Chapter 10: Climate Change in East Africa and the World

What is climate change?

Climate change refers to a change in global or regional climate patterns.
Climate change is a long term change in the expected patterns of weather of a region over a significant period of time

Over the years, there has been a change in the elements of weather and climate over the world. Scientists have confirmed that climatic conditions are no longer the same as they used to be.

Indicators of climate change

These are things that show climate has changed over the years;

- Rainfall seasons started in the months that were known while in the present, the rainy seasons come late, too early or unpredictable.
- Prolonged droughts in some areas
- Heavy rainfall in some areas
- Very hot temperatures that have led to melting of glaciers such as those of Rwenzori mountains
- Air temperatures are increasing
- Glaciers are melting/snow is decreasing
- Sea levels are rising
- Ocean heat content is increasing

Causes of climate change

Climate change is caused by both natural factors and human activities.
Natural causes of climate change

- Volcanic eruptions
- Earth's revolution changes/orbital changes
- Reflectivity or absorption of the sun's energy
- Solar effect/solar variations
- Ocean currents

Human activities that cause climate change

- Industrialization releases greenhouse gases (smoke) to the atmosphere
- Exhaust fumes from motor vehicles
- Deforestation leads to destruction of trees which act as "carbon sinks"
- Bush burning by pastoralists
- Swamp reclamation
- Poor waste management such as burning, burying in landfills produces carbon dioxide and methane

- Rapid population growth increases demand for food and leading to deforestation for fuel and space for settlement.
- Open-cast mining destroys natural vegetation which would otherwise absorb carbon dioxide
- Road construction
- Pollution by cars

Problems resulting from climate change

- It leads to increased occurrence of floods
- It leads to prolonged drought (El-Nino)
- It leads to rise in temperature (global warming)
- It leads to occurrence of landslides on the highland areas due to heavy rainfall
- It accelerates soil erosion/ siltation of river valleys.
- It leads to outbreak of diseases due to very hot temperatures.
- It leads to destruction of wildlife.
- It leads to occurrence of varied rain fall seasons.
- It leads to low crop yields.
- It lowers soil fertility.
- It leads to increased migration of people.
- It lowers water levels in lakes and rivers.
- It reduces potential for HEP generation.
- It causes poor visibility this may cause accidents especially in the air transport industry.
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Global Warming

Global warming refers to the increase in global temperatures.

Or

Global warming refers to a general rise in the temperatures of the earth's atmosphere. This rise in temperatures has been a major aspect of climate change.

Causes of Global Warming

- Solar effect i.e. an increase in sun's heat energy received on earth
- Volcanic eruptions which releases gases and dust particles into the atmosphere
- Bush burning by pastoralists which increases carbon dioxide levels in the atmosphere
- Swamp reclamation because swampy areas release methane gas in the atmosphere
- Poor waste management such as burning, burying in landfills, produces carbon dioxide and methane
- Rapid population growth increases demand for food and land, leading to deforestation to provide fuel and space for settlement, as a result more greenhouse gasses are produced

- Open cast mining destroys natural vegetation which would otherwise absorb carbon dioxide in the atmosphere.

Effects of Global Warming

- Famine due to decline in agriculture
- Drought causing limited water for animals and plant growth
- Wild fires due to an increase in temperatures that generates a lot of heat, which destroys forests.
- Changing patterns of rainfall causing crop failure
- Hot temperatures due to increase in solar radiation
- Rising sea level causing flooding
- Changes in plant life i.e. loss of plant species as they dry or wither, they become less productive due to stress caused by heat waves
- Changes in animal migrations and animal life cycle

Greenhouse Effect

The warming of the earth's atmosphere by the sun's rays can be compared to what happens in a greenhouse. A greenhouse is a structure with walls and the roof made of transparent materials such as glass in which plants requiring regulated climate conditions are grown for example vegetables and tomatoes.

How a Greenhouse Works

A greenhouse stays warm inside, even during winter. In the day time, sun shines into the greenhouse and warms the plants and air inside. At night-time, it is colder outside but the greenhouse stays pretty warm inside. That is because the glass walls of the greenhouse trap the sun's heat.

Similarity between a Greenhouse and the Atmosphere

The greenhouse effect works much on earth. Gases in the atmosphere, such as carbon dioxide, trap heat just like the glass of a greenhouse. These heat-trapping gases are called greenhouse gases. [Others include: Chloral-ferrous-carbons, carbon monoxide and methane]

During the day, the sun shines through the atmosphere. Earth's surface warms up in the sunlight. At night, earth's surface cools, releasing heat back into the air. But some of the heat is trapped by the greenhouse gases in the atmosphere.

Greenhouse Effect on Global Warming

When the sun rays reach the earth, they are turned into heat energy. The earth is warmed up and it in turn releases this heat into the atmosphere. The gases which include carbon dioxide, methane, nitrous oxide, water vapour among others do not allow this heat to freely escape to the outer atmosphere. This is what is known as the Greenhouse effect.

The greenhouse effect is an important part of the earth's climate, without which the planet would be much cooler. This effect is natural and not new.
However, when the greenhouse gases increase in the atmosphere, naturally or through human activities, the temperature will increase beyond what is supposed to be normal. This is referred to as enhanced global warming.

Difference between Natural Global Warming and Enhanced Global Warming
Global warming exists naturally to maintain temperatures on planet earth by gases that exist in natural concentrations. Enhanced global warming is as a result of increased greenhouse gases in the atmosphere leading to less heat escaping into space, more heat re-radiated to the earth.

Similarities between Enhanced and Natural Global Warming

- Solar radiation from the sun reaches the earth normally
- The earth re-radiates the heat in both

Causes of Enhanced Global Warming

- Increased burning of fossil fuels like coal, oil, and natural gas
- Increased clearing of land for agriculture use
- Increased urban development
- Increased use of automobiles
- Increased levels of industrialization
- Increased swamp reclamation
- Increased bush burning by pastoralists

Effects of enhanced global warming

- Increased temperatures
- Shortage of water
- Shortage of food
- Foods
- Wildfires
- Death of livestock due to prolonged drought
- Crop failures
- Landslides

Benefits of global warming
Global warming is generally regarded as totally dangerous. However, several scientists think that the increasing temperatures could actually be an advantage to mankind, particularly farmers;

In some high latitude areas;

- Increase in temperature , a variety of n crops grow because the growth period for crops increases
- Increase in temperature in high altitudes mean more warmer days for crop growth
- The growing seasons become longer which results into increased agricultural production.

Effects of climate change in east Africa and other parts of the world

- Shortage of water in some parts of the world
- Shortage of food due to prolonged droughts
- Flooding due to increasing water levels
- Death of livestock due to prolonged droughts
- It has led to increase in temperatures which makes many pests and diseases to thrive
- Waterborne diseases due to floods
- Displacement of people/migrations
- Loss of vegetation cover
- Wildfires which destroy property and cropland
- Landslides leading to loss of lives
- High increase in temperatures and heat waves
- Stronger storms
- Changes in plant life cycle
- Migrations of animals and extinction [birds and whales]
- Thawing permafrost/melting of glaciers
- Rainfall unreliability leading to crop failures
- Drying of crops during prolonged drought

Case studies; - Somalia, Australia, Uganda

Ways of controlling climate change in east Africa

- Planting trees to modify the climate and creating carbon sinks to clean the atmosphere [Afforestation and Re-afforestation]
- Population control through family planning methods [like celibacy]
- Proper waste management such as the recycling /treatment of waste
- Sensitizing people about the benefits of conserving the environment
- Establishing and enforcing strong laws to safeguard the environment
- Use of energy saving technologies in order to conserve forests e.g. cooking using energy saving stoves
- Use of friendly environmental alternative sources of fuels such as solar, bio-gas, and wind power so as to conserve forests
- Research into disease resistant, high yielding and drought resistant crop varieties
- Rainwater harvesting so as to have water supply throughout the year

- Construction of water reservoirs/ dams and ponds for use during the dry seasons
- Practicing irrigation farming for food security
- Adopting use of environmentally-friendly means of transport such as bicycles
- Conservation of available resources such as forests, swamps, by gazetting them into national parks, sanctuaries, etc.

Global agreements on controlling climate change (learners' book ... act 10.13)

Difficulties faced in trying to control climate change

- Inadequate funds for adoption most especially in developing countries
- Limited support from government
- Incapable leaders
- Inadequate information on climate change

TRIAL QUESTIONS.

1. Observing Local Climate Shifts

In a rural community in East Africa, local elders observe that the rainy seasons have become highly unpredictable, often starting late or too early, making traditional farming calendars unreliable. They also note increasingly prolonged periods of drought, leading to shortages of water for both people and livestock. Simultaneously, they've witnessed a reduction in snow cover on mountain peaks that were once snow-capped. Near their village, a new large-scale industrial plant has opened, emitting significant smoke, and there has been a noticeable increase in open-cast mining activities in the region.

TASK:

a) Based on the elders' observations, identify and explain three indicators of climate change.
b) Explain how the human activities mentioned contribute to climate change.
c) Beyond the observed indicators, describe two additional potential effects of climate change or global warming that this community might experience.

2. The Greenhouse Effect and Its Double-Edged Sword

A student is learning about the Earth's atmosphere and the concept of a "greenhouse." They understand that gases in the atmosphere trap heat, similar to how a glass greenhouse keeps plants warm, which is essential for life on Earth
. However, their teacher explains that while this natural process is beneficial, an increase in certain human activities is leading to "enhanced global warming". On the news, they hear a report about farmers in some high-latitude regions experiencing longer growing seasons and increased crop yields due to warmer temperatures, while other reports highlight severe global consequences like rising sea levels and increased wildfires

Questions:

i. Describe how the Earth's atmosphere works like a greenhouse to warm the planet, identifying the key components (gases) involved.
ii. Explain the difference between "natural global warming" and "enhanced global warming," detailing what causes the "enhanced" version.

iii. Discuss the seemingly contradictory information in the news report: how can warmer temperatures lead to benefits for some farmers while simultaneously causing widespread negative effects globally?

3. Tackling Climate Challenges in a Developing Nation

The government of a developing East African nation is facing a severe crisis: widespread crop failures due to unreliable rainfall, increased deaths of livestock from prolonged droughts, and rising cases of waterborne diseases following periods of intense flooding. They acknowledge that climate change is exacerbating these issues and are determined to implement control measures. However, the nation has limited financial resources and faces challenges with public awareness and government support

TASK.

a) Identify three specific effects of climate change that this East African nation is currently experiencing, as described in the scenario
b) Propose three practical ways this nation could control climate change and its effects, drawing directly from the recommended strategies in the sources
c) Based on the scenario's mention of limited funds and public/government support, explain two difficulties this nation might encounter when trying to implement the proposed control measures

Chapter 11: Climate Zones of the World

Climate is an area's long term weather patterns. The simplest way to describe climate is to look at the average temperature and precipitation over time.

Whereas it is easy to do this by looking at weather data, it is important to consider all the factors that work together to determine climate.

Factors that influence/ factors affecting climate.

Latitudes; places located at high latitudes (far from the equator) receive less sunlight than places at low latitudes (close to the equator)

Relief; mountains receive more rainfall than lowlying areas because as air is forced over the higher ground, it cools, causing moist air to condense and fall out as rainfall.

When the place is higher above sea level the colder it will be. This happens because as altitude increases, air becomes thinner and is less able to absorb and retain heat. That is why you may see snow on the top of mountains all year round.

Distance from water bodies; the water body affects the climate of a place. Coastal areas are cooler and wetter than inland areas.

The centre of continents are subject to a large range of temperatures. In summer, temperatures can be very hot and dry as moisture from the sea evaporates before it reaches the centre of the landmass.

Direction of prevailing winds; winds that blow from the waterbodies often bring rain to the coast and dry weather to inland areas. Winds that blow from warm inland areas tend to be warm and dry.

Distance from the equator; areas near the equator are hotter than areas far from the equator.

Ocean currents; ocean currents can increase or reduce temperatures

Major world climatic zones

World climatic zones have been classified in categories each with sub-climatic types and this is done depending on the distance from the equator.

Location of world climatic types and regions

(provide learners with an atlas and guide them to locate climate zones)

Climatic zones	**Region of location**
Polar zones	They are found near the southern and northern poles
Temperate zones	Between the tropics and the polar regions of the earth
Savannah zones	Found between the equator and the tropics
Tropical zones	This zone is found near the equator

Deserts	This zone lies between 15^{o} and 35^{o} north and south of the equator
Mediterranean zones	Located along the western sides of continents, between roughly 30^{o} and 45^{o} north and south of the equator

Polar region/zone

Polar zones are found north of the arcticcircle and south of the Antarctic circle. Cold climates describe this climate type perfectly.

These climates are part of areas where permanent ice and tundra are always present, and only about four months of the year have above freezing temperatures.

Polar climate zones, Alaska in the USA, Norway, Finland, Iceland, Denmark.

Characteristics of polar climate zone/region

- It is very cold and dry throught the year
- The summers are cool while winters are very cold
- Every month has an average temperatures of less than 10^{o}c
- Precipitation comes in form of snow
- Winters are long while summers are short

Temperate Zones

Temperate zones lies roughly between 25^{o} and 60^{o} North and south latitudes. It lies between the tropics and the polar zones. These climates have warm dry summers and cool wet winters.

Temperate climatic zones;, Austria, Belgium, Canada, France, Italy, USA.

Characteristics of temperate climate zone/region

- Moderate temperatures and rainfall throughout the year
- Cold snowy winters
- Hot humid summers.

Tropical zone

This zone is located near the equator. It lies between 23$^{1}/_{2}$N and 23$^{1}/_{2}$ S of the Equator. Most tropical climates are known for high temperatures all year round and for their large amount of annual rainfall.

Tropical climate zones;, DRC, Uganda, Tanzania, Liberia Kenya, Ecuador, Peru, Brazil, Venezuela, Colombia, India, Sri Lanka.

Characteristics of Tropical climate zone/region

- Hot temperatures of between 25^{o}C and 27^{o}C
- Heavy rainfall of about 1500 mm annually
- Some areas experience double maxima of rainfall
- High relative humidity

Desert climate zone

Most deserts lie between 15º and 35º North and South of the Equator. All over the world many deserts lies in these regions e.g. Sahara, Kalahari, Arabian desert, Atacama desert. Desert zones include Iraq, Jordan, Kuwait, Oman, Saudi Arabia, Botswana, Namibia, Egypt, Libya.

Characteristics of Desert climate zone

- Hot temperatures of about 35º C
- Low and unreliable rainfall
- Very low humidity

TRIAL WORK.

1) The Climates of Mysteria.

Explorers have discovered two new, uncharted islands in the "Mysteria" archipelago. They are tasked with predicting their climates based on geographical observations: Mysteria Island A is found very close to the equator and is a vast, flat landmass located deep in the centre of a large continent. It is also noted that no major mountain ranges are present on this island. Winds typically blow across the island from its warm, dry inland areas. Mysteria Island B is situated at a high latitude, far from the equator and closer to one of the Earth's poles. It is dominated by towering mountains with permanent snow cover. Prevailing winds on Island B consistently arrive from a large water body situated nearby.

TASKS.

a. Analyze and compare the likely average temperature and precipitation patterns for Mysteria Island A and Mysteria Island B. For each island, justify your reasoning by explicitly referencing at least three distinct factors that influence climate from the sources (e.g., latitude, relief, distance from water bodies, prevailing winds)
b. Which of the major world climatic zones is each island most likely to belong to? Explain your classification for both Mysteria A and Mysteria B by detailing at least two specific characteristics of that climate zone that match the island's description.
c. If a new, cold ocean current were to shift its path and begin flowing directly past Mysteria Island A, how might this potentially alter its climate characteristics, specifically concerning its average temperatures, and why, based on how ocean currents influence climate.

2) Riverbend's Climate Conundrum.

The historic town of Riverbend is nestled at a moderate latitude, geographically positioned between the tropics and the Polar Regions. It lies on the western side of a large continent, directly along its coastline, adjacent to a vast ocean. For generations, Riverbend has been characterized by its distinct warm, dry summers and cool, wet winters. However, recent climate data shows a concerning trend: winters are becoming increasingly cold and snowy, while summers are experiencing periods of unusually high temperatures and humidity. Local meteorologists are investigating whether changes in ocean currents or regional prevailing wind patterns could be contributing to these observed climatic shifts.

TASKS:

1. Based on Riverbend's long-term characteristics (moderate latitude, western side of a continent, warm dry summers, cool wet winters), identify the specific major world climatic zone it historically belongs to provide two key characteristics from the sources that support this classification

2. Explain how Riverbend's coastal location and the prevailing winds originating from the ocean would typically influence its moderate temperatures and rainfall patterns, referencing the factors of "distance from water bodies" and "direction of prevailing winds"

3. Analyze the recent observed changes in Riverbend's climate (colder, snowier winters; hotter, more humid summers). Discuss how these changes align with or diverge from the typical characteristics of its identified climate zone
. Furthermore, considering the meteorologists' suspicions, how might a significant shift in ocean currents or a change in the direction of prevailing winds potentially explain these new, anomalous weather patterns in Riverbend?