Geography and the Environment

Pupil's Book

Standard 5

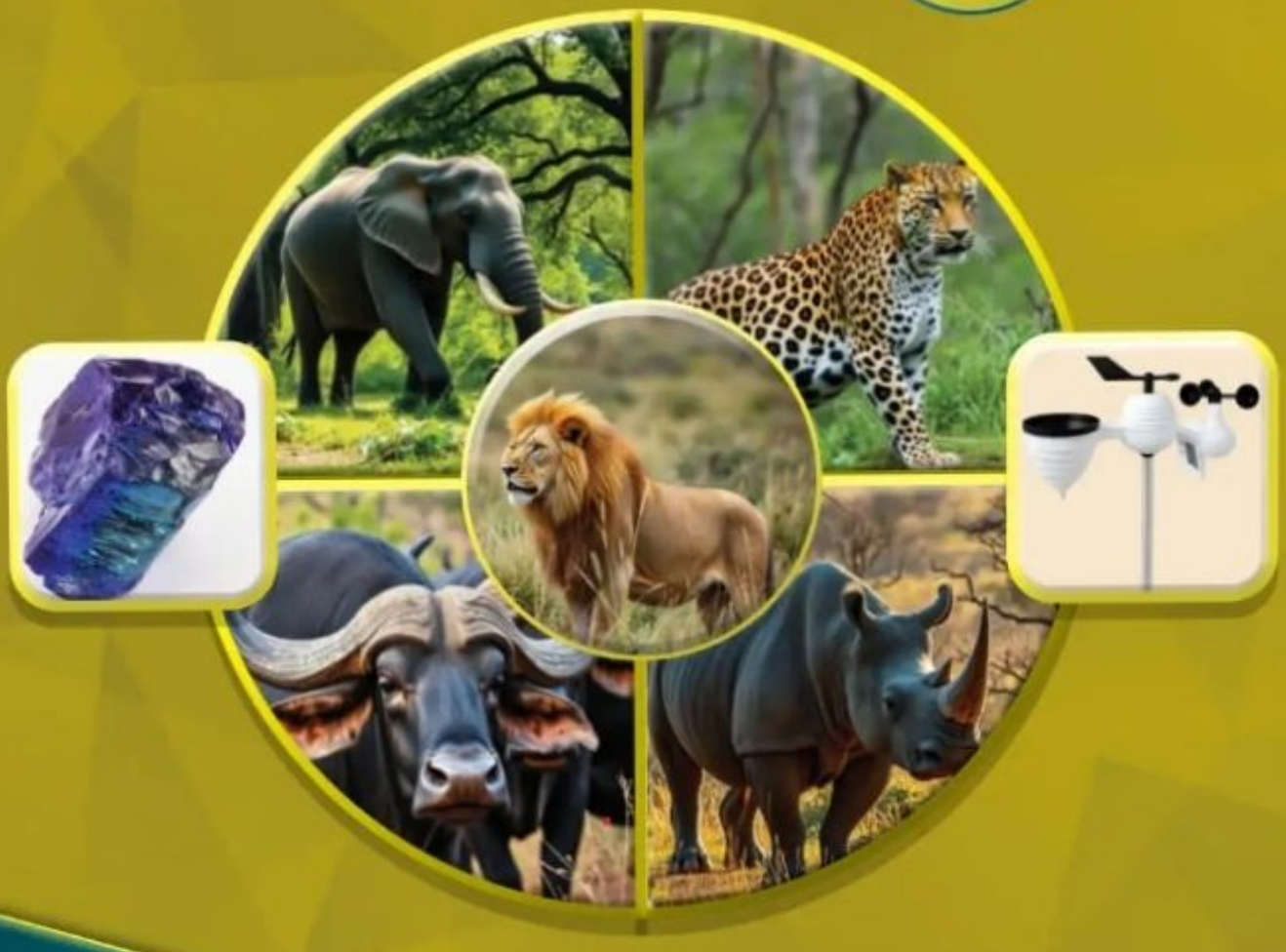

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Table of Contents

Table of Contents iii

Acknowledgements iv

Introduction v

Chapter One 1

The natural resources of Tanzania 1

Chapter Two 35

Population distribution and the use of natural resources 35

Chapter Three 49

Weather 49

Chapter Four 72

The relationship between weather and production activities 72

Test 84

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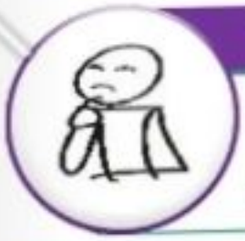
Chapter One

The natural resources of Tanzania

Introduction

Tanzania is blessed with various natural resources essential for economic growth and preserving the nation's heritage. These resources include land, forests, lakes and rivers, minerals, and a wide range of wildlife that collectively contribute to the nation's development. In this chapter, you will learn the meaning of resources, the types of natural resources found in Tanzania, their geographical distribution, and the relationship between natural resources and development. The competencies developed will enable you to use Tanzania's natural resources efficiently for individual and national development.



Think

Various income-generating activities for the people in your community.

Meaning of resources

Resources are things that enable us to achieve our goals or meet our needs. We use resources in our daily activities, such as production activities or learning. Resources make our lives easier and better.

Types of resources



Activity 1

Think of starting a vegetable farming project. Prepare a table showing the important resources needed and state the usefulness of each resource in implementing the project.

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Resources are of different types, including natural resources such as land, water, forests, animals, and minerals; human resources such as skills and labour; and capital resources such as money, machines, buildings, and other infrastructure. Each of these resource helps us in different ways to attain our goals and improve our lives. In this textbook, you will learn more about natural resources.

Natural resources

Natural resources are things and raw materials found in the natural environment that can be used by human being for different purposes. Natural resources include air, natural gas, water, sunlight, land, minerals, oil, forests, and animals. Broadly, natural resources are divided into two main groups: renewable and non-renewable resources.

Renewable resources

Renewable resources are those that can constantly regenerate themselves relatively in short periods after being used. Sunlight, wind energy, water and forest are good examples of renewable resources.

Non-renewable resources

Non-renewable resources are finite resources that are not easily regenerated or take a long time to form; thus, they become exhausted after use. Examples include oil energy, minerals, and natural gas.

Natural resources found in Tanzania



Activity 2

Observe different places surrounding you, then list the natural resources found in the area.

Tanzania has valuable natural resources that contribute to the nation's economic growth and development. Such resources need to be identified, conserved, and developed for the benefit of the present and future generations. The following are some of the natural resources found in Tanzania:

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Minerals

Tanzania has many mineral resources, including gold, tanzanite, diamonds, coal, copper, salt, tin, nickel, uranium, and other precious stones. It is one of Africa's top producers of gold, with substantial gold reserves spread over several regions. Tanzanite is a precious mineral found only in Tanzania. The mining sector in Tanzania is essential to the country's economy because it attracts foreign investment and generates revenue through export of minerals. Figure 1 represent some of the minerals found in Tanzania.



Tanzanite Gold Diamond

Figure 1: *Some of the minerals found in Tanzania*

Land

Tanzania is rich in land resources, including fertile land and large grazing areas. Tanzania has fertile soil suitable for cultivating various crops like coffee, tea, tobacco, maize, beans, sunflowers, paddy and other crops. The country also has large tracts of land for raising animals like cattle, sheep, and goats. Some areas in Tanzania are designated as wildlife parks and reserves, protecting plants, animals, and other living organisms. Other land is used for human settlements, industries, and businesses. Thus, land is an essential resource that contributes to Tanzania's economic growth and the well-being of communities and improves the lives of individuals.

Water

Water is an essential resource for all living things, including humans, animals and plants. Tanzania has many water resources found in different areas, sources, and regions of the country, including dams, rivers, lakes, the ocean and groundwater. Water resources contribute to the country's economy and people's daily lives. The Indian Ocean, Lake Victoria, Lake Tanganyika, and Lake Nyasa are some of the significant water bodies. There are also rivers, including Rufiji, Ruvuma, Malagarasi, Ruvu, Wami, Kagera and Pangani, and large dams like Julius Nyerere Hydropower, Mtera, Nyumba ya Mungu and Kidatu. People and other living organisms use water to sustain their lives.

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Additionally, the water resources support the development of the blue economy-related sectors. The blue economy in Tanzania involves a wide range of sectors related to the use of oceans, coasts and fresh waters like rivers, lakes and dams. The blue economy-related sectors include fishing, transportation, tourism, agriculture and energy, essentially electricity generated from water, natural gas and oil. The blue economy also contributes to improving livelihoods and employment, at the same time as emphasising the preservation of biodiversity and promoting sustainable use of water resources.

Forests

A forest is an area with a collection of many large and small trees, shrubs and grasses. Tanzania has various types of forests, covering about 40% of the total land. These forests include mountain forests, miombo woodlands, and mangroves. The forests provide shelter for many animals and other living organisms, making them essential for wildlife and other living things. Forests are valuable as they provide wood for construction, firewood for cooking, and medicinal plants. By absorbing carbondioxide from the atmosphere, forests also assist in regulating the climate and maintaining the purity of the air and water. Forests are a source of income for many people who engage in beekeeping, harvesting fruits, and gathering other natural forest-related goods. Forests are therefore important for the local population in their respective areas, and they conserve the environment.

Wildlife

Wildlife are natural resources, which include all animals and birds that live in a natural environment without being introduced by humans. Some examples of wildlife include elephants, lions, rhinos, buffalo, leopards, antelope, zebras, giraffes, ostriches and many others. Tanzania is home to famous African wildlife, including the animals known as "The big five", which are the lion, elephant, rhino, buffalo, and leopard, as shown in Figure 2. The wildlife is largely found in national parks, conservation areas and game reserves covering approximately 38% of the total land area in Tanzania. Some of the national parks and conservation areas are the UNESCO World Heritage Sites, including Ngorongoro Conservation Area, Serengeti, Nyerere and Kilimanjaro National Parks.

Tanzania has authorities responsible for managing protected areas. The Tanzania National Parks Authority (TANAPA) manages all national parks, and the Ngorongoro Conservation Area is managed by the Ngorongoro Conservation Area Authority (NCAA). The game reserves, such as Ugalla, Moyowosi, Rungwa, Biharamulo,

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Ibanda, and Selous, are managed by the Tanzania Wildlife Management Authority (TAWA). Wildlife resources provide various benefits that contribute to the development of the nation through tourism, wildlife education culture national heritage and animal harvesting.



Figure 2: *The big five animals*

Energy

Tanzania has various energy resources, both renewable and non-renewable. The country mainly depends on hydroelectric, natural gas, and biomass energy to generate electricity. Hydroelectric forms a large share of the electricity produced in the country, although its production is affected by drought conditions. Coastal areas rich in natural gas reserves have become a key energy source for the country's electricity generation and industrial use. Biomass, particularly from wood and agricultural residues, is commonly used for cooking, especially in rural areas. In addition, Tanzania has other renewable energy sources such as wind and solar, which help the country reduce dependence on oil, gas, and hydropower.

In general, Tanzania's natural resources significantly contribute to the economy through sectors such as agriculture, mining, tourism, and industry. The government is implementing strategies to ensure these resources are used sustainably, for the benefit of the current and future generations.

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Exercise 1

1. What sources of cooking energy are used by the people in your community?
2. Which natural resources are the sources of energy you mentioned in question (1) above?
3. Imagine your school wants to generate electricity. There are two sources: wind and coal. Which source will you suggest? Give reasons for your answer.
4. Explain the benefits of wildlife resources in Tanzania.
5. Explain the use of land resources in your community.
6. Briefly explain how you will efficiently use the available natural resources in your area to generate income.

Distribution of natural resources in Tanzania

In Tanzania, natural resources are not evenly distributed across the country. Some places have abundance of certain resources, while others have very little, or none, and some have different resources. This situation is called the distribution of natural resources. The following is an overview of how natural resources are distributed in Tanzania.

Distribution of mineral resources

Tanzania is rich in mineral resources, with large deposits spread throughout the country. Important minerals include gold, which is mainly found in Bukombe, Nyang'hwale, and Mbongwe districts in Geita region. Also, gold is found in Bunda, Tarime, and Butiama disricts in Mara region, and at Bulyanhulu in Msalala council Kahama district in Shinyanga region. In addition, gold is found in Mpanda district in Katavi region; in Amani area between Muheza and Korogwe districts in Tanga region; in Sekenke area in Iramba district in Singida region; and Chunya district in Mbeya region. This makes gold one of the Tanzania's main export products.

Tanzanite is another valuable mineral resource found in Tanzania. It is found only at Mererani area in Simanjiro district, Manyara region. This mineral is important to Tanzania's identity, as it is not found elsewhere. Moreover, there are large deposits of coal in the southern and western regions, such as Mchuchuma in Ludewa district, Njombe region; Kiwira in Rungwe district, Mbeya region; Tunduma

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in Momba district Songwe region; and Ngaka in Mbinga district, Ruvuma region. Coal contributes to Tanzania's economy through its uses in industries and export activities. Figure 3 indicates coal mining.



Figure 3: *Coal mining*

Diamonds in Tanzania are found mainly in Mwadui in Kishapu district, Shinyanga region. Mwadui continues to be one of the primary sources of diamond production in Tanzania.

Uranium minerals are found primarily in the Manyoni district in Singida region, the Bahi district in Dodoma region, and the Namtumbo district in Ruvuma region. Currently, uranium minerals are being explored for energy production purposes, although their extraction is still in development.

Iron minerals are found in Liganga in Ludewa district in the Njombe region. These areas are famous for having a large reserve of iron minerals. Liganga's iron is expected to contribute to the country's industrial sector.

Tanzania is also famous for various gemstones, including rubies and sapphires. Rubies are found in Tunduru and Songea districts in Ruvuma region, as well

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as in rural Morogoro and Ulanga districts in Morogoro region. Sapphires are found in Tunduru district in Ruvuma region. Both rubies and sapphires are very popular in international markets.

Other minerals in Tanzania include salt found in Bagamoyo district in Pwani region, Mikindani in Mtwara region, Kilwa and Lindi districts in Lindi region, and Uvinza in Kigoma region. Phosphate minerals, which are used to produce fertilizers, are found in Tanga and Lindi regions. Calcium sulphate (gypsum) is found in the Mbeya and Rukwa regions, while limestone is found in Tanga, Mbeya, and Arusha regions.



Activity 3

Draw the map of Tanzania, then use different colours to indicate the distribution of gold, diamond, Tanzanite, coal, uranium, and salt mineral deposits.

Distribution of water resources

Tanzania's water resources include groundwater, dams, rivers, lakes, and the ocean. The following is the distribution of water resources in Tanzania.

Dams

Tanzania has many large and small dams in various areas across the country. These dams assist in irrigation farming, fishing activities, electricity production, and other human uses. Some of the important dams found in the country include:

The Julius Nyerere Hydropower station

The Julius Nyerere Hydropower Project (JNHPP) is the largest hydropower dam project for Tanzania, aiming to meet the growing energy demands and reduce power shortages in the country. It is located at Stiegler's Gorge on the Rufiji River. The dam creates a water reservoir with a storage capacity of about 34 billion cubic meters, covering an area of approximately 1, 200 square kilometers. The dam also helps in the control of floods. Figure 4 indicates a part of the Julius Nyerere Hydropower Project.

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Figure 4: *Julius Nyerere Hydroelectric Power Project*
Source: https://www.tanesco.co.tz

Mtera dam

This dam is located in Chamwino and Mpwapwa districts in Dodoma region and Iringa district in Iringa region. The source of the Mtera dam is the Great Ruaha River. Mtera dam covers an area of 660 square Kilometres and is one of the dams used for electricity generation through the Mtera Hydropower Project. In addition, the dam supports fishing activities and irrigation agriculture in nearby areas. Figure 5 indicates a part of Mtera dam.



Figure 5: *The Mtera dam*

Nyumba ya Mungu dam

Nyumba ya Mungu dam is located in Mwanga district in Kilimanjaro region. Its sources are the Kikuletwa and Lumi rivers. The dam covers an area of 180 square kilometers. It is one of the major dams for electricity generation and is used for irrigation agriculture, mainly in Kilimanjaro and Tanga regions. Figure 6 indicates the Nyumba ya Mungu dam.

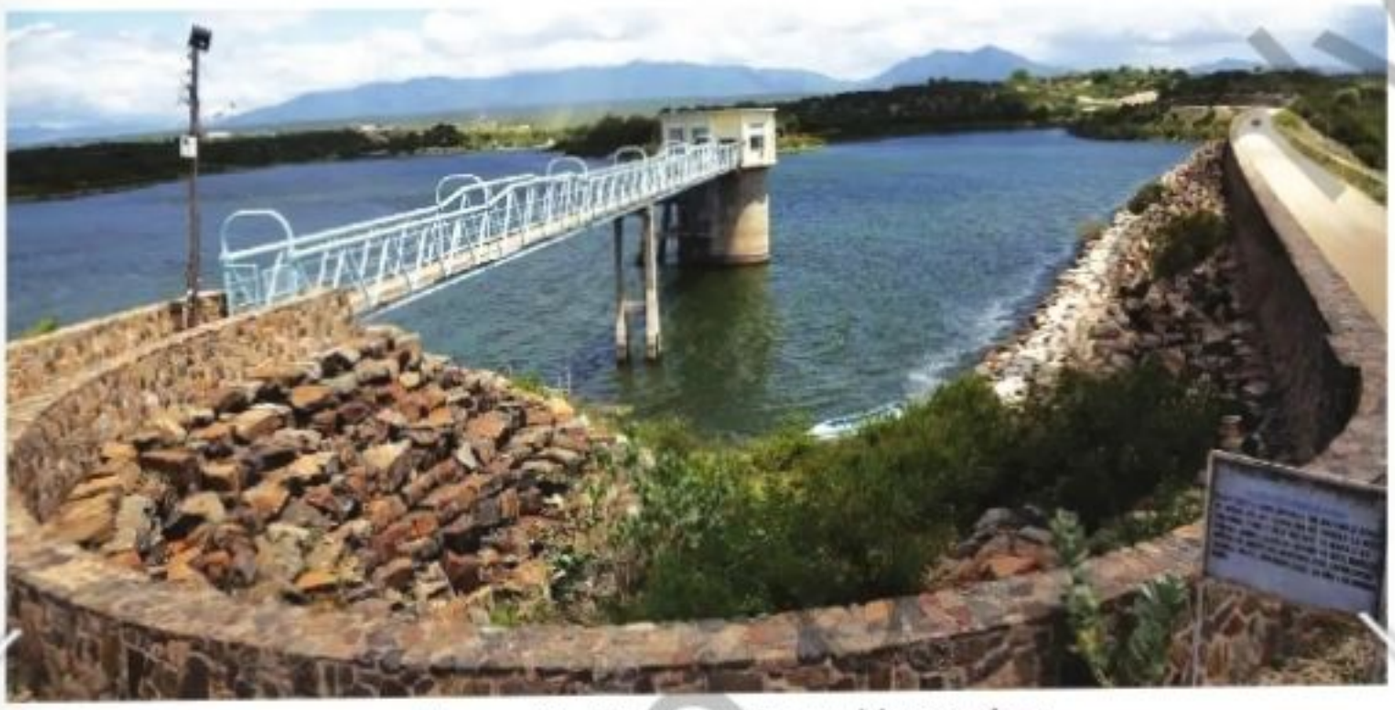
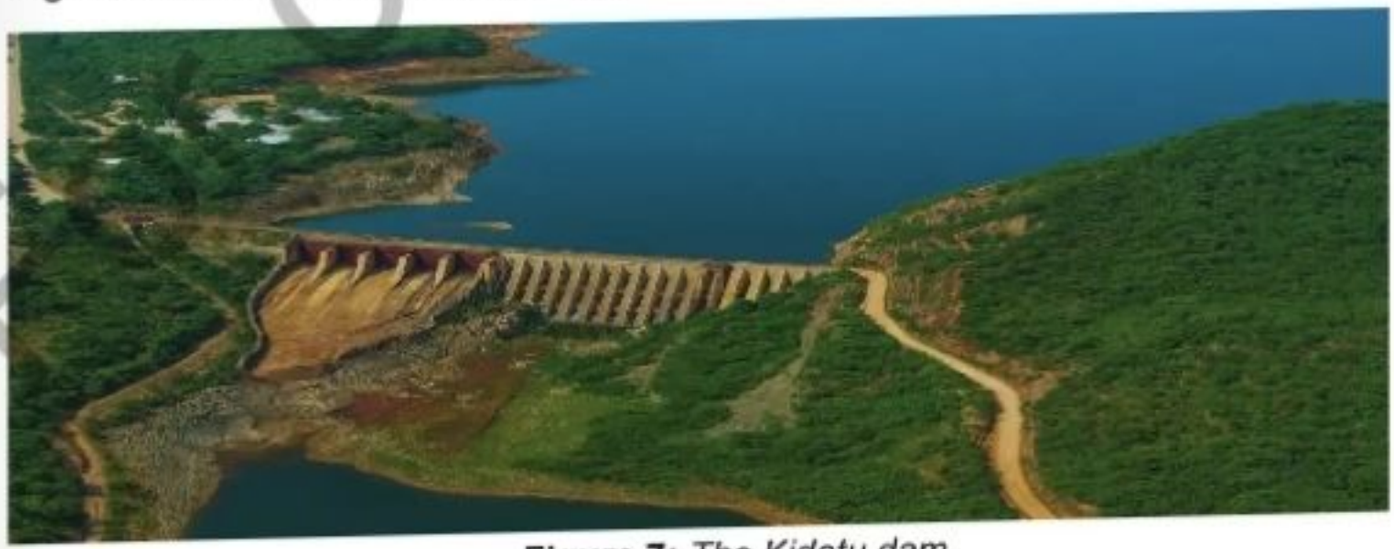


Figure 6: *The Nyumba ya Mungu dam*

Kidatu dam

The Kidatu dam is located in Kilosa district in Morogoro region. Its source is the Great Ruaha River. The dam covers an area of 10 square kilometres and is used for electricity generation through the Kidatu Hydropower Project. In addition, it contributes to flood control and water distribution for agricultural purposes. Figure 7 indicates the Kidatu dam.



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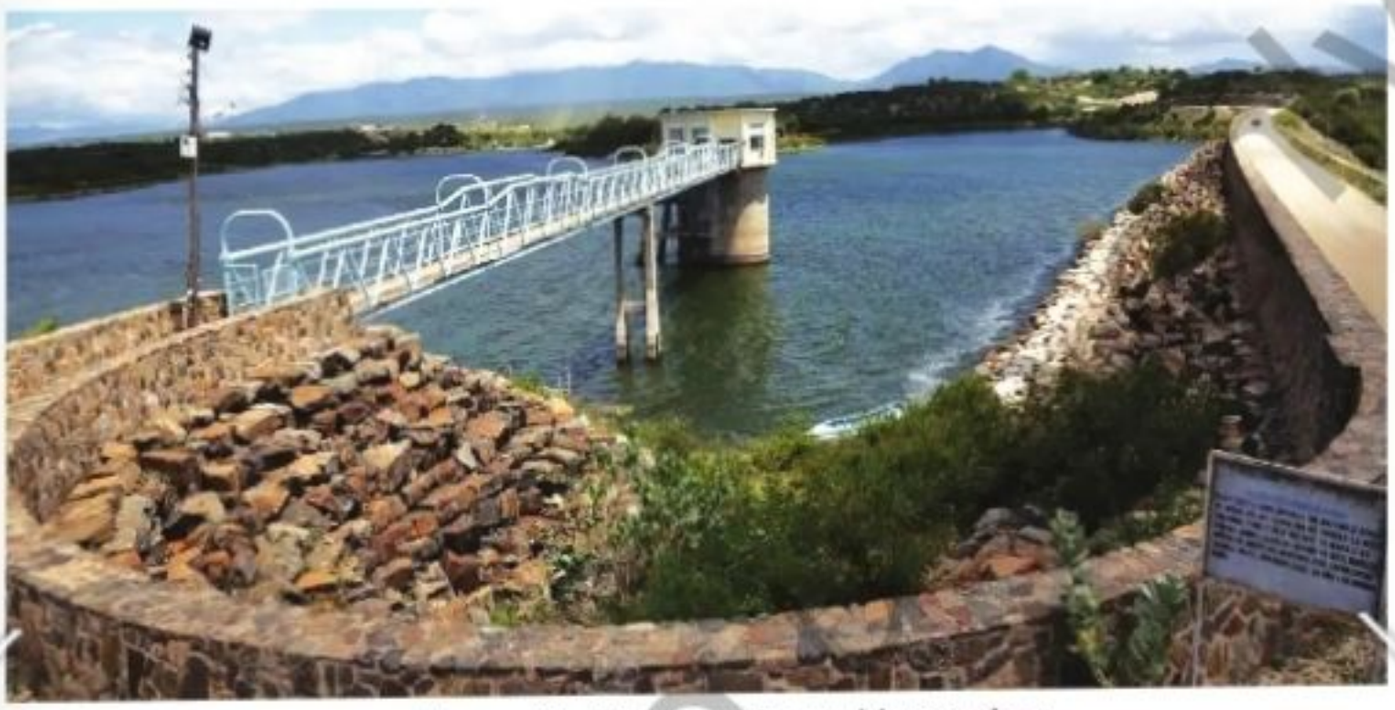

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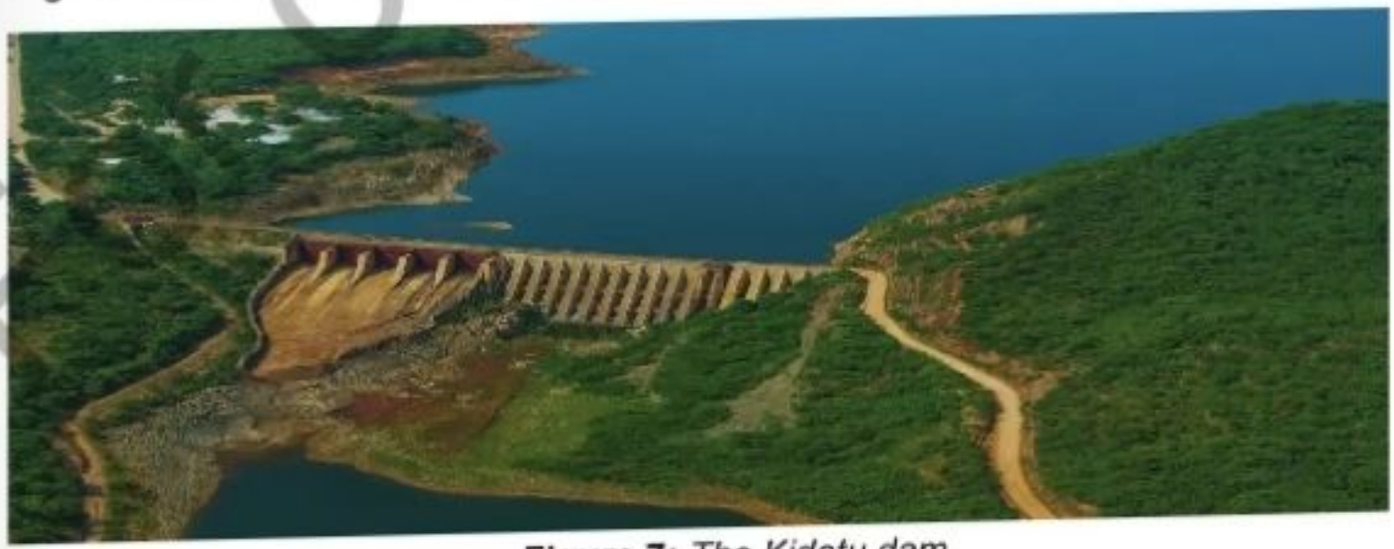

Figure 7: *The Kidatu dam*

Hombolo dam

Hombolo dam is located in the city of Dodoma, in Dodoma region. Its source is the Kinyasungwe River. This dam is important for irrigation agriculture, watering livestock, fishing, and domestic use in this drought-prone area. Figure 8 indicates the part of the Hombolo dam.



Figure 8: *The Hombolo dam*

Source: https://www.biorxv.org/content/10.1101/452847v2.Full

Rivers

Tanzania has many important rivers that provide water services for human beings, industry, animals, and plants. These rivers flow across various districts and regions in the country. Here are some notable rivers in Tanzania, along with their sources, pathways, and endpoints.

Rufiji River

The Rufiji is the longest river in Tanzania, originating from the Udzungwa Mountains in Iringa and Motogoro regions. The tributaries of the Kilombero, Luwegu, and Great Ruaha rivers form the Rufiji River, flowing through various regions, including Morogoro and Pwani regions. The river empties into the Indian Ocean through the Rufiji Delta in the Pwani region. The Rufiji River is important for irrigation in the areas it passes, particularly in the Kilombero valley and in the Lower Rufiji basin, which are famous for rice cultivation. Moreover, the Rufiji River basin is home to diverse wildlife and supports ecological systems. Moreover, the Rufiji River contributes to various hydroelectric projects, such as the Julius Nyerere Hydroelectric Power Project.

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Ruvuma River

The Ruvuma River begins as a small stream in the Matogoro mountains in southern Tanzania, near Songea town. It flows towards the Namtumbo district and the neighbouring country of Mozambique. On the Mozambique side, it empties into the Indian Ocean. This river is significant for Tanzania as it forms a natural border between Tanzania and Mozambique in the southern part of the country. The Ruvuma River is also essential for irrigation, supplying water for domestic use, and supporting ecological systems in the region.

Wami River

This river originates in the Uluguru Mountains in the Morogoro region, where various streams join to form a single river that flows southeast, passing through the Morogoro and Pwani regions. In Pwani region, the river crosses in Chalinze and Bagamoyo districts, and finally the river empties into the Indian Ocean through Wami Delta near Bagamoyo town. The Wami River is important for agricultural activities, livestock keeping, supplying water for industrial and domestic use, and supporting ecological systems.

Ruvu River

The Ruvu River originates in the Uluguru Mountains in Morogoro region. It flows through areas of Morogoro before moving into Pwani region, and in the end empties into the Indian Ocean through Ruvu Delta. This river is important for agricultural activities, livestock keeping, fishing, and supplying water for industrial and domestic use. It also plays an important part in supporting ecological systems in the region.

Pangani River

The Pangani River is formed by two tributaries. The first tributary originates from the slopes of Mount Kilimanjaro, forming the Lumi River. The second tributary comes from the slopes of Mount Meru, forming the Kikuletwa River. Both rivers meet at the Nyumba ya Mungu Dam. After converging at the Nyumba ya Mungu Dam, the Pangani River flows southeast through Kilimanjaro region and empties into the Indian Ocean near Pangani town in Tanga region. This river is crucial for agricultural activities, livestock keeping, and hydroelectric power generation through the Hale Hydroelectric Power Station.

Great Ruaha River

This river originates in the Kipengere Mountains and flows through the Usangu plain, passing through Ruaha National Park and Nyerere National Park before

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joining the Rufiji River. It is one of the important rivers in Tanzania, contributing to the country's ecological system and economy.

Other rivers in Tanzania include the Kagera River, which is found in Kagera region and empties its water into Lake Victoria. The Malagarasi River, which is found in Kigoma region, flows into Lake Tanganyika, and the Mara River, which is found in Mara region, also empties into Lake Victoria.

Lakes found in Tanzania

Lake Victoria

Lake Victoria is the largest freshwater lake in Africa and the second largest in the world. The lake is positioned in Tanzania, Kenya, and Uganda. Tanzania covers approximately 49% of the lake's area, followed by Uganda by 45% and Kenya by 6% of the total area. The lake covers about 68,800 square Kilometres. In Tanzania, Lake Victoria is found in Mwanza, Kagera, Mara, Geita, and Simiyu regions. It hosts several significant islands, including: Ukerewe Island, the largest island in Lake Victoria and Tanzania in general, covering about 530 square Kilometres, and is among the districts in Mwanza region, as well as the Saanane Island, which is a national park. Additionally, Lake Victoria is one of the primary sources of the Nile River, which flows through South Sudan, Sudan, Ethiopia and Egypt before ending in the Mediterranean Sea.

Lake Tanganyika

Lake Tanganyika is the East African Rift Valley Lake, located in the western part of Tanzania, in Kigoma, Rukwa, and Katavi regions. The lake is also found in the Democratic Republic of Congo (DRC), Burundi, and Zambia. Tanzania covers about 46% of the lake's area, approximately 32,900 square Kilometres, making it the most significant portion compared to other countries. Lake Tanganyika is the longest freshwater lake in the world, stretching 673 Kilometres from North to South. Similarly, Lake Tanganyika is also the second deepest lake in the world and the first deepest in Africa with a depth of 1,470 meters.

Lake Nyasa

Lake Nyasa is the East African Rift Valley Lake, covering an area of about 29,600 square Kilometres. It is the third largest and second deepest lake in Africa, following Lake Tanganyika. Tanzania shares approximately 50% of its area. Lake Nyasa forms part of the southern border between Tanzania and Malawi. In Tanzania, Lake Nyasa is found in the regions of Ruvuma (Nyasa districts), Mbeya (Kyela district), and Njombe (Ludewa district).

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Lake Rukwa

Lake Rukwa is located in the East African Rift Valley in southwestern Tanzania. It is situated within the regions of Rukwa, Songwe, and Katavi. This saline lake is known for its high salinity and presence of soda ash. Half of the lake lies within the boundaries of Katavi National Park, making it an important ecological area. Other Important Lakes in Tanzania include Lake Manyara, Eyasi and Natron. Lake Manyara is a saline and soda lake in the East African Rift Valley, within the Manyara Arusha regions, near Mto wa Mbu and Karatu towns. The lake is known for its unique ecosystem and is home to various bird species such as the flamingo. This lake is part of Lake Manyara National Park, which is known for its diverse wildlife and scenic landscapes.

Lake Eyasi is also a saline lake found in the Karatu district, in the Arusha Region in northern Tanzania. The lake lies within the Rift Valley, southwest of the Ngorongoro Conservation Area. Lake Natron is a highly saline and alkaline lake in northern Tanzania, the Arusha Region, and the Ngorongoro district bordering Kenya. The lake is within the East African Rift Valley, near Oldoinyo Lengai volcanic mountain. The lake is famous for its remarkable red or pink coloured water caused by salt-loving microorganisms such as cyanobacteria. These organisms produce special pigments that appear red or pink, especially when the water decreases and the salt increases.

All these lakes play an essential role in promoting the blue economy. For instance, fishing is a source of income for communities around these areas and contributes to the national economy. Also, these lakes facilitate transportation services and tourism; for example, the clear water and sandy beaches attract tourists in the Mbamba Bay area in the Ruvuma Region. Figure 9 shows the distribution of rivers and lakes found in Tanzania.

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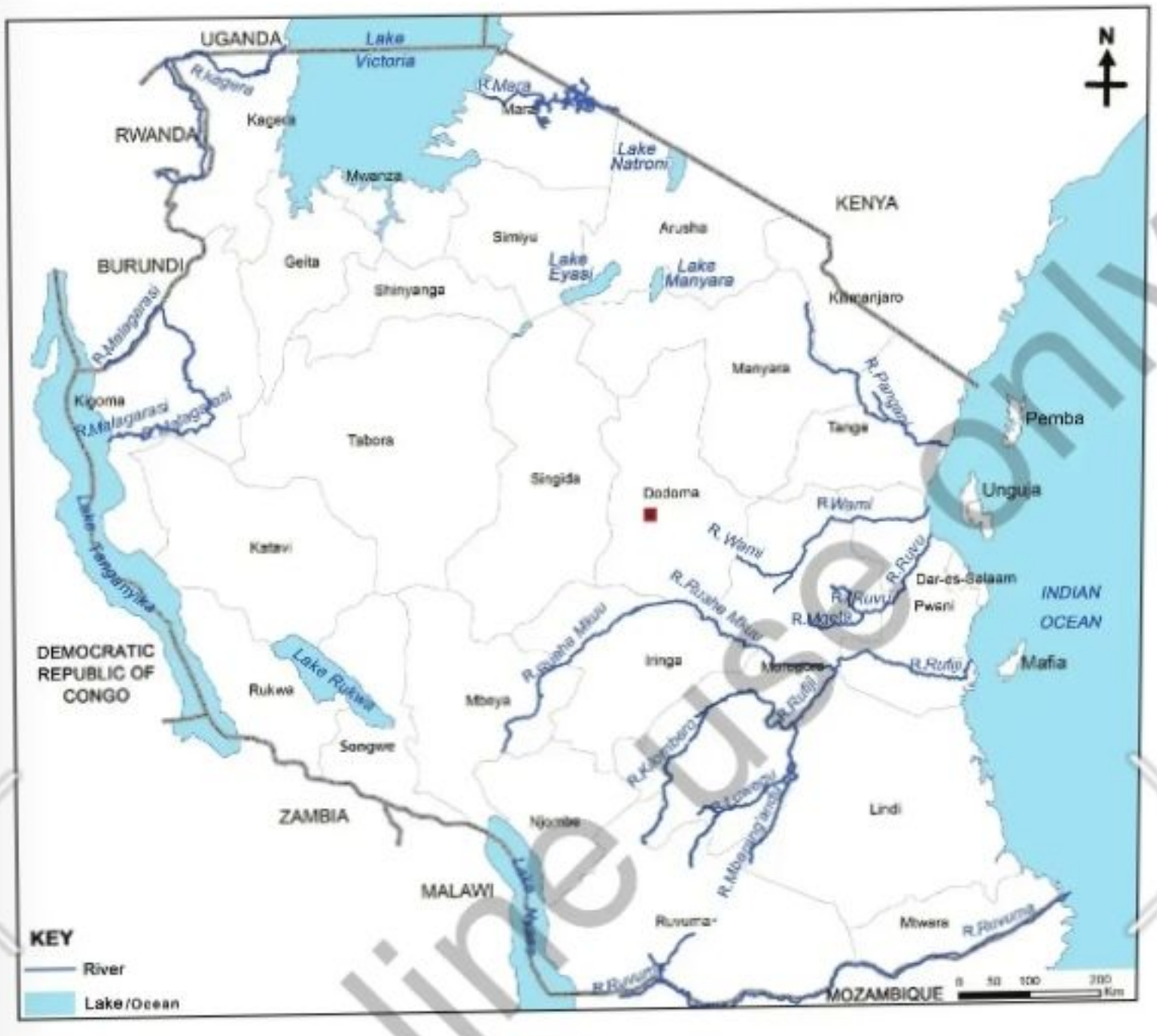

Figure 9: *Distribution of rivers and lakes in Tanzania*

Overall, Tanzania is rich in water resources that contribute to the nation's development, particularly in agriculture, energy, trade, fishing, industry, tourism, and transportation.

Activity 4

Use an Atlas or online reliable sources to read about the water resources available in your region. Then, list them and specify their distribution within the region.

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Indian Ocean

The Indian Ocean is an essential water resource located on the eastern side of Tanzania. The ocean borders five regions of mainland Tanzania: Tanga, Pwani, Dar es Salaam, Lindi, and Mtwara, and it surrounds the islands of Unguja, Pemba, and Mafia, as shown in Figure 9 above. The beaches of the Indian Ocean have natural attractions, including sandy shores, mangrove forests, and coral reefs. The Indian Ocean hosts ports such as Dar es Salaam, Tanga, and Mtwara. The Indian Ocean stimulates the blue economy sectors such as transportation, fishing, trade, and tourism.

Distribution of wildlife resource in Tanzania

Wild animals are mostly found in spefic areas that have water, shelter, food and safety. They prefer to live in peaceful places with water and vegetation for their food. In Tanzania, wild animals are commonly found in national parks, conservation areas, and game reserves. These areas are designated to protect wildlife, plants, water sources, and natural environments from destruction caused by human activities. Due to their unique characteristics, these areas have become significant tourism attractions in the country. Table 1, 2 and 3 summarises some of Tanzania's national parks and conservation areas, game reseves and marine parks respectively. Figure 10 indicates the distribution of these Parks, major protected areas, and conservation areas.

Table 1: Some National Parks and Conservation Area in Tanzania

National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Serengeti	Northwestern (Mara, Arusha, Simiyu)	14,763	Migration of large herds of wild animals such as wildebeest, presence of the "Big Five" and various wildlife species	Part of a major ecological system, vast open grassland plains a UNESCO World Heritage Site, and year-round wildlife presence

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National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Ngorongoro Conservation Area	Northern (Arusha)	8,292	Ngorongoro Crater, Empakaai and Olmoti, Maasai culture, presence of "Big Five" and other wildlife	UNESCO World Heritage Site, one of the largest and most famous craters in the world, coexistence of wildlife, livestock, and human settlements (Maasai, Sonjo, Hadzabe)
Kilimanjaro	Northern (Kilimanjaro)	1,688	Mount Kilimanjaro and birds	Africa's highest mountain (5,895 m), its diverse habitats, and a UNESCO World Heritage Site.
Tarangire	Northern (Manyara, Arusha, Dodoma)	2,850	Large elephant herds, various wildlife species, unique baobab trees, and bird species	Largest elephant herds of any park, iconic baobab trees
Lake Manyara	Northern (Arusha and Manyara)	649	Flamingos, tree-climbing lions, Lake Manyara, hippos, hot springs, and groundwater forest	Alkaline lake, suspension bridge

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National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Ruaha	Southwestern (Iringa and Mbeya)	20,226	Large herds of elephants and buffaloes, other wildlife, the Great Ruaha River, Taiga fish species, cultural sites (Chief Mkwawa's house and Isimila)	The second largest national park in Tanzania
Mahale Mountains	Western (Kigoma)	1,613	Chimpanzees, forests, Lake Tanganyika, Mahale mountain ranges	Chimpanzee habitat, Lake Tanganyika shoreline
Gombe	Western (Kigoma)	56.2	Chimpanzees, Lake Tanganyika	Renowned for chimpanzee research
Mikumi	Eastern (Morogoro)	3,230	Various wildlife such as giraffes, zebras, lions, antelopes and eland hippos dam	Savannah landscape and flat plains
Nyerere	Southeastern (Morogoro, Coast, Lindi, Ruvuma)	30,893	Boat safaris on the Rufiji River, Mwalimu Nyerere Hydroelectric Dam, and a wide variety of wildlife	Largest protected wildlife area in Africa, UNESCO World Heritage Site and the largest national park in Tanzania
Saadani	Eastern (Coast and Tanga)	1,100	Beaches, Wami River delta, various wildlife and green sea turtles	Only park with both marine and savannah environments

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National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Udzungwa Mountains	Southeastern (Morogoro and Iringa)	1,990	Dense forests, rare monkey species (Kipunji) and waterfalls	No roads inside the park, only hiking trails for mountain climbing
Katavi	Southwestern (Katavi)	4,471	Hippos, crocodiles, lions, various antelope species (hartebeest, roan antelope, sable antelope)	Remote area with abundant wildlife
Rubondo Island	Lake Victoria	457	Wildlife, including chimpanzees, sitatunga antelopes and elephants. Rare birds like hornbills, grey parrots, and fish eagles, as well as boat and canoe tourism,	Rare species such as the sitatunga
Saanane Island	Lake Victoria (Mwanza City)	2.18	Boat safaris, wildlife such as rock hyrax, lions, hyenas, monkeys and crocodiles, Klipspringer	The only national park within city boundaries

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National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Kitulo	Southern Highlands (Njombe and Mbeya)	465	Various types of flowers, birds, and waterfalls	"Garden of God" due to its richness in flowers
Mkomazi	Northeastern (Kilimanjaro and Tanga)	3,245	Black rhinos, wild dogs and rare antelopes such as gerenuk, lesser kudu, and dik-dik	Habitat for endangered species
Arusha	Northern (Arusha)	552	Mount Meru, Lake Momela, black and white colobus monkeys	Landscape of savannah and forest
Burigi-Chato	Northwestern (Geita)	4,707	Hippos, birds	New national park in Tanzania
Ibanda-Kyerwa	Western (Kagera)	294	Kagera River and various wildlife, including leopards, lions, hippos, and buffalo	Remote area with serene and unique landscapes
Rumanyika-Karagwe	Western (Kagera)	247.5	Wildlife, many ponds, and mountains	Quiet landscape near the Uganda border

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National Park and Conservation Area	Location	Size (square km)	Attractions	Uniqueness
Ugalla River	Western (Tabora)	3,865	Hippos, crocodiles, lions, elephants, wild dogs, topi elands, storks, sable antelopes, roan antelopes, buffaloes, duikirs warthogs, oribis, reedbucks, bushbucks	Rivers and wetlands with abundant large hippos and crocodiles in Africa
Kigosi	Northwestern (Geita, Kagera, Shinyanga, Tabora)	8,265	Wildlife like otters, hartebeest, bushbucks, waterbucks duikers, crocodiles, hippos; Rare birds such as shoebill storks, bearded vultures, and pygmy geese; miombo woodlands	The largest wetland in East Africa, home to rare bird species such as storks
Jozani-Chwaka Bay	Unguja (South Zanzibar)	50	Red colobus monkeys, forests, birds, and butterflies	UNESCO World Heritage Site, the only national park in Zanzibar

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Table 2: Some game reserves in Tanzania

Game reserves	Location	Area in km²
Ikorongo and Grumet	Mara	5000
Selous	Lindi and Pwani	18020
Maswa	Simiyu	2200
Mpanga Kipengere	Njombe and Mbeya	1574.3
Kijereshi	Simiyu	82
Lukwati and Piti	Songwe	6118.9
Moyowosi	Kigoma	6000
Mkungunero	Dodoma and Manyara	743.9
Swagaswaga	Dodoma and Manyara	871
Luganzo-Tongwe	Katavi, Tabora and Kigoma	5746.2
Rungwa	Singida and Mbeya	9000
Muhesi	Singida	2000
Kizigo	Singida	4000
Liparamba	Ruvuma	570
Lwafi	Rukwa	2228
Lukwika Lumesule	Mtwara	444
Msanjesi	Mtwara	210
Pande	Dar es Salaam	15
Rukwa	Katavi	4000
Ugalla	Tabora	7577.4
Uwanda	Rukwa	5000
Wamimbiki	Morogoro and Pwani	2466.6
Inyonga	Katavi	6569.9
Wembere	Tabora and Singida	5385.8
Igombe	Tabora	1367.1

Source: *https://www.tawa.go.tz/*protected-areas

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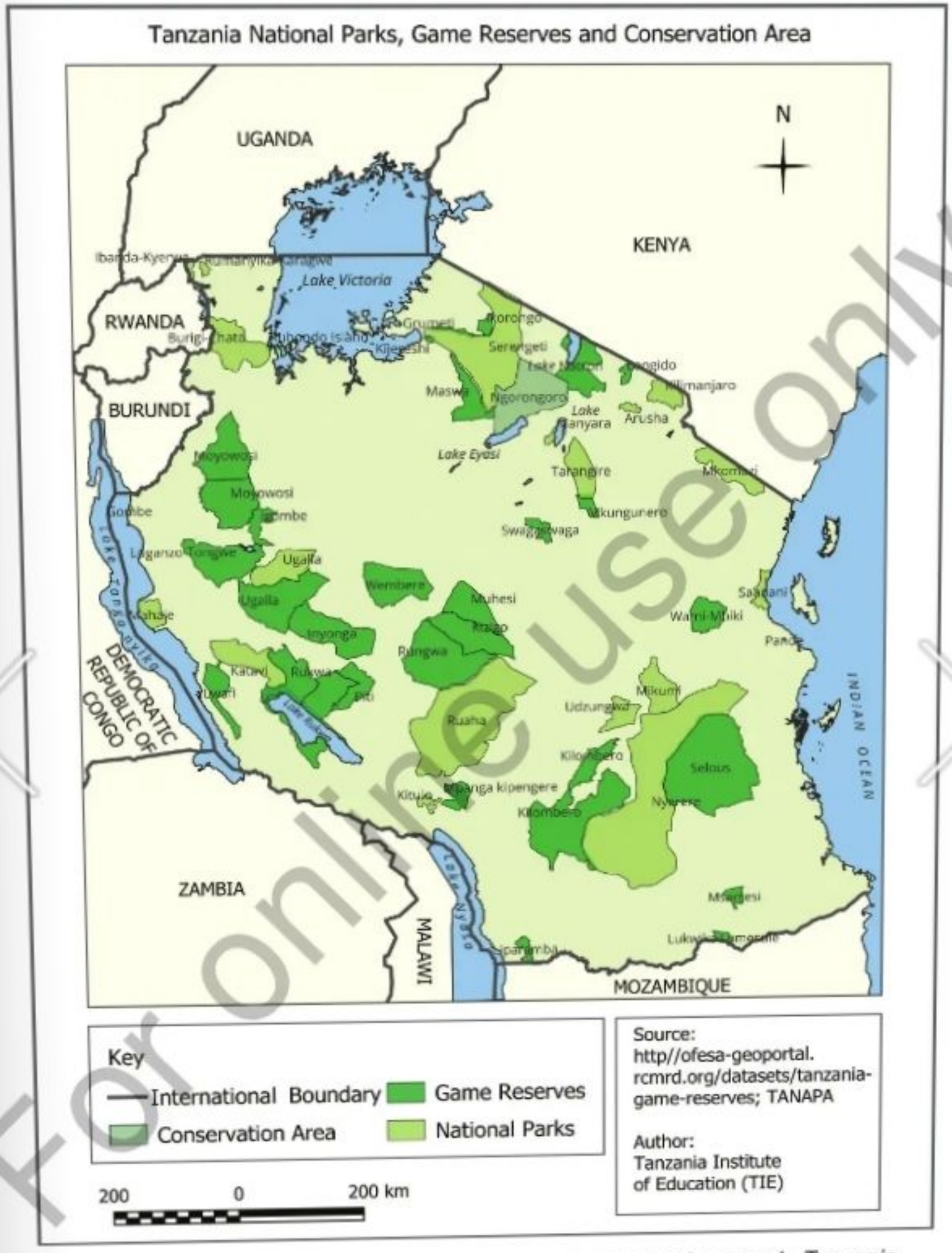

Figure 10: *National parks, game reserves and conservation area in Tanzania*

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Activity 5

Using reliable online sources, read about the reasons and importance of the Ngorongoro Conservation Area and the Serengeti National Park being UNESCO World Heritage Sites.

Besides land-based protected areas, Tanzania has a good marine reserve system that protects marine biodiversity and provides unique tourism opportunities. These reserves are managed by the Marine Parks and Reserves Unit (MPRU). Table 3 presents some of the marine reserves in Tanzania.

Table 3. Some of the marine parks in Tanzania

Reserve name	Location	Attractions	Unique features
Mafia Island	South (Coast)	Mangroves, seagrass, coral reefs, islands (Shungimbili, Nyororo)	Presence of rare creatures like hippos and colourful fish
Mnazi Bay	South (Mtwara)	Mangroves, saltwater	Marine environment with hippos and saltwater fish
Tanga Silikanti	North (Tanga)	Coral reefs, colourful fish	Stunning scenery for divers
Dar es Salaam Marine Reserve System (DMRS)	Dar es Salaam	Islands (Bongoyo, Mbudya), military birds, coral reefs, sea cucumbers	Sea cucumbers – the largest marine invertebrates

Exercise 2

1. Use examples to explain the difference between national parks, a conservation area, and game reserves.
2. Which National Park in Tanzania experiences migration of large herds of wildbeest yearly?
3. What unique feature differentiates Lake Manyara National Park from other national parks?
4. Which National Park is a research site for chimpanzees?
5. What characteristics distinguish wild animals known as the 'Big Five'?

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Energy resource distribution

Tanzania has several energy resources, including renewable and non-renewable sources, which contribute to economic development and address electricity needs. The following are some of the important energy sources available in Tanzania.

Natural gas energy

Tanzania has rich natural gas resources, mainly found in Lindi and Mtwara regions, where the first discoveries were made in 1974 in Songo Songo Island (Lindi) and 1982 in the Mnazi Bay area (Mtwara). Presently, more natural gas deposits have been discovered in deep-water areas of the Indian Ocean in these two regions. Natural gas is important for the national economy as it generates about 50% of the country's electricity through gas processing plants, such as those in Madimba (Mtwara). Natural gas is used in industries, transportation (including cycle rickshaws and vehicles) and cooking. Natural gas also contributes to national revenue through export to neighbouring countries such as Burundi, Malawi and Uganda. Tanzania also aims to increase natural gas exports to the Democratic Republic of the Congo, Kenya, and Zambia.

Oil energy

Oil exploration activities in Tanzania began in 1952. Until now, Tanzania has signed contracts with various companies for oil exploration. However, Tanzania still plays a significant part in the *East African Crude Oil Pipeline (EACOP)* project, which runs from (Hoima) in Uganda to the Tanga region in Tanzania. The implementation of this project started in 2022 and is estimated to be completed by 2026. Upon the completion of the project, it will contribute to the development of the economy and energy sectors in Tanzania.

Hydropower, solar, and wind energy

Water, solar, and wind projects are essential for promoting the energy sector in Tanzania. For example, there is wind power project in the Singida region. In addition, the Julius Nyerere Hydropower Project on the Rufiji River. Moreover, more hydroelectricity is produced at the Mtera, Nyumba ya Mungu, and Kidatu dams.

The relationship between Tanzania's natural resources and development activities

Tanzania's natural resources are essential to the country's development activities. Fertile land, minerals, water, and forests provide a solid foundation for the growth

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of various sectors, including agriculture, fishing, construction, energy, tourism, and industry. The effective use of these resources encourages economic growth, social well-being, and environmental sustainability. The following are some developments in various sectors triggered by natural resources availability in Tanzania.

Developments in the fishing sector

Natural resources in Tanzania play a crucial role in the development and sustainability of the fishing sector. Water resources are the mainstay for the development of this sector and for promoting the blue economy. Major lakes such as Lake Victoria, Tanganyika, and Nyasa are habitats for various fish species, including Nile perch, tilapia, catfish, sardine, kampango, kamongo, migebuka, and others. Rivers like Rufiji, Ruvuma, Wami, Ruvu, and Pangani also contribute to fishing, providing species like mudfish, lungfish, kumba, pale, kambale, perege, kamongo, ngocho and kitoga. The Indian Ocean offers opportunities for catching fish such as octopus, crabs, prawns, tasi, vibua, changu and kolekole. These water resources serve as breeding and production grounds for fish, ensuring the long-term viability of the fishing sector. Fish provide food for communities and are sold domestically and internationally, increasing individual and national income. In addition, the development of fisheries sector and the blue economy largely depend on the availability and proper management of water resources.

Developments in the agricultural sector

The presence of fertile land, (nutrient-rich soil) and favourable climatic conditions has contributed to the successful crop production such as maize, rice, potatoes, cassava, coffee, tea, tobacco, sunflowers, beans, vegetables, and fruits. Tanzania also has water resources from rivers, lakes, and groundwater, which are used for irrigation, especially in areas with low rainfall. These natural resources support subsistence and commercial agriculture and employ many of the population. Better management and investment in these resources are essential to increase opportunities within the agricultural sector and promote the blue economy in Tanzania.

Developments in the mining sector

The presence of many mineral deposits in Tanzania provides a solid basis for the growth of the mining sector, which is one of the key contributors to economic development. Gold, in particular, has contributed to the country's revenue by providing export products and attracting significant foreign investment. The mining of tanzanite, a precious gemstone found only in Tanzania, has placed

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the country on the global map as a leader in mining these rare minerals.
The mining sector also benefits from a large reserve of coal, which is used for industrial electricity production and export. The availability of minerals such as limestone and phosphates has also supported the growth of industries like cement manufacturing and fertiliser production, thereby contributing to the expansion of the mining sector. Thus, with good management and investment in Tanzania's mineral resources, there is a potential for significant economic development, job creation, and poverty reduction.

Developments in the energy sector

Energy resources such as oil, natural gas, and coal, are essential in meeting the country's growing energy demands. Natural gas, in particular, has become a primary energy source for electricity generation, as it is used in gas-fired power plants, providing a cleaner and more efficient alternative to traditional energy sources like biomass, charcoal, and firewood. In addition to natural gas, Tanzania also has large coal reserves, which are utilised for industrial energy production and export. These resources are essential for expanding the national grid, increasing electricity access, and improving energy security in the country.

Tanzania is also rich in renewable energy resources, including solar and wind. Biogas is also a renewable energy resource found in Tanzania which is produced from animal wastes, food wastes and sewage wastes. These forms of energy have a large capacity for electricity production. Due to several rivers, dams, and lakes suitable for power generation, the country has great potential to generate electricity using hydropower. Solar and wind energy availability can also support the development of clean and sustainable energy. The availability of these natural resources presents an opportunity for the country to reduce dependence on imported energy. This promotes economic growth through affordable and reliable energy sources.

Developments in the industrial sector

Tanzania is endowed with numerous natural resources that contribute to the development of the industrial sector. Various minerals such as gold, diamonds, tanzanite, coal, and other industrial minerals like limestone, phosphates, and salt serve as raw materials for different industries. Gold and precious gemstones, for example, contribute to the growth of the jewellery industry, while limestone is used in cement manufacturing. The availability of salt and phosphates aids in the chemical and fertiliser production industries, which are required for agriculture.

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The abundant water resources in the country provide essential support for water dependent sectors, such as beverage production and food processing industries. The existence of forests also supplies raw materials for the wood and paper industries. Similarly, extensive agricultural lands support processing industries related to food, textiles, and other agricultural products. Examples of processing industries include the *Bakhresa Food Products* beverage processing plant located in Mwandege, in Mkuranga district, in Pwani region; the TANICA coffee processing plant in Bukoba municipality, Kagera region; and the Mtibwa sugar factory in Mvomero district and Kilombero sugar factory in Kilombero districts, Morogoro region.

The development of these industries contributes to job creation, economic growth, and the domestic and international trade sectors. Effective management and investment in these resources are essential to maximising Tanzania's industrial sector's potential.

Developments in the tourism and wildlife management sector

Tanzania is blessed with diverse terrestrial and marine environments. The terrestrial environment includes savannas, forests, and grasslands and marine environment include the ocean and its beaches which make it a significant destination for wildlife and eco-tourism. The rich biodiversity, featuring iconic species such as elephants, lions, giraffes, buffalo, and rhinos, draws tourists worldwide. National parks like Serengeti, Ruaha, Nyerere, Tarangire, and the Ngorongoro Conservation Area are among the key sites that attract tourists and contribute mainly to the country's revenue.

Apart from terrestrial wildlife, Tanzania is also rich in marine resources such as coastal areas, Zanzibar Islands provides beautiful beaches, marine life, and coral reefs, which increase tourists' attraction and promote the tourism sector. Natural resources like freshwater lakes, such as Lake Tanganyika, Lake Nyasa, and Lake Victoria, also provide opportunities for water-related tourism, including fishing, boat safaris, and lakeside hotels.

In addition, forests and national parks play a central role in biodiversity conservation, helping to protect endangered species and maintain ecological balance, which supports the tourism sector in Tanzania.

In general, Tanzania's rich natural resources provide a basis for the growth of the tourism and wildlife management sectors, creating significant employment opportunities, improving the economy, and preserving the country's natural

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heritage. The effective management and sustainable use of these resources is important for the long-term success of the tourism industry in Tanzania.

Developments in the construction and infrastructure sector

Natural resources play a significant role in Tanzania's construction and infrastructure sector. The country has essential materials such as limestone, clay, and sand, which produce cement, bricks, and other construction materials. Limestone is used for building roads, houses, and commercial buildings. In contrast, sand and clay serve as key raw materials for brickmaking. On the other hand, forests provide timber used in the construction and manufacturing of furniture and other wooden products. These resources demonstrate how natural materials contribute to improving infrastructure and advancing the construction sector in Tanzania. The better use and management of these resources is needed for the sustainable development of the construction and infrastructure sector.

Developments in the business sector

The available natural resources significantly contribute to the development of the business sector in Tanzania. The presence of minerals and precious gems has created opportunities for both domestic and foreign investment. Thus stimulating businesses in the processing, transportation, and marketing sectors. Agriculture benefits from fertile land and a favourable climate. This supports food processing, packaging, and distribution businesses locally and internationally. Natural resources also foster entrepreneurship and job creation, contributing to individuals' economic growth. Proper use of these resources can help Tanzania attract more investments and strengthen local businesses. It can also help Tanzania, achieve sustainable development in the business sector.

Developments in the transportation sector

Water resources, such as lakes and rivers, play a significant role in Tanzania's transportation sector, including the transportation of passengers and goods, especially in areas that are difficult to access by road. For example, the development of the Kigoma Port on Lake Tanganyika, which transports passengers and cargo to Democratic Republic of Congo, Zambia, and Burundi; the Mwanza Port on Lake Victoria, serves transportation to the regions surrounding Lake Victoria; and the Mbamba Bay Port located on Lake Nyasa in Ruvuma region, which facilitates water transport to Malawi. Also, coastal ports such as Dar es Salaam, Mtwara, and Tanga provide maritime transport opportunities, supporting trade within the country and international trade by connecting Tanzania to the

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global markets. Land resources also contribute to the transportation sector by constructing roads, railways, and airports, thus improving the country's overall transportation infrastructure, as shown in Figures, 11, 12 and 13.



Figure 11: *Mfugale bridge in Dar es Salaam*



Figure 12: *Julius Nyerere International Airport in Dar es Salaam*



Figure 13: *Tanzania Standard Gauge Railway*

In summary, Tanzania's rich natural resources provide a solid foundation for developing various economic sectors and enhancing the lives of its people. Better management and strategic investment in these resources are essential for achieving sustainable economic growth in the country.

Exercise 3

1. If you were tasked to plan development projects using the water resources available in your region, what kind of projects would you propose to be established?
2. What methods can be used to ensure the sustainability of water resources in the country?
3. Provide examples of opportunities that come from forest resources.
4. In one paragraph, explain the blue economy. Use the following points:
   (a) Meaning;
   (b) Sectors involved; and
   (c) Importance of the blue economy.

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Revision exercise

Section A: Choose the latter of the correct answer

1. Which of the following is a non-renewable resource?
   (a) Water
   (b) Sunshine
   (c) Fuel
   (d) Wind

2. In which part of Tanzania, is the tanzanite mineral found?
   (a) Bulyanhulu
   (b) Mwadui
   (c) Mererani
   (d) Uvinza

3. On which river in Tanzania is the Nyerere hydroelectric dam built?
   (a) Ruvuma River
   (b) Pangani River
   (c) Rufiji River
   (d) Wami River

4. To promote the blue economy sector, what sustainable use of resources should we focus on?
   (a) Minerals
   (b) People
   (c) Water
   (d) Land

5. Which natural resources does the development of the agricultural sector mostly depend on?
   (a) Water and minerals
   (b) Land and energy
   (c) Land and minerals
   (d) Water and land

Section B: Matching items questions

6. Match the water resources of Tanzania listed in Column A with the corresponding countries they border in Column B.

No.	Column A	Column B
(i.)	Lake Victoria	(a) Mozambique

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No.	Column A	Column B
(ii.)	Lake Tanganyika	(b) Uganda, Rwanda and Burundi
(iii.)	Lake Nyasa	(c) Kenya and Uganda
(iv.)	Ruvuma River	(d) Democratic Republic of Congo, Burundi, and Zambia
(v.)	Kagera River	(e) Malawi

Section C: Short answers question

7. How do mineral resources contribute to the development of Tanzania's economy?
8. With examples, explain the natural resources found in the Ruvuma and Mtwara regions.
9. What important features differentiate Ngorongoro Conservation Area from Serengeti National Park?
10. Explain with examples how the blue economy contributes to the development of Tanzania.

Vocabulary

Blue economy	economic activities linked to water resources
Biodiversity	a variety of living organisms in an area
Capital resources	tools, machines, and infrastructure used for production
Delta	a landform at the mouth of a river which is created by sediment deposits
Export	selling goods to other countries
Game reserve	a protected area for wildlife where regulated hunting may be allowed
Gemstones	precious stones used in jewellery
Hydropower	electricity which is generated using moving water

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Human resources	people's skills, knowledge, and labour
Infrastructure	physical systems like roads, buildings, and electricity
Irrigation	the supply of water to crops to help growth, typically by means of channels
National park	a large area of natural land protected for conservation and tourism
Rift Valley Lake	a lake formed due to tectonic activity in the East African Rift Valley
Saline lake	a lake with high salt content
Sustainable use	using resources wisely to ensure they last
Tributary	a smaller river or stream that flows into a larger one

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Chapter Two

Population distribution and the use of natural resources

Introduction

Population distribution can either promote or hinder the sustainable use of natural resources. As the population increases and spreads across various areas of Tanzania, the demand for natural resources such as water, land and energy also rises. In this chapter, you will learn about the meaning and types of population distribution, the geographical and human factors of population distribution, and the relationship between population distribution and the use of natural resources. Additionally, you will learn about the impacts of population distribution on the environment. The competencies developed will enable you to conserve natural resources for sustainable use.



Think

The impact of population distribution on the use of resources available in your community

Concept of population distribution

The meaning of population distribution

Population distribution refers to how people spread across different geographical areas, such as countries, regions, districts, cities, wards, and villages. Population distribution varies from one area to another. There are areas with many people, average number of people, and areas with few people.

Types of population distribution

The types of population distribution explain how people are spread across different areas. There are three main types of population distribution, which are:

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Clustered population distribution

This refers to a situation where people concentrate in one area for settlement or engagement in various social and economic activities. For example, the population in urban areas such as Dar es Salaam, Dodoma, Mwanza and Arusha, or in areas rich in resources and economic opportunities. Figure 1 indicates clustered population distribution.



Figure 1: *Clustered population distribution*

Uniform population distribution

This refers to a situation where people are evenly spread across a large area. The number of people is about the same in different places, with no area having more or fewer people. This type of distribution often happens in farming areas, where people live based on resources like water or fertile land for growing crops. Figure 2 indicates uniform population distribution.

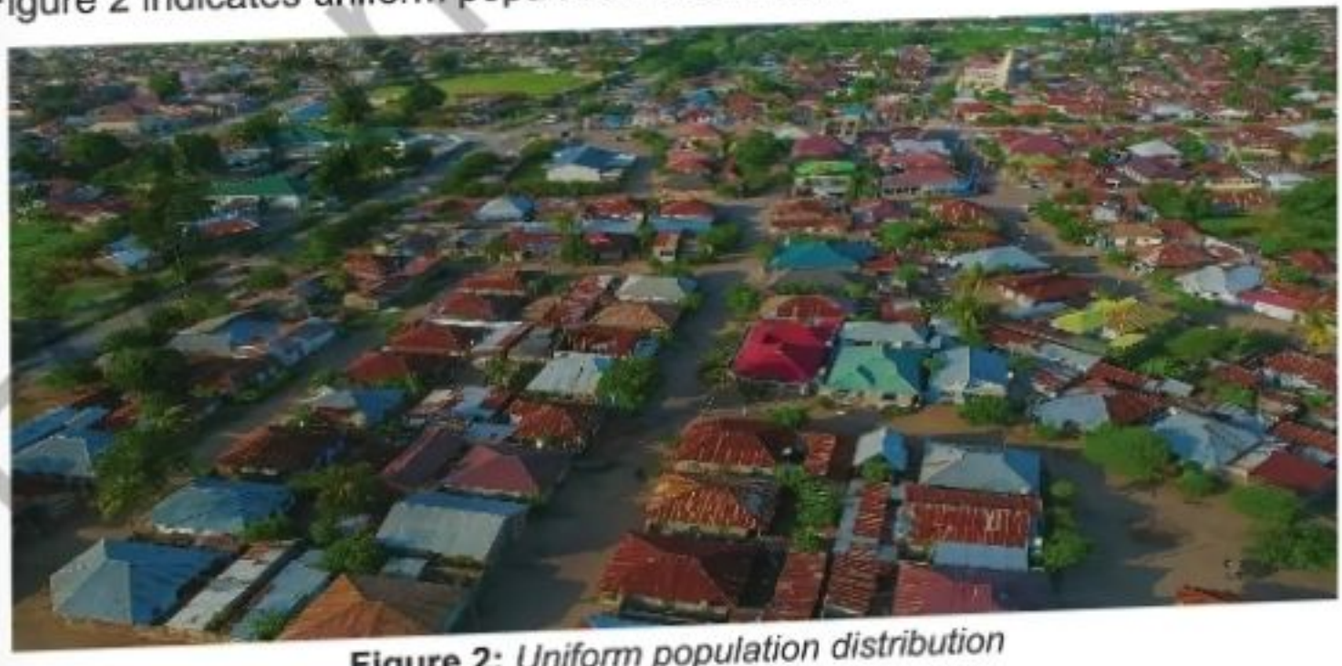

Figure 2: *Uniform population distribution*

Sparse population distribution

This refers to a situation where people live in scattered arrangements across large areas without a specific arrangement. It often occurs in rural or challenging environments, where resource availability is limited and people may live far from one another. Figure 3 indicates sparse population distribution.



Figure 3: *Sparse population distribution*

Activity 1

Observe the population distribution in your village or street, and then write a summary describing the type and reasons for the population distribution you observed.

Factors affecting population distribution

Population distribution results from various factors. These can be geographical factors such as climate, relief, soil fertility, availability of water resources, and minerals or human factors like infrastructure, social services, politics, business, and the growth of technology and industries. All these factors are important in making decisions about where to live.

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Geographical factors

Climate

Climate refers to the long-term weather conditions of a specific area, often thirty years or more. The climate of a place significantly contributes to population distribution. Areas with moderate temperatures, abundant rainfall, and sufficient humidity attract many people for farming and living. In these areas, there are many people, leading to a dense or uniform population distribution. On the other hand, areas that are extremely hot or cold, such as deserts or mountainous regions, tend to have fewer people, resulting in sparse population distribution. This is because the weather in these areas is not conducive to human health, agriculture and other social and economic activities; therefore, people are not attracted to settle in such areas. Additionally, changes in climate, such as rising temperatures or droughts, also affect population distribution, as people are forced to move from affected areas to seek environmentally safe places.

Relief

Areas with gentle slopes attract more people because they are suitable for settlement, agriculture and infrastructure development. As a result, many people choose to live in such areas. In contrast, mountainous regions, steep slopes and large valleys tend to have fewer people. This is because it is difficult to carry out construction, agriculture, and infrastructure development in these areas.

Availability of water resources

Water is essential for human life. The availability of water resources such as oceans, rivers, lakes, dams and groundwater significantly contribute to the high population density in an area. This is because water resources are required for various economic activities, including agriculture, fishing, transportation and tourism which generate income to people. Furthermore, areas with water resources provide reliable access to water for drinking, cooking and sanitation purposes. Such areas offer attractive environments due to pleasant weather and existing vegetation. Therefore, areas with water resources typically support larger populations because water is a fundamental need for human survival.

Soil fertility

Soil is one of the geographical factors that influences the distribution of people in various areas. Fertile soil promotes the growth of crops and pasture. People are attracted to live in these areas to engage in farming and livestock keeping. The population in these areas increases rapidly because they have a reliable food supply. However, infertile soil does not support crop growth, leading to

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food shortages. Therefore, people tend to avoid living in such areas due to the uncertainty of sufficient food. This situation leads to a sparse population distribution in these areas.

Minerals

Minerals are valuable resources extracted from the ground. Areas rich in minerals often provide various opportunities due to mining activities. These opportunities include jobs in mines, businesses related to food, clothing, accommodation, entertainment places, and financial services. There are also transportation opportunities to serve the workers, other residents, and to transport various goods. People are attracted to live in areas with these resources to take advantage of the available opportunities. Additionally, people are attracted to these places because they experience rapid development, such as roads, schools, and hospitals.

Human Factors

Human factors refer to social, economic, political, and cultural aspects that influence the distribution of people in various areas. Some of these factors include the following:

Infrastructure

Infrastructure such as roads, bridges, communication systems and electricity influence people's selection of where to live. Areas with good infrastructure like Dar es Salaam, attract many people because they are easily accessible. Furthermore, such infrastructure facilitates business and improves the quality of life. As a result, this situation causes an increase in the population in these areas.

Social Services

The availability of social services such as healthcare, education and housing affects the distribution of people within wards, districts or regions. For example, in Tanzania, urban areas have better social services compared to rural areas. More people choose to move from rural areas to establish homes in urban areas to be closer to quality healthcare and education for their children. For instance, the presence of referral hospitals and universities in large cities attracts people from other areas, leading to a higher population in urban areas.

Political decisions and government policies

Political decision and government policies can significantly affect the distribution of people. For example, the decision of the government to shift headquarters

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to the city of Dodoma has led to infrastructure development and has increased the population of that city.

Business and economic opportunities

Areas with many business opportunities attract many people due to employment and investment opportunities. In Tanzania for example, Dar es Salaam city is a major business hub where jobs are available in sectors like trade, manufacturing and services. For example, the Dar es Salaam Port is the largest in East Africa and serves as a key gateway for international trade. Thus, attracting businesses and investors.

Technological development

Technological development leads to an increase in the population in some areas. For example, digital technology, the internet, and mobile phone networks have attracted many people to live in areas where these services are available. Additionally, improvements in mobile financial transaction services offered by different mobile network companies have facilitated easy and quick access to financial services. This encourages significant business activity and attracts people to live in these areas in search of business opportunities.

Industrial development

Industrial development and companies are among the factors that influence the distribution of people. The development of industries in Tanzania has led many people to move to areas with factories in search of employment and business opportunities. For example, Dar es Salaam, Dodoma, Tanga, Mwanza, Mbeya, and Arusha regions attract more people due to the availability of various industries such as agriculture and food processing, fisheries, manufacturing, shipping and mineral procesing industries.



Activity 2

Read various reliable sources about the distribution of people in the regions of Tanzania. Then, examine the region you live in, and explain the geographical and human factors that have led to the identified population distribution.

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Exercise 1

1. Explain why some places have fertile soil for farming, but only a few people live there.
2. Provide reasons why areas of the Dar es Salaam city have clustered population distribution compared to other regions of Tanzania.

The Relationship between population distribution and the use of natural resources



Activity 3

Observe the number of pupils in your school, then write a summary explaining its relationship with available resources such as classrooms, sports fields, and toilet facilities. Write a conclusion for your summary focusing on the impact of the identified pupils' population on the use of available resources.

Human life depends on resources to carry out various activities. The use of resources varies from one place to another. This is due to the distribution of people in those areas. Therefore, there is a significant relationship between population distribution and the use of natural resources as follows:

The level of resource demand

Areas with large populations, such as major cities, have a high demand for resources like water, energy and land. Due to the large number of people, many resources are used in large quantities for various uses. For example, land resources can be used for building housing, industries, hospitals, schools, businesses, and for agriculture. Additionally, energy may be used heavily in industries and households, leading to shortages of these sources. Generally, the demand for natural resources in densely populated areas is high. This results in the overuse of a single resource by a large population exceeding its availability. This situation affects the sustainability of the resource concerned. In areas with fewer people, the demand for natural resources is low because they have limited use. For example, water resources in areas with fewer people are used primarily for household activities such as drinking, cooking, laundry, and bathing. Thus, resources in these areas can be utilised more efficiently without rapid depletion or destruction.

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Access and distribution of resources

Areas with fewer people may have abundant natural resources, such as water or energy, but the challenge can be in how such resources are distributed across the community. Thus, in these areas, there is low competition for resources, but poor access is caused by higher distribution costs. For example, poor infrastructure and long distances to essential services like water and electricity make it difficult to access resources. This leads to a low level of resource utilisation. In areas with clustered populations like urban centres, the distribution technology may be of high quality so that resources are easy to access, but there is high competition for their use. This results in the risk of resource depletion or destruction. Therefore, the large population leads to high resource usage, which can affect the sustainability of the resources.

Management and conservation of resources

In areas with fewer people, the management of natural resources can be easier due to the lower demand for these resources. In such areas, resources can be used more efficiently and controlled more easily by establishing sustainable usage practices and the involvement of citizens in the use. On the other hand, in densely populated areas, the increase in population leads to significant pressure on natural resources. This results in conflicts over usage, environmental degradation, and other challenges in resource management. Therefore, the management of natural resources in densely populated areas requires modern and sustainable strategies for resource use to reduce harmful environmental impacts.



Activity 4

Observe the uses of available natural resources in your village or street, then explain how those uses reflect the sustainability of those resources.

As the population increases, the use of natural resources also rises. Resources such as water, land, energy and forests are utilised more to meet people's needs. This is because people require food, clothing and shelter and all of these depend on available resources. Therefore, it is important to understand this relationship to ensure that we use resources carefully for the benefit of today and future generations.

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Activity 5

Using various reliable sources, including online ones, read about how population growth affects the use of energy resources in Tanzania.

The relationship between population distribution and environmental conservation

Meaning of environmental conservation

Environmental conservation is the act of using available resources in the environment sustainably. It is important to conserve our natural resources so that we can continue to use them for the current and future generations. Moreover, environmental conservation largely depends on the distribution of people in the specific area. This is because population distribution determines the level of resource use, conservation and management of the relevant resources.

Effects of population distribution on the environment

There is a significant relationship between population distribution and environmental conservation. In densely populated areas, resource use tends to be high. When resource consumption is high and not sustainable, it leads to environmental degradation. Therefore, when we fail to conserve these resources, the following effects may occur on the environment:

Deforestation

In highly populated areas, the use of forest resources such as trees for firewood and charcoal, unsustainable farming practices and the expansion of residential areas lead to deforestation. This results in climate change and the destruction of wildlife habitats. On the other hand, areas with fewer people or a balanced population distribution have sufficient land for agriculture and housing, which in turn helps to conserve the forest environment.

Pollution and shorteage of water resources

Population distribution, especially in densely populated areas, can pollute water sources. This is because these areas often produce waste products from households, farms, fishing tools and industries. This situation negatively affects water quality and contributes to the spread of waterborne diseases, which impact

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human health and other living organisms. Additionally, excessive water use can deplete water sources, leading to water shortages for communities and the loss of habitats and breeding grounds for aquatic life. In contrast, areas with fewer people or a balanced population distribution experience low water resource use, resulting in the sustainability of the water sources.

Land degradation

In densely populated areas, land is overused for activities such as agriculture, residential construction, commerce, industry and various social activities. This leads to land degradation, including loss of fertility, soil erosion, and drought. In contrast, areas with fewer people tend to use land sustainably because fewer activities take place. Thus, the land does not easily become exhausted or lose its fertility.

Insufficiency of energy resources

Due to the increasing energy demand, densely populated areas often face energy challenges, especially in rural areas, where firewood and charcoal is their main energy sources. The higher demand of firewood and charcoal leads to deforestation and damaging the natural environments. Additionally, high demand for water resources, particularly in urban areas, affects the availability of hydroelectric power. This is because water depths rapidly decrease leading to impacts on the acquatic organisms.

Degradation of ecosystems and biodiversity

Population distribution, especially in highly populated areas, reduces natural habitats and contributes to ecological degradation. This occurs due to the excessive use of natural resources such as forests, land and water. As a result, there is a decline in biodiversity and the destruction of habitats for animals and plants. This situation threatens ecological balance. The loss of biodiversity can have significant impacts on food security. It also affects the survival of both animals and plants.

Methods of environmental conservation

When the population increases in a particular area, it is important to use the available resources carefully to prevent negative impacts on the environment. The following are the methods that promote sustainable environmental conservation:

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Providing environmental conservation education

Education is a vital way to bring about change in any community. Communities should be educated on effective waste management practices to help keep urban areas clean. This will help prevent outbreaks of diseases caused by pollution.

Using sustainable agricultural practices

Communities should be educated and encouraged to adopt sustainable agricultural practices. These practices include: avoid farming along riverbanks to protect water sources and promoting organic farming instead of using chemical fertilisers to reduce soil degradation. Also, practising contour farming and avoiding cultivation on steep slopes to prevent soil erosion. In addition, the burning of forests when preparing farmland should be avoided to preserve forests and wildlife. When these methods are applied correctly, the land and water resources will be conserved for sustainable development.

Improving urban planning and infrastructure

Urban planners should develop plans for residential areas, offices, schools, markets and sports fields. Since people travel within cities, roads, bike paths, and public transportation systems should be clearly defined. This will help enhance public transport systems, thereby reducing traffic congestion. An urban plan clarifies land resource usage and prevents improper land use. Well-organised cities facilitate waste management and recycling systems. Thus, contributing to ecological health, improving air quality, and enhancing the quality of life for urban residents.

Encouraging urban tree planting and protecting green spaces

Various measures can protect green spaces in cities. These measures include; implementing strict laws to prevent deforestation and unplanned construction, regulating mining activities to ensure they observe environmental conservation, promoting the use of eco-friendly technologies in agriculture and industry, planting trees and restoring degraded forests, and investing in renewable energy sources such as wind and solar instead of firewood and charcoal.

Generally, population distribution should be balanced so that existing natural resources are used sustainably. The government should improve services in both urban and rural areas to reduce migration of people to cities.

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Exercise 2

Answer the following questions:

1. Explain the effects resulting from a large population on the environment.
2. How can communities conserve green spaces?
3. Explain how the government can manage environmental conservation in large cities like Dar es Salaam and Mwanza.
4. Why is it easier to manage the environment in areas with sparse population or uniform population distribution?
5. Using the saying 'Take care of the environment and the environment will take care of you', write an essay to encourage people living in densely populated areas to conserve the environment.

Revision exercise

Section A: Choose the letter of the correct answer

1. What are the main reasons contributing to the overcrowding of people in mining areas such as Geita?
   (a) Presence of roads
   (b) Clean weather
   (c) Economic and employment opportunities
   (d) Availability of health services
2. Which of the following is the proper way of managing and conserving natural resources?
   (a) Preventing people from using natural resources completely
   (b) Allowing citizens to use natural resources without restrictions
   (c) Involving citizens in planning the use of natural resources
   (d) Allowing investors to use resources without conditions
3. Which of the following ways can be used to reduce the impact of excessive use of natural resources in densely populated areas?
   (a) Encouraging people to migrate to urban areas
   (b) Increasing the number of primary schools
   (c) Implementing proper land use planning
   (d) Reducing product prices in rural areas

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4. Which of the following is the effect of sparse population distribution in a particular area?
   (a) High consumption of natural resources
   (b) Major environmental degradation
   (c) Low consumption of natural resources
   (d) Shortage of agricultural land

5. What challenge can an area with sparse population face in utilising natural resources?
   (a) Scarcity of natural resources
   (b) Limited access to natural resources
   (c) High usage of gas
   (d) Lack of natural environment

Section B: Matching items

6. Match the item in column A with the corresponding item in column B to get the complete meaning.

No.	Column A	Column B
(i)	High use of natural resources	(a) Resources are easily accessible
(ii)	An area with sparse population distribution	(b) Has few people due to water scarcity and harsh living conditions
(iii)	An area with clustered population distribution	(c) Causes environmental degradation
(iv)	Desert areas	(d) Has many people due to easy access to essential services
(v)	Areas with good infrastructure	(e) Resource accesibility is limited
		(f) Leads to an increase in resources
		(g) Has many people due to access to land and minerals

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Section C: Short answers questions

7. Explain how the increase in population in Dodoma city can affect the use of available natural resources. What immediate measures should be taken to mitigate these effects?

8. If the population in your community is increasing rapidly, what environmental impact may arise? What can be done to prevent the negative effects on the environment?

9. Describe how the existence of the Dar es Salaam port has influenced the population growth in the city?

10. How does the sparse population distribution, especially in rural areas, affect the use of natural resources?

11. What measures does the Tanzanian government use to reduce or prevent the negative environmental impact caused by population increase in urban areas?

Vocabulary

Geographical factors	factors related to the natural environment that affect population distribution, including climate and water availability
Mining	the activity of extracting minerals from the ground for various uses
Migration	the movement of people from one place to another for residence or work.
Sustainability	the use of resources in a way that ensures their availability for current and future generations
Tourism	the activity of travelling for leisure, learning, or visiting an interesting place

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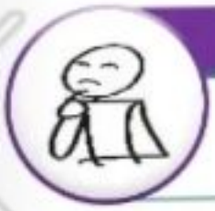
Chapter Three

Weather

Introduction

Understanding the elements of weather is essential in our daily lives. Weather affects nearly everything we do. This includes choosing what to wear, planning a trip, or carrying out various production activities. Therefore, people must develop an understanding of the weather. In this chapter, you will learn the concept of weather and how to measure and record weather elements. The competencies developed will enable you to adopt a lifestyle that adapts to changes in weather.



Think

Activities you do when it rains and when the sun shines

Meaning of weather

Weather refers to the atmospheric conditions of a specific area recorded over a short period, usually hours or a few days. For example, the atmosphere may be cloudy, sunny or rainy on a particular day. Weather affects the activities we do and the type of clothes we wear. For instance, we wear light clothes on hot, sunny days. On cold days, we wear coats and sweaters, or raincoats during rainy conditions.

Weather is measured and recorded at specific centres called weather stations. The study of the atmosphere and weather is known as meteorology. A person who is knowledgeable about weather is called a meteorologist or weather expert.



Activity 1

Observe the weather in your present location, then write a short report on what you have discovered.

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Elements of weather

Elements of weather are various conditions that indicate what the atmosphere is like at a specific time and place. Elements of weather include temperature, rain, sunlight, clouds, wind, humidity and atmospheric pressure.

Weather changes

The weather in a specific area changes over time. These changes can be observed within hours, days, weeks, or even months. Sometimes the sky might be cloudy, and it may be humid and hot. After a while, it might rain. Later, the rain could stop, and the sun might come out again.

Thus, different weather element can occur within the same hour or day. Some days may have few weather element for the entire day, while other days may have many weather elements. These weather changes affect our daily activities.

Measuring and recording weather elements

To understand weather changes, we must measure and record their elements such as temperature, rain, sunlight, clouds, wind, humidity and atmospheric pressure. Various instruments can be used to measure and record weather elements. Some of these instruments are modern, while others are ordinary. The following are weather elements, and the instruments used to measure and record them.

Temperature

Temperature is the measure of heat or cold in a body, object, or place. Temperature is measured using an instrument called a thermometer. Temperature readings are given in degrees on the Centigrade (°C) or Fahrenheit (°F) scales. There are various types of thermometers, such as medical thermometers used to measure body temperature, laboratory thermometers that measure the temperature of liquids and gases in experiments, and ambient thermometers used to measure the daily temperature of a location. In the geographical context, you will learn about ambient thermometers that measure the maximum or minimum temperature of the day.

An ambient thermometer can be digital or analogue. A digital thermometer shows temperature using numbers on a screen. An analogue thermometer measures the temperature by showing how high a liquid, like mercury or coloured alcohol, rises in a glass tube.

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Activity 2

Follow the following steps, and then answer the following questions:

1. Take two containers of equal volume.
2. Fill both containers with the same amount of water.
3. Place one container in a location that does not get direct sunlight.
4. Place the second container outside where there is direct sunlight.
5. Leave both containers undisturbed for four hours.
   (a) After four hours measure the temperature of the water in both containers using a thermometer. Compare which container has a higher water temperature than the other.
   (b) Write a short report of the results from your experiment using the following points:
      (i) The difference in the water temperatures you measured; and
      (ii) The reasons for the difference in the water temperatures you measured.

Measuring air temperature using an analogue thermometer

Air temperature is measured at weather stations using two types of thermometers. These are the *maximum thermometer* and the *minimum thermometer*.

Maximum thermometer

This thermometer indicates the highest temperature of the day and is often read in the evening. Inside the thermometer, there is mercury that provides an accurate reading. If the day becomes hotter, the mercury expands and rises up within the thermometer. Even if the temperature drops later, the mercury remains at the highest level, allowing us to see the maximum temperature of that day. Mercury also has a reflective quality, making it easy to read. This is why mercury is used in maximum thermometers.

Minimum thermometer

This thermometer indicates the lowest temperature, often read at night or early morning. It contains coloured alcohol because alcohol performs well in measuring low temperatures. Alcohol does not freeze easily, allowing the thermometer to function even in extreme cold. It rises and falls as the temperature changes, which helps indicate the level of cold present. The alcohol is coloured so that it is visible

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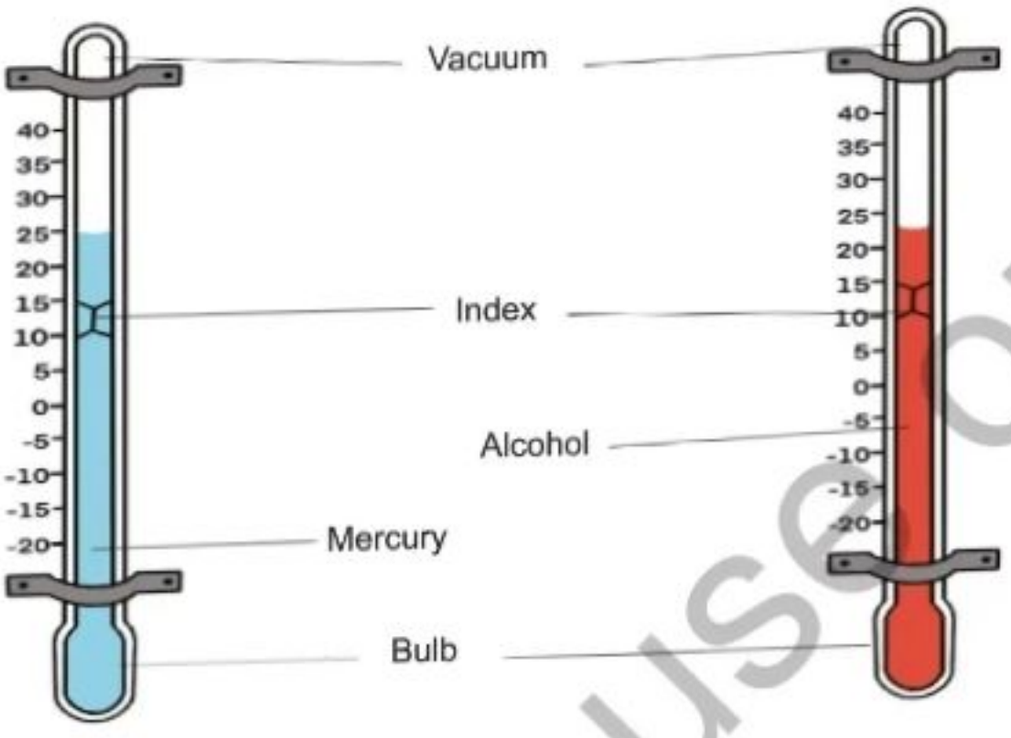
within the thermometer. Additionally, it is safer to use than other substances like mercury. This is why coloured alcohol is used in minimum thermometers. Figure 1 shows the maximum thermometer and the minimum thermometer.



(a) Maximum thermometer (b) Minimum thermometer

Figure 1: *Maximum and Minimum thermometer*

The maximum and minimum thermometers are kept in a special box called a *Stevenson screen*. The Stevenson screen is a wooden box painted white. The white colour helps reflect light. This reflection prevents solar radiation from affecting the temperature readings. Figure 2 shows the Stevenson screen.

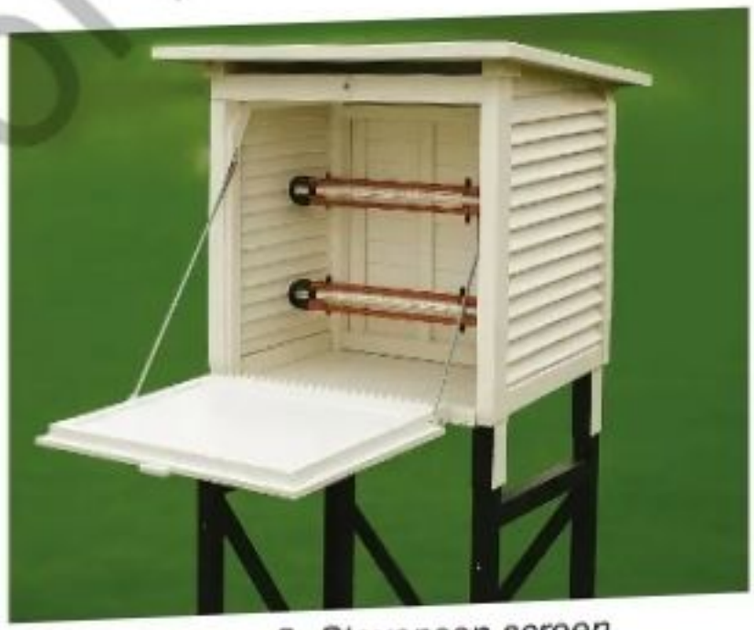


Figure 2: *Stevenson screen*

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Steps for measuring temperature using a maximum thermometer

(a) Place the maximum thermometer outside where it can sense the day's temperature, for instance, under a shaded area, but not in direct sunlight.

(b) Wait for the temperature to rise, as the temperature increases, the mercury inside the thermometer expands and rises in the glass tube.

(c) By the evening, take the thermometer and read the highest temperature by checking where the mercury has reached. Note that the highest point where the index has stopped indicates the maximum temperature of that day.

(d) Record the number closest to the index line to show the maximum temperature of the day.

Steps for measuring temperature using a minimum thermometer

(a) Place the minimum thermometer outside, in a cool area, close to the ground, to measure the minimum temperature (cold).

(b) Wait for the temperature to drop. As it gets colder during the night or early morning, the alcohol inside the thermometer will fall down the glass tube.

(c) In the early morning, before the sun rises, check where the alcohol has moved to. The point where the index stops shows the lowest temperature of the day.

(d) Record the number closest to where the index has stopped to show the coldest or minimum temperature of the day.

Activity 3

Use various reliable sources including online ones, to explore how to measure temperature. Then use a maximum thermometer to measure the temperature for a day in your environment.

Exercise 1

1. Why is it important to monitor and determine changes in the weather for the next hour or day?
2. Imagine that there is heavy rainfall in your area. How will this affect the following?
   (a) The clothes people wear.
   (b) The activities people can do.

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3. Your school is planning to have a sports day. What weather would be best for this event? Explain why?
4. What changes would occur in the mercury if the maximum thermometer was placed in a cold area instead of a warm area?

Wind

Wind occurs due to differences in atmospheric pressure in the atmosphere. Thus, wind is air moving from areas of high atmospheric pressure to low atmospheric pressure. For example, if you take an inflated ball and then puncture it with a needle, the air inside will rush out quickly. This happens because the atmospheric pressure inside the ball is higher than outside. Therefore, the air inside the ball (at high pressure) escapes to the outside (at low pressure).

Measurement of wind

When the wind blows, there are two things we can observe: the direction of the wind and the speed of the wind. In normal conditions, you can determine the direction of the wind by observing in which side trees or leaves bend. The speed of the wind can be identified by watching how much trees and leaves sway or how various objects are blown around. For accuracy purposes, special instruments are used to measure wind direction and speed. An instrument used to measure wind speed is called *an anemometer*, and an instrument used to measure wind direction is called *a wind vane*.

Anemometer

This is an instrument with three or four bowl-shaped cups held by metal arms that rotate when the wind blows. The speed of the rotation of the cups indicates the wind speed. The number of rotations is recorded on a gauge within the device. Wind speed is measured in kilometres per hour. Figure 3 shows an anemometer.



Figure 3: *Anemometer*

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Measuring wind speed

Steps to measure wind speed using an anemometer:

(a) Hold/place the anemometer in an open area where the wind can blow freely.

(b) Observe the rotation of the cups, which is measured on a gauge and converted into wind speed.

(c) Read the wind speed on the gauge connected to the anemometer.

(d) Record the wind speed in units of meters per second, kilometres per hour, or miles per hour.

Wind vane

This is an instrument with an arrow on top that indicates the direction of the wind. The arrow is fixed on a rod. At the bottom of the arrow, there are boards or pieces of metal that show the four cardinal directions: North, East, South, and West. When the wind blows, the arrow points towards the direction from which the wind is coming as shown in Figure 4.

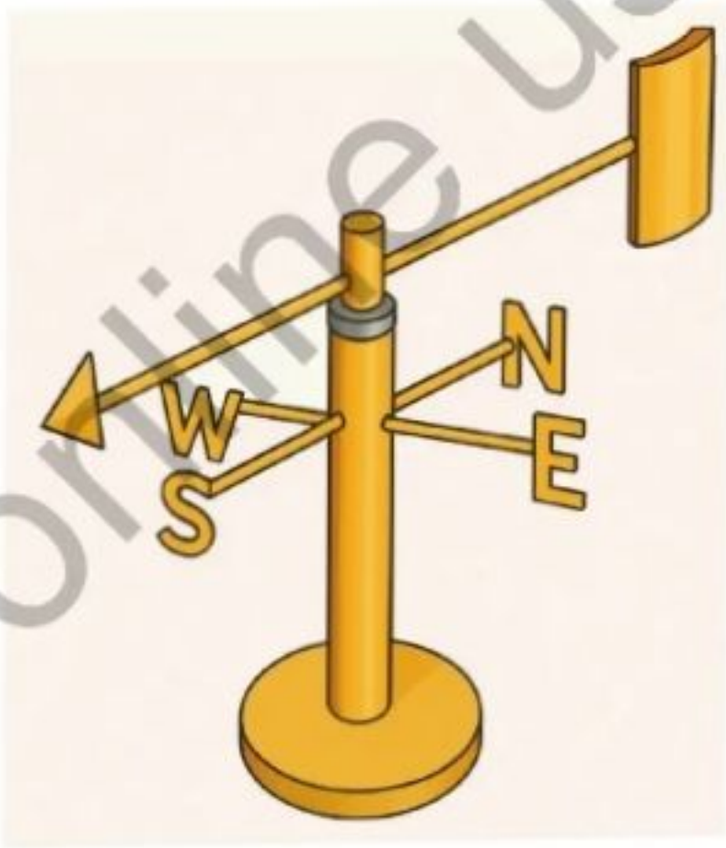

Figure 4: *Wind vane*

Note: In meteorology, winds are named based on the direction they come from. For example, a wind that blows from south to north is called a South wind, and vice versa.

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Activity 4

Use reliable online sources or visit a nearby airport observe an instrument used to measure wind direction, then draw and explain how it works in guiding aircraft

Measuring wind direction

Steps to measure wind direction using a wind vane:

(a) Examine the top part of the wind vane which has an arrow mounted on a rod at the top.

(b) Check if the cardinal directions (North, East, South, and West) are indicated below the arrow.

(c) When the wind blows, observe how the arrow moves.

(d) Note the direction of the arrow; this will help you determine where the wind is coming from and where it is heading.

Note: **(i)** If an arrow points South, it implies that the wind direction is from South to North.

(ii) If an arrow points North, it implies that the wind direction is from North to South.

Activity 5

Using materials available in your surroundings, create a model of a wind vane. Observe the wind direction over three different days and, write a summary on what you have observed.

Exercise 2

1. Explain how you can determine the direction and speed of the wind in your environment without using a wind vane and anemometer.
2. Describe the direction of the wind if the arrow of the wind vane points:
   (a) East
   (b) West

Humidity

Humidity is the amount of water vapour in the air. Sunlight causes water to evaporate from plants, the sea surface, lakes, rivers and other water bodies.

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This creates water vapour to the atmosphere. The level of humidity increases or decreases depending on the rise or fall in temperature of the specific area. Humidity is measured in percentage (%), and the instrument used to measure humidity is called a hygrometer. This device measures the percentage of moisture present in the air.

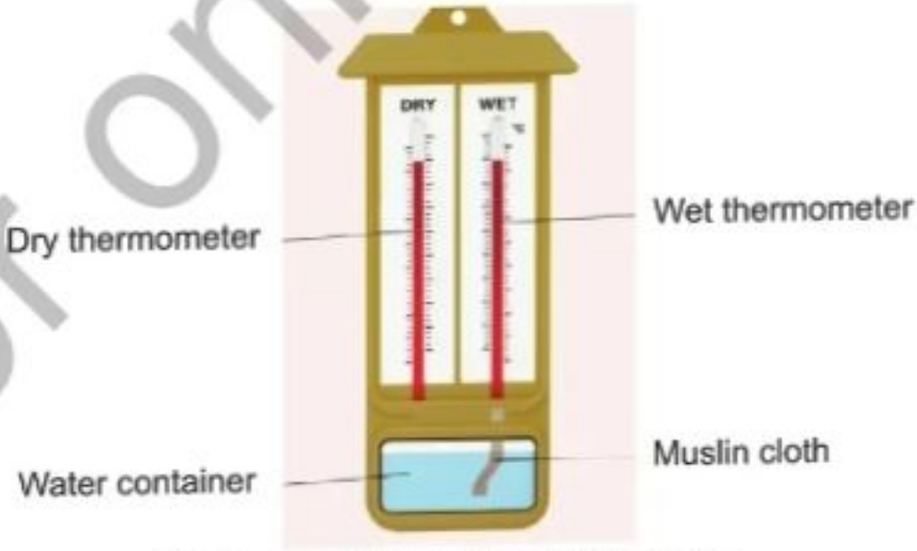
There are three types of hygrometers. The first type is a hygrometer with an arrow, which measures humidity by directly recording and displaying the percentage of vapour in the air using an arrow. The second type is a dry and wet bulb hygrometer, consisting of two thermometers in a single tube. A dry thermometer that measures air temperature and a wet thermometer with a muslin cloth dipped in water that measures humidity. The third type is a digital hygrometer, which provides humidity readings electronically. Figure 5 shows the three types of hygrometers.



(a) Arrow hygrometer



(b) Digital hygrometer



(c) Dry and Wet bulb hygrometer

Figure 5: *Types of hygrometers*

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Measuring humidity

Measuring humidity using a dry and wet bulb hygrometer

The following are the steps to measure humidity using a dry and wet hygrometer:

(a) Take one thermometer and wrap the lower part with a muslin cloth.

(b) Take the wrapped thermometer and dip the muslin into a container of water to allow the muslin to soak, to get a wet thermometer.

(c) Take another thermometer, leave it unwrapped, and position it in a dry area (the dry thermometer) next to the first thermometer.

(d) Take the thermometers (the dry and wet hygrometer) and place them outside in a clear area.

(e) Leave them for approximately 5 -10 minutes.

(f) Read and record the temperature on the dry thermometer and wet thermometer.

(g) Calculate the temperature difference between the readings from the dry thermometer and the wet thermometer to determine the humidity level.

In measuring atmospheric humidity, the difference in readings obtained from both thermometers is considered. If there is no difference in the readings, it implies that the air has a very high humidity level and cannot absorb any more moisture. A small difference which is below 40% indicates high humidity. When a large difference exists, above 70%, it indicates that the humidity level is low. When the difference is between 40% and 70%, it implies an average humidity in the atmosphere. Hygrometers are stored in a Stevenson screen.

Additionally, digital hygrometers display the humidity level as a number on the screen, for example, sixty percent (60%). In contrast, analogue hygrometers (an arrow hygrometer) show the percentage of humidity using an arrow.



Activity 6

Use a digital hygrometer or visit a weather station to observe how the hygrometer works, then explain the humidity level displayed on the hygrometer you used.

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Exercise 3

1. If the difference in readings between the wet hygrometer and the dry hygrometer is 70%, what does this mean?
2. If you find that both hygrometers show the same reading, what is your opinion about the humidity of the area?
3. Why it is not advised to place the hygrometer directly in sunlight when measuring humidity?
4. If a digital hygrometer shows a humidity level of thirty percent (30%), what does this mean?

Atmospheric pressure

Atmospheric pressure is the force created by the weight of air pushing down towards the Earth's surface. It is caused by the concentration of various gases in one area of the atmosphere. These gases include oxygen, nitrogen, and carbon dioxide. The pressure created by these gases varies from one place to another. Additionally, even within the same area, atmospheric pressure fluctuates depending on the increase or decrease in the concentration of air. Differences in atmospheric pressure lead to the formation of wind. When the temperature in an area increases, atmospheric pressure decreases. The difference in temperature between two areas causes air to move from the area with higher atmospheric pressure to the area with lower atmospheric pressure.



Activity 7

Watch or listen to the weather forecast from mass media, and then write a summary about the elements of weather that have been reported.

Measuring atmospheric pressure

Atmospheric pressure is measured in millibars using an instrument called *barometer*. There are three main types of barometers: mercury barometers, aneroid barometers, and digital barometers. All three types serve the same function of recording atmospheric pressure. A mercury barometer is a long glass tube with a measuring scale. The tube is filled with mercury and placed in a container with more mercury. When the atmospheric pressure changes, the level of mercury in the tube goes up or down. If the mercury is higher, it means

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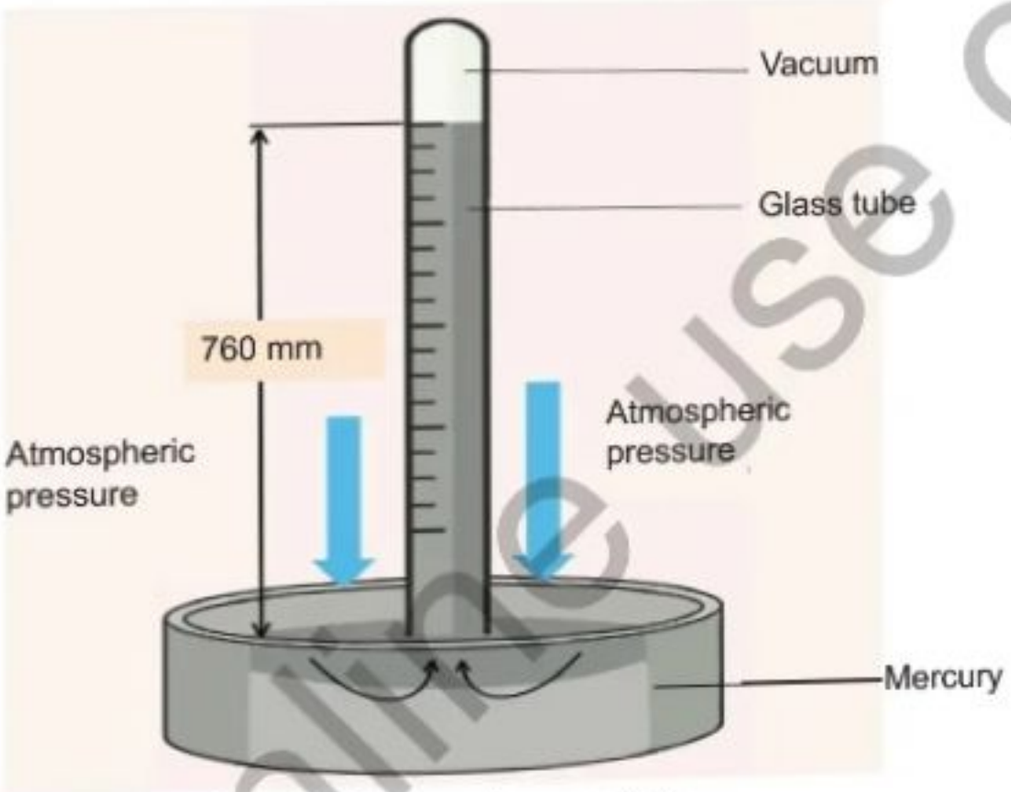
the atmospheric pressure is high. If it's lower, the atmospheric pressure is low. Many weather stations use mercury barometers because they are bigger and easier to read than aneroid barometers.

A digital barometer has an atomic clock that uses electronic sensors to measure atmospheric pressure. It gives information about atmospheric pressure more accurately and quickly than mercury and aneroid barometers. Figure 6 shows the three types of barometers: a mercury barometer, an aneroid barometer, and a digital barometer.



(a) Mercury barometer



(b) Aneroid barometer



(c) Digital barometer

Figure 6: *Types of barometer*

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Activity 8

Prepare an empty plastic bottle, two bowls, a balloon, warm water, and cold water.

(a) Pour warm water into one bowl and cold water into another.
(b) Place the balloon over the mouth of the bottle.
(c) Put the bottle in the warm water and observe what happens.
(d) Then, place the bottle in the cold water and observe what happens.

Explain why the balloon expands or shrinks after being placed in warm or cold water.

Rain

Rain consists of droplets of water that fall to the Earth's surface from the atmosphere after condensation of frozen clouds. When the sun heats the Earth's surface, the air warms up and becomes lighter. This air carries moisture that turns into vapour and rises into the atmosphere. As this air rises, the temperature decreases, causing the vapour to condense and eventually reaching a point of saturation where it can no longer hold more vapour. As the vapour gathers, it becomes heavier and eventually falls to the ground as droplets.

Measuring rainfall

Rain is measured by collecting droplets that fall from the sky using *a rain gauge*. This helps determine the amount of rainfall in a specific area over a certain period. Rainfall is measured in millimetres. A rain gauge consists of four components: a funnel, a cylinder, a container, and a measuring cylinder.

How to measure rainfall

The cylinder is placed inside a container that is dug into the ground, and a funnel is placed on top of the cylinder to collect rain droplets and direct them into the cylinder. The container with the cylinder inside is left 30 centimetres above the ground. If the cylinder fills up before the rain stops, it is taken out and emptied into a measuring cylinder to check the amount of rain, then returned to the container until the rain stops. After the rain has stopped within 24 hours, record the amount of rain on that day's chart. Ensure that daily rainfall measurements are recorded accurately. This process helps track the amount of rain in a specific area over time. Figure 7 shows a rain gauge.

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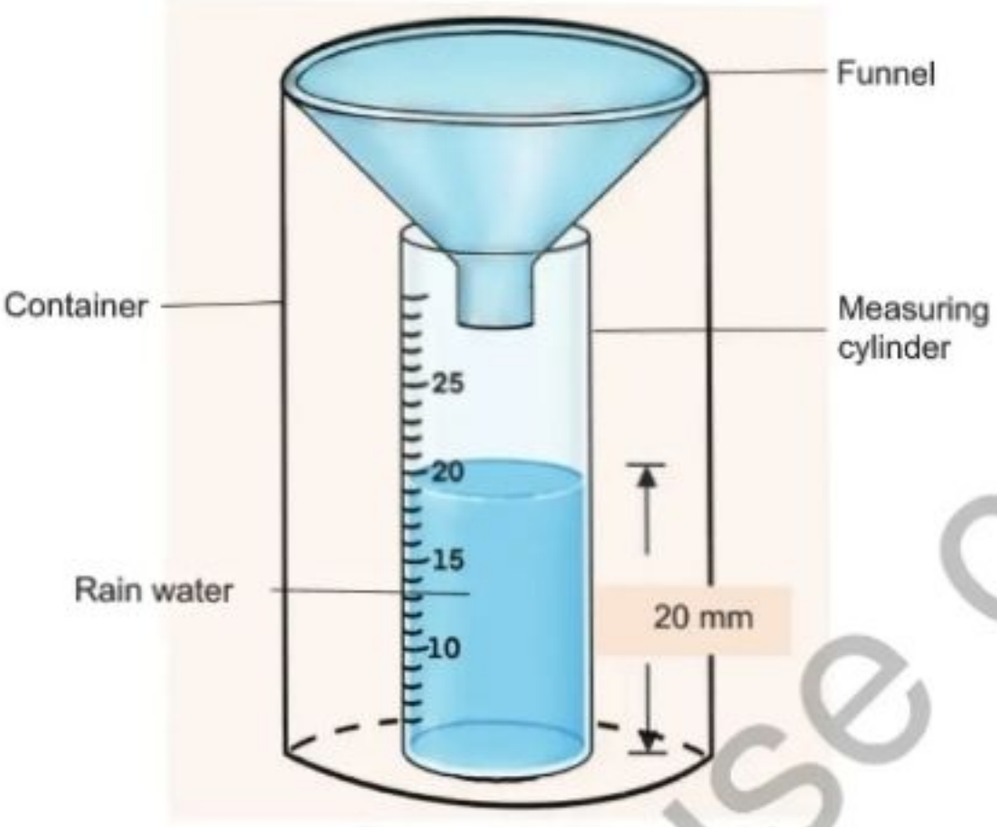

Figure 7: *Rain gauge*

Activity 9

Use the materials available in your surroundings to create a rain gauge, then measure and record the amount of rainfall over one week. Write a summary of your experiment results and share it with your classmates.

Exercise 4

1. What will happen to atmospheric pressure if temperature increases in a certain area?
2. What will happen if there is a difference in atmospheric pressure between two areas?
3. Explain how rain occurs.
4. What benefits does rain provide to people?
5. Explain what will happen if it does not rain for a year in a certain area.

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Sunlight

Sunlight is the natural light and energy that comes from the sun and reaching the Earth's surface without obstruction in the atmosphere. Sunlight is one of the essential elements of weather that is crucial for the life and well-being of all living organisms. Solar rays are a source of heat, light, and energy that are vital for life on Earth. Additionally, sunlight helps plants grow through photosynthesis and aids in drying grains and clothes. Furthermore, morning sunlight is a source of vitamin D, which helps strengthen bones, especially for children.

Measuring Sunlight

Sunlight is measured in hours, week, month, year, or as a daily average. An instrument called *a sunshine recorder* is used to measure sunlight. This instrument measures the duration of which sunlight reaches the ground in a specific area. The sunshine recorder has a glass sphere held by metal and has card with hour and minute marks. This card can sense sunlight each day when the sun shines, it burns the card. At the end of the process, the card is taken out and read to see how many hours and minutes of sunlight there were in a specific day. Figure 8 shows a sunshine recorder.

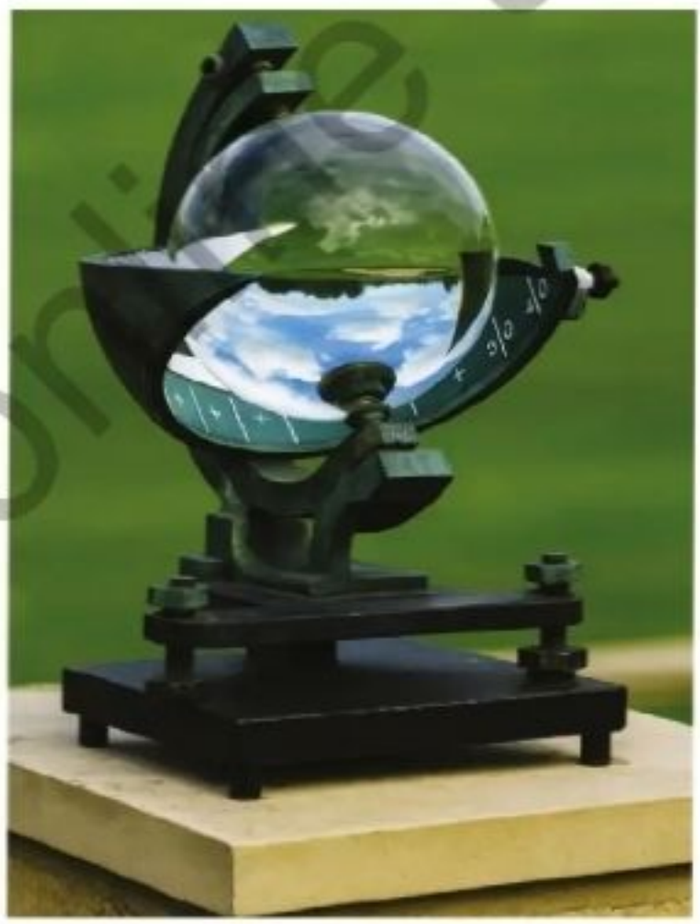

Figure 8: *Sunshine recorder*

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Steps to follow when measuring sunlight

(a) Place the sunshine recorder outside in an open area where sunlight can shine directly on it. Ensure that no trees or buildings block the sunlight from reaching the sunshine recorder.

(b) Make sure the glass sphere is oriented correctly to allow sunlight to pass through.

(c) The sunlight will burn the recording card. This will indicate how long the sun was shining.

(d) Check the card to see the marks. Each mark shows how long the sun has been shining.

(e) The longer the sun shines, the more marks accumulate and become longer on the card.

(f) You can count the marks to see how much sunlight was recorded for that day; see Figure 9.

(g) After finishing the exercise, clean the glass sphere to ensure it works well next time.



Figure 9: *Sunshine recording card*

Clouds

Clouds are collections of tiny water or ice droplets floating in the atmosphere. Clouds are formed from vapour-laden air caused by evaporation from plants, oceans and various water sources. After the vapour rises into the atmosphere, it meets cold air, which cools it down, leading to the formation of small water droplets in the sky.

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Types of clouds

Various criteria can be used to identify different types of clouds. Some of these criteria include considering the distance from the ground and examining the shape and appearance of the clouds. Using the distance criterion, there are three main types of clouds: high-level clouds, mid-level clouds, and low-level clouds. In contrast, using the shape and appearance criterion, there are several types of clouds, such as *cumulus clouds*, which are white, fluffy, and resemble small cotton balls. *Stratus clouds* appear like grey blankets covering the sky. Another type is *cirrus clouds*, which look like horse tails or thin, curled fibres. The last type is *nimbostratus* clouds, which are thick and dark, often associated with rain. These clouds vary in shape, altitude, and their relationship with other weather elements such as rain, temperature, and atmospheric pressure.
Generally, clouds protect us from intense sunlight during the day. Weather authorities monitor cloud patterns to predict short-term weather.

Measuring clouds

Measuring clouds involves observing the coverage, direction, type, and height to help us understand the weather. The amount of cloud cover can be assessed visually using the *Oktas measurement*. The following are the steps to follow when measuring cloud coverage:

(a) Stand outside and look at the sky.
(b) Imagine that you are dividing the sky into 8 equal sections.
(c) Count how many of the 8 sections are covered by clouds.
(d) Write down the number of sections covered by clouds.
(e) Use the number of Oktas to conclude about the sky conditions for that day.

Note: The sky conditions can vary based on the number of Oktas. If there are 0 Oktas, it means there are no clouds, and the sky is clear. If there are 1 to 2 Oktas, it means the sky has few clouds. If there are 3 to 4 Oktas, it means the sky has scattered clouds. If there are 5 to 7 Oktas, it means a large part of the sky is covered with clouds, and if there are 8 Oktas, it means the sky is filled with clouds. See Figure 10.

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Oktas	Symbol	Meaning
0		Sky clear
1		Few clouds
2		Few clouds
3		Scattered clouds
4		Scattered clouds
5		Broken clouds
6		Broken clouds
7		Broken clouds
8		Overcast
9		Sky obscured
(/)		Weather measurements were not conducted

Figure 10: *Oktas chart*

Experts use a special instrument called *ceilometer* to measure the cloud height. They also utilise weather Radars and Satellites for cloud measurement. Refer to Figure 11 (a) and (b) for more details. Knowing the height of clouds is essential for accurate weather forecasting and for pilots navigating through cloudy skies.



(a) Ceilometer



(b) Radar

Figure 11: Instruments used to measure the height of clouds

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Also, the direction, speed, and type of clouds can be measured using a Nephoscope, as shown in Figure 12. This instrument helps weather experts understand the clouds' dynamics. It is usually used with other equipment like weather telescopes or aerial cameras.



Figure 12: *Nephoscope*

Activity 10

Go outside during the day. Observe the state of the sky, then use the criteria of shape and appearance to identify

(a) The amount of cloud cover

(b) The type of clouds; and

(c) The expected weather based on the type of clouds you identified.

Exercise 5

If the sky condition is 8 Oktas, and the type of clouds present is *cumulus*, explain the existing state of weather.

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Weather data logger

A weather data logger is a device that collects and stores weather information automatically for a certain period for further analysis. This device is used to monitor and record weather such as temperature, humidity, wind speed and direction, rainfall, atmospheric pressure, and sunlight using sensors for each element.

The weather data logger can operate 24 hours a day without supervision and provides accurate records for the scheduled time. The collected data is stored in a digital format on a USB or SD card, which can be downloaded or sent for further analysis. This device is often used by weather authorities, in agriculture, for climate change research, and environmental monitoring. Figure 13 shows a weather data logger.

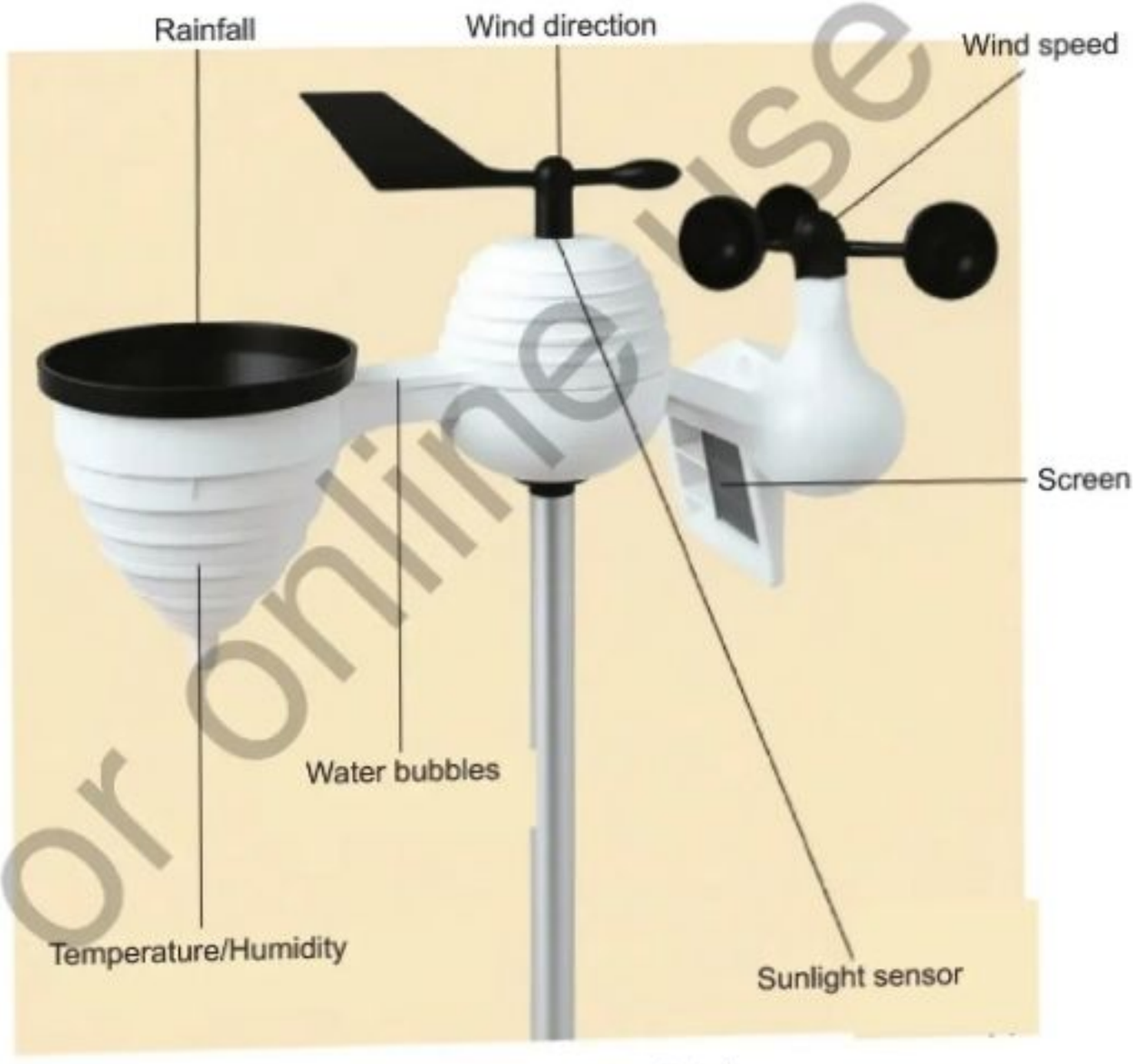

Figure 13: *Weather station data logger*

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In Tanzania, some weather stations use outdated weather recording instruments. However, due to advances in science and technology, these stations are being upgraded from manual to automated weather stations that use modern equipment to record and store weather data.

Measuring and recording weather is important because it helps us understand the weather for a specific day or period. This enables individuals to plan their activities effectively and take environmental precautions. Furthermore, long-term weather measurements help identify the climate of different regions.

Revision exercise

Section A: Multiple choice questions

Choose the letter of the correct answer:

1. What type of cloud causes heavy rainfall that lasts for a long time?
   (a) Stratus
   (b) Nimbostratus
   (c) Cumulus
   (d) Cumulonimbus

2. What is the field that deals with weather matters called?
   (a) Astronomy
   (b) Meteorology
   (c) Atmosphere
   (d) Weather system

3. When weather conditions persist for a long time, typically more than thirty years, what is it called?
   (a) Daily weather
   (b) Desert
   (c) Climate
   (d) Atmospheric pressure

Section B: Short answers questions

Answer briefly the following questions:

4. Explain the relationship between the following weather elements:

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(a) Atmospheric pressure and wind
(b) Clouds and sunlight
(c) Sunlight and humidity
(d) Clouds and rain

5. What is the importance of studying weather in our local areas?

6. Describe the type of weather associated with the following types of clouds:
   (a) Cumulus
   (b) Stratus
   (c) Cumulonimbus
   (d) Nimbostratus

7. Explain the reason that causes air to move from one place to another.

8. **Section C:** Match the elements of weather from **Column A** with the instruments used to measure and record those elements from **Column B**.

No.	Column A (Weather elements)	Column B (Instruments)
(i)	Wind speed	(a) Barometer
(ii)	Humidity	(b) Ceilometer
(iii)	Atmospheric pressure	(c) Nephoscope
(iv)	Temperature	(d) Wind vane
(v)	Cloud speed and direction	(e) Anemometer
		(f) Hygrometer
		(g) Thermometer

Vocabulary

Analogue	A system that shows data continuously, like an analogue clock with moving hands, unlike a digital clock that uses numbers.
Droplets	Tiny round drops of liquid that form when liquid spreads into the air like rain droplets.

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Experiment	The scientific method which is used to explore or study a phenomenon.
Instrument	Tools or devices used for a specific purpose, often to perform a task or to measure something.
Mercury	Chemical element with the symbol Hg
SD Card	A small, portable card used to store digital data

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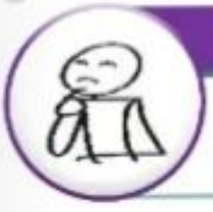
Chapter Four

The relationship between weather and production activities

Introduction

Production activities are important for the economic development as these activities supply goods and services that are used by people. For production activities to be carried out effectively, suitable weather is necessary. In this chapter, you will learn the concept of production activities, the connection between weather and production activities, and ways to cope with the changing weather on production activities. The competencies to be developed will enable you to plan production activities based on the weather.



Think

How weather can affect different production activities.

Meaning of production activities

In chapter one, you learned about natural resources. People use these resources to produce goods, enabling them to earn income, obtain food and meet other needs. Production activities include everything that is done to create items needed by people to meet their daily needs. These activities include the production of goods and the provision of services.

Types of production activities

Production activities include farming, livestock keeping, fishing, mining, manufacturing, trade, and various service activities such as medical care, nursing, and teaching. These activities can be grouped into three main categories: primary activities, industrial activities, and service activities.

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Primary activities: These are activities that involve the direct use of natural resources. Such activities include farming, livestock keeping, mining, and harvesting from the forest for making timber furniture and paper production. These activities form the foundation of all other types of production activities.

Industrial activities: These activities involve the production of goods using raw materials obtained from primary activities. They include the use of machines, such as grain-milling machines to produce flour, making clothes from cotton, making furniture like tables and chairs from wood, and constructing houses and roads.

Service activities: These activities focus on production related to providing services to people. These services support the production of goods and contribute to the overall quality of life. Examples include: teachers educating students in schools, doctors treating patients in hospitals, drivers transporting passengers and goods, and traders selling various products.



Activity 1

Observe the production activities taking place in your environment, then write a summary explaining the benefits obtained from those activities.

The relationship between weather and production activities

Farming

Farming is a production activity that involves the production of crops such as maize, sorghum, potatoes, rice, sesame, beans, cashew nuts, coffee, and cassava. For farming to yield a good and better harvest, it depends on conducive weather. This is because weather affects the growth of crops, and the amount of products harvested. For crops to grow well and produce high yields, they need sunlight, water, and optimal temperature at specific times. For example, if it is too hot or too cold, plants may not grow properly. If there is too much rain, the crops may become waterlogged and get damaged. Similarly, if there is too little rain, the crops may wither and dry out.

Strong winds can damage crops by breaking branches and stems or by causing flowers, leaves, and fruits to fall off. Crops such as maize, rice, and beans can be damaged by strong winds, leading to reduced yields. At the same time, moderate wind is needed during specific periods, especially for flowering plants

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like maize and rice, to support pollination. Therefore, for successful farming, farmers should understand and pay close attention to the weather to determine when to prepare fields, plant seeds, and harvest.



Activity 2

Observe the different stages of farming practised by people in your community, or read from various reliable sources, then identify the variation in weather at each stage and explain the importance of that weather for each specific stage.

Exercise 1

1. Identify the types of production activities, in the following occupations:
   (a) Fishing
   (b) Driving
   (c) Shopkeeping
   (d) Farming
   (e) Carpentry
   (f) Construction
   (g) Livestock keeping
2. Identify primary production activities conducted by the people in your community.
3. Think about the clothes you are wearing; What type of production activity is the tailor who made them engaged in?
4. Assume your parent/guardian is a teacher; what type of production activity would he/she be engaged in? Give reasons.
5. Explain the weather elements that can affect the cultivation of the following crops:
   (a) Tea
   (b) Bananas
   (c) Sunflower
   (d) Maize

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Livestock keeping

Livestock keeping is the activity of keeping livestock such as cattle, goats, sheep, and chickens to obtain food and income through the sale of meat, hides, milk, eggs, and manure. There are various types of animal husbandry, including zero grazing (indoor rearing), traditional herding, nomadic herding, and ranching. Zero grazing is a type of animal husbandry that involves keeping a small number of animals in a designated area. The animals are kept in cages and are provided with food and water.

In traditional herding, herders take their animals to grazing areas in the morning and return them to the sheds in the evening. In nomadic herding, herders are forced to move with their livestock from one place to another in search of pasture and water. Ranching involves keeping a large number of animals in vast designated areas known as ranches. Unlike zero grazing, in ranching, the animals are allowed to roam freely in search of pasture and water within the ranch.

Weather can affect livestock keeping, especially traditional and nomadic systems. When it rains, animals often run to shelter from the rain and stop grazing, which impacts feeding. Also, when it stops raining for a long time, grass and water dry up, leaving animals without pasture and water. In addition, extreme cold weather affects livestock; for example, chickens require moderate temperature to lay many eggs and successfully hatch chicks. Likewise, for chicks to grow well, they also need moderate temperature, as too much heat or extreme cold can cause their death.



Activity 3

Visit a livestock keeper in your community or read from various reliable sources, including online sources, to learn how weather can affect livestock, and then write a summary of what you have found.

Fishing

Fishing is a production activity that involves the harvesting of products from the sea, lakes, rivers, and ponds using special tools such as nets and hooks. In the past, this activity was carried out mainly for obtaining food. Over time, fishing has become a source of income like other occupations. This is due to the high demand for fish and the availability of modern fishing equipment such as advanced boats. Weather is important in fishing activities. Cool weather, for

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example, allows fishing to take place, while strong winds and heavy rains can make fishing difficult and dangerous. In addition, fishing is mostly done at night, early morning, or in the evening because the darkness encourages fish to gather near the water surface in large numbers, making them easier to catch. However, when there is sunlight or moonlight, most fish tend to hide, making it harder for fishermen to catch them easily.



Activity 4

Observe your surroundings or read from various sources about how the weather affects fishing activity and then write a summary of what you have found.

Exercise 2

1. If you were required to advise livestock keepers on how to keep their animals safe during extreme hot or cold weather, what advice would you give?
2. Explain advantages of a livestock keeper having access to weather forecast information.
3. Explain how rain can affect fishing activities.
4. How can strong winds affect fishing activities?
5. Explain how weather forecast can help a fisherman.

Industries

An industry is a place where various products are manufactured using machines. These products include items such as clothes, mattresses, iron sheets, agricultural inputs, food, and beverages. Weather has a significant impact on industries. Heavy rains can damage road infrastructure, preventing the transportation of raw materials to industries and finished products from industries to markets. It can also affect the electricity used in production and damage industrial infrastructure. High temperatures can increase energy consumption for industries that require moderate temperature, thus raising production costs. Strong winds can damage electrical infrastructure, equipment, and industrial buildings. Prolonged intense sunlight can cause droughts, reducing the water supply and essential raw materials needed for food and beverage industries. Overall, weather should be considered to maintain efficiency in industrial production and avoid losses.

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Activity 5

Using reliable online sources, read about the effects of weather on industrial activities, and then write a summary of what you have identified.

Mining

Mining involves the extraction of valuable materials found underground. Usually, it is carried out using machines or manually with simple tools like hoes and pickaxes. Changes in weather can have a major impact on the efficiency, safety, and well-being of miners. Heavy rains can block mining channels and cause flooding, making the environment dangerous for miners, such as landslides that can damage machinery and equipment, leading to accidents or fatalities.

Drought reduces water availability and hardens the ground for mining, making mining more difficult and reducing the quality of mineral processing. High temperature can lead to health issues for miners. Strong winds increase dust levels. This leads to respiratory diseases such as severe colds, and tuberculosis (TB), which affect miners' health. Therefore, miners should use specialised equipment to predict weather or monitor hourly weather forecasts. This will help them determine when it is safe to carry out mining activities.



Activity 6

Visit or use reliable online sources to study the environment of an area where mining activities take place. Then, write a summary explaining the possible impacts of weather changes on mining activities.

Exercise 3

1. Explain how heavy rainfall can affect the transportation of raw materials and industrial products.
2. In what ways does technology help industries cope with changing weather?
3. How can heavy rainfall affect mining activities?

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Energy

Energy is the power used to perform work. Therefore, it is an important resource in the production of goods. We need energy to drive vehicles, turn on lights, cook food, or run machines. Usually, energy production relies on various sources such as water, wind, and sunlight. Weather plays a major role in developing these energy sources. For example, to generate solar power, sunlight is needed to light on the solar panels. When the sun is shining, the solar panels function properly because of adequate sunlight. However, when there are clouds, the panels cannot generate electricity because clouds block the sunlight, leading to reduced power production.

Additionally, to produce electricity using wind energy, enough wind is needed to turn the wind turbine that generates electricity. If the wind is low, the turbine cannot spin and therefore, it cannot produce electricity. However, strong winds can damage the wind turbines.

Hydropower depends on water to generate electricity. If the water level in rivers and dams decreases, the machines that produce electricity cannot function properly. Likewise, heavy rainfall can cause floods that may damage infrastructure used for electricity production. Therefore, to generate hydropower, adequate and moderate rainfall is needed, as excessive rain can negatively affect energy production.



Activity 7

Read various references, including reliable online sources, then explain how weather changes affect the generation of solar electricity.

Business

Business is the activity of buying and selling goods, assets, or items to make a profit. Weather has a significant impact on business activities, especially those related to agricultural products, tourism, fishing, and industry. Weather changes can affect the availability of goods, market demand, and operational costs of businesses.

Weather changes affect the agricultural business in various ways. For example, adverse weather leading to droughts and floods, which reduce crop yields, increases crop prices, and affects the availability of agricultural products in the

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market. Transportation costs may also rise due to damaged infrastructure, and perishable goods may spoil quickly, leading to losses for traders. However, good weather increases crop production, leading to higher and better yields and better prices for farmers. Increased production also lowers food costs to consumers and boosts input-related businesses such as fertilisers and seeds. To maximise benefits, traders should monitor weather forecasts.

Good weather, such as rain, sunshine, and moderate temperature, attract many tourists. This increases income for hotel owners, tour guides, and tourism-related businesses. These businesses include selling clothes, carvings, scenic photos, and various souvenirs. Good weather also enables tour guides to provide better services. However, heavy rains or storms can lead to a decrease in the number of tourists, damage tourism infrastructure, disrupt transportation, and cause wildlife to hide. This affects tourism activities, reduces income and profits, and increases operational costs for tourism activities.

In the transportation of goods, adverse weather such as strong winds and heavy rain delay the movement of goods via roads, railways, seas, and air. Floods caused by heavy rain can make roads impassable, disrupt train schedules, and even cause transportation accidents. This situation increases transportation costs as traders are forced to use alternative routes or wait for the weather to improve.

Exercise 4

1. Explain the effects of strong winds on the production of wind energy.
2. How can heavy rainfall affect electricity production?
3. Explain the importance of understanding weather information.
4. Identify the effects of floods and strong winds on transportation and tourism.
5. Using examples, explain the types of businesses that are favourable during periods of rainfall and high temperature.

Ways to address the effects of weather changes

Weather change is associated with conditions such as little or heavy rainfall, rising and falling temperatures, and normal or strong winds. These can cause major effects on production activities, health, and the environment. To cope with these effects, here are some simple strategies to follow:

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Sustainable farming

Farmers can use sustainable farming techniques such as irrigation farming and planting improved seeds that are resistant to bad weather, like drought or heavy rainfall. Farmers can also practice crop rotation, where a certain type of crop is grown in one season, for example, maize, and then grow beans or potatoes in the next season. This can help ensure that crops are produced even if the weather changes.

Tree planting

Planting trees is an important way to protect the environment and cope with bad weather. Trees help reduce wind speed in fields, clean the air, bring rainfall, and lower temperatures. In addition, tree roots hold the soil together and prevent soil erosion. To protect the environment, everyone is advised to plant and care for trees.

Conserving water resources

During times of low rainfall, it is important to use water carefully to ensure its availability for a long time. This can be done by harvesting rainwater and storing it in ponds, wells, and special water tanks so that it can be used during droughts. Additionally, using efficient and modern irrigation methods such as drip irrigation and moisture retention systems in the soil helps reduce water loss. Conserving water resources is an important step, especially in areas affected by drought, to ensure longterm water availability for human use, farming, livestock, and other living organisms.

Strengthening infrastructure

To address the effects of weather change, it is important to strengthen urban and rural infrastructure so that it can withstand bad weather such as heavy rainfall, flooding, and strong winds. Strengthening infrastructure includes building effective drainage systems to prevent rainwater from accumulating and causing flooding and soil erosion. Roads should be able to properly withstand damage from heavy rainfall. Additionally, environmental conservation and the use of eco-friendly technologies should be considered in the construction of infrastructure to minimise the effects of bad weather.

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Building resilient structures

To address the impacts of weather change, it is essential to consider best construction practices. These practices can be designing buildings that are strong and durable enough to withstand flooding, strong winds, and other bad weather. Houses should be built using durable materials to resist the effects of flooding. Additionally, it is beneficial to use eco-friendly construction technologies, such as roofs designed to collect rainwater. By doing so, communities will be safer and better equipped to weather changes for a longtime.

Education and awareness

Educating the community about the effects of weather change is important. People should be informed about how to protect themselves, for example, by avoiding environmental degradation, rainwater harvesting, properly disposing of waste, planting trees, and using clean energy sources like solar, wind, and gas. This knowledge and awareness will help people make informed decisions to protect the environment and ensure a better quality of life for future generations.

Activity 8

Prepare a talk note that you will present at a community meeting in your area regarding various ways of addressing the effects of weather changes. Explain how each way helps in coping with those effects.

Revision exercise

Section A: Choose the letter of the correct answer

1. What are the benefits of modern agriculture in addressing the effects of climate change?
   (a) Helps in crop production using only traditional seeds
   (b) Helps increase production and withstand climate change
   (c) Helps reduce yields due to lack of improved seeds
   (d) It only helps in garden farming
2. What type of weather is suitable for poultry farming?
   (a) Adequate rain and strong wind

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(b) Cold temperatures and high humidity
(c) Moderate warmth and good ventilation
(d) Extreme heat and sunlight

3. What is an important factor a road engineer should consider to reduce the effects of heavy rainfall on roads?
   (a) Constructing rainwater drainage ditches alongside the road
   (b) Preventing road use during rainy periods
   (c) Building extra-wide roads
   (d) Constructing elevated roads

4. Why is climate change education important in society?
   (a) To help people conserve their environment
   (b) To make people have different opinions about climate change
   (c) To make people depend on charcoal as an energy source
   (d) To make people avoid the use of clean energy

5. In what way can heavy rainfall affect the industrial production sector?
   (a) Affects the availability of industrial safety equipment
   (b) Affects the capacity of industrial workers
   (c) Affects infrastructure for transporting goods and raw materials
   (d) Affects access to markets for produced goods

Section B: Matching item questions

6. Match the weather conditions in Column A with their impacts on production activities from Column B

No.	Column A	Column B
(i)	Drought	(a) Can cause floods, which affect crop production.
(ii)	Tsunami	(b) Helps in planning production activities safely.
(iii)	Extreme heat	(c) Causes water shortages, thus affecting agriculture and livestock.
(iv)	Heavy rainfall	(d) Affects the growth of poultry chicks.
(v)	Weather forecasting	(e) Can reduce the efficiency of wind-powered machines.
		(f) Affects fishing activities at ocean.

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Section C: Short answer questions

7. Explain the benefits of wind in crop production.
8. Why is fishing mostly done at night, early morning, or evening?
9. Explain the methods that can be used to adapt with the effects of drought in agriculture.
10. Describe how tourism activities can be affected by weather conditions.

Vocabulary

Bad weather	Weather that is harmful, severe, or unfavourable, potentially causing damage or disruption
Consumers	individuals or groups who purchase and use goods and services
Drought	a long period when there is little or no rain
Durable materials	materials that are strong and capable of withstanding stress, wear, and adverse conditions
Eco-friendly	something that is not harmful to the environment.
Miners	people who work to extract minerals, from underground or surface
Pasture	land covered with grass or other low plants suitable for grazing animals
Production activities	Structured processes of producing goods or provision of services

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Test

Section A: Choose the correct letter for the correct answer

1. Which of the following is a natural resource?
   (a) House
   (b) Labour
   (c) Minerals
   (d) Money

2. Which of the following resources is not a renewable source of energy?
   (a) Oil
   (b) Wind
   (c) Water
   (d) Sun

3. What is the longest river in Tanzania?
   (a) Ruvuma River
   (b) Rufiji River
   (c) Pangani River
   (d) Wami River

4. Which national park in Tanzania is known for having a large number of elephants and baobab trees?
   (a) Mikumi National Park
   (b) Ruaha National Park
   (c) Serengeti National Park
   (d) Tarangire National Park

5. Which river is used for irrigation farming in the Usangu Basin area?
   (a) Pangani River
   (b) Ruvuma River
   (c) Great Ruaha River
   (d) Wami River

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6. What will happen if people are evenly distributed across different areas?
   (a) Natural resources will be used quickly and depleted
   (b) Natural resources will be used systematically and conserved
   (c) There will be conflicts over natural resources
   (d) People will sell available natural resources

7. Which weather condition is most likely to affect transport systems?
   (a) Sunlight
   (b) Humidity
   (c) Heavy rain
   (d) Heat

8. Which of the following is a human factor that influences population distribution?
   (a) Weather
   (b) Mountains
   (c) Infrastructure
   (d) Rivers

9. How does high humidity in the atmosphere affect local weather?
   (a) Causes strong winds
   (b) Causes drought
   (c) Causes clouds and rain
   (d) Causes strong sunlight

10. What is the importance of improving urban and rural infrastructure in dealing with the effects of climate change?
   (a) To withstand heavy rain and strong winds
   (b) To prevent only temperature changes
   (c) To stop rain from falling in towns and villages
   (d) It has no importance

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Section B: Short answer questions

11. What natural resources are used in electricity generation in Tanzania?
12. Explain why using renewable energy is important for environmental conservation.
13. Explain how weather changes can affect solar power generation.
14. What are the benefits of tree planting in fighting the effects of climate change?
15. Explain the difference between a south wind and a north wind in terms of their direction.
16. What does 8 oktas mean about the state of the sky?

Section C:

17. Match items in column A with the corresponding items in column B

No.	Column A	Column B
(i)	High population concentration	(a) People are evenly spread in an area
(ii)	Even population distribution	(b) Reason people avoid forests
(iii)	Low population concentration	(c) Many people live in one place
(iv)	Infrastructure	(d) Roads, bridges, and electricity
(v)	Soil fertility	(e) Reason people live in fertile areas
		(f) People live on top of mountains
		(g) Uneven settlement in a wide area

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