate the diverse learning abilities of learners.

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SECTION 8: THE STRUCTURE AND COMPOSITION OF THE ATMOSPHERE

Strand: **The Earth and Its Neighbourhoods**

Sub-Strand: The Earth Atmosphere

Learning Outcome: *Analyse the physical structure and composition of the Earth's atmosphere and explain the term weather and climate.*

Content Standard: Demonstrate knowledge of the structure and composition of the Earth's atmosphere and explain the terms weather and climate.

INTRODUCTION AND SECTION SUMMARY

This section covers the structure, composition, and importance of the atmosphere. It examines the essential characteristics and elements of the earth's atmosphere, including the layers, composition, and the crucial role in sustaining life. Areas such as temperature, humidity, air pressure, wind patterns, and precipitation, and the presence of key gases like nitrogen, oxygen, and carbon dioxide are covered. Understanding the structure and composition of the atmosphere is vital for comprehending various atmospheric phenomena and processes. Additionally, the field of weather and climate which investigates the dynamic nature of the earth's atmosphere in relation to weather patterns and long-term climate trends are also studied. The section also differentiates between weather, which pertains to short-term atmospheric conditions, and climate, which characterises long-term weather patterns in specific regions. These areas of study collectively provide a fundamental understanding of the atmosphere's structure, composition, and its impact on weather and climate. This section can be linked to General Science and Social Studies at the Junior High School.

The week(s) covered by the section is/are:

> **Week 15**: *Structure, Composition and Importance of the Atmosphere*
>
> **Week 16**: *Weather and Climate*

SUMMARY OF PEDAGOGICAL EXEMPLARS

The main pedagogical exemplars used in this section are digital learning, collaborative learning, talk for learning and activity-based learning. These pedagogical exemplars play crucial roles in enhancing the learning experience. Digital learning, which involves watching of videos and the use of power-point presentations, provides visual and multimedia resources that engage learners and facilitate comprehension. Collaborative learning encourages learners to actively participate, share their ideas, and construct knowledge together, foster critical thinking and teamwork skills. Talk for learning promotes effective communication and helps learners articulate their thoughts, deepen understanding, and develop higher-order thinking skills. Activity-based learning, such as designing word clouds**,** encourages hands-on engagement, enabling learners to actively explore concepts, apply knowledge, and enhance creativity. These pedagogical exemplars collectively create an interactive and learner-centred environment, foster active engagement, critical thinking, and collaborative skills, and ultimately enhance the overall learning outcomes.

ASSESSMENT SUMMARY

The assessment strategies of group assignment, strategic reasoning, and class exercises provide comprehensive formative and summative assessment opportunities. Group assignments allow learners to collaborate, apply knowledge, and engage in higher-order thinking, promoting critical thinking skills and competencies. Learners work together to solve complex problems, analyse information, and communicate their findings effectively. Strategic reasoning assessments assess learners' ability to think critically, make logical connections, and evaluate evidence, aligning with curriculum standards. Class exercises, including short assessments, gauge learners' understanding, recall of information, and application. These assessments provide ongoing feedback, allowing learners to monitor their progress, identify areas for improvement, and make necessary adjustments. In summary, the combination of these assessment strategies provides a comprehensive evaluation of learners' knowledge, skills, and abilities, covering a range of DoK levels and promoting holistic learning outcomes.

Week 15

Learning Indicator: *Discuss the physical structure and composition of the Earth's atmosphere.*

Theme or Focal Area: **Structure, Composition and Importance of The Atmosphere**

What is the Atmosphere?

The atmosphere is a mixture of gases surrounding the Earth. The Earth has a gravitational field strong enough to prevent gases from escaping; the atmosphere is the gaseous envelope of the Earth. Without our atmosphere, there would be no life on Earth. The atmosphere consists of layers of gases that support life and provide protection from harmful radiation.

Structure of the Atmosphere

The atmosphere is divided into a series of layers, based on the changes in air temperature at different altitudes. These layers are Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere. Gravity holds the layers of air to the earth's surface. Air pressure is caused by the weight of air above any place on the Earth's surface.

The Troposphere

It is the first layer of the Earth's atmosphere from the Earth's surface. It can extend to an average height of about 12 to 17 km depending on the season and latitude.

Characteristics/Features of the Troposphere (lowest layer)

1. Average height of 12-17 km.
2. Thickness is more at the equator (0-17 km) than the poles (0-12km).
3. Contains dust particles and water vapour.
4. This is the layer that supports life.
5. Changes in weather conditions occur in this layer.
6. Temperature decreases with increasing altitude.
7. Temperature drops about 6.5°C for every 1000m (1km) above earth's surface.
8. This is called **Environmental Lapse Rate** or **Normal Lapse Rate.**
9. It is well mixed by rising and descending air currents
10. The troposphere is the densest layer of the atmosphere
11. The zone that separates the troposphere from the stratosphere is called tropopause.
12. At this level, temperature remains fairly constant.

The Stratosphere

This layer is the second layer of the earth's atmosphere after the troposphere. It is separated from the troposphere by the tropopause. The stratosphere extends to about 50 km above the earth's surface.

Characteristics/Features of the Stratosphere (above Troposphere)

1. It is above the tropopause and extends up to 50km.
2. It contains ozone which acts as a shield for the Earth's surface.
3. The ozone absorbs ultraviolet radiation from the sun.
4. In the lower portion of the stratosphere, the temperature remains nearly constant with height (about -60°C).

5. In the upper portion the temperature increases rapidly with height-**temperature inversion (or reversal)**

6. The stratosphere is stable and almost completely free of clouds or other forms of weather

7. Jet streams, high-speed air currents that flow from west to east, are prominent in the stratosphere.

8. The stability and lack of weather disturbances in the stratosphere make it an ideal region for aircraft to ply.

9. The stratosphere has an upper boundary called the stratopause.

10. The stratopause separates the stratosphere from the mesosphere.

Mesosphere

The mesosphere, which is the third layer of Earth's atmosphere, extends for about 50 km from the stratopause to about 85 km above the Earth's surface.

Characteristics/Features of the Mesosphere (Above the Stratosphere)

1. The Mesosphere lies above the Stratosphere.

2. It extends up to a height of 85km.

3. Temperature decreases with height.

4. Temperature drops to about -90°C.

5. It is the coldest region in the atmosphere.

6. The mesosphere is known for the occurrence of noctilucent clouds-**high altitude made up of ice crystals and are visible during twilight hours in polar regions.**

7. This layer protects the earth from meteors by burning and vaporising them. This phenomenon produces the visible streaks of light known as **shooting stars.**

8. The upper limit is known as the mesopause.

Characteristics/Features of the Thermosphere (Above the Mesosphere)

1. It lies above the Mesosphere and extends to between hundreds and thousands of kilometres above the earth's surface.

2. The thermosphere is characterised by an extremely low density of gas particles.

3. Thermosphere means "heat sphere."

4. Temperature rises sharply to about 2000°C during the day.

5. Temperature can drop significantly low at night.

6. The thermosphere has a high temperature but does not feel very hot in ordinary sense due to low density of gas.

7. The lower part of the thermosphere, known as the ionosphere, is where electrically charged gas particles interact with earth's magnetic field.

8. The charged particles reflect radio signals around the earth.

9. Many satellites, including communication, weather, and scientific satellites, reside in the Thermosphere.

10. The upper limit is known as the *thermopause.*
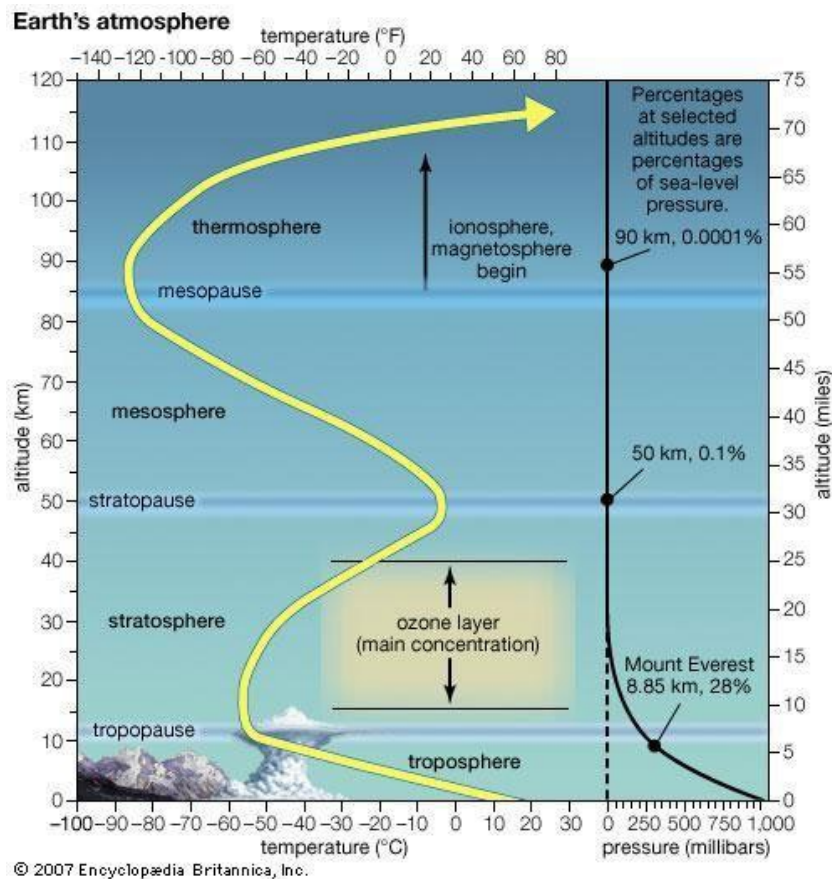
Fig. 15.1: *Structure of the Atmosphere*
Source: Encyclopedia Britannica, 2007

Exosphere

It is the outermost layer of the Earth's atmosphere. It extends from the upper part of the thermosphere with a least thick layer and gradually moves into outer space.

Characteristics of the Exosphere

1. The Exosphere is the top layer of the atmosphere and is around 10,000km thick, extending halfway to the moon.

2. The density is so low here that any molecules that do exist rarely collide.

3. At the top of the exosphere is the vacuum of outer space.

Altitude and Temperature Calculation

How to calculate temperature of higher altitude or peak of mountains

*Procedure***:**

Step 1: Determine the altitude difference between the base and the peak of the mountain.

Step 2: Use the normal or environmental lapse rate to calculate the temperature difference due to the change in altitude. (Thus, 6.5°C for every 1000m or 1km ascent)

Step 3: Subtract the temperature difference from the temperature at the base, since temperature decreases with increasing altitude.

Worked example.

1. Calculate the temperature at a height of 5000 metres when the temperature of the base of the mountain at sea level is 29°C.

| 25 |

Solution

$$\text{Difference in altitude} = 5000m - 0m = 5000m$$

Difference in temperature

If $1000m = 6.5°C$

$$5000m = \frac{5000m}{1000m} \times 6.5°C$$

$$= 32.5°C$$

Temperature at the height of $5000m = 29°C - 32.5°C$

$$= -3.5°C$$

How to calculate temperature of lower altitude or base of mountains

Procedure

Step 1: Determine the altitude difference between the base and the peak of the mountain.

Step 2: Use the normal or environmental lapse rate to calculate the temperature difference due to the change in altitude. (Thus, 6.5°C for every 1000m or 1km ascent)

Step 3: Add the temperature difference from the temperature at the peak, since temperature increases with decreasing altitude.

Worked Example

1. What will be the temperature at sea level when the temperature at a height of 8000m is -27.5°C?

   Solution

   $$\text{Difference in altitude} = 8000m - 0m = 8000$$

   Difference in temperature

   If $1000m = 6.5°C$

   $$8000m = \frac{8000m}{1000m} \times 6.5°C$$

   $$= 52°C$$

   Temperature at the height of $5000m = -27.5°C + 52°C$

   $$= 24.5°C$$

Composition of the atmosphere

1. **Nitrogen (N2):** Nitrogen is the most abundant gas in the atmosphere, constituting approximately 78% of the total volume. It is a crucial component for life and various biochemical processes.

2. **Oxygen (O2):** Oxygen makes up about 21% of the atmosphere's volume. It is essential for the respiration of organisms and supports combustion and various chemical reactions.

3. **Argon (Ar):** Argon is a noble gas and accounts for approximately 0.93% of the atmosphere. It is chemically inert and does not readily react with other substances.

4. **Carbon Dioxide (CO2):** Carbon dioxide is a minor but important gas in the atmosphere, currently making up about 0.04% (400 parts per million) of the total volume. It plays a significant role in the greenhouse effect and the regulation of Earth's temperature.

5. **Neon (Ne), Helium (He), Methane (CH4), and other trace gases**: These gases, including neon, helium, methane, ozone, and others, exist in very small concentrations in the atmosphere. While individually they make up a tiny percentage of the atmosphere, they can have significant impacts on climate, atmospheric interactions, and other processes.

6. **Variable amounts of water vapour (H2O),** which can range from nearly 0% to about 4% by volume. Water vapour plays a critical role in weather patterns and the hydrological cycle.

7. The atmosphere contains various **aerosols,** suspended solid or liquid particles, such as dust, pollutants, and volcanic ash. These aerosols can impact air quality, climate, and the formation of clouds and precipitation.

General Importance of the Atmosphere to Humans

1. **Air to breathe:** The atmosphere is made up of about 78% nitrogen, 21% oxygen, and 1% other gases. Oxygen is essential for respiration, the process by which our cells produce energy.

2. **Protection from harmful radiation:** The atmosphere protects us from harmful radiation from the Sun, such as ultraviolet (UV) radiation. UV radiation can cause skin cancer and other health problems. The ozone layer in the stratosphere absorbs most of the Sun's UV radiation, preventing it from reaching the Earth's surface.

3. **Regulation of temperature:** The atmosphere helps to regulate the Earth's temperature. Greenhouse gases in the atmosphere trap heat from the Sun, preventing it from radiating back into space. This helps to keep the Earth's temperature warm enough for life to exist.

4. **Weather and climate:** The atmosphere is responsible for weather and climate. Almost all the weather conditions occur in the troposphere.

5. **Transportation:** The atmosphere allows us to travel by air, which is a fast and efficient way to get around the world.

6. **Communication:** The atmosphere allows us to communicate with each other through radio, television, and other forms of telecommunications.

7. **Recreation and Sports:** The atmosphere provides us with opportunities for recreation, such as flying kites, skydiving, aerobatic sand paragliding.

Learning Tasks

1. Watch videos, pictures or PowerPoint slides on the components of the earth's atmosphere.

2. Identify and explain the main components of the atmosphere

3. Compute for temperature variations at different altitudes

Pedagogical Exemplars

Digital Learning:

Watch videos, pictures or PowerPoint slides on the components of the earth's atmosphere.

1. Use a variety of modalities to present information. Include clear and engaging visuals like pictures, diagrams, and animations in the videos, pictures, or slides. Incorporate movement breaks or short activities related to the content

2. Use frequent questioning throughout the presentation to check for understanding and encourage participation from all learners.

3. Provide scaffolds and supports for struggling learners. This could involve sentence starters to help them answer questions and mnemonic devices to remember key terms.

4. Review key points from the lesson and provide opportunities for learners to reflect on their learning.

5. Use exit tickets to assess learner understanding and identify areas where they might need additional support

Collaborative Learning:

Initiate discussion to identify and explain the main components of the atmosphere (troposphere, stratosphere, mesosphere, thermosphere and exosphere), and explain the gases and their importance in the atmosphere *ensuring all-inclusiveness and being mindful of reserved learners. Learners should be able to manage their emotional reactions and behaviours using techniques such as mindfulness strategies, breathing, and self-talk.*

1. Provide a list of key terms (troposphere, stratosphere, mesosphere, thermosphere, exosphere) with definitions or visuals appropriate for different reading levels.

2. Start with open-ended questions to encourage participation from all learners

3. Pose a question, allow wait time for learners to think individually (Think), then have them discuss their ideas with a partner (Pair), and finally share their thoughts with the class (Share).

4. Use clear diagrams or animations of the atmosphere's layers. Consider incorporating kinaesthetic activities to reinforce understanding.

5. Allow learners to use graphic organisers, take notes, or draw diagrams to capture information.

6. Review key points from the lesson and provide opportunities for learners to reflect on their learning.

7. Use exit tickets to assess learner understanding and identify areas where they might need additional support.

Key Assessment

Level 1:

1. The layer of the atmosphere where daily weather patterns occur is_____

2. True or False: The ozone layer is located in the stratosphere.

Level 2: Create a labelled model (drawing or physical) to represent the different atmospheric layers and their relative thicknesses.

Level 3: Why does the temperature generally decrease with increasing altitude in the Troposphere

Level 4: The average height of a highland is 8800m above sea level. In dry and wet seasons, the estimated temperatures at the summit are 29°C and 25°C respectively. What will be the temperature at the foot during?

1. wet season

2. dry season

Week 16

Theme or Focal Area 1: Weather and Climate

Meaning of Weather and Climate

Weather is the state or condition of the atmosphere at a particular place and time. The weather in a particular place can vary greatly from day to day, and even from hour to hour. The study of weather is called *meteorology* and the person who studies and predicts weather is called *meteorologist*. Climate is the average weather condition of a particular area over a long period of time, usually over 30 years. The study of climate is called *climatology* and the person who studies climate is called *climatologist.*

Differences between weather and climate

Theme	Weather	Climate
1. Definition	Weather is the state or condition of the atmosphere at a particular place and time.	Climate is the average weather in a particular area over a long period of time.
2. Time period	Weather conditions are transient and can change rapidly, typically occurring over a period of hours, days, or weeks.	Climate describes the average weather patterns observed over a much longer time frame, usually not below 30 years.
3. Spatial coverage	Weather conditions are localised and specific to a particular place or region.	Climate represents broader patterns and trends over larger areas.
4. Variability	Weather is highly variable and subject to short-term fluctuations.	Climate is characterised by its relative stability and long-term averages.
5. Predictability	Weather forecasts aim to predict short-term atmospheric conditions, typically up to a week in advance, using meteorological models and observations.	Climate projections focus on long-term trends and changes, aiming to provide insights into the general patterns and conditions that are expected to occur over decades or longer.
6. Impact	Weather can have a significant impact on our daily lives, but its effects are typically short-lived.	Climate, on the other hand, can have a long-term impact on our environment and our way of life.

Similarities between weather and climate

1. Weather and climate are both concerned with the study of the Earth's atmosphere, including elements such as temperature, humidity, wind patterns, and precipitation.

2. Both weather and climate are influenced by the incoming solar radiation from the sun. Solar energy drives various atmospheric processes, affecting both short-term weather patterns and long-term climate changes.

3. Meteorologists and climatologists rely on similar data sources to study weather and climate. They use observations from weather stations, satellites, radar, and other instruments to analyse atmospheric conditions.

4. Both weather and climate exhibit variability. Weather can change rapidly from day to day, while climate represents long-term averages and trends over extended periods usually not less than 30 years.

5. Both weather and climate have significant impacts on human activities. Weather affects daily decisions, such as clothing choices or travel plans, while climate influences agriculture, water resources, and the overall habitability of different regions.

6. Both weather and climate are affected by the Earth's geography. The Earth's mountains, oceans and deserts all influence the weather and climate.
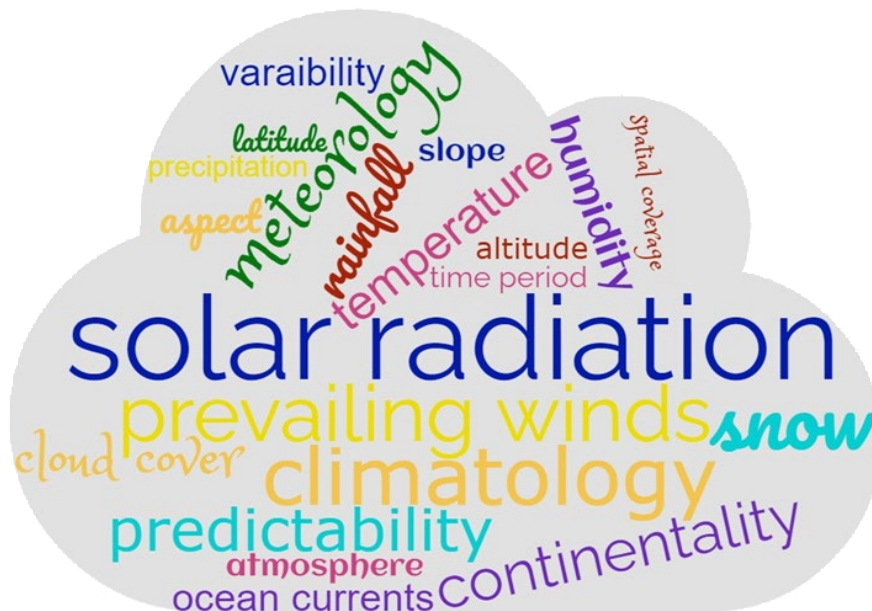
Fig. 16.1.: *Sample Word Cloud on weather and climate*

Factors Affecting Weather

1. **Solar radiation:** The sun's energy in the form of shortwave radiation is the primary driver of weather. The amount of solar radiation reaching a particular location determines how much heat is available to warm the air and influence atmospheric circulations.

2. **Rotation of the Earth:** Earth's rotation on its axis creates the day-night cycle and influences wind patterns. The rotation also affects how sunlight strikes different parts of the planet, leading to temperature variations.

3. **Latitude:** The angle at which sunlight hits the Earth's surface varies depending on latitude. Areas closer to the equator receive more direct sunlight, leading to warmer temperatures. Conversely, polar regions receive sunlight at a slanted angle, resulting in colder temperatures.

4. **Moisture:** Water vapour in the atmosphere plays a significant role in weather. It can condense to form clouds and precipitation, releasing heat as it does so. The amount of moisture in the air affects humidity, cloud formation, and precipitation patterns.

5. **Land and water distribution:** Land and water have different heat capacities. Land heats and cools faster than water. This difference creates temperature variations between coastal and inland regions, influencing wind patterns and local weather.

6. **Atmospheric Pressure:** Air pressure plays a crucial role in weather systems. Differences in pressure create forces that drive winds. High-pressure systems are associated with clear skies and calm conditions, while low-pressure systems are linked to cloud formation and precipitation.

7. **Ocean Currents:** Large-scale ocean currents transport heat around the globe, influencing global climate patterns and regional weather. Warm ocean currents can moderate temperatures in coastal regions, while cold currents can create cooler and drier conditions.

Factors affecting climate.

1. **Latitude:** Latitude dictates climate by controlling how much sunshine a place gets. Areas closer to the equator receive direct sunlight, heating up more and creating warm, tropical climates. As you travel towards the poles, the sun's rays hit at an angle, spreading the heat over a larger area. This results in less intense heating and colder climates at higher latitudes. This uneven heating drives global wind patterns that further influence regional climates, creating distinct zones like hot tropics, mild temperate, and frigid polar regions.

2. **Altitude:** As altitude increases, it affects climate by causing a drop in temperature and atmospheric pressure. The thinning atmosphere at higher elevations reduces its heat-trapping capacity, resulting in cooler temperatures. This change in temperature influences weather patterns, leading to increased rainfall or snowfall in mountainous areas. Additionally, the lower atmospheric pressure impacts air composition, oxygen levels, and the types of organisms that can thrive at different altitudes. Altogether, altitude plays a vital role in shaping climate by affecting temperature, pressure, precipitation, and the distribution of life.

3. **Winds:** Wind plays a significant role in shaping climate by influencing temperature, precipitation patterns, and the distribution of moisture. Wind movement is primarily driven by differences in air pressure, which occur due to variations in temperature across different regions. As air flows from areas of high pressure to low pressure, it transports heat, moisture and pollutants, affecting the local climate. For example, winds blowing over a large body of water can bring moist air inland, resulting in increased rainfall. Conversely, winds passing through arid regions can contribute to dry conditions. Wind also plays a role in ocean currents, which have a significant impact on coastal climates. Overall, wind acts as a dynamic force that redistributes heat and moisture, shaping the overall climate patterns of a region.

4. **Distance from the sea**: Coastal areas experience a maritime climate, characterised by milder temperatures, higher humidity, and more moderate seasonal variations compared to inland regions. This occurs because the ocean acts as a heat sink, absorbing and releasing heat more slowly than land. During summer, land near the coast is cooled by the sea breeze, which brings in cooler air from the water. In winter, the ocean releases stored heat, keeping coastal areas relatively warmer. In contrast, areas far from the sea, known as continental or interior regions, have a continental climate with greater temperature extremes, lower humidity, and less moderation in seasonal changes. The distance from the sea affects climate by influencing temperature, humidity, and the frequency of weather patterns, resulting in distinct climatic conditions between coastal and inland areas.

5. **Aspect**: The compass orientation or aspect of slopes affects the amount of sunlight and heat received, which in turn influences temperature and moisture conditions. In the northern hemisphere the sun rises in the east, follows a path southward and sets in the west. Consequently south-facing slopes in the northern hemisphere are usually warmer and drier than north facing slopes. In the southern hemisphere the sun rises in the east, follows a path northward. Consequently, slopes facing north in the southern hemisphere are warmer and drier than south facing slopes.

Learning Tasks

1. Discuss the differences between weather and climate.

2. Discuss the similarities between weather and climate.

3. Discuss the factors affecting weather and climate.

4. Design word clouds based on the explanation, similarities and differences between weather and climate.

Pedagogical Exemplars

Talk for Learning:

Initiate discussion and help shape learners to understand the differences between weather and climate, and the factors influencing them.

1. Introduce the topic by activating prior knowledge of learners about weather and climate through questioning.

2. Provide a brief overview of the key concepts and vocabulary related to weather and climate.

3. Offer differentiated resources, such as simplified readings or visual aids, to provide learners with varying entry points into the topic.

4. Provide guiding questions for learners to consider while watching the video or listening to the presentation.

5. Pause the video or presentation at strategic points to allow learners to reflect, discuss, and ask questions.

6. Facilitate class discussions that cater to different intellectual abilities. For approaching proficiency learners, provide clear explanations and examples to help them grasp the basic differences between weather and climate. For proficient and highly proficient learners, encourage them to analyse and compare the factors that influence weather and climate, such as latitude, altitude, and distance from the sea.

7. Provide opportunities for learners to reflect on the video or presentation using various modalities, such as written responses, group discussions, or multimedia presentations.

8. Encourage learners to connect what they have learnt to their own experiences, observations, or local weather and climate patterns and offer individualised feedback and support, tailoring it to each learner's intellectual abilities and areas for growth.

Learners during discussions should provide opportunities for others to practise identifying potential situations or experiences that lead to feeling overwhelmed and struggling to manage emotions.

Activity-Based Learning

Design word clouds based on the explanation, similarities and differences between weather and climate.

1. Introduce the concept of word clouds and their purpose as visual representations of key terms and ideas and provide a clear explanation of the differences between weather and climate, emphasising their distinct characteristics and similarities.

2. Offer simplified explanations and visuals for approaching proficiency learners, ensuring they understand the basic concepts.

3. For approaching proficiency learners, provide a list of key terms related to weather and climate. Guide them in selecting and arranging these terms in a word cloud format. Offer support through templates or pre-selected terms to aid their understanding. Proficient and highly proficient

learners can be encouraged to identify similarities and differences between weather and climate. Ask them to create separate word clouds for each concept, using appropriate terminology.

4. Offer a range of tools and platforms for creating word clouds, such as online generators or traditional pen and paper methods. Free online word cloud generators include WordArt.com, WordClouds.com and Worditout.com

5. Provide differentiated resources, such as word banks, visual prompts, or concept maps, to scaffold the word cloud creation process.

6. Consider the use of colour and font variations to highlight the relative importance of terms within the word clouds.

7. Provide opportunities for peer collaboration, where learners of different abilities can work together, supporting one another in creating their word clouds.

8. Allow time for learners to reflect on their word clouds and identify patterns or insights they have gained about weather and climate.

9. Provide opportunities for learners to share their word clouds with the class, explaining their choices and interpretations and encourage peer feedback and discussions, fostering a collaborative learning environment.

Key Assessment

Level 1: Verbally differentiate between weather and climate.

Level 2: Explain why knowing the weather conditions of a place is essential in life.

Level 2: Explain how the aspect of a slope influence its temperature.

Level 3: Design word clouds using 10 keywords in weather and climate lessons. (Free online word cloud makers include WordArt.com, WordClouds.com and Worditout.com).

Theme or Focal Area 2: Calculation of Annual, Mean Rainfall and Temperature Data

Some Elements of Weather, their Measuring Instruments and Units of Measurement

Element	Measuring instrument	Unit of measurement
Temperature: It is the measure of how hot or cold the air is.	Thermometer	Degrees Celsius (°C) or degree Fahrenheit(°F)
Rainfall: It is a form of water that falls from the atmosphere.	Rain gauge/pluviometer	Millimetres (mm) or inches (in)
Wind speed: It measures the rate of fastness at which air moves.	Anemometer	Metres (m/s) per second or kilometres per hour(km/h) or knot
Wind direction: It measures direction of movement of air.	Wind vane	Cardinal or compass directions or degrees
Air pressure: It is the force exerted on a given area of earth's surface by the weight of air above it.	Barometer	Millibars (mb)
Humidity: It is the amount of moisture or water vapour present in the air.	Hygrometer (wet bulb thermometer and dry bulb thermometer)	Percentage (%)
Cloud cover: It is the amount and type of cloud present in the atmosphere.	Eyes observation	Oktas or Percentage (%)
	Ceilometer	Metres or feet
Sunshine: It is the direct or indirect sunlight that reaches the surface of the earth.	Sunshine recorder	Hours or minutes
Solar radiation: It is the energy emitted by the sun in the form of magnetic waves.	Pyranometer	Watts per square metres
Visibility: It is the clarity at which objects can be seen in the atmosphere.	Visibility sensor/ transmissometer	Metres or kilometres

Images of Instruments used to Measure Weather and Climate

Fig. 16.2: *Rain Gauge/pluviometer*

Fig. 16.3: *Thermometer*

Fig. 16.4: *Anemometer (Left) and Wind Vane (Right)*

Fig. 16.5: *Barometer*   **Fig. 16.8:** *Wet & Dry bulb Thermometer*
                                                                    (Hygrometer)
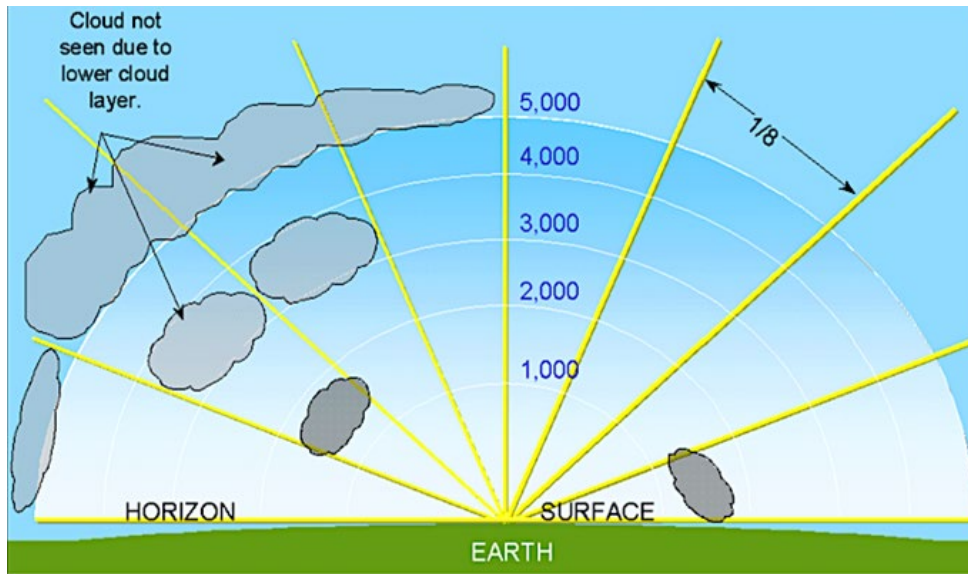
Fig. 16.9: *Cloud observation in oktas*

Fig. 16.10: *Ceilometer*   **Fig. 16.11:** *Sunshine Recorder*

Fig. 16.12.: *Pyranometer*   **Fig. 16.13:** *Transmissometer*

Calculate the Annual and Mean Rainfall and Temperature Data of a Station

1. **Total Annual Rainfall (TAR)** is the sum of the amount of rainfall recorded in the year.
   $$\text{Thus, }\textbf{TAR} = J + F + M + A + M + J + J + A + S + O + N + D$$

2. **Mean Annual Rainfall (MAR)** is the average amount of rainfall in the year.
   $$\text{Thus, }\textbf{MAR} = J + F + M + A + M + J + J + A + S + O + N + D$$

   $$= \frac{J + F + M + A + M + J + J + A + S + O + N + D}{12}$$

3. **Annual Range of Temperature (ART)** the difference between the highest and lowest temperatures recorded over a specific period of one year.
   $$\text{Thus, }\textbf{ART} = Tmax - Tmin$$

4. **Mean Annual Temperature (MAT)** is the average temperature of the year
   $$\text{Thus, }\textbf{MAT}$$

   $$= \frac{J + F + M + A + M + J + J + A + S + O + N + D}{12}$$

WORKED EXAMPLE

Use the rainfall and temperature data of station A below to answer the questions that follow.

Station A

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Rain (mm)	180	200	220	240	260	300	340	380	320	280	240	200
Temp (°C)	26	27	28	29	30	31	32	33	32	31	30	29

Calculate the:
  (a) Total annual rainfall
  (b) Mean annual rainfall
  (c) Annual range of temperature

Solution
  (a) Total annual rainfall:
      $180 + 200 + 220 + 240 + 260 + 300 + 340 + 380 + 320 + 280 + 240 + 200 = 3{,}160$ mm
  (b) Mean annual rainfall
      $$= \frac{3160 \text{ mm}}{12} = 263 \text{ mm}$$
  (c) Annual range of temperature $= 33°C - 26°C = 7°C$

Learning Task

1. Using a 30-year weather data from a station, Learners calculate annual and mean rainfall and temperature data to differentiate between the terms weather and climate

Pedagogical Exemplars

Project-based Learning:

Using 30-year weather data from a station (e.g TAHMO and GMet) or repository, learners calculate annual and mean rainfall and temperature data to differentiate between the terms weather and climate.

1. Provide an overview of annual and mean calculations, explaining their significance in analysing long-term weather trends.

2. Provide access to weather data from a reliable source, such as TAHMO or GMet, or other reputable repositories.

3. Offer differentiated datasets, considering the varying abilities of learners. For approaching proficiency learners, provide pre-organized data sets with fewer variables and simplified formats. Proficient and highly proficient learners can work with more comprehensive datasets, allowing them to analyse multiple variables, such as rainfall and temperature, over the 30-year period.

4. Provide clear instructions and templates for data organisation and calculation to support learners in all ability levels. Spreadsheet tools, such as Microsoft Excel or Google Sheets may be utilised to facilitate calculations.

5. Provide scaffolded support, such as step-by-step examples, for learners who may require additional guidance whilst allowing for peer collaboration and support.

6. Provide guidance on data interpretation, helping learners identify trends, patterns, and anomalies in the data.

7. Engage learners in discussions where they can compare their findings, exploring the factors that may have influenced the variations in rainfall and temperature.

8. Allow time for learners to reflect on their calculations and findings, considering the implications for local climate patterns or environmental impacts.

Learners should be able to manage their emotional reactions and behaviours using techniques such as mindfulness strategies, breathing, and self-talk.

Key Assessment

Level 2: Calculate the monthly, annual and means of rainfall or temperature data of any station.

Teacher should provide climatic data of various stations for learners to calculate annual and mean rainfall and temperature.

Section Review

Weeks 15 and 16 delved into the focal areas of the structure, composition, and importance of the atmosphere, as well as weather and climate. The intricate characteristics and components of Earth's atmosphere, including its layers, composition, and the crucial role it plays in supporting life on the planet were explored. During weeks 15 and 16, topics such as atmospheric pressure, temperature variations, and the significance of key gases like nitrogen, oxygen, and carbon dioxide were examined. Additionally, the dynamic nature of Earth's atmosphere in relation to weather patterns and long-term climate trends were investigated. These weeks provided learners with a comprehensive understanding of the atmosphere's structure, composition, and its influence on weather and climate, enabling them to appreciate the mechanisms that shape the planet's atmospheric dynamics and their impact on the society.

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SECTION 9: METHODS OF COLLECTING GEOSPATIAL DATA

Strand: **Navigating Our Environment**

Sub-Strand: Geospatial Data Collection, Representation and Interpretation

Learning Outcome: *Collect geospatial data using both traditional methods e.g., chain and compass surveying and modern methods e.g., remote sensing, Global Positioning System (GPS) and mobile Apps*

Content Standard: Demonstrate knowledge and skills in basic geospatial data collection methods

INTRODUCTION AND SECTION SUMMARY

Methods of collecting geospatial data explores various techniques like remote sensing, global positioning system, aerial photography, satellite imaging, and surveying to gather spatial and geographic information. These methods facilitate the collection of data on geographical features, land use, topography, and natural resources. Understanding these approaches is crucial for accurately capturing, analysing, and visualising spatial information for applications like urban planning, environmental management, and disaster response. The section highlights benefits such as remote data collection, accuracy, and efficiency, while acknowledging challenges like costs, limited resolution, and data interpretation complexities.

The week(s) covered by the section is/are:

Week 17: Methods of Collecting Geospatial Data

Week 18: The Advantages and Disadvantages of Geospatial Data Collection Methods/Tools

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars such as talk for learning (brainstorming and pyramid discussions), Activity-based learning (mobile and computer apps, talk for learning with video-watching), and Collaborative learning (discussions) play crucial roles in enhancing the learning experience. Talk for learning through brainstorming and pyramid discussions promotes active participation and critical thinking, enabling learners to generate ideas, explore diverse perspectives, and develop communication skills. Activity-based learning with mobile and computer apps engages learners through interactive and hands-on experiences, fostering creativity, problem-solving, and technological literacy. Talk for learning with video-watching enhances visual and auditory learning, enabling learners to grasp complex concepts, analyse information, and deepen understanding. Collaborative learning with discussions encourages teamwork, and the exchange of ideas, promoting social skills, critical thinking, and a deeper understanding of the subject matter. These pedagogical exemplars enhance the overall learning outcomes.

ASSESSMENT SUMMARY

Assessment strategies such as group projects, class exercises and fieldwork provide comprehensive formative and summative assessment opportunities. Group projects allow learners to collaborate, apply knowledge, and engage in critical thinking. Learners work together to solve complex problems, analyse information, and present their findings, demonstrating their understanding of concepts.

Class exercises, such as quizzes or short assessments, assess learners' understanding, recall of information and application. Fieldwork assessments involve hands-on engagement, allowing learners to apply knowledge in real-world contexts, analyse data, and make observations.

Week 17

Learning Indicator: *Discuss the methods of collecting geospatial data (surveying, remote sensing and GPS)*

Theme or Focal Area: Methods of Collecting Geospatial Data

Meaning and types of Geospatial Data

Geospatial data is data with a geographic component. It includes any information that is associated with a location on or near the Earth's surface. This data can describe both natural features (such as landforms, bodies of water, and vegetation) and human-made structures (such as roads, buildings, and public transport).

Types of Geospatial Data

1. Vector Data**:** In vector data, points, lines, and polygons (irregular shapes) represent features. For example, houses can be represented by points, roads by lines, blocks of houses or entire towns by polygons. Here is an example of vector data to show point line and polygon representations:
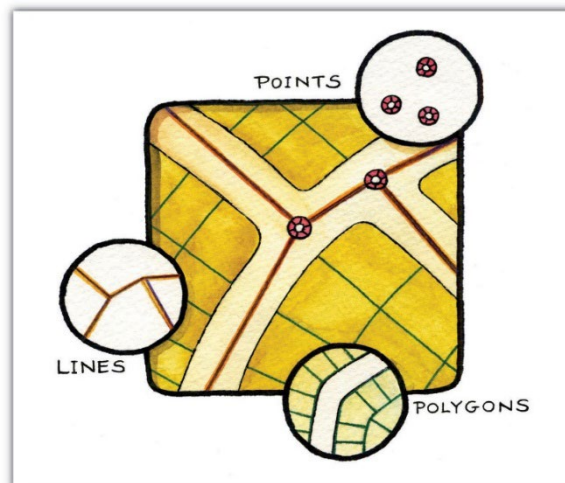
Fig. 17.1: *Vector Data Models (saylordotorg.github.io)*

2. Raster Data: Raster data consists of pixelated or gridded cells identified by rows and columns. It is used for more complex imagery, such as photographs and satellite images. Here is an example of raster data at three different magnifications. In the first image the human eye cannot see the pixels:

Fig. 17.2: *https://spatialvision.com.au/blog-raster-and-vector-data-in-gis/*
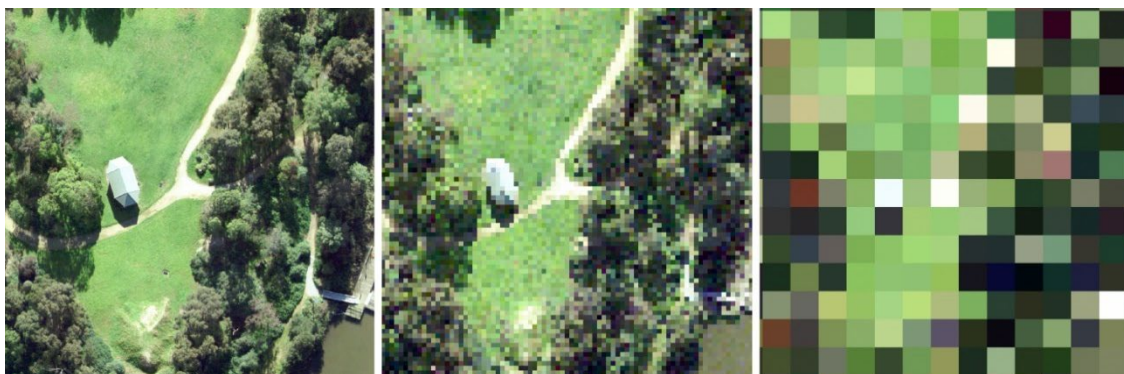
3. Attribute data: This includes non-spatial data associated with geographic features and involves details about the characteristics or attributes of the features, such as population, temperature, land use or any other relevant information about the geographic feature. Geospatial data can be captured, stored, analysed and visualised in a variety of ways through the utilisation of GIS (Geographic Information Systems) or other geospatial technologies.

Tools for Collecting Geospatial Data

1. **Field Survey Methods and Ground-Based Sensing Systems:** Field surveys involve manually collecting data on the ground using both traditional surveying instruments and modern data collection technologies like total stations, theodolites, measuring tapes, mobile phones, tablets and advanced GPS Systems. Ground-based sensors, such as weather stations or air quality monitors theodolites, sounders and spectrometers, gather specific environmental data.

2. **Remote Sensing:** It is the process of collecting data about an object or area without being in physical contact with it. Remote sensing data can be collected from ground-based platforms, airborne or space-borne systems. The airborne systems include the use of aircraft mounted with detectors and Unman Aerial Vehicles (UAVs) (Drone).

Fig. 17.1: *Aerial Photograph (Jeffrey Milstein, 2020)*

3. **Global Positioning System (GPS)**: It is a satellite-based radio navigation system used on land, sea and air to determine the exact location, time and velocity information on earth, irrespective of the weather conditions.

Fig. 17.2: *Handheld GPS (Copilot AI, 2024)*

4. **Geographic Information System (GIS):** It is a computer-based system designed to capture, store, analyse, manipulate, and present spatial or geographic data. GIS combines hardware, software, spatial data, organisation and people to manage and analyse various types of data (spatial and attribute) tied to specific locations on the Earth's surface. In a GIS, spatial data and attribute data are employed. Attribute data, also known as non-spatial data or tabular data, refers to information that is associated with specific geographic features or locations in a GIS. It provides additional details or characteristics about the spatial features represented in the GIS. This includes attributes such as names, labels, addresses, population counts, temperature measurements, elevation values, date and time. Notable GIS software includes ArcGIS, QGIS, GRASS GIS, MapInfo Pro, GeoServer and Google Earth Pro.

5. **Satellite Imagery:** This refers to images of the Earth's surface captured by satellites orbiting the Earth. It's a vital tool in geospatial data collection, providing valuable information for various applications. Satellites carry specialised sensors that detect and record reflected and emitted energy from the Earth surface target. These sensors can capture data across various wavelengths of the electromagnetic spectrum, including visible light, infrared, and microwave. The captured data is then transmitted back to receiving stations on Earth, processed to create digital images, and made available for analysis. The images captured may be panchromatic - one spectral band image, multispectral - two to hundred spectral bands image or hypespectral - over Hundred spectral bands image.
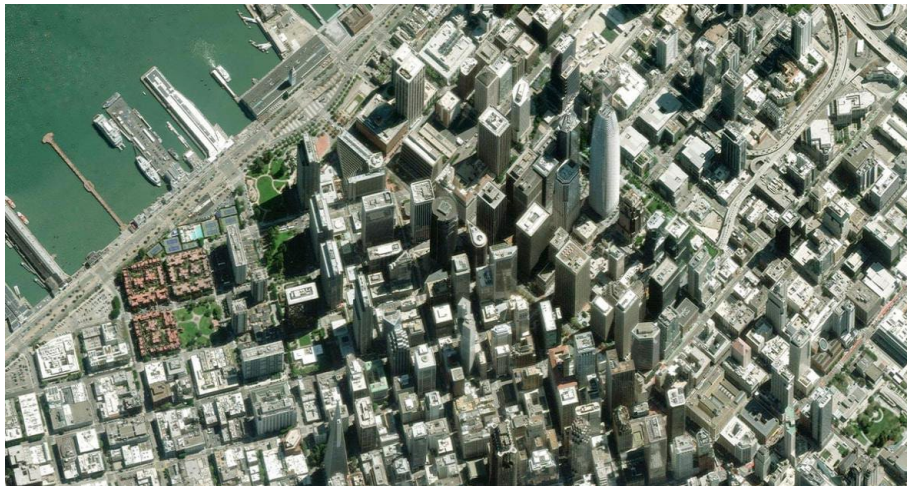

Fig. 17.3: *Satellite image (Burkhard Boeckem, 2020)*

6. **Mobile Mapping Systems:** This involves collection of data from a moving vehicle fitted with various sensing devices, including Global Navigation Satellite Systems (GNSS), photographic cameras, radar and scanners (e.g. LiDAR).

Fig. 17.5.: *Mobile mapping system (Sameer Khan, 2023)*

Examples and uses of Geospatial Data:

1. Satellite Imagery: Derived from satellites orbiting the Earth, this data provides detailed views of the planet's surface like the images found on Google Maps or Google Earth.

2. GPS Data: Collected from global positioning systems, it helps track locations accurately. Smartphones use this technology by processing three signals from a satellite to work out positions on the Earth's surface and a fourth to work out height above sea level.

3. Remote Sensing Data: Captured by sensors on aircraft or satellites, it provides information about land cover, including, vegetation, crop production, ice masses, and volcanic lava flows.

4. Address Point data: Captured by satellites and remote sensing methods. Specific locations are represented by coordinates (latitude and longitude). Provides information on exact locations on roads and streets, for example house numbers. Used by international postal services.

5. Map data: Captured by satellites, remote sensing methods. Geospatial data is fundamental for creating digital and paper maps that visualise spatial relationships and patterns.

Areas Or Fields That Utilise Geospatial Data

Some areas or fields that utilise geospatial data include;

1. **Mapping and Cartography:** Geospatial data forms the foundation of digital maps and cartographic products, enabling accurate representation of geographical features and their attributes.

2. **Environmental Monitoring:** Geospatial data helps in monitoring changes in the environment, such as land use changes, deforestation, urbanisation, and natural disasters.

3. **Urban Planning:** Geospatial data assists in urban development and planning by providing insights into population density, infrastructure, transportation networks, and land use patterns.

4. **Agriculture:** Geospatial data is used for precision agriculture, which involves optimising farming practices based on specific field conditions and environmental factors.

5. **Natural Resource Management:** Geospatial data helps in managing and monitoring natural resources like forests, water bodies, minerals and wildlife.

6. **Emergency Response and Disaster Management:** Geospatial data aids in assessing the impact of disasters, planning evacuation routes and coordinating relief efforts.

7. **Transportation and Logistics:** Geospatial data is vital for route planning, location-based services and optimising transportation and logistics operations.

8. **Utilities and Infrastructure:** Geospatial data assists in managing utility networks such as electricity, water and telecommunications, and in planning infrastructure development projects.

9. **Decision Support System:** Geospatial data allows simulation of future outcome of today's decision, using '*what if scenarios*'. Based on observed outcomes of different scenarios, decision makers chose the most favourable.

Learning Task

With mobile or computer or any other form of digital data collection system or App, collect and present geospatial data within the school compound.

Pedagogical Exemplars

Talk for learning:

Brainstorm on the meaning of geospatial data, and the geospatial data that learners can acquire in the school compound or field.

1. Provide examples of geospatial data, such as maps, satellite images, or GPS coordinates, to help learners understand its practical applications.

2. Use a variety of brainstorming techniques suitable for different abilities, such as group discussions, mind mapping, or individual written responses.

3. Frame open-ended questions to stimulate thinking about the types of geospatial data that can be acquired in the school compound or field. Ask Approaching Proficiency learners to imagine how maps or aerial photographs of the school grounds would be. Proficient and Highly Proficient learners can be challenged to think beyond the immediate surroundings and consider more diverse forms of geospatial data. Proficient learners can be challenged to think beyond the immediate surroundings and consider more diverse forms of geospatial data. Encourage them to explore the use of GPS devices and digital mapping tools to collect location-based data within the school compound or on field trips.

4. Encourage learners to share their ideas and findings with their peers through group discussions or presentations.

5. Foster a supportive and inclusive learning environment where learners at different levels of proficiency can contribute and learn from one another.

6. Provide opportunities for learners to reflect on the brainstorming session and summarise the key geospatial data ideas generated.

7. Encourage learners to explore practical applications of the geospatial data they brainstormed, such as creating a mental map of the school compound or designing a field data collection project.

Learners should consider the emotions of individuals who struggle to express themselves.

Use pyramid discussion to initiate discussion on

   (i) the modern geospatial data collection methods/tools

   (ii) how they are used

   (iii) what data these methods/tools can collect.

1. Introduce the concept of geospatial data and its relevance in various fields, such as geography, environmental science, or urban planning. Provide an overview of modern geospatial data collection methods/tools.

2. Explain the pyramid discussion format where learners engage in a structured discussion starting with individual responses and gradually building up to group discussions.

3. Provide clear guidelines and expectations for each stage of the pyramid discussion, including time limits and discussion prompts.

4. Scaffold the discussion by gradually increasing the complexity of the prompts to cater to different intellectual abilities.

5. Offer differentiated prompts or questions based on learners' abilities. For Approaching Proficiency learners, provide more straightforward questions that focus on basic understanding and examples. Proficient and Highly Proficient learners can be challenged with more complex questions that require analysis of the advantages, limitations, and real-world applications of different geospatial data collection methods/tools.

6. Foster a supportive and inclusive learning environment where learners at different levels of proficiency can contribute and learn from one another.

7. Allow time for learners to reflect on the discussions and summarise the key points raised during each stage of the pyramid discussion.
8. Provide closure to the discussion by facilitating a whole-class reflection, where learners can share their insights and takeaways.

Ensure that reserved learners contribute during the brainstorming and discussion.

Activity-based learning:
Group learners to use mobile and computer Apps to collect geospatial data on the field and discuss their findings in class.

1. Familiarise learners with mobile and computer apps that allow geospatial data collection, such as GPS apps, mapping tools or geospatial data applications (such as Apps include ArcGIS, Google Earth, MapIt GIS)

2. Create diverse groups that include learners with different abilities. Consider grouping learners with varied strengths and expertise to promote collaboration and peer learning.

3. Ensure that each group has a mix of learners who are comfortable using mobile and computer apps and those who may require additional support.

4. Provide hands-on training sessions to familiarise learners with the selected mobile and computer apps. Offer differentiated training materials, such as video tutorials or step-by-step guides, to cater to different abilities.

Talk for learning:
Learners watch videos on how satellites (e.g. Landsat) revolve around the earth and collect repetitive spatial data around the world and discuss that in class.

1. Choose a video with clear narration, visuals, and appropriate pacing for the learners' abilities. Consider using closed captions or transcripts for struggling readers.

2. Pause the video at key points to allow learners to process information and ask questions. Briefly summarise the main ideas after each section.

3. Incorporate diagrams, animations, or simulations alongside the video to visually represent satellite movement and data collection.

4. Facilitate a class discussion using clear and concise questions to encourage participation.

5. Discuss real-world applications of satellite data collection, such as monitoring deforestation, tracking weather patterns, or managing agricultural resources. This can motivate learners and help them see the value of the lesson.

Key Assessment

Level 1: Outline two examples of geospatial data.

Level 2: Choose from lettered A-D the correct option.

Geospatial data can include information about:

    I. coordinates that represent the precise location of a point
    II. attributes or properties associated with geographic features.
    III. emotions, preferences, or opinions about a geographic location or feature.
    IV. the spatial relationships between different geographic features.

A. I , II and III only

B. I, II and IV only

C. II III and IV only

D. I, III, and IV only

Level 3: Compare and contrast field survey methods and remote sensing as tools for collecting geospatial data.

Level 4: As a professional driver entrusted with the safe delivery of products to an unfamiliar location, explain how geospatial data can assist you in successfully reaching the destination and completing the delivery.

Week 18

Learning Indicator: *Assess the geospatial data collection tools.*

Theme or Focal Area: The Advantages and Disadvantages of Geospatial Data Collection Methods/Tools

Traditional geospatial data collection involves the use of various tools and techniques that have been employed for many years. While modern technologies like GPS (Global Positioning System) and remote sensing imagery have become prevalent.

Advantages of modern geospatial data collection tools

1. Modern geospatial data collection tools such as GPS, remote sensing, mobile Apps and others offer high accuracy in data collection. This level of accuracy allows for more precise mapping and analysis, which is critical in many fields such as urban planning, disaster response, agriculture and environmental management.

2. Modern geospatial data collection tools are highly efficient and allow for faster data collection and processing. This allows for real-time monitoring and decision-making, which is crucial in many applications such as emergency response and disaster management.

3. Modern geospatial data collection tools can cover large areas quickly and accurately. This is particularly important in applications such as forestry management, geological surveys, and land use planning.

4. Modern geospatial data collection tools allow for easy integration of data from multiple sources and formats. This integration can provide a more comprehensive understanding of a particular location or phenomenon, which is essential in many fields such as environmental management, urban planning and transportation.

5. Modern geospatial data collection tools have become more affordable over time, making them accessible to a wider range of users. This has enabled many organisations, including small businesses and non-profit organisations, to access and utilise geospatial data for their applications and decision-making processes.

6. It has the ability (especially with remote sensing) to detect features at electromagnetic wavelengths (beyond the visible range), which are not visible to the human eye.

7. Changes in land use and condition can be routinely or regularly monitored. For example, as a satellite regularly passes over the same plot of land capturing new data each time (repetitive coverage), changes in the land use and condition can be routinely or regularly monitored. Thus, RS provides consistent repeat coverage at frequent intervals, making the detection and monitoring of change feasible. Landsat, for example, has a 16-day repeat cycle.

8. Provides landscape or land cover data over inaccessible areas.

9. Able to obtain images of any area over a continuous period.

10. Rapid production and update of maps for interpretation are made possible.

Disadvantages of modern geospatial data collection tools

1. Buying some new geospatial data collecting tools like LiDAR, drones and satellites can be costly, which can make it hard for smaller companies or individuals to get their hands on them.

2. Some people do not have the technical know-how or the training to use modern geospatial tools, which can make it hard for them to get the most out of them.

3. Battery life of geospatial data collecting tools can be short, especially when they are used in remote locations where they cannot be easily recharged.

4. Modern tools that collect geospatial data usually need to be connected to the internet for synchronising or sending data to the cloud, which can be a problem if you are in an area with weak or no internet.

5. Geospatial data with high resolution can be large and require substantial amounts of data storage and effective management solutions.

> **Learning Task**
>
> Justify some five advantages of modern geospatial data collection tools.

Pedagogical Exemplars

Collaborative learning:

Discuss the advantages and disadvantages of the geospatial data collection methods/tools

1. Create diverse groups that include learners with different abilities. Consider grouping learners with varied strengths and expertise to promote collaboration and peer learning.

2. Ensure that each group has a mix of learners who can contribute their perspectives and insights regarding the advantages and disadvantages of geospatial data collection methods/tools.

3. Offer differentiated prompts or questions based on learners' abilities. For approaching proficiency learners, provide more straightforward questions that focus on identifying basic advantages and disadvantages of geospatial data collection methods/tools. For example, ask them to consider the speed and accuracy of GPS devices compared to traditional mapping methods. Proficient learners can be challenged with more complex questions that require deeper analysis and evaluation of the advantages and disadvantages of the geospatial methods/tools. Encourage them to think about the data acquisition and coverage, cost-effectiveness, accuracy and precision, scalability and efficiency, training and expertise or accessibility of different geospatial data collection methods/tools.

4. Monitor the discussions to ensure that learners stay on track, address misconceptions, and encourage deeper analysis of the advantages and disadvantages.

5. Offer support and scaffold the discussions as needed, providing additional explanations, examples, or resources to help learners understand and evaluate the advantages and disadvantages.

Ensure that reserved learners contribute during discussion. The emotions of approaching proficiency learners should not be overridden when they don't contribute to discussion as expected.

Key Assessment

Level 1: State three advantages of using GPS technology for geospatial data collection.

Level 1: List two limitations of using paper maps and compasses for geospatial data collection.

Level 2: With examples or illustrations, explain two limitations of remote sensing in gathering geospatial data.

Level 3: Justify three reasons a geospatial scientist will rather choose satellite imagery as a data collecting tool than chain surveying.

Section Review

Weeks 17 and 18 highlighted two key focal areas - methods of collecting geospatial data and the advantages and disadvantages of geospatial data collection methods. Geospatial data collection method delved into various techniques, including remote sensing, GPS, aerial photography, and surveying. These methods enable the collection of spatial and geographic information, such as land use, topography, and natural resources. Additionally, the strengths and limitations of each method in terms of data collection were examined. Understanding these methods, their advantages and disadvantages is vital for making informed decisions about selecting the most suitable approach for specific geospatial data collection needs.

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SECTION 10: THE CLIMATE, VEGETATION AND SOILS IN GHANA

Strand: **Human and Environment**

Sub-Strand: Physical Settings and People

Learning Outcome: *Examine the physical environment of Ghana (relief, drainage, climate, vegetation and soils) and their socio-economic importance*

Content Standard: Demonstrate understanding of the physical environment of Ghana and its socio-economic importance and challenges

INTRODUCTION AND SECTION SUMMARY

The section on climate, vegetation and soils of Ghana shows the distribution, the characteristics and the factors that shape Ghana's climate, vegetation and soil patterns. The climate of Ghana is influenced by factors such as latitude, altitude, prevailing winds and the presence of the Atlantic Ocean. The country experiences a tropical climate with distinct wet and dry seasons. Understanding Ghana's climate is crucial for the agriculture sector, water resource management, and the tourism sub-sector. Ghana's vegetation ranges from rainforests and savannah to coastal mangroves and grasslands. The country's soils exhibit variations, with different types found across the regions, impacting agricultural practices and land use. The study of Ghana's climate, vegetation and soils will help learners gain insights into the country's environmental dynamics, enabling effective planning, resource management, and sustainable development. This section is linked to Agricultural Science in the Senior High Schools and Social Studies in the Junior High Schools.

The week(s) covered by the section is/are:

> *Week 19*: *Climate of Ghana*
>
> *Week 20*: *Vegetation and Soils of Ghana*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars such as collaborative learning and Activity-based learning play crucial roles in enhancing the learning experience of learners. Collaborative learning fosters inclusivity and active engagement by organising learners into small groups based on their vegetation zones. This allows learners to share insights, collaborate and develop a deeper understanding of the subject matter. Activity-based learning through drawing the climate, vegetation and soil map of Ghana encourages hands-on exploration and critical thinking, enabling learners to apply their knowledge in a practical context while engaging in discussions. This approach promotes creativity, problem-solving, and the development of key technological literacy skills.

ASSESSMENT SUMMARY

Assessment strategies such as group projects, class exercises, and individual assignments offer diverse opportunities for both formative and summative assessments. Group projects enable learners to collaborate, apply knowledge, and engage in critical thinking. They work collectively to tackle complex problems, analyse information, and present their findings, showcasing their comprehension of concepts. Class exercises, such as quizzes or short assessments, evaluate learners' understanding, ability to recall information, and application of knowledge. Individual assignments foster independent

thinking and allow learners to demonstrate their understanding and mastery of specific topics or skills. Furthermore, fieldwork assessments enable learners to apply their knowledge in real-world contexts, analyse data, and make relevant observations. These assessment strategies enable teachers to holistically assess learners' skills, knowledge, and abilities, ensuring a comprehensive evaluation of their learning progress.

Week 19

Learning Indicator(s): *Discuss the climate, vegetation and soil types in Ghana and their importance and challenges to socio-economic development.*

Theme or Focal Area: Climate of Ghana

Climatic regions of Ghana

Climate is the average weather conditions of a given place over a long period of time, usually not less than 30 years**.**

Major climatic elements in Ghana include temperature, rainfall, relative humidity, air masses, atmospheric pressure and sunshine.

1. **Temperature**
   a) Temperature is the degree of hotness or coldness of a place. It is measured with a thermometer and its unit of measurement is **degree Celsius/Centigrade** or **degree Fahrenheit**.
   b) Lines drawn on maps to join places of equal amount of temperature are isotherms.
   c) Factors that affect temperature distribution in Ghana include latitude, altitude, ocean currents, distance from the sea, prevailing winds, vegetation, cloud cover and others.
   d) Temperatures in Ghana vary throughout the year depending on the location.
   e) The average monthly temperature in Ghana is between 26°C and 30°C since the country is in the tropics.
   f) Hottest months in Ghana are March, April and May.
   g) The coldest months in Ghana are usually between December and January.

2. **Rainfall**
   a) It is the amount of precipitation in the form of water droplets that falls from the atmosphere to the earth's surface.
   b) It is measured using a **rain gauge** and its unit of measurement is **millimetres**. Lines on maps joining places that receive equal amounts of rainfall are called **isohyets**.
   c) Factors influencing rainfall distribution in Ghana are latitude, topography, ocean current, prevailing air masses, vegetation cover and others.
   d) The distribution of rainfall is not uniform across the country.
   e) In the north of Ghana, there is a one rainfall period (single maxima) between May and August, while in the south, there are two rainfall periods (double maxima) between March and July and between September and November.
   f) The area with the highest amount of rainfall is the south-western part of Ghana (around Axim which receives more than 2,000 mm of rainfall per year).
   g) Kumasi receives more than 1,500 mm per year, Tamale around 1,100 mm, and Bawku on the northeast corner around 1,000mm. High rainfall amounts are more common in mountain areas than in the surrounding lowlands, and this is due to the relief effect.
   h) For instance, Abetifi gets around 1700mm of rainfall per year.
   i) The driest region of Ghana is the south-eastern coastal plains east of Accra, where the dry season is between December and January.
   j) The region receives less than 750 mm of rainfall annually.

   The dryness of the area is because it is in a rain shadow area, the flat nature of the land, the cold current and others.

3. **Humidity**
   a) Humidity is the concentration of water vapour present in the air.
   b) The amount of moisture in a given volume of air is Absolute humidity.
   c) Relative humidity is the amount of moisture or water vapour in the air compared to the maximum amount of moisture the air can hold at a specific temperature.
   d) It is expressed in percentages and measured with an instrument called a hygrometer.
   e) Air absorbs water in the atmosphere through evaporation and transpiration.
   f) The humidity levels in Ghana are typically high during the wet season, because of the south-western monsoon winds.
   g) During the rainy season, the humidity levels may reach up to 80-90% and as low as 30% in the northern parts in the dry season.

4. **Air masses in Ghana**

   An air mass is a large body of air in the atmosphere that has nearly uniform properties of temperature and humidity.

   Air masses cover many hundreds or thousands of square miles and adapt to the characteristics of the surface below them. They are classified according to their latitude and origin (continental or maritime).

   The climate of Ghana is influenced by;
   a) The Tropical Continental (cT) Air Mass.
   b) The Tropical Maritime (mT) Air Mass.
   c) Equatorial Easterly Air Mass

Tropical Continental (cT) Air Mass

1. It is locally referred to as the North-East Trade Winds or Harmattan. It is a type of cold dry wind originating in the Sahara Desert, with extremely high daytime temperatures and low nighttime temperatures.

2. When blowing, the wind carries dust particles into the atmosphere, resulting in a hazy atmosphere and reduced visibility.

Tropical Maritime (Mt) Air Mass

1. It is locally called Southwest Monsoon Winds.

2. It originates from the South Atlantic Ocean.

3. It is a warm moist wind which brings rainfall to the entire country during the months of June and July.

Equatorial Easterly Air Mass

It originates from the soft tropical high-pressure systems located near the equator. This air mass brings about moisture and warmth, contributing to the rainy season in southern Ghana, particularly from April to June and September to October.

The Movement of the Inter-Tropical Convergence Zone (ITCZ)

1. The ITCZ, or Inter-Tropical Front (ITF) or Inter-Tropical Boundary (ITB) or Inter-Tropical Discontinuity (ITD), is a band of thunderstorms and heavy rain that encircles the Earth near the equator. In Ghana, it is caused by the convergence of Southwest Monsoon Winds and the Northeast Trade Winds.

2. The ITCZ migrates north and south seasonally because the rotation of the Earth around the sun on its inclined axis leads to variations in heating at the surface: Solar heating drives this seasonal migration.

3. In Ghana, the ITCZ reaches its northernmost position in **July**, when it is located around 15°N latitude. The north pole and therefore Ghana is closest to the sun at this point in the year.

4. This is the **wet season** in Ghana, when the country receives the majority of its annual rainfall. The ITCZ then moves south in October, reaching its southernmost position in **January**, around 5°S latitude.

5. This is the **dry season** in Ghana, when the country receives very little rainfall. The wet season is characterised by high temperatures and high humidity, while the dry season is hot and dry.

6. The movement of the ITCZ is also affected by other factors, such as the Earth's rotation and the presence of mountains.

7. For example, the Earth's rotation causes the ITCZ to be displaced to the west of the equator.

8. This is why the wet season in Ghana starts a few weeks later in the western part of the country than in the eastern part.

9. Mountains can also affect the movement of the ITCZ, by blocking the flow of air and causing it to rise.

10. This can lead to the formation of thunderstorms and heavy rain.
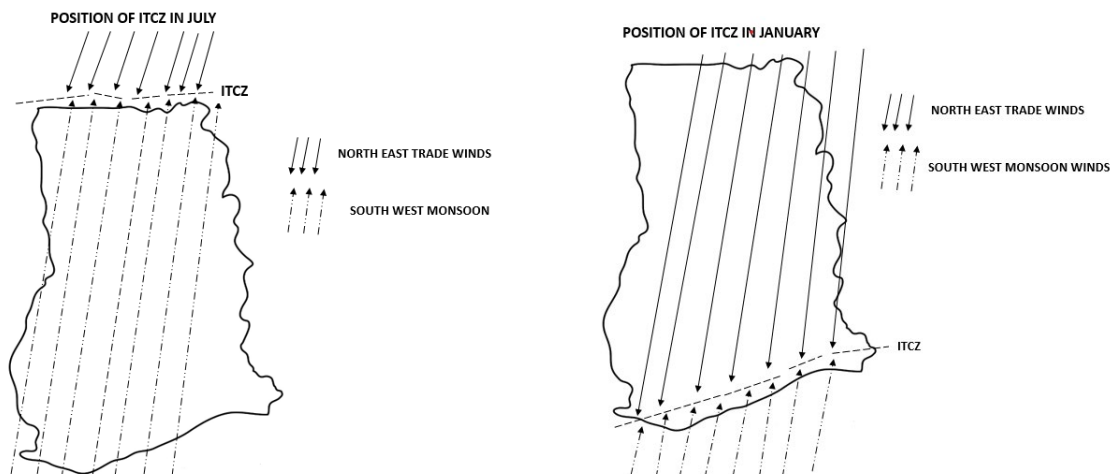
Fig. 19.1: *Position of the ITCZ in July and January*

Factors affecting Climate of Ghana

1. Latitudinal position

2. Prevailing winds

3. Air masses

4. Topography/Altitude/Nature of relief

5. Ocean currents

6. Continentality/Distance from the sea

7. Changing position of the ITCZ

Climatic Regions of Ghana

A climatic region is a continuous geographic area in which similar climatic characteristics are observed. These characteristics include temperature, precipitation, humidity, and wind patterns. Climatic regions are typically defined by their dominant climate type.

There are four climatic regions in Ghana. These are;
1. South-western Equatorial
2. Wet semi-Equatorial
3. Tropical Continental or savannah
4. Dry Equatorial

I-South-Western Equatorial Climate
II-Wet Semi-Equatorial Climate
III-Dry Equatorial Climate
IV-Tropical Continental Climate

Fig. 19.2: *Climate map of Ghana*

1. **South-western Equatorial Climate**
   Location: This region covers the south-western part of Ghana.

   Climatic Characteristics of South-Western Equatorial Climate
   a) **Rainfall**
      i. The rain falls throughout the year.
      ii. The rainfall is double maxima or regime type (major season - May to July and
      iii. minor season is in September to October).
      iv. The mean annual rainfall is about 2000mm.
      v. Rainfall is accompanied by thunderstorms and lightning.
      vi. Rainfall type is convectional.
      vii. This is the wettest climatic region in Ghana.
      viii. A typical station is Axim.

   b) **Temperature**
      i. The temperatures are high throughout the year (about 27°C).
      ii. The daily or diurnal range of temperature is ranging between 6°C to 8°C.
      iii. The annual range of temperature is very small, about 2°C to 4°C.

   c) **Relative Humidity:** It is very high between 80% - 90%.

Effects of Ocean Current on South - Western Equatorial Climate

a) This climate is influenced by a warm ocean current called the Warm Guinea Current.

b) This ocean current increases the temperature of the adjacent shorelines.

c) It increases rainfall in the coastal regions of Ghana.

d) It reduces the annual range of temperature (i.e., 2° C to 3⁰C).

2. **Wet semi-Equatorial**

Location: It is found mainly in the middle belt. A typical station is Kumasi.

Climatic Characteristics of Wet Semi-Equatorial Climate

a) **Rainfall**

    i. The region records annual rainfall between 1250mm and 1700mm.

    ii. The rainfall pattern is double maxima.

    iii. The rainfall types are relief (orographic), cyclonic and convectional. Highland areas like Kwahu-Mampong Scarp and Akwapim-Togo Ranges in the area experience relief rainfall.

b) **Temperature**

    i. It is characterised by high temperatures throughout the year.

    ii. The mean temperatures range from 30°C to 31°C between March and April and about 26°C in August.

    iii. It has a low annual range of temperature below 6°C.

c) **Relative Humidity**: The relative humidity is high between 75% and 80%.

3. **Tropical Continental or Savannah Climate**

Location: This climatic region is found in the Northern belt of Ghana. A typical station in this climatic region is Tamale.

Climatic Characteristics of Tropical Continental or Savannah Climate

a) **Rainfall**

    i) The region records low annual rainfall of about 1000mm to 1500mm.

    ii) The annual rainfall decreases with increasing latitudes.

    iii) The rainfall pattern is single maxima (May to October).

    iv) It has a long dry season which often follows the short rainy season.

    v) The dry season happens from November to April.

    vi) The rainfall types are cyclonic and convectional.

b) **Temperature**

    a) The mean monthly temperatures vary from 36° C in March to 27° C in August during the rainy season.

    b) It has a high annual range of temperature between 9°C to 11°C.

c) **Relative Humidity:** The relative humidity is between 70% and 95% during the wet season and around 20% in the dry season.

4. **Dry Equatorial**

Location: It is found in the south eastern coastal part of Ghana. It stretches from Cape Three Points to the south eastern corner of Ghana. A typical station is Accra.

Climatic Characteristics of Dry Equatorial Climate

a) **Rainfall**

    i) The region records low annual rainfall with an average of 740 mm to 890 mm.

    ii) The rainfall pattern is double maxima yet the area is marked by dry season.

    iii) The rainfall types are cyclonic and convectional.

The reasons the Dry Equatorial Climatic region records low rainfall

1. **Rain Shadow Effect:** The Southeastern region of Ghana is located in the rain shadow of the Akwapim-Togo Ranges, which are a series of mountains running parallel to the coast.

2. **Uneven Topography:** The Southeastern region's topography is characterised by a combination of rolling hills and valleys, resulting in an uneven topography. This uneven topography usually impedes the circulation of moisture-rich air masses, resulting in localised rain clouds and an uneven rainfall distribution.

3. **Coastal parallelism:** The Southwest Monsoon Winds blow almost parallel to the coast, east of Cape Three Points and therefore do not bring rain to the land.

4. **Presence of cold current:** The body of cold water off-the shore of Cape Three Points is very stable and chilled by the rain bearing winds. This does not influence the formation of rain.

5. **Absence of thick vegetation cover:** The area is not having thick tall forest vegetation cover to help induce the moist wind from the sea in order to bring rain.

Learning Tasks

1. Draw an outline map of Ghana to show climatic zones

2. Discuss the characteristics of the climatic zones

3. Compare and contrast Tropical Continental Air Mass and Tropical Maritime Air Mass

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Pedagogical Exemplars

Collaborative learning

In small all-inclusive groupings, *with emphasis on learners from different climatic zones*, use maps to

  i. Identify the climatic zones

  ii. Describe the factors that affect the climate of Ghana.

Learners should create an environment in which others believe that their thoughts and opinions are valued.

1. Briefly introduce and define climatic zones

2. Form mixed-ability groups where stronger learners can support their peers. Consider assigning roles within each group based on strengths (reading, summarising, map interpretation).

3. Prepare climate maps templates with the demarcations of the zone.

4. Provide each group with a set of guiding questions to focus their map analysis. For instance, Proficiency and Highly Proficient learners in the groups could describe the major factors affecting vegetation and soils and identify the main vegetation zones on the map and soil types in each map whilst Approaching Proficiency learners use different colours or shades to identify vegetation zones on the map. Prompt the group to prepare a key/legend and indicate a title for the map

5. Let each group present their findings to the class, using their maps and notes.

Activity-based learning

In mixed groups of different climatic regions:

  i. Draw the climate map of Ghana

ii. Discuss the characteristics of the climatic zones and compare and contrast Tropical Continental Air Mass and Tropical Maritime Air Mass

1. Provide learners with maps depicting climatic zones found in Ghana. Learners should use an Atlas to help them in this activity

2. Offer brief descriptions of the characteristics of each climatic zone, with varying complexity levels to cater to different reading abilities.

3. With various drawing tools, guide learners within their groups to draw a climate map of Ghana. Prompt them to provide features such as scale, title, authorship, key/legend and compass direction.

4. Have groups display their drawings and move around the classroom to observe and discuss each group's work.

5. Offer constructive feedback on their maps to fill the gaps in knowledge.

Key Assessment

Level 1: Name one climatic zone found in the southern part of Ghana and give two rainfall characteristics

Level 2: Explain three reasons why the dry equatorial climate region of Ghana records low rainfall.

Level 3: Draw an outline map of Ghana to show the climatic regions and explains their key characteristics

Level 4 Evaluate the impact of the annual movements of the Inter-Tropical Convergence Zone on the climate of Ghana with the help of diagrams.

Week 20

Learning Indicator(s): *Discuss the climate, vegetation and soil types in Ghana and their importance and challenges to socio-economic development*

Theme or Focal Area: **Vegetation and Soils of Ghana**

Vegetation is a group or association of plants that grow and thrive in a specific area or region.

Factors that Influence Vegetation Distribution in Ghana

1. Climate
2. Topography
3. Soil
4. Presence of Water Bodies
5. Human Activities
6. Time

Vegetation zones in Ghana

1. Tropical rainforest
2. Moist semi-deciduous forest
3. Coastal scrub and grassland
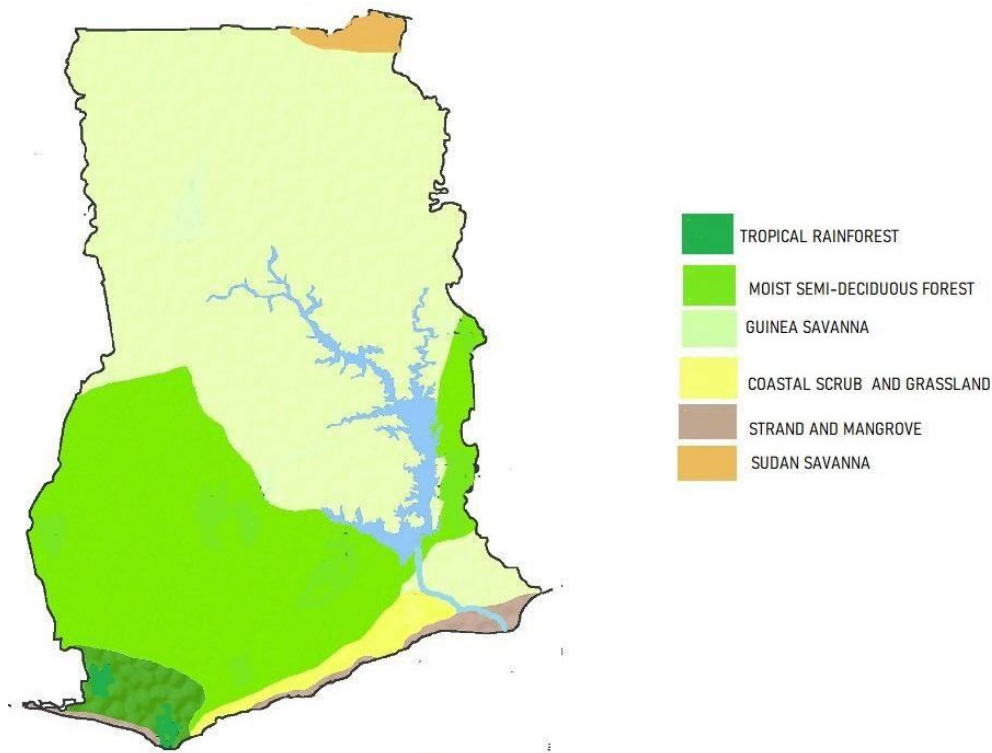4. Strand and mangrove
5. Guinea savannah
6. Sudan savannah

Fig. 19.3: *Vegetation zones of Ghana*

1. **Tropical Rainforest**

   Location/Areas: It is located in the south-western climatic region of Ghana. The most important towns in this vegetation are Tarkwa, Nsuta, Prestea, and Samreboi in the Western Region.

   Characteristics of Tropical Rainforest
   1. The trees are tall with buttress roots.
   2. The trees are evergreen with broad leaves.
   3. It has the presence of climbers, creepers, epiphytes, and parasitic plants.
   4. The tree species in the forest include Odum, mahogany, sapele, ebony, and wawa.
   5. The trees form three main layers, storeys, tiers or strata. These are upper or emergent (32m-60m), the middle (15m-30m) and the lower layers (up to 15m or 17m).
   6. The tree branches form canopies with little or no undergrowth.

2. **Moist Semi-Deciduous Forest**

   Location: This forest belt is found in the wet semi-equatorial climate. It covers regions or areas like Ashanti, Eastern, and parts of Brong Ahafo, Central, Volta and Western Region. The most important towns in this vegetation include; Kumasi, Koforidua, Akim Oda, Sunyani, Jasikan, and Kadjebi. It is the second largest vegetation zone in Ghana.

   Characteristic of Moist Semi - Deciduous Forest
   1. The tall trees have buttress roots which support them against strong winds.
   2. The trees are mostly deciduous, that is, they shed their leaves during the dry season.
   3. The trees are not in pure stands i.e., the tree species are mixed up.
   4. Plants species are not in pure stands. That is, tree species are scattered.
   5. The trees are in three layers namely; upper, middle and lower.
   6. The forest is made up of tree species like Odum, mahogany, wawa, sapele, and Makore.
   7. It has the presence of climbers, creepers, lianas and other parasitic plants.
   8. The forest has dense undergrowth because the plants on the ground easily receive much sunshine.

Climatic Conditions which Favour the Growth of Forest Vegetation

1. **High temperature**: The temperature is very high throughout the year of about 21°C -27°C. The temperature range is small thus, 3°C. It is warm throughout the year.

2. **High daily insolation**: The daily percentage of sunshine is quite high. The midday sun is high in the sky throughout the year.

3. **High annual rainfall**: The total annual precipitation is high throughout the year about 1500mm - 2000 mm and well distributed. It rains in the afternoon and is mostly convectional.

4. **High relative humidity**: The relative humidity is high throughout the year ranging between 70% -80%. There is light or stagnant wind.

Adaptation of Tropical Rainforest/Moist Semi-Deciduous Forest to the Climate

1. Most of the trees have buttress roots to support them against strong winds.

2. Trees have shallow roots that spread out for the abundant water supply in the soils.

3. The branches interlock or intertwine to give continuous canopy and this prevents sunlight from reaching the ground.

4. Most trees are straight and tall as they compete for sunlight.

5. The leaves are evergreen and there is growth throughout the year due to continuous rainfall and high temperature throughout the year.

6. Fruiting and flowering also occur throughout the year.

7. The leaves are broad and left open with many stomata to enhance evapo-transpiration.

Benefits of Forest Vegetation to Economic Development of Ghana/Economic Importance of Forest Vegetation

1. Provision of food

2. Provision of fuel wood

3. Provides herbs for medicine

4. Foreign exchange / Timber for export

5. Provision of jobs

6. Provides wood for construction

7. Provides habitats for wildlife

8. Provides raw materials for arts and crafts

9. Tourist attraction

10. Provides raw materials for industries

Economic/Human Activities in the Forest Vegetation

1. Lumbering activities

2. Mining activities

3. Hunting

4. Agricultural activities

5. Manufacturing activities

6. Food gathering

7. Tourism

Human Activities Causing Depletion of the Forest Vegetation

1. Poor System of Farming

2. Lumbering Activities

3. Settlement Purposes

4. Bush Burning

5. Mining Activities

6. Construction of transportation networks

3. **Coastal Scrub and Grassland**

   Location: This vegetation is found in south-eastern coastal plains of Ghana i.e., on top of Strand and Mangrove Forest. The most important towns of this vegetation are Nsawam and Agona Swedru.

   Characteristic of Coastal Scrub and Grassland
   1. This vegetation is made up of scrubs and grasses.
   2. The scrubs grow in groups and the grasses grow in between them.
   3. The plants appear green during the rainy season and brown in most parts of the year.
   4. The common plants in this vegetation are neem tree, raffia palm, coconut, and wild oil palm.

4. **Strand and Mangroves Vegetation**

Location: This vegetation is found along the south-east and south-west coastal margins of Ghana. The important towns of this vegetation are Axim, Keta and Ada.

Characteristic of the Strand and Mangrove Forest

1. The vegetation is made up of red and white tall mangrove trees.
2. The trees are very close to each other, and they are evergreen throughout the year.
3. The trees have thick barks which help them to withstand the corrosion of the salty water.
4. The trees have aerial roots and long tap roots.
5. The important trees in this forest include; mangrove, coconut and raffia palm.

5. **Guinea Savannah**

Location: It is found in the Northern belt of Ghana. The important towns are Tamale and Wa. This vegetation marks the transitional zone as one moves from the moist semi-deciduous forest to the north.

Characteristics of Guinea savannah

1. This vegetation is made up of tall grasses like elephant grass and wiregrass.
2. The grasses grow in tussocks (longer and thick) and can reach a height of 3 meters or more.
3. The grasses look green in the rainy season, turn brown in the dry season and may even wither.
4. There are few short trees which are widely scattered in the grasses.
5. The trees are deciduous in nature, that is, they shed their leaves during the dry season.
6. The trees have long tap roots, big trunks and thick barks.
7. The common trees include acacia, silk cotton, shea tree, locust bean, baobab, and dawadawa.
8. Gallery or fringing forests are found along the course of rivers like Kulpawn, Sisili, Mole, Oti, and Black Volta.

6. **Sudan Savannah**

Location: It is found in the extreme north-eastern corner of Ghana. The most important town of this vegetation zone is Bawku.

Characteristics of Sudan savannah

1. This vegetation is made up of short grasses.
2. There are few short trees which are widely scattered in the grasses.
3. The trees have thick barks and are drought resistant.
4. The trees are deciduous in nature, that is, they shed their leaves during the dry season.
5. The vegetation looks green during the rainy season but turns brown in the long dry season.
6. The common trees in this savannah are silk cotton, acacia, dawadawa, shea tree, and baobab.
7. The gallery or fringes of the forest is along river basins of White and Red Volta.

Adaptation of savannah Vegetation to the Climate

1. Trees like the baobab store water in their trunks against the dry season.
2. Some trees lose their leaves to prevent loss of water from their trunk and roots.
3. Most trees have long roots to reach layers of moist soil several metres below the surface.
4. Some trees like acacia conserve soil moisture by developing an umbrella shaped crown which provides shade around the trunk and roots.
5. The roots of the grasses remain dormant during the dry season and germinate again in the rainy season.

Learning Tasks

1. Draw an outline map of Ghana to show vegetation zones

2. Discuss the characteristics of the vegetation zones

3. Compare and contrast the forest and savannah vegetations in Ghana.

Soils In Ghana

A soil is defined as the weathered top layer of the earth's crust on which plants grow and from where they derive their nutrients.

Factors influencing Soil Formation

1. The type of the parent material

2. The climate of the area

3. Vegetation cover

4. Living organisms

5. Relief or Topography

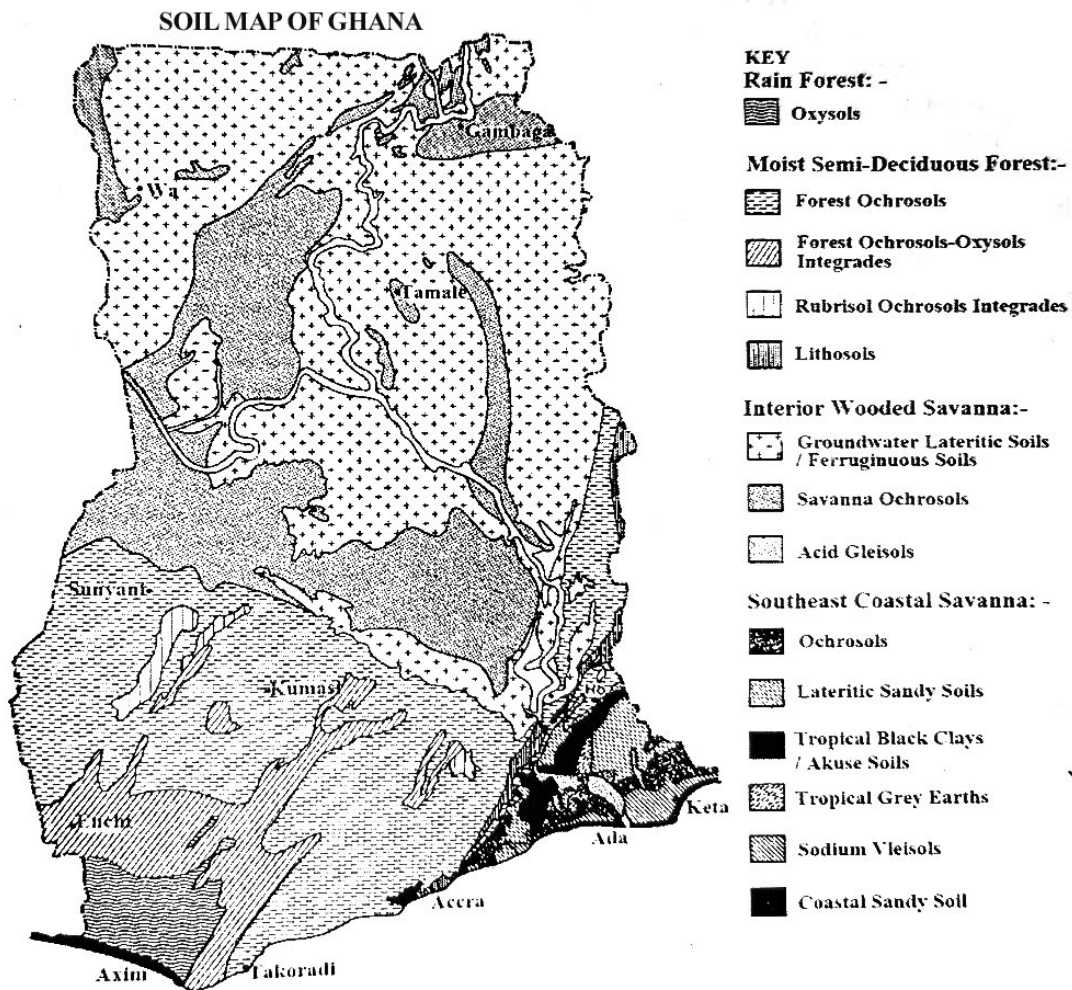6. The length of time the soil has been formed

Fig. 19.4: *Soil in Ghana*

Soils in the Forest Regions (Rainforest and Moist Semi-Deciduous Forest)

The common soils found in the forest regions of Ghana are:

1. **Forest oxysols**: This soil develops from the weathered granite rock like Tarkwaian and Birrimian. It is acidic in nature due to the heavy rainfall in the forest belt which reduces their nutrient content. It is brownish-orange in colour, porous and well drained and loamy in texture. The soil is found in towns like Tarkwa and Elubo. It supports tree crops such as oil palm and rubber.

2. **Forest ochrosols:** This soil also develops from the weathered granite rocks like Tarkwaian and Birrimian. It is alkaline in nature. This is because it does not leach like that of soil oxysols. The soil nutrient content is very high. This soil is found in Kumasi, Koforidua and Sunyani. It supports crops like coffee, cocoa, banana, kola nut and others.

3. **Forest oxysols - ochrosols intergrade:** This soil does not have a different appearance from the forest oxysols and ochrosols. However, it is not purely acidic or alkaline. It contains many nutrients as the forest ochrosols.

4. **Lithosols (stony soils):** This is an immature soil which covers some highland areas like Akwapim Togo Ranges. The soil is poor in nutrients due to the short time of its formation and distribution.

5. **Rubrisol - ochrosol integrades:** This soil has the same characteristics as dark red soil and the ochrosols. It is sometimes called Red Soil due to its colour.

Soils in the Interior Wooded Savannah

6. **Ground water lateritic soils/Ferruginous soil zone / savannah soils:** This soil covers the interior wooded savannah. The lateritic soils support crops like yam, groundnut and cereals.

   Characteristics of Lateritic/Ferruginous Soil Zone
   i) It develops from granite and shale.
   ii) It is not deeply weathered.
   iii) It has a few mediums of soil fertility.
   iv) The soil is reddish to brown colours and contains a lot of stones.
   v) It is generally sticky when wet.
   vi) It cracks into irregular blocks during the dry season.
   vii) It is impervious to water.

7. **Savannah ochrosols:** This soil develops from Birrimian rocks which consist of schist and metamorphosed lava. It is poor in organic matter content, but it is loamy, well-drained and porous.

8. **Acid gleisols:** This soil is very silty, clayey and often leached. It is usually acidic in nature and occurs with savannah ochrosols. They are easily saturated by water during the rainy season.

Soils in the South-East Coastal Savannah

9. **Coastal sandy and soils:** This soil is pale yellow in colour and poor in organic matter content. It supports crops like coconut. It can only support cassava, maize and shallot when manure is added to it. This soil is found in Keta (Volta Region) and supports crops like beans, millets, groundnuts and others.

10. **Akuse soils or Tropical black clay**: This soil develops from basic gneiss and alkaline in nature. It becomes heavy and sticky during the wet season but hard, compact and cracked in the dry season. This soil has a local accolade "Akuse black soil" because the colour of the soil ranges from dark brown to black.

11. **Tropical grey earth:** This soil is developed over an acid gneiss area lying east of the Akuse soil. It is purely acidic. It consists of little firm grey sand lying over the hard compact clay.

12. **Sodium vleisols:** This soil is associated with coastal lagoons, and it is alkaline in nature. It is very common near the mouth of Volta River at Ada.

Alluvial Soils

This soil is located around the lower Densu and course of Black Volta, especially in Bamboi, Yeji and Kete-Krachi.

Characteristics of Alluvial Soil Zone

1. This soil is associated with water deposits along rivers like Black Volta and Densu.

2. The soil colour varies from black to dark grey.

3. The soils are made up of mud, silt and other debris.

4. The soils are sticky and it supports waterlogging.

5. The soils are very sandy, porous and permeable.

6. Soils support growing of crops like swamp rice, raffia palm, and coconut.

Importance/Uses/Benefits of Soil

1. Provides medium for agriculture.

2. Provides sites for building and other constructional purposes

3. Source of constructional materials

4. Habitat for organisms

5. Storage of nutrients

6. Provision of employment

7. Income to workers

8. Revenues to government

9. Holds water and air

Pedagogical Exemplars

Collaborative learning:

In small all-inclusive groupings, with emphasis on learners from different vegetation zones, use maps to

(i) Identify the vegetation and soil types zones.

(ii) Describe the factors that affect vegetation and soil types of Ghana.

Learners should create an environment in which others believe that their thoughts and opinions are valued.

1. Briefly introduce terms like vegetation zones and soil types

2. Form mixed-ability groups where stronger learners can support their peers. Consider assigning roles within each group based on strengths (reading, summarising, map interpretation).

3. Prepare vegetation and soil maps templates with the demarcations for each group.

4. Provide each group with a set of guiding questions to focus their map analysis. For instance, Proficiency and Highly Proficient learners in the groups could *describe the major factors affecting vegetation and soils and identify the main vegetation zones on the map* and *soil types in each map* whilst Approaching Proficiency learners *use different colours or shades to identify*

vegetation zones on the map. Prompt the group to prepare a key/legend and indicate a title for the map

5. Let each group present their findings to the class, using their maps and notes.

Activity-based learning:

In mixed groups of different climatic regions.

a) Draw the vegetation and soil maps of Ghana.

b) Discuss the characteristics of the vegetation and soil types zones.
    1. Provide learners with maps depicting different vegetation zones and soil types found in Ghana. Learner should use Atlas to help them in this activity
    2. Offer short brief descriptions of the characteristics of each vegetation and soil type, with varying complexity levels to cater to different reading abilities.
    3. With various drawing tools, guide learners within their groups to draw vegetation and soil types map in Ghana. Prompt them to provide features such as scale, title, authorship, key/legend and compass direction.
    4. Have groups display their drawings and move around the classroom to observe and discuss each group's work.
    5. Offer constructive feedback on their maps to fill the gaps in knowledge.

Key Assessment

Level 1: Identify a tree species that is commonly found in the rainforest regions of Ghana.

Level 1: What are the key differences between Forest oxysols and forest ochrosols

Level 2: Use Venn Diagram to compare and contrast Forest vegetation and Savannah vegetation

Level 3: Draw an outline map of Ghana showing the vegetation zones and discuss with reasons the ways in which any of the vegetation zones is influenced by climate.

Level 4: Create a public service announcement (PSA) campaign to raise awareness about the importance of protecting vegetation in Ghana. *The PSA can be a poster, a short video, or a social media campaign (depending on available resources).*

Section Review

Weeks 19 and 20 focused on the climate, vegetation and soils of Ghana. The section explored the climate, vegetation and soils of Ghana. The four climatic regions and the factors influencing them were discussed. The section also listed Ghana's vegetation as ranging from rainforests and savannahs to coastal mangroves and grasslands. The country's soils exhibit variations, with different types found across the regions, impacting agricultural practices and land use. By studying the climate, vegetation, and soils of Ghana, learners gained insights into the country's environmental dynamics, enabling effective planning, resource management, and sustainable development.

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SECTION 11: **MINING IN GHANA**

Strand: **Human and Environment**

Sub-Strand: Economic Activities

Learning Outcome: *Examine the methods, importance and problems of agriculture, lumbering and mining in Ghana*

Content Standard: Demonstrate an understanding of the various primary economic activities in Ghana and beyond

INTRODUCTION AND SECTION SUMMARY

The section discussing mining in Ghana covers extraction methods, importance, and environmental effects. Mining is pivotal to Ghana's economy, driving employment, revenue, and mineral exports. It explores mineral deposit distribution, emphasising gold, bauxite, manganese, and oil, and their economic potential. Different mining methods like surface and underground mining are examined, alongside their environmental and social impacts. This focal area will enable learners to gain insights into the complexities of the mining industry, its economic significance, and the need for responsible mining practices to ensure long-term environmental and social sustainability.

The week(s) covered by the section is/are:
> *Week 21: Mining in Ghana*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars of utilising talk for learning, which involves viewing a video presentation or listening to a presenter, holds significant value in improving the learning journey for learners. This pedagogy offers a chance for learners to interact with both visual and auditory materials, aiding them in comprehending intricate concepts, analysing data, and deepening their understanding. Through watching videos or listening to presenters, learners can witness practical examples, demonstrations, and expert insights, enriching their learning experience. This pedagogical approach encourages active learning and critical thinking as learners actively engage with the content, pose questions, and take part in discussions.

ASSESSMENT SUMMARY

Assessment strategies such as discussions, question and answer sessions, and presentations offer valuable formative and summative assessment opportunities. Discussions as an assessment strategy provide a platform for learners to actively engage in dialogue, share their perspectives, and demonstrate their understanding of concepts through thoughtful contributions. Question and answer sessions assess learners' comprehension, critical thinking, and ability to articulate their knowledge verbally. These assessment strategies encourage active participation, promote critical thinking, and assess learners' abilities to analyse, synthesise, and communicate information effectively. Incorporating discussions, question and answer sessions, and presentations, teachers can gain insights into learners' understanding, provide timely feedback, and evaluate their overall grasp of the subject matter. These strategies facilitate a well-rounded assessment approach that supports learner development and enhances the learning experience.

Week 21

Learning Indicator(s): *Examine the methods, importance and problems of lumbering and mining in Ghana (Mining)*

Theme or Focal Area: Mining In Ghana

Meaning of Mining

Mining is a primary economic activity which involves the extraction and processing of valuable mineral resources for industrial, domestic and commercial purposes.

Principal minerals and where they are mined

Mineral	Location
Gold	Obuasi, Bogoso, Konongo, Dunkwa, Tarkwa, Prestea, Bibiani, Ahafo-Kenyase etc.
Crude oil	Half Assini, Cape Three Points.
Salt	Ada, Elmina, Winneba, Daboya.
Bauxite	Awaso, Kibi.
Diamond	Bonsaso, Birim valley, Akwatia, Oda, Kade.
Manganese	Nsuta, Himakrom.

Factors promoting mining Ghana

1. Favourable government policy
2. Availability of good transportation systems
3. Availability of mineral ore deposits
4. Availability of large and cheap labour
5. Access to capital

Methods of Mining in Ghana

1. **Deep Shaft Method or Underground mining**
   a) **Exploration:** This involves exploring the area to identify areas of ore deposit.
   b) **Construction of shaft:** This involves digging of vertical shafts to reach the mineral ore. The shaft is typically a cylindrical tunnel drilled deeper.
   c) **Construction of horizontal tunnels:** Horizontal tunnels drilled to link various vertical shafts. The overlying rock or roof of the tunnels are supported with concrete and steel beams to prevent it from collapsing**.**
   d) **Drilling and blasting:** The exposed ore is drilled and blasted into smaller fragments using power drills and explosives like dynamite.
   e) **Conveying of fragmented ore surface:** Locomotives are used to convey the ore to a cage or dump trust and subsequently to the surface.
   f) **Hauling and transport:** The fragment ore is loaded onto large trucks and hauled away from the pit to the processing plant for further treatment.
   g) **Processing/Extraction of mineral:** This is typically done by crushing and grinding the ore and then using a variety of chemicals such as cyanide, mercury, carbon-in-leach (CIL) and physical methods to separate the mineral from its ore.

h) **Rehabilitation of site:** After the mineral-bearing ore is exhausted the mined pits are refilled with waste material to restore the land to its natural contour with the aim of minimising environmental impact and promoting land reclamation.

2. **Open-Cast or Surface Mining method**
   a) **Exploration:** This involves exploring the area to identify areas of ore deposit. Exploring and identifying is easier since mineral ore is found close to the surface of the earth.
   b) **Clearing the area:** The area is cleared of any vegetation and other obstacles. This includes relocating wildlife if necessary and adhering to environmental regulations to minimise impact on the ecosystem.
   c) **Removal of top layer soil:** Heavy machinery such as excavators, bulldozers and dump trucks are used to remove the top soil and rock to expose mineral-bearing ore.
   d) **Drilling and Blasting**: The exposed ore is drilled and blasted into smaller fragments using power drills and explosives like dynamite.
   e) **Hauling and transport:** The fragment ore is loaded onto large trucks and hauled away from the pit to the processing plant for further treatment.
   f) **Processing/Extraction of mineral:** This is typically done by crushing and grinding the ore and then using a variety of chemical methods such as cyanide leaching and physical methods such as gravity concentration to separate the mineral from its ore.
   g) **Rehabilitation of site:** After the mineral-bearing ore is exhausted the mined pit is refilled with waste material to restore the land to its natural contour with the aim of minimising environmental impact and promoting land reclamation.

3. **Dredging Method**
   a) **Exploration:** This involves exploring the area to identify rivers or streams that have alluvial gold deposits. Identifying potential gold-rich areas along rivers or streams. After identifying the site, the necessary permits and approvals are obtained from authorities.
   b) **Dredge Setup:** Once the site has been secured, the dredging operation is initiated. The dredge is the primary floating platform fitted with specialised equipment. Depending on the size and scope of the mining operation, the size and capacity of the dredge may differ.
   c) **Dredging Operations:** The dredge is placed in the water and works by using a suction hose and pumps to suck sediment, sand and gravel, as well as gold-bearing material, from the riverbed. The material is then pumped through the dredge pipelines to a processing facility on the riverbank on a floating barge.
   d) **Material Processing:** At the processing plant, the material is screened and sorted to remove larger rocks and debris. The remaining material, which contains gold particles, is then processed to extract the gold. Common methods for gold extraction in dredging operations include gravity separation and amalgamation.
   e) **Gold Retrieval:** The gold, which is heavier than other sediment, is deposited at the bottom of equipment, such as sluice boxes and centrifugal concentrators, which are utilised to concentrate the gold through the application of gravity and other forces in order to collect and process the gold.
   f) **Monitoring and Reclamation:** Monitoring environmental conditions during and after dredging operations is environmental compliance. After the dredging operation is finished, reclamation activities are carried out to bring the affected areas back as close as possible to their original condition. This includes regrading riverbanks and replanting vegetation to reduce erosion and restore habitats

Economic Importance of Mining in Ghana

1. Provision of employment

2. Provision of income to workers

3. Generation of Revenue to the government

4. Foreign exchange earnings and conservation

5. Infrastructural Development

6. Attraction of foreign direct investment

7. Diversification of Economy

Problems associated with mining activities in Ghana

1. Illegal mining or "galamsey"

2. Inadequate capital

3. Lack of skilled personnel

4. Low level of technology

5. Inadequate and poorly maintained infrastructure

6. Pollution of water bodies

7. Destruction of agricultural land

8. Deforestation

9. Conflict between miners and local communities

10. Corruption and Governance Challenges

11. Health issues

12. Mining pits as death traps

Solutions to the problems of mining in Ghana

1. Easy accessibility to capital.

2. Supporting research and the adoption of innovative technologies can lead to more environmentally friendly mining practices.

3. Strengthening regulations of mining activities.

4. Encouraging mining companies to adopt sustainable and responsible mining practices is crucial.

5. Engaging with local communities and establishing mechanisms for benefit-sharing.

6. Promoting responsible mining practices, such as using cleaner technologies, minimising waste, and rehabilitating mining sites after mining operations are complete.

7. The government should work towards formalising and regulating the small-scale mining sector to curb illegal mining activities (''galamsey'').

8. Strict enforcement of health and safety regulations such as providing proper training, safety equipment, and medical support to prevent accidents and mitigate health risks.

Learning Tasks

1. Explain the methods of mining in Ghana.
2. Discuss the major problems and their remedies for mining activities in Ghana.

Pedagogical Exemplars

Talk for Learning:

Watch a video presentation or listen to a resource person give a presentation on:

   i.   meaning of mining, identify minerals mined in Ghana using question and answer techniques.

  ii.   factors influencing mining and methods of extraction.

iii.   importance and challenges facing mining activities and their solutions in Ghana.

> **Option 1-Using Video**
>
> Find and present videos that showcase mining activities in Ghana including the various methods both legal and illegal.
>
> **Option 2- Using Resource Person**
>
> Invite guest speakers who are professionals in the mining sector to deliver a seminar on mining activities in Ghana.

1. Facilitate class discussions after watching videos or listening to resource persons.

2. Adjust the level of questioning and discussion prompts based on learners' abilities. For approaching proficiency learners, provide more concrete questions focusing on the basic characteristics and impacts of mining activities in Ghana. For example, ask them to consider the types of minerals mined and the potential environmental consequences. Proficient and Highly Proficient learners can be challenged with more analytical and evaluative questions. Encourage them to examine the economic benefits, social implications or regulatory frameworks related to mining in Ghana. They can also explore the role of multinational corporations and sustainable mining practices.

3. Create diverse groups that include learners with different abilities. Consider grouping learners with varied strengths and expertise to promote collaboration and peer learning. Provide clear discussion prompts or guiding questions that encourage learners to share their thoughts, insights, and concerns about mining activities and methods in Ghana.

4. Monitor the discussions to ensure that learners stay on track, address misconceptions, and encourage deeper analysis of mining activities and methods in Ghana. Offer support and scaffold the discussions as needed, providing additional explanations, examples, or resources to help learners understand the complexities and implications of mining in Ghana.

5. Allocate time for groups to summarise their discussions and findings regarding mining activities and methods in Ghana. Facilitate whole-class discussions where each group can share their insights and observations, fostering a broader understanding of the topic. Encourage learners to reflect on the varying perspectives shared within the groups and consider the social, economic, and environmental factors that shape mining activities in Ghana.

Learners should accurately assess their own capabilities as they watch videos or listen to the resource person.

Key Assessment

Level 1: Name one mineral that is commonly mined in Ghana and a town where it is mined

Level 2: Describe the process of open-cast mining

Level 3: Organise a class debate on the topic "Should mining companies be required to obtain community consent before initiating mining projects in Ghana?" Encourage learners to present arguments based on ethical, legal, and social considerations. (This can be done in mixed ability groups)

Level 4:

1. (a) Draw an outline map of Ghana. On the map, insert and name
    i. two towns where gold is mined
    ii. Two towns where diamonds are mined
    iii. one town where crude oil extracted

   (b) What measures can be implemented to mitigate the negative impact of mining on the environment.

Section Review

In Week 21, the subject of mining in Ghana was discussed. The section delved into its importance, methods, and effects on the country. It also explored the distribution of mineral deposits, including gold, bauxite, manganese, and oil, highlighting their economic value and potential for development. Additionally, the section scrutinised various mining techniques like surface and underground mining, discussing their environmental and social repercussions. The section has helped learners gain insights into the complexities of the mining sector, its economic significance, and the imperative of responsible mining practices for long-term environmental and social well-being.

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SECTION 12: **POLLUTION IN GHANA**

Strand: **Human and Environment**

Sub-Strand: Environmental Degradation

Learning Outcome: *Evaluate the causes, effects and measures of preventing or mitigating water and air pollutions*

Content Standard: Demonstrate an understanding of the causes of environmental pollution and the strategies for dealing with it

INTRODUCTION AND SECTION SUMMARY

The section on air and water pollution provides an in-depth exploration of two critical environmental issues. The section examines the sources of air pollution, including industrial emissions, vehicle exhaust, and biomass burning, as well as the impacts and consequences of prolonged exposure to polluted air. Water pollution, on the other hand, focuses on the contamination of water bodies, such as rivers, lakes, and oceans, with pollutants and contaminants. The section also explores the causes of water pollution, including industrial waste, agricultural runoff, and improper waste disposal, as well as the ecological and human health consequences. This section will help learners gain insights into the causes, impacts, and potential solutions to mitigate air and water pollution, fostering a commitment to sustainable practices and the preservation of our natural resources.

The week(s) covered by the section is/are:

> **Week 22**: *Air Pollution*
>
> **Week 23**: *Water Pollution*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars, including think-pair-share, whole class discussions, and activity-based learning, are invaluable in enriching the learning process for learners. These pedagogies promote active participation and collaboration by allowing learners to reflect individually, discuss their thoughts with a partner, and share their ideas with the whole class.

They also encourage critical thinking, enhances communication skills, and fosters a supportive classroom environment. Whole class discussions, particularly through the creation of posters based on mixed ability groupings, promote inclusivity and cooperative learning. Learners work together, pooling their diverse perspectives and knowledge to create visually engaging posters that showcase their understanding of the subject matter.

By visually organising information and making connections, learners deepen their understanding, develop analytical skills, foster creativity and are equipped with the tools needed for lifelong learning and success.

ASSESSMENT SUMMARY

Various assessment strategies, including discussions, question and answer sessions, individual assignments, and homework, offer both formative and summative evaluation opportunities. Discussions enable active engagement and concept demonstration, while question and answer sessions assess

comprehension and critical thinking. Individual assignments demonstrate independent understanding and research skills, and homework reinforces learning beyond the classroom.

These methods help teachers gauge understanding, critical thinking, and independent work. These assessment strategies facilitate holistic assessment supporting learner growth and development.

Week 22

Learning Indicator: *Examine causes and measures for preventing or mitigating air pollution in Ghana*

Theme or Focal Area: Air Pollution

Meaning of Air Pollution

Air pollution is a term used to describe the presence of pollutants in the atmosphere that cause harm to people, the environment and the health of other living things.

Some common air pollutants and their sources
1. **Particulate Matter:** This refers to particles, either solid or liquid, suspended in the atmosphere. Particulate matter comes from a variety of sources, including emissions from vehicles, industrial activities, construction, dust, volcanic eruption, wildfire and others.

2. **Nitrogen Oxides**: They are mainly produced as a by-product of vehicle and industrial combustion processes and are responsible for the formation of ozone and fine particulate matter at ground level, which can cause respiratory issues and smog.

Fig. 22.1: *Emission of particulate matter and NO from locomotives and industries*

3. **Sulphur Dioxide (SO_2):** These are emitted from the burning of fossil fuels containing sulphur compounds, such as coal and petroleum.

4. **Carbon Monoxide (CO):** It is a colourless and odourless gas produced from incomplete combustion of carbon-containing fuels.

Fig. 22.2: *Emission of CO from gas stove*

5. **Volatile Organic Compounds (VOCs):** These are emitted from various sources like solvents, paints, adhesives, pesticides cleaning and personal care products and vehicle exhaust. VOCs can react with other pollutants to form ground-level ozone and contribute to smog formation.

Fig. 22.3: *Release of VOCs from insecticide spray*

6. **Lead (Pb):** Lead emission is mainly from industrial sources and from leaded fuel.

Effects of Air Pollution

1. The ozone layer is depleted and this increases the ultra-violet rays from the solar radiation.

2. Air pollution is a major contributor to climate change. Greenhouse gases released into the atmosphere from human activities, such as burning fossil fuels, trap heat and cause the planet to warm.

3. It gives rise to accelerated rusting, deterioration of paints and other protective coatings.

4. It leads to a short life span through lung cancer i.e., it leads to death of humans and other living things.

5. It also increases skin cancer; destroys chlorophyll in plants and increases earth's surface temperatures.

6. It causes acid rain and acid deposition.

7. Air pollution can damage the lining of the arteries and increase the risk of heart disease and stroke.

8. Air pollution can damage crops and forests, reducing food production and biodiversity.

9. Air pollution can contribute to ocean acidification, which is the process of seawater becoming more acidic due to the absorption of carbon dioxide from the atmosphere. Ocean acidification can harm marine life and ecosystems.

Measures for preventing or mitigating Air Pollution in Ghana

1. Promoting renewable energy sources such as solar energy, wind power, and hydro power can lead to a decrease in fossil fuel dependency and a reduction in emissions from energy production.

2. Implementing measures to reduce vehicle emissions. These measures may include encouraging the use of public transport, setting fuel efficiency requirements, and promoting the use of electric vehicles.

3. Establishing and enforcing strict emission standards for industries can significantly reduce pollution. Regular monitoring and penalties for non-compliance can incentivise industries to adopt cleaner technologies.

4. Proper waste management practices, including waste segregation, recycling, and waste-to-energy processes, can help prevent the release of harmful pollutants from waste burning and landfill sites.

5. Creating and preserving green spaces within urban areas can help absorb pollutants and improve air quality. Trees and vegetation act as natural air filters.

6. Discouraging open burning of waste, agricultural residues, and other materials can reduce the release of harmful particulate matter and toxic substances into the air.

7. Raising awareness about the causes and consequences of air pollution can encourage public participation in pollution prevention efforts and support policy changes.

8. Promoting sustainable agricultural practices by providing farmers with training and resources, and by regulating the use of pesticides and fertilisers.

Learning Task

Discuss the effects of air pollution and suggest remedies based on known experiences.

Pedagogical Exemplars

Talk for Learning:

Learners think, pair and share the meaning of air pollution.

1. Introduce the topic by explaining air pollution. Provide simplified explanations and examples for approaching proficiency learners to understand the basic concept of air pollution and its connection to everyday life. Use visual aids, such as images or diagrams, to help learners visualise the sources and effects of air pollution.

2. Begin the activity by asking learners to individually think about and write down their understanding of air pollution. This allows each learner to reflect on their prior knowledge and personal experiences. After the individual thinking phase, pair learners with different abilities, pairing a more proficient learner with an approaching proficiency learner. This promotes collaboration and peer learning, allowing learners to support and learn from one another. Encourage learners to share their definitions and explanations of air pollution with their partners. Proficient learners can help clarify concepts and provide examples, while approaching proficiency learners can contribute their own ideas and ask questions for further understanding.

Talk for Learning:

In an all-inclusive whole class discussion, and with the aid of pictures/videos discuss the causes of air pollution in Ghana. Use mind maps to organise learners' thoughts.

1. Gather a variety of visual resources, such as pictures, infographics, or short videos, that illustrate the causes of air pollution in Ghana. Select visuals that cater to different learning styles and abilities. Ensure that the visuals represent a range of causes of air pollution.

2. Model the process of creating a mind map by starting with a central topic, such as "*Causes of Air Pollution in Ghana*," and adding branches for different causes.

3. As learners contribute their ideas, synthesise their responses and organise them on the mind map. Encourage learners to make connections between different causes, indicating how one cause may lead to or exacerbate another. Use different colours, symbols, or shapes to visually represent different causes or categories of causes, which can aid in understanding and retention.

4. Conclude the discussion by reflecting on the completed mind map as a whole class. Encourage learners to identify patterns, commonalities, or key themes within the mind map. Summarise the main causes of air pollution in Ghana based on the collective contributions of the class.

Activity-Based Learning:

In mixed ability and mixed gender groupings, create posters on the effects of air pollution and ways of addressing air pollution.

1. Form a mixed ability and mixed gender group, ensuring that each group has a mix of learners with different strengths and areas of expertise to facilitate peer learning and collaboration.

2. Clearly explain the purpose and objectives of the poster project, emphasising the focus on the effects of air pollution and ways to address it.

3. Assign differentiated roles within each group to leverage individual strengths and promote collaboration. Examples of roles can include researcher, artist/designer, writer/editor, presenter, and organiser.

4. Distribute tasks based on learners' abilities. For approaching proficiency learners, assign tasks that involve gathering basic information. Proficient and highly proficient learners can take on more complex tasks, such as conducting in-depth research, designing visually appealing posters.

5. Provide poster templates or layout suggestions to help learners structure their posters effectively, especially for those who may need additional support or guidance.

6. Encourage learners to collaborate within their groups, share ideas, and support one another throughout the poster creation process. Posters can be created using manila cards and colour pens of varied colours. Digital posters can also be created using free poster creator Apps like Canva, Poster Maker, Adobe Express and VistaCreate.

7. Allocate time for groups to present their posters to the class or in small groups, sharing their findings on the effects of air pollution and their proposed solutions.

8. Encourage learners to reflect on their learning experience, including the challenges they faced, the strategies they employed, and the knowledge they gained from researching and creating the posters.

Learners should be able to manage their emotional reactions and behaviours using techniques such as mindfulness strategies, breathing, and self-talk

Key Assessment

Level 1: Explain air pollution

Level 2: Describe how industrial emissions contribute to air pollution and provide examples of industries that release harmful pollutants.

Level 3: Explain the impact of air pollution on the ozone layer and its consequences for human health and the environment.

Level 4: Imagine you are an urban planner. Examine three practical measures you would implement to reduce air pollution in a densely populated city.

Week 23

Learning Indicator: *Examine causes and measures for preventing/mitigating water pollution in Ghana*

Theme or Focal Area: Water Pollution

Meaning of Water Pollution

It refers to the contamination of water bodies such as lakes, rivers, oceans, groundwater and drinking water sources.

Some common water pollutants and their sources

1. **Sewage and Wastewater:** Untreated or inadequately treated sewage and wastewater from residential, industrial, and commercial sources can introduce a wide range of pollutants into water bodies.

Fig. 23.1: *Impure sewage water pouring into running water*

2. **Industrial Discharges:** These are pollutants released into water bodies by industrial facilities. They include heavy metals (mercury, lead, cadmium), toxic chemicals (chlorinated solvents, pesticides), and organic compounds (petroleum hydrocarbons, PCBs).

3. **Agricultural Runoff:** Fertilisers, herbicides, and pesticides used in agriculture can be carried by rainwater for irrigation run-off into nearby rivers and lakes.

Fig. 23.2: *Surface run-off from farmland (nrdc.org, 2022)*

4. **Oil and Petroleum Products:** Oil spills from accidents during transportation, offshore drilling, or leakage from storage facilities can contaminate water bodies.

5. **Heavy Metals:** Heavy metals, such as mercury, lead, arsenic, and cadmium, can come from various sources, including industrial discharges, mining activities, and atmospheric deposition.

6. **Plastic Waste:** Plastics are a significant source of pollution in water bodies, particularly in the oceans.

Fig. 23.3: *Plastic waste in and near the sea*
(bbc.com, 2017)

Effects of Water Pollution

1. Water pollution can cause plants and animals to die and wither away.

2. Eutrophication happens when there is too much nitrogen and phosphorus in the water from farming and untreated sewage.

3. Industrial waste spills and bad waste disposal can release toxic chemicals like heavy metals and pesticides, as well as industrial chemicals, into the water supply.

4. Water pollution can contaminate drinking water sources and cause serious health problems for people.

5. Water pollution can degrade and destroy aquatic habitats, including wetlands, marshes, and coral reefs.

6. Pollution, especially from oil spills, can have devastating effects on coastal ecosystems, including mangroves, and estuaries.

7. Water pollution can have significant economic impacts. It can affect fisheries, aquaculture, tourism, and industries that rely on clean water for their processes.

Measures for preventing or mitigating Water Pollution in Ghana

1. Implementing and enforcing stringent regulations for industrial and municipal waste water treatment is essential.

2. Investing in modern and efficient sewage treatment plants for urban areas can help prevent untreated sewage from contaminating water sources.

3. Encouraging and supporting farmers to adopt sustainable agricultural practices, such as reduced pesticide and fertiliser use, contour ploughing, and agroforestry, can minimise agricultural run-off and nutrient pollution in water bodies.

4. Establishing and maintaining buffer or riparian zones along rivers and lakes can help filter pollutants and prevent sediment run-off from adjacent lands.

5. Raising public awareness about the importance of water conservation and pollution prevention is crucial. Educating communities about the impacts of water pollution and promoting responsible waste disposal can foster a culture of environmental stewardship.

6. Recycling programs and waste collection initiatives should be promoted to reduce the amount of waste entering water systems.

7. Supporting the adoption of green technologies and cleaner production processes in industries can reduce pollution and minimise the release of harmful substances into water bodies.
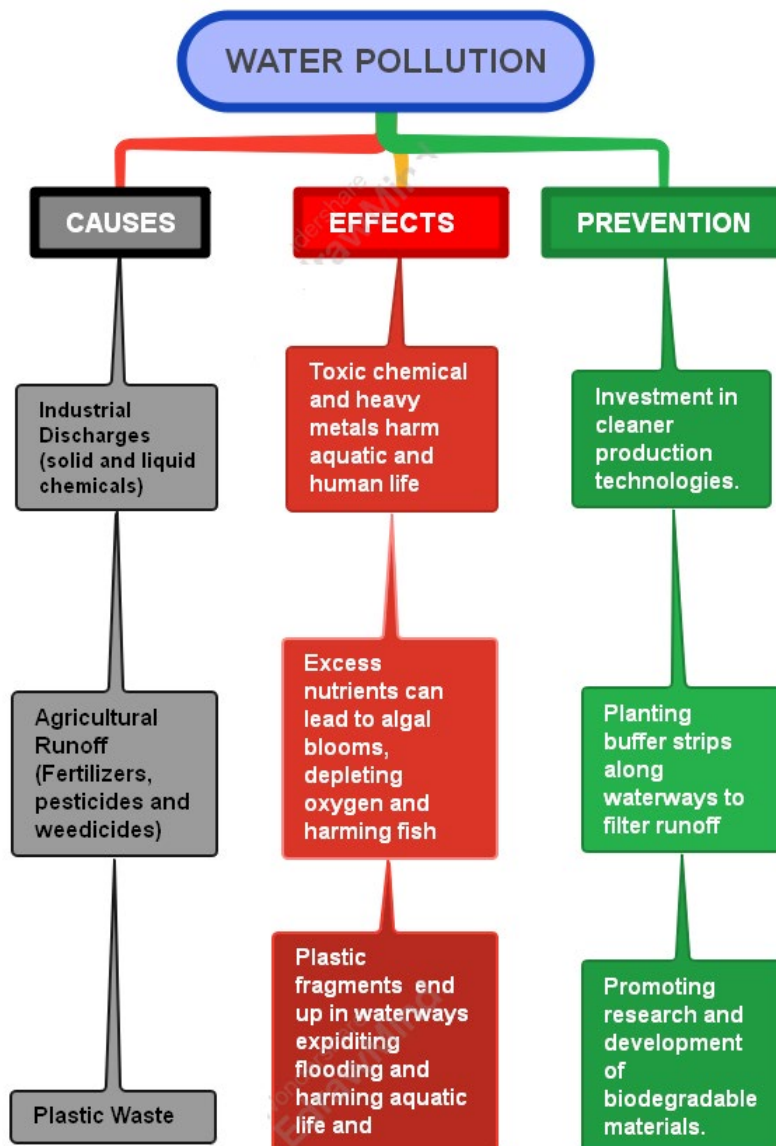

Fig. 23.5: *Sample mind map of water pollution showing causes, effects and prevention*

Learning Task

Discuss the effects of water pollution and suggest remedies based on known experiences

Pedagogical Exemplars

Exploratory Learning:

Embark on a trip to a nearby polluted water body/watch a video on water pollution.

1. Conduct activities like KWL charts, open-ended questions, or simple drawings to gauge prior knowledge about water pollution.

2. Provide pre-reading materials with varying complexity levels (text with visuals, audio) to cater to different learning styles and reading abilities.

3. If visiting a polluted water body, ensure accessibility for learners with physical limitations (e.g., walking trails, accessible viewing platforms).

4. For the video option, form mixed-ability groups where more confident learners can support their peers.

5. Discuss appropriate behaviour and safety protocols for both the field trip and video viewing sessions.

During the field trip

6. Emphasise the importance of staying on designated paths and avoiding contact with the polluted water.

7. Incorporate activities that engage multiple senses (smell, sight, touch - if safe) to enhance learning for learners with kinaesthetic or visual learning styles.

8. Provide differentiated observation guides with varying levels of detail and tasks to cater to different learning abilities. learners can record observations, collect samples (if safe), or sketch what they see.

During video presentation

9. Choose a video with clear narration, visuals, and appropriate length for the learners' attention spans. Consider incorporating subtitles or closed captions for auditory learners.

10. Pause the video periodically to allow learners time to process information and ask questions. Again, graphic organisers like flowcharts or cause-and-effect charts for learners to take notes and visualise the key points about water pollution.

Post-Trip/Post-Viewing Activities

11. Offer various options for reflecting on the experience. learners can write a report, create a drawing or infographic, or participate in a group discussion (depending on ability)

12. Guide learners in brainstorming solutions to water pollution. This could involve creating a public awareness campaign, writing letters to local authorities (with teacher support), or smaller actions like water conservation practices at home.

13. For proficient and highly proficient learners, assign research projects on specific aspects of water pollution or local water quality issues.

Talk for Learning:

Brainstorm on the definition of water pollution.

In an all-inclusive whole class discussion, and with the aid of pictures/videos discuss the causes of water pollution in Ghana.

Learners during discussions should provide opportunities for others to practise identifying potential situations or experiences that lead to feeling overwhelmed and struggling to manage emotions.

1. Provide a graphic organiser with a central question like "*What is water pollution?*" learners can contribute words and phrases around the centre to brainstorm ideas.

2. Divide the class into pairs. Learners brainstorm ideas within their pairs and then share their thoughts with the whole class. This allows quieter learners time to formulate ideas before sharing publicly.

3. Offer sentence starters like "*Water pollution is...*" or "*When water gets...*" to guide learners and provide a structure for their definitions.

4. Incorporate various activities to cater to different learning styles. Kinaesthetic learners can act out scenarios of water pollution, while visual learners can draw pictures depicting polluted water.

5. Use pictures or videos depicting various sources of water pollution. Provide differentiated prompts for discussion based on ability levels. (e.g., "*What's happening in this picture?* "for Approaching Proficiency learners*; "How does this activity contribute to water pollution?*" for Proficient and Highly Proficient)

6. Present pictures/videos showcasing different types of pollution *(industrial waste, littering, agricultural runoff)*. Have learners categorise the visuals based on the source of pollution.

7. Ask a series of questions with varying levels of complexity to engage all learners. (e.g., "*What do you see in this picture?*" "*How might this activity affect the water?*" "*What are some long-term consequences of this type of pollution?*")

Activity-Based Learning:
Create a mind-map on the causes, effects and prevention of water pollution.

1. Provide a word bank with terms related to water and pollution to help learners build the definition collaboratively.

2. Start with a central image or phrase like "Water Pollution" in the centre of the mind map (digital e.g. Canva, EdrawMind or paper)

3. Provide differentiated prompts for each branch of the mind map to guide learners with varying abilities.
   a) **Causes:**
      • Approaching Proficiency: "*List specific sources of water pollution*"
      • Proficient and Highly Proficient: "*Draw pictures of things that can make water dirty*"

   b) **Effects:**
      • Approaching Proficiency: "*Show how polluted water can harm fish or other living things*"
      • Proficient and Highly Proficient: "*Identify the impact of water pollution on plants, animals, and humans*"

   c) **Prevention:**
      • Approaching Proficiency: "*Draw pictures of ways to keep water clean*)"
      • Proficient and Highly Proficient: "*Brainstorm solutions to reduce water pollution*"

4. Encourage learners to use a variety of elements in their mind map - words, short phrases, pictures, symbols - to cater to different learning styles.

5. Suggest using colour coding to differentiate between the main topic (causes, effects, prevention) to enhance visual organisation.

6. Provide scaffolding and support for learners who need additional assistance. This could involve helping them write down ideas, suggesting visuals, or completing parts of the mind map together.

Key Assessment

Level 1: Define water pollution in your own words.

Level 2: Explain the role of urbanisation in causing water pollution in Ghana.

Level 3: Group Project and Presentation: Research and analyse a specific case study of water pollution in Ghana. They should write a short essay explaining the causes and impacts, as well as proposed remedies based on their findings. Ask them to prepare a presentation (traditional or digital) to share their research and recommendations with the class.

Level 4: Evaluate the effects of water pollution in Ghana and suggest remedies based on known experiences.

Section Review

Weeks 22 and 23 focused on the critical subjects of air and water pollution. The causes, sources, and impacts, emphasising their harmful effects on human health, ecosystems, and the environment were examined. Various contributors to air pollution, like industrial emissions and vehicle exhaust, were discussed, underscoring the necessity for sustainable solutions. The section also addressed water pollution, highlighting the contamination of water bodies by chemicals, waste, and agricultural runoff. The consequences on aquatic life, human health, and ecosystems, stressing the importance of responsible waste management were analysed. Through these discussions, learners gained insights into the complexities of pollution and the urgent need for sustainable practices to protect our planet's well-being.

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SECTION 13: ENVIRONMENTAL HAZARDS AND DISASTERS IN GHANA

Strand: **Human and Environment**

Sub-Strand: Environmental Hazards and their Management

Learning Outcome: *Sketch a map showing the environmental hazard areas in Ghana*

Content Standard: Demonstrate understanding of the concepts 'hazard' and 'disaster'

INTRODUCTION AND SECTION SUMMARY

The section on environmental hazards and disasters in Ghana explores the various threats and risks faced by the country and the measures taken to mitigate and respond to such events. Ghana is prone to a range of hazards, including floods, droughts, earthquakes, and coastal erosion. The section delves into the causes and impacts of these hazards, emphasising the importance of preparedness, early warning systems, and resilience-building strategies. The section also examines the role of government agencies, community involvement, and international collaborations in disaster management and response. This focal area will help learners appreciate the complexities of disaster management, the importance of proactive measures, and the need for sustainable approaches to minimise the impacts of hazards on communities and promote sustainable development.

The week(s) covered by the section is/are:

Week 24: Hazards and Disasters in Ghana

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical strategies like questioning, collaborative learning, and project-based learning greatly enhance the learning journey regarding hazards and disasters in Ghana. Questioning encourages critical thinking and active participation, while collaborative learning fosters teamwork and deeper understanding. Project-based learning goes a step further by immersing learners in real-world scenarios, allowing them to apply knowledge and grasp the complexities of disaster management. Through these strategies, teachers cultivate an engaging environment that promotes critical thinking, problem-solving, and essential skills necessary for addressing hazards and disasters in Ghana.

ASSESSMENT SUMMARY

Assessment strategies such as group work, question and answer sessions, and class exercises offer a well-rounded approach to both formative and summative assessments. Group work provides learners with opportunities to collaborate, apply their knowledge, and engage in critical thinking. Through group projects, learners work together to solve complex problems, analyse information, and effectively present their findings, demonstrating a deep understanding of the concepts. Question and answer sessions, including class discussions and individual responses, assess learners' understanding, recall of information, and application of knowledge. These interactive assessments allow teachers to gauge learners' comprehension and encourage active participation. Class exercises, such as quizzes or short assessments, further evaluate learners' understanding, recall, and application of concepts. These exercises provide immediate feedback and help identify areas for further improvement.

Week 24

Learning Indicator(s):

1. *Differentiate between hazards and disasters*
2. *Sketch areas in Ghana prone to floods, drought, bush fires and earthquakes*

Theme or Focal Area 1: Hazards and Disasters In Ghana

The meaning of Hazard and Disaster

Hazard: A potentially harmful physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, and affect socio-economic activities as well as the environment.

Disaster: A disaster is a significant disruption to a community or society that leads to widespread human, material, economic, or environmental losses that exceed the **affected group's ability to cope using their own resource**s. The key difference between hazards and disasters is that a hazard is a potential source of harm, while a disaster is the actual occurrence of harm resulting from a hazard.

Risk: The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes, which increase the chances of a community to the impact of hazards.

Resilience: The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Types of environmental hazards

1. **Natural hazards:** These are hazards caused by natural processes. Examples include earthquakes, tidal waves, floods, landslides, drought and hurricanes.

2. **Human-induced hazards:** These are hazards caused by human activities. Examples include fire, flooding, famine, gas explosion and oil spillage.

Differences between Hazards and Disasters

Theme	Hazards	Disasters
Definition	A natural or human-induced event that has the potential to cause damage or loss of life.	A hazard that has actually caused damage or loss of life.
Causes	Can be caused by a variety of factors, including earthquakes, floods, hurricanes and wildfires.	Can be caused by a single hazard or a combination of hazards.
Effect	Do not necessarily cause any damage or loss of life.	Cause damage or loss of life.
	Can be prevented or mitigated through planning and preparedness	Can only be responded to and recovered from once it has occurred.

Theme	Hazards	Disasters
Examples	Examples of hazards in Ghana include earthquakes and tremors, floods, wild and domestic fires, explosions, landslides, drought and tidal waves.	Examples of disasters that have happened in Ghana include 1995, 1999 and 2015 Accra floods, 2021 Keta Tidal waves, 1983 Drought, 1939 Accra Earthquake, 2018 Upper East Floods, 2008 Fufute-Adukrom Landslide, 2017 Atomic-Junction Gas Explosion, 2022 Apeate Dynamite Explosion, 2020, 2021, 2022, 2023 Kumasi Central Markets.

Pedagogical Exemplars

Talk for Learning:

Through questioning, learners brainstorm

   i.   the definition of hazards and disasters.

   ii.   types of hazards and disasters in Ghana from their communities.

Learners during discussions should provide opportunities for others to practise how to identify potential situations or experiences that lead to feeling overwhelmed and struggling to manage emotions.

1. Begin with general questions like "*Mention any event/ an activity/ a phenomenon that can cause harm to human lives or the community*? This activates prior knowledge and eases learners into the topic.

2. Provide a KWL chart (Know, Want to Know, Learnt) where learners can brainstorm what they already know (K) about hazards and disasters. Differentiate by offering sentence starters for younger learners or learners needing more support (e.g., *"A hazard is something that can..."*).

3. Ask questions that encourage learners to think broadly and share their experiences. For example, "*What are some events that could cause damage in our community?*" or "*Have you ever heard stories about past disasters in Ghana?*"

4. Adapt the difficulty of questions based on learners' understanding. For example, after a general question, ask more specific ones like "*Can you think of natural hazards?*" or "*Are there any hazards caused by people?*"

5. Show pictures or videos depicting different hazards (floods, droughts, fires) and ask learners to describe what they see and the potential dangers associated with them.

6. Provide learners with pictures containing a list of different events (e.g., car accident, earthquake, heavy rain). Ask them to sort the pictures into categories like "natural hazards" and "human-induced hazards."

7. Once learners brainstorm a variety of hazards, guide the discussion towards hazards specific to Ghana. Ask questions like "*Which of these hazards are more likely to happen in Ghana?*" or "*Why might some hazards be more common here than in other places?*"

8. Create a supportive and inclusive classroom environment where all learners feel comfortable sharing their thoughts and contributing to the discussion.

Key Assessment

Level 1: In your own words, explain the difference between hazard and disaster.

Level 2: Use the word search game below to search for at least 10 words that represent hazards and disasters in Ghana

Hazards and Disasters in Ghana

R	E	E	A	T	E	A	O	D	E	U	G	D	D
O	E	U	O	F	G	G	X	T	W	S	A	D	S
F	O	L	A	N	A	S	T	S	I	O	S	L	R
D	I	P	S	X	L	L	H	U	L	W	E	E	O
S	H	G	I	F	L	P	L	O	D	E	X	D	M
C	A	L	P	H	I	A	W	E	F	I	P	I	E
I	I	L	I	L	P	M	V	O	I	O	L	L	R
M	L	I	E	H	S	P	O	A	R	M	O	S	T
E	D	R	O	U	G	H	T	L	E	O	S	D	H
D	F	L	O	O	D	S	L	S	Q	L	I	N	T
I	M	U	V	R	W	N	S	A	O	D	O	A	R
P	E	A	R	T	H	Q	U	A	K	E	N	L	A
E	T	A	T	I	D	A	L	W	A	V	E	S	E
W	I	N	D	S	T	O	R	M	Q	O	N	N	R

Level 3: Explain why Ghana might be more vulnerable to certain hazards than other countries.

Theme or Focal Area: **Areas In Ghana Prone To Environmental Hazards and Disasters**

The table below shows areas in Ghana where environmental hazards and disasters have occurred in the past and in recent times.

Hazards and Disasters	Area
Floods	Accra; Bolgatanga, Bawku, Pusiga (Upper East); Takoradi
Earthquake and Earth tremors	Accra
Landslides	Fufute-Adukrom, Aburi-Peduase
Tidal waves	Agavedzi, Salakope (Ketu South); Keta
Drought	Bawku, Navrongo (Upper East); Kete-Krachi; Savelugu; Ahafo-Tanoso
Wildfires	Bolgatanga, Bawku, Navrongo, Savelugu, Tamale, Kintampo and Techiman.
Fire outbreaks (Industrial and Domestic)	Nationwide

In Ghana, the National Disaster Management Organization (NADMO) is the line institution for disaster response.

Pedagogical Exemplars

Collaborative Learning

In pairs, map areas prone to environmental disasters (e.g., earthquakes or tremors, landslides, floods and drought) in your community or Ghana.

1. In pairs briefly discuss hazards and disasters common in Ghana.

2. Prepare multiple versions of the Ghana map template with varying levels of detail. Approaching Proficiency learners can be given map templates that show major towns and regions for basic placement of disaster zones. Proficiency and Highly Proficient learners can also be given map templates that include additional features like rivers, lakes, and relief features for a more precise mapping.

3. Strategically group learners based on mixed abilities to encourage collaboration and peer support.

4. Provide learners with access to different resources to identify disaster-prone areas. Teachers should guide learners to list areas or places in Ghana where disasters commonly occur.

5. With the given map templates, guide learners on how to shade or mark areas on the map. Offer varying levels of support based on learners' needs

6. Lead the learners through a discussion on the effects of disasters and ways in which these disasters can be mitigated.

7. Learners, in their mixed ability groups, can compare and contrast disaster risk in different regions of Ghana using tables or diagrams.

8. Display learners' completed maps and have them explain their work to their peers

9. Provide differentiated reflection prompts based on learners' abilities. Example: *"What did you learn from this activity?*" or *"How can maps be used to reduce the impact of natural disasters?"*

Project-based learning:

In an all-inclusive grouping, visit a nearby area in your locality that is prone to hazard and produce a disaster map.

1. Scout the field trip location beforehand to identify potential accessibility challenges and plan accommodations for learners with physical limitations.

2. Prepare pre-reading materials with varying levels of complexity (text, visuals, audio options) to cater to different learning styles and reading levels.

3. Form mixed-ability groups where proficient learners can support their peers. Consider assigning roles within each group based on individual strengths (writing, drawing, observation etc.).

4. Thoroughly discuss safety protocols for the field trip, including potential hazards specific to the location (e.g. slippery rocks in flood-prone areas).

5. Encourage learners to collect data through various methods like photos, sketches, notes, or audio recordings, depending on their preferences and learning styles.

6. Be present and available to answer questions, clarify concepts, and offer support to all learners during data collection.

7. Offer various options for learners to create their disaster maps. This could include paper maps with pre-drawn symbols or digital mapping software.

8. Encourage collaboration within groups, allowing learners to share their strengths and learn from each other while creating the disaster map.

9. Guide learners in presenting their disaster maps to the class, encouraging them to explain their observations, highlight potential hazards, and propose safety measures. Offer different presentation formats to cater for various learning styles (e.g., oral presentation, written report, infographic).

Key Assessment

Level 1:(MCQ)

Which of the following natural hazards is Ghana **most** susceptible to?

A. Earthquakes

B. Tornadoes

C. Landslides

D. Flooding

Level 2: (Matching)

Match the following types of disasters with their causes:

A.

Disaster	Cause
A. Drought	A. Human activities and negligence
B. Fire outbreaks	B. Natural climate patterns Natural climate patterns
C. Gas explosions	C. Infections from virus or bacteria
D Road accidents	D. Poor infrastructure and safety measures
	E. Combustible materials and ignition sources

Level 3: Explain the relationship between deforestation and landslides in hilly regions of Ghana, highlighting the consequences for local communities.

Level 4: Using online mapping tools or traditional mapping methods, create a map of Ghana that shows different types of natural hazards (e.g., floods, droughts, wildfires) and their risk zones.

Section Review

Week 24 focused on hazards and disasters in Ghana, examining various threats like floods, droughts, earthquakes, and coastal erosion. The discussions covered causes, impacts, and mitigation strategies, emphasising preparedness, early warning systems, and resilience-building. The role of government agencies, community participation, and international cooperation in disaster management were also explored. Learners gained insights into disaster risk reduction, emergency response, and sustainable development.

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