Geography

for Secondary Schools

Student's Book

Form Four

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Student's Book
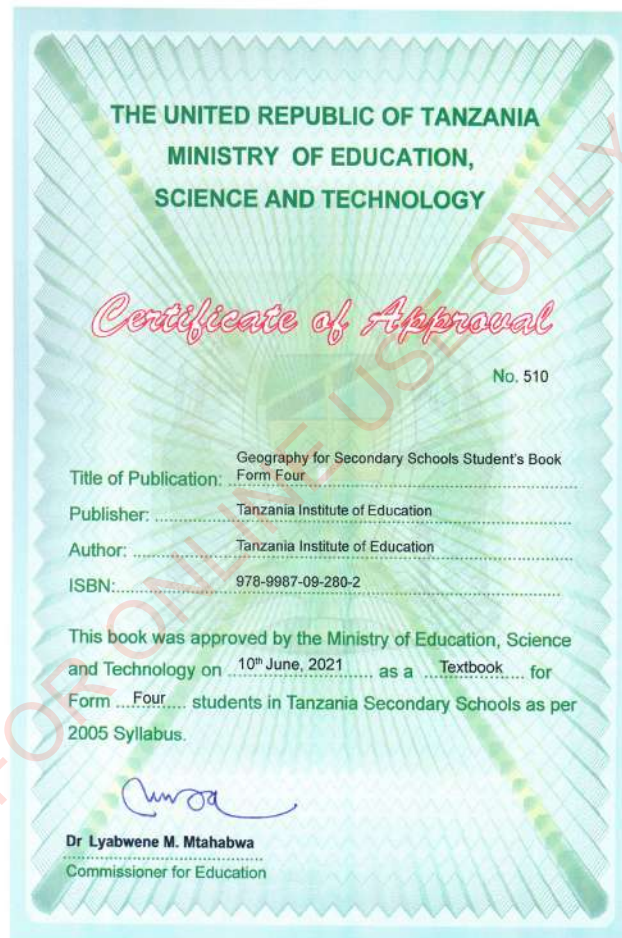
Form Four

Tanzania Institute of Education

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Preface

This textbook, *Geography for Secondary Schools* is written specifically for Form Four students in the United Republic of Tanzania. The book is prepared in accordance with the 2005 Geography Syllabus for Secondary Schools, Form I-IV issued by the then Ministry of Education and Vocational Training (MoEVT).

The book is divided into the following five chapters: Introduction to geographic research, Climate and natural climate regions, Human population, Settlements, and Environmental issues and management. In addition to the content, most of the chapters comprise illustrations, activities and revision exercises. You are encouraged to do all the activities and revision exercises together with other assignments that will be provided by your teacher. This will enhance the development of the intended skills and competencies for this level.

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Chapter One

Introduction to geographic research

Introduction

In this chapter, you will learn about the meaning of geographic research, importance of geographic research, types of and approaches to research, research data, field research, stages of conducting geographic research, ethical considerations as well as the uses of research findings and recommendations. The competencies developed from this chapter will enable you to conduct geographic research, present and discuss research findings and make recommendations to improve the existing situation.

The concepts of geographic research

This part consists of the following concepts:

The meaning of geographic research

Geographic research is a scientific investigation or inquiry that involves the collection, analysis and interpretation of data to generate knowledge on the geographical phenomena. Examples of geographical phenomena include occurence of global warming, environmental pollution and earthquakes.

Geographic research can be conducted to get an explanation on the nature of these phenomena, their causes and effects on the environment or human societies.

Findings from geographic research provide knowledge that is useful in solving problems faced by our environment and societies. It enables one to get knowledge on unknown issues. For example, greenhouse gases were known to cause greenhouses effects after a geographic research that investigated why the Earth's temperature increases.

Importance of geographic research in daily life

For planning: In our everyday life, geographic research is useful in planning and making proper decisions. Examples, for urban planning, planning for irrigation projects, hydroelectric power plant and for waste management.

For understanding the principles and laws of nature in the universe: It is useful in understanding the principles and laws of nature as well as the surrounding environment. Examples, gravitation forces, movement of the Earth and solar system.

For searching new knowledge: It contributes new knowledge on a certain phenomenon. Every research should contribute new knowledge to the existing body of knowledge. For a research to contribute to new knowledge, it needs a review of the existing literature so as to be familiar with what is known and what is not known. Generally, research is the source of new knowledge.

For solving problems in the society: It helps to identify and solve particular problems in our society. One of the primary roles of research is to investigate problems facing societies to find solutions to those problems. By investigating geographical phenomenon, researchers get to know the causes of and the solution to the problems. Example, measures to reduce land pollution on Earth.

For developing various programmes and policies: It is important in developing various programmes and policies because research aims to find accurate information on a certain phenomenon. Research findings facilitate the making of informed decisions on the type of programmes to be developed and policies to be formulated. Example, a geographic

research can be done to improve national population policy and family planning in Tanzania.

For testing validity of theories: It can be used to test the validity of theories and, possibly, develop new theories and laws. Through research, the existing theories and models can be tested to measure their applicability in different contexts. Research may also generate new knowledge that will lead to the formulation of new theories. Example, the disappearance of planet Pluto from the solar system can be proved by doing geographic research.

For informing the citizens about the socio-economic activities: It enables citizens to be informed about their socio-economic activities. Most of the social science researches investigate socio-economic aspects of the communities such as age, sex, marital status, income, economic activities (occupation), assets and expenditure. Such information is important for economic planning and individual wellbeing. Through geographic research, socio-economic information is collected and analysed to inform the community. Example, the Government of Tanzania will use tablets to collect population data during the national population census in 2022.

For creating economic opportunities to researchers: Research activities create jobs. Many individuals get opportunities to be employed either temporarily or permanently by various institutions,

companies and organisations on research activities. Through research, some individuals build their careers. Examples, land surveyors, cartographers and urban planners.

It clarifies confusion: Research helps to clarify complicated facts. It also helps to remove all sorts of confusion and provides a proper understanding of various issues. Examples, formation of continents, formation of universe, solar eclipse, and causes of climate change.

Types of and approaches to research

Basically, research is mainly of two types: Basic and applied research. Basic research aims to gain a better understanding of a subject, phenomenon or basic laws of nature. This type of research primarily focuses on the advancement of knowledge rather than own solving a specific practical problem. For example, a research can be conducted to generate knowledge on causes of Earthquakes and deforestation.

Applied research, on the other hand, is conducted to guide actions for solving particular practical problems rather than for the sake of generating knowledge. For instance, the government may conduct a study on causes of farmer-pastoral conflicts in order to resolve them.

There are two main research approaches: Quantitative research and qualitative research.

Quantitative research approach

This type of research approach is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity, for example, population data, tonnage of oil, crops and minerals. Research data are in numerical form, thus known as quantitative data. These data may include height, weight, distance, age and any information that can be assigned numerical value.

Methods used in quantitative research approach include surveys that use a questionnaire with closed-ended questions as a tool to collect data. Instruments that can yield quantitative data include rain gauge, thermometer, and tape measure. Quantitative methods focus on gathering numerical data from a sample. Findings from that sample are generalised to a population that has been targeted by a study.

Qualitative research approach

Qualitative research approaches study subjects in their natural habitat. The focus is on understanding the why and how of human behaviour in situations. It is a scientific research approach of investigation that gathers non-numerical data such as people's opinions, views and narratives. It uses methods which seek to develop a deep understanding of how people perceive their social realities and, in consequence, how they act within the social world. It is concerned about a qualitative phenomenon. Qualitative

research normally uses the following methods of data collection: Observation, interview, focus group discussion, oral stories, and document review.

Research data

In research, information is collected from different sources to describe a certain phenomenon. The information collected is known as data.

Types of data in research

There are two main types of data: primary and secondary data.

Primary data

Primary data are data collected directly from a source as first-hand information. They are original in character. Data collected through experiments or field research (field surveys) are good examples of primary data.

Secondary data

Secondary data, on the other hand, are collected from researches done by other reseachers. These data can be obtained from published documents such as papers and books. Also, they can be obtained from reports prepared by various organisations or institutions. They are secondary data because they are not directly collected from the field by the researcher.

Field research

Field research is a task of collecting data physically from the field. Data could be collected from areas such as villages, streets, towns, forest, school environment, industrial environment and libraries or other places where data are stored. Field research has some advantages and challenges as described below:

Advantages of field research

Field research:

(i) Provides researcher(s) with first-hand experience and knowledge about people, events and processes of the study;

(ii) Allows researchers to observe the relationship between various things, events, behaviour and trends. For example, in field research, the relationship between the application of farm inputs and crop production can be well observed;

(iii) Allows researcher(s) to understand the relationship between human beings and the natural environment; and

(iv) Provides practical knowledge to researchers through selecting, observing, reporting and presenting geographical data from the field.

Challenges of field research

The challenges of field research include the following:

(i) Field researches are expensive and time-consuming;

(ii) It is difficult for the researchers to distance themselves from biasness in the research study;

(iii) Documentation of observations is usually difficult. For example, it is not easy to decide which details are important to write down. In addition, it is difficult to remember all the details if you write your notes later;

(iv) When the researcher is perceived as a stranger to the community, he or she may lack trust from the community members and fail to access some data;

(v) Sensitivity of the topic researched may affect adequate access to data or respondents. For example, researches on farmer-pastoral conflicts or environmental crimes may make it difficult for a researcher to get data related to the nature of the phenomena; and

(vi) Failure of researchers to be flexible in the field in terms of time, financial resources (cost) and unexpected events. Thus, things in the field may vary contrary to what was planned or expected.

Stages of conducting a geographic research work

A research process follows the following stages:

Identification and formulation of geographic research problems

The first stage in conducting geographic research is to identify, select and define properly a geographic research problem.

A reseacher, should identify a general area or topic of interest, relevant for geographic research. The topic could be climate change, urbanisation, or environmental pollution. Initially, the problem may be stated in a broad or general manner. The general problem will then be narrowed into a focused problem that needs to be studied. A statement of the research problem, therefore, is developed to show a gap in knowledge that needs to be filled by a particular research. For example, if climate change is a topic of interest, there could be knowledge on the causes and the effects. The knowledge on human responses to effects of climate change might be scant in relation to a particular society. This may prompt a geographic research to fill that gap.

Sources of geographic research problems

There are different sources of a geographic research problems. The sources include the following:

Personal experience: A person may experience a variety of issues surrounding human kind and the environment that can be developed into a geographic research problem. For example, a person or researcher living in urban areas is likely to experience issues such as traffic congestion, urbanisation and environment pollution. Such experiences may act as sources of geographic research problems. Also, a person familiar with areas where farmer-pastoral conflicts are

common may find that as an issue which requires research attention to understand causes of conflicts.

Practical experience: A researcher can get ideas from a work-place. As a forest officer, you can gain experience on issues you want to research on. Example, a forest officer working in a forestry department may recognise indicators of forest destruction from his or her routine activities and decide to study the causes of such destruction. Also, a geography teacher can develop a research problem on why students perform poorly in Practical Geography subject.

Literature review: Literature consists of scholarly publications. Literature review involves a critical review of the existing publications such as books, journal papers and other reports relevant to a topic under consideration. Literature review is done to identify gaps of knowledge from existing body of knowledge. For example many scholars may have written about causes of migration but may not have written about the effects of migration. Thus, a review of literature may provide gaps of knowledge which call for further research to fill those gaps.

Monitoring and evaluation activities: These activities can be carried as research projects at different stages by mid or end of the year to measure the performance of a project or development processes. Usually, targets or goals help to determine on the extent to which a

project or a process can reach set targets or goals.

Societal issues: Sometimes, research problems or topics could be obtained from real problems that face societies, for example, plastic waste pollution, traffic congestion in urban areas and land degradation are some of the current social problems potential for further research.

Mass media: The mass media may report on a number of environmental issues. These issues can be sources of research topics. For example, in 2008 the media reported conflicts between farmers and pastoralists in Kilosa District, which later captured the research attention of several researchers and research institutions.

Areas for further studies identified by other researches: While conducting research, one could face a new situation that may trigger a new research topic or problem. For example, researchers may go to the field to study land conflicts and encounter another issue such as land pollution and decide to investigate the new issue.

Consultations with experts: Experts generally have sound experience in their respective fields, which may suggest a significant problem for research. In addition, experts may help to find a current problem to be solved in a particular discipline. This may serve as a basis for formulating a research

problem. For example, by investing in solar technology, especially in central and northern parts of Tanzania, we can gain sound knowledge from developed countries such as Germany, Italy, China, the USA and Japan as experts in solar technology in the world.

Steps in developing a geographic research problem

(i)   Identify an issue that requires research attention. An issue can be a problem facing society or a need of knowledge on something;

(ii) State what would be a favourable situation if that issue is resolved;

(iii) State what the current situation is that exists in relative to the favourable situation;

(iv) Review the literature available to determine whether there has been any research or documented knowledge on the problem to fill the knowledge gap; and

(v)   Show how important is your research in filling that knowledge gap.

Characteristics of a good geographic research problem

The following are the characteristics of a good geographic research problem:

A good geographic research problem should be clear: The researcher should indicate clearly the knowledge gap to be filled to generate relevant knowledge. After all, not every problem

is researchable or requires scientific procedures to be solved.

A geographic research problem should be clearly stated: The language used should not be ambiguous or too technical to be understood by people or learners. The language should be simple enough to be understood by any reader.

A geographic research problem should stem from issues: A research problem should be limited in scope and specific. A research problem should focus on the topic (problem) to be studied and it should not be too broad. Its scope should be clearly defined. The stated geographic research problem should also be specific to the study area. Not every problem deserves a research attention.

A geographic research problem should be time limited: A research is conducted with a purpose; thus, it needs to be carried out within a specific time-frame to achieve the intended goal. Therefore, a geographic research problem should be manageable within a given period.

A geographic research problem should aim at generating new knowledge and not repetitive: Research should not be repetitive. If the research is not novel, it is difficult for the researcher to generate new knowledge.

A geographic research problem should be researchable: A research topic must be doable in terms of time, resources,

expertise and practicability. The research topic selected must allow for empirical investigation to be carried out.

Literature review

Once the research problem is formulated, the researcher should undertake extensive literature review relating to the research problem. This review entails reading various publications to grasp what is already known about a research problem. In literature review, books, academic journals, magazines and various reports are consulted to get relevant information on the suggested research problem to be studied.

Importance of literature review in research

Literature review is important in research as it:

(i)   Provides an understanding of the topic, what has already been done and how it has been researched. Hence, it helps the researcher to identify methods of collecting and analyzing data;

(ii)   Enables the researcher to build on previous research rather than duplicating findings;

(iii) Enables the researcher to know the relevance of different theories and principles relating to the identified topic;

(iv)   Helps the researcher to build the rationale for conducting the study;

(v)   Explains the relationship between previous studies and the current study;

(vi)   Determines gaps, consistencies and inconsistencies about a subject, concept or problem;

(vii) Helps to discover unanswered questions on a subject, concept or problem; and

(viii) Helps to understand the strengths and weaknesses of a research design, methods of inquiry and instruments used in earlier stages of a research work.

Research objectives

In any research, the researcher should seek to attain specific research objectives. A research has one general objective from which several specific objectives are derived. The general objective seeks to give a broad response to the research problem. It should be output or outcome oriented. Specific objectives, on other hand, break down the general objective into smaller logically connected parts. Specific objectives systematically address various aspects of the research problem. Also, specific objectives are specific, measurable, attainable (achievable), realistic, and time-bound, and are commonly abbreviated as "SMART" as shown below:

•   Specific: The specific objectives should have a clear statement focusing on a specific issue;

- **Measurable:** The specific objectives should consist of measurable variables;

- **Attainable:** The specific objectives must state or ensure that those objectives are achievable;

- **Realistic:** The specific objectives must be relevant or focus on the outcome; and

- **Time-bound:** The specific objectives must be accomplished within a specified time limit.

Formulation of hypotheses and research questions

At this stage, the researcher should state clearly the research questions or research hypotheses. Usually, qualitative studies use research questions instead of hypotheses. Both hypotheses and research questions are written before the research process begins and serve to guide the researcher.

An hypothesis is a tentative statement that gives an intellectual guess showing the relationship between variables under study. It can also be testable explanation of the relationship between variables in research.

Types of hypotheses

There are two types of hypotheses: alternative and null hypothesis.

The alternative hypothesis: This suggests the existence of relationship between variables of the study. For example,

drought (climate) is the cause of food shortage in Dakawa-Dodoma. Here, the variables of study are drought and food shortage.

The null hypothesis: This is a statement which suggests non existence of relationship between the variables of the study. It is stated as a negation to the alternative hypothesis. Example, drought (climate) is not the cause of food shortage in Dakawa.

Variables

A variable is a measurable characteristic in a research. Research is about examining the relationship between or among variables. For example, one can study the relationship between drought (climate) and food production. The assumption here is that drought (climate) conditions influence food production. In this example, drought (climate) and food production are two variables that the researcher would want to test in research.

There are two major types of variables: Independent and dependent variables.

Dependent variable: A dependent variable is also known as an outcome variable. It is a variable which is influenced by independent variables. In the example above, food production is a dependent variable which is affected by drought (climate).

Independent variable: An independent variable, also known as the predictor variable, is the one which causes changes

or influence or affect another variable. In the example above, drought (climate) is an independent variable which may affect food production in Dakawa.

Activity 1.1

In groups, find any academic research report and:

(a) Identify the main and specific objectives of the report;

(b) Identify the hypotheses tested or the research questions;

(c) Identify the independent and dependent variables; and

(d) Explain how the variables you have identified in (c) differ.

Pre-survey or reconnaissance

Pre-survey or reconnaissance refers to a brief survey of the study area or site. This brief survey familiarises a researcher with an area. He or she gets valuable information that helps him or her to plan for field data collection. It undertakes observation and documentation of bio-physical characteristics, socio-economic features, issues, problems, threats and opportunities, and concerns not mentioned in literature or interviews. Specifically, pre-survey enables researchers to:

(i) Finalise the selection of the study sites or areas for field data collection;

(ii) Collect preliminary information on the number and location of the study population;

(iii) Identify logistical requirements based on local conditions and plan for field data collection;

(iv) Familiarise with the area or site where the research will be conducted; and

(v) Prepare a work plan for conducting research activities.

Determination a research design

A research design is a framework or plan on how data will be collected and processed. A research design consists of research methods and techniques chosen by a researcher. It is an outline of what the researcher will do in the whole research process. It involves providing answers to questions such as where, what, when, how much and by what means. It is also a strategy which specifies what approach to use for gathering and analysing data.

Selecting a target population and sample

Research targets specific categories of elements. Population in research forming a research population may be defined by human or animals, objects, institutions, interest groups, and many others, with common characteristics that are of interest to the researcher. For example, if your study is about coffee farming in Bukoba, the target population of the study will be composed of only coffee farmers in Bukoba. Non-coffee farmers will not be part of the target population

for the study. Similarly, if the study is on the seaweed farming in Zanzibar, the target population will only be seaweed farmers. Other people can be involved in particular studies as informants but not as the target population for the study.

It is usually difficult to study everyone in your target population due to financial and time limitations. Thus, you should choose a sample of people to represent your target population.

A sample is a subset of the target population which is systematically chosen from that population. Sampling is a process of selecting individual members of the target population to form a sample for study. A sample should be representative for statistical inference to the whole target population. Inference means findings from the sample are generalisable to the whole target population.

Sampling techniques

Sampling refers to the procedure that a researcher adapts to select a sample from a target population. For example, the sum of coffee farmers in Bukoba can be a target population. If one decides to pick a few coffee farmers to participate in a study, then this becomes a sample of all coffee farmers in Bukoba that are the target of a study. The method used or procedures one follows in picking the few farmers to participate in research is a sampling technique.

Types of sampling techniques

The method of selecting a sample is important. It depends on the nature of data and investigation. The techniques for selecting a sample are categorised into probability and non-probability sampling.

Probability sampling: Also known as random sampling or chance sampling, this type of sampling allows every item (individual) in a population to have an equal chance of being selected. Probability sampling techniques are mostly used in quantitative research.

Non-probability sampling: This sampling approach does not give every member in a population an equal chance of being included in the sample. The sampling is based on quality only. Non-probability sampling techniques are mostly used in qualitative research.

Characteristics of a good sample

A good sample should have the following characteristics:

Representativeness: A sample must be representative of the whole target population. If the population of coffee farmers consists of male and female farmers, the sample should also proportionally consist of farmers from both genders.

Accuracy: This refers to the degree to which bias is absent from a sample. An accurate (unbiased) sample is one which

represents the population. It is free from any influence that causes any difference between the sample value and the whole population value.

Adequacy in size: A good sample must be adequate in size to be reliable.

Sampling design

A sampling design is a framework or roadmap that serves as a basis for the selection of a sample. This design constitutes plans and methods for drawing a sample from a target population. Therefore, a sampling design simply refers to the technique or procedure the researcher adopts for selecting items for the sample.

Activity 1.2

In groups, discuss a research design, then explain what the researcher should consider when drawing a good sample in research.

Data collection

Data collection is a process of gathering appropriate information on variables of interest, systematically to answer the research questions, test the hypotheses and evaluate research outcomes. In data collection, a researcher must have a clear understanding of what, why, how and where to obtain data.

Once the sample has been obtained, the next step is to get information from individuals in the sample. There are several methods for collecting data from a sample. These include a survey, interviews, observations, focus group discussions, experimentation and measurements. Selection of an appropriate research method for data collection depends on the nature, scope and objectives of the study, and time available.

Before collecting data, the researcher should prepare and pre-test the research instruments or tools. Research instruments or tools include the questionnaire, interview guide, observation guide, checklist, measurement apparatus, and laboratory apparatus. Pre-testing of the instruments is also known as piloting. It is done to collect data from a small sample. This important exercise enables the researcher to establish whether the tools used can measure what is supposed to be measured. It also provides information to the researcher on whether there is any bias. Pre-testing, gives a researcher an opportunity of correcting all shortcomings found in the research tools before administering them to the whole sample in the field.

Data collection methods and tools

The following are some of the methods and tools for collecting data from a sample:

Survey

A survey is a method of collecting quantitative data from a pre-defined group of respondents. In survey a

questionnaire is, thus, a tool designed for collecting data from respondents.

A questionnaire consists of a series of questions. The questions are either closed-ended, or open-ended. Closed-ended questions use Yes or No, True or False responses or multiple-choice questions. Often, closed questions cover a large portion in the questionnaire. The information collected from the respondents sampled is quantified to perform statistical analysis. Open-ended questions leave a space at the end for a respondent to mention the answer, list items, or explain.

Essentials of a good questionnaire are:

(i)   It should clearly explain the aim of the study;

(ii) Questions should be as simple as possible and the organisation should start with simple to more complex questions;

(iii) Questions should be arranged in a logical sequence usually reflecting the arrangement of research objectives;

(iv) Personal and sensitive questions should be avoided;

(v)   Questions should be clear; as such, ambiguous questions should be avoided; and

(vi) Questionnaire should be as short as possible. A questionnaire with too many questions will tire or bore the respondent.

The researcher can use different ways to administer a questionnaire. These ways of administering a questionnaire include face-to-face, posting, emailing, or phone calling. Nowadays because of technology, one can develop an online questionnaire. The questionnaire can be sent to different people who have access to the internet.

Advantages of a questionnaire

(i)   A large amount of information can be collected from a large number of people in a short period;

(ii) A questionnaire survey is a relatively cost-effective way of collecting data from a large group of people;

(iii) The results of a questionnaire can quickly and easily be quantified during analysis. The most common software for quantitative analysis is the Statistical Package for Social Science (SPSS) but since 2019, the name of this software for quantitative analysis changed to the Statistical Product and Service Solution (SPSS);

(iv) Data collected using a questionnaire can be analysed more statistically and objectively;

(v)   Data generated from a sample can be generalised to the entire population; and

(vi) Data from respondents can easily be compared.

Challenges of a questionnaire

(i) It is not flexible since the questions are structured in advance;

(ii) It cannot capture people's emotions, behaviour or feelings; and

(iii) It is most appropriate for those who can read and write.

Interview

An interview is a verbal interaction between an interviewer and an interviewee. An interviewee is a respondent, the one who is targeted by a study, or a key informant, one who is interviewed because of his or her knowledge of the topic of interest. It is a face-to-face question and answer conversation between an interviewer and an interviewee or respondent. Interviews can also be conducted through the telephone, zoom and skype meetings. Interviews are mostly used to collect qualitative data. The interview gathers people's opinions, attitudes and experiences. The tool used to collect data during interviews is an interview guide. An interview guide consists of a few questions the interviewer will ask the interviewee.

Advantages of an interview method

(i) The method allows the researcher to be sure that the respondent understands questions properly;

(ii) Interviews can be held with both literate and illiterate respondents;

(iii) Interviews generate in-depth data which is not possible to get in questionnaires;

(iv) Interviews can clarify and elaborate on the purpose of the research and effectively convince respondents about its importance; and

(v) Unlike questionnaires, interviews allow for probing and asking of follow-up questions when needed.

Challenges of an interview method

(i) It is not appropriate for a large number of respondents as it is time-consuming;

(ii) Some respondents may provide irrelevant or wrong information especially when they are suspicious;

(iii) It cannot provide very reliable information on issues which happened a long time ago;

(iv) An interview requires a high level of skills for asking questions to get proper information;

(v) The method may face language barriers; and

(vi) The interviewer may fail to record an interviewee's responses promptly.

Principles of conducting an interview

In conducting an interview, an interviewer should observe the following:

(i) Explain briefly the purpose of the interview to the interviewee;

(ii) Create a friendly atmosphere for the interviewee to talk comfortably and provide his or her thoughts in-depth;

(iii) Instil confidence and trust in the interviewees by assuring them that the information (data) they provide would remain confidential;

(iv) Encourage the interviewees to keep on talking and avoid interrupting them unnecessarily;

(v) Do not record the responses, unless it is necessary to do so. Recording might inhibit the interviewee from interpreting and talking effectively. If recording is necessary, it should be done with an interviewee's consent.

(vi) Be neutral in tone and do not suggest any answer by asking leading questions;

(vii) Use simple language which will be understood by the interviewee; and

(viii) The questions to the interviewee should be direct and clear.

Focus group discussion (FGD)

A focus group discussion is a method of data collection which involves an intensive discussion done by a small group of 5 to 8 people. This number is important to give an opportunity to every member to participate in the discussion and provide diversity in perspective. This method allows the researcher to guide or facilitate the discussion and record the data resulting from the discussion by the participants. The tool used in an FGD is called a checklist. A checklist consists of items expected to be touched upon during a focused discussion.

Advantages of focus group discussion

(i) It provides room for participants to understand the topic well;

(ii) It develops critical thinking among the participants;

(iii) It makes the research topic live and interesting among participants;

(iv) Data collected are reliable because of thorough checks and balances among the participants; and

(v) A large amount of data can be collected from a small group of participants.

Challenges of focus group discussion

(i) Some participants may not be in a good position to contribute to a particular topic. So, it is important to ensure that the participants selected are knowledgeable enough about the topic. The facilitator should ensure all participants participate during the FGD.

(ii) Since this data collection method produces a lot of information, it may be difficult to compile and analyse;

(iii) If the discussion is not well-guided, participants may extend discussion

to irrelevant stories outside the scope of the study;

(iv) It is a time-consuming method as the discussion involves interaction of different views; and

(v) If the discussion is not well-organised, some of the participants may dominate the discussion. The facilitator should ensure that those less talkative also contribute to the discussion.

Observation

Observation is a systematic data collection method that allows researchers use their sense organs to examine people in natural settings or naturally occurring situations. This method allows the researcher to observe without asking anything from the respondents. For an effective observation, the researcher should consider issues such as; what should be recorded and how the accuracy of the observation can be ensured. The researcher uses an observation guide as a tool. This tool itemises what should be observed. Observation can either be participatory or non-participatory.

Participatory observation: This refers to direct observation. The researcher observes by making himself or herself more or less a member of the group under observation. This makes him or her go through what members of the group experience. It is a method in which the researcher observes actions, behaviours and activities of members of a group while actively engaged in the lives of those people. The researcher observes all the activities and actions done by the group but without the members of the research population realising that the researcher is observing them.

Non-participatory observation: This observation entails limited interaction between the people and the researcher, or the observed and the observer. Here the researcher observes people without interacting with them. Sometimes, the research group may be informed by the researcher that they are being observed, but this is normally done if the research is not confidential.

Advantages of the observation method

(i) It provides correct data since the researcher observes the phenomenon in a natural setting;

(ii) The researcher gets to know ideas of the group he or she is observing or studying;

(iii) The data are recorded as they occur or observed in their natural setting; and

(iv) The method helps to develop skills for observing, recording, interpreting and imaging geographical phenomena.

Challenges of the observation method

(i) It is risky to the researcher's life, especially when the researcher

observes people who are doing something illegal in the society;

(ii) The method is inappropriate for a large population;

(iii) Non-participant observation does not capture the natural context of the social life of the group of people in the study; and

(iv) It is a time-consuming method.

Data processing and analysis

Data processing: It involves manipulation of raw data into their readable form. It includes validation, sorting, classification, calculation and organisation of data.

Data analysis: It is a process of inspecting, rearranging, modifying and transforming data to extract useful information from them. Also, data analysis involves cleaning, analysing, interpreting and visualising data to discover valuable insights into the problem. Once the data have been collected, they have to be processed and analysed.

Data presentation and interpretation

Data presentation: This depends on the nature of the data, whether quantitative or qualitative. Quantitative data presentation involves the use of statistical techniques such as tables, graphs and diagrams. Qualitative data, on the other hand, are presented in textual format. They can be in form of direct quotes or paraphrasing.

Data interpretation: This exercise entails making sense of the data collected and considering the implications of the findings after an analytical and or experimental study. It involves examining wider meanings from the research findings. Interpretation involves drawing conclusions based on the facts collected after an analytical and experimental study. When interpreting data, the analysed data are reviewed to arrive at an informed conclusion.

Report writing

Report writing is the last stage in a research process. A research report is significant for the researcher because it explains what has been done. It has three parts: *Preliminary pages, main body* and *supplimentary pages (end matters)*. The end matters include references or bibliography section and appendices.

Preliminary pages

Preliminary pages carry the title of the research, declaration and copyright, certification, abstract, dedication, list of abbreviations, verification and oath of the researcher. They also include acknowledgement where the researcher expresses gratitude to all those who were involved in the study and the table of contents. Here, the pages of the report are written in roman numbers.

Main body

This part consists of a complete report with all the details. The details of the report are presented in chapters and pages are in arabic numerals. In general, the main body can be divided into the following areas:

Introduction

This part introduces the research to the readers. It contains the background to the research problem, statement of the research problem, research objectives, research questions or hypotheses, scope of the study, and significance of the study. The background should be sufficient to justify why the problem was worth investigating.

Literature review

This section defines key terms and concepts used in the study. Moreover, it reviews empirical findings in the body of literature on the research topic. Furthermore, it reviews relevant theories and models which guide the study. In this part, the researcher also establishes the knowledge gap from the existing literature.

Methodology

In this part, the researcher describes the methodology adopted in conducting the study or research. It shows how the study was carried out and the research instruments or tools used to collect, process and analyse data.

Research findings and discussion

This section presents the findings of the research or study. The presentation of research findings depends on the nature of the study. A research, which uses a qualitative approach, usually presents data in form of quotations and analysed by thematic approach, which involves classification of data into relevant themes. A quantitative research approach presents data using statistical methods such as tables, figures, and charts. The findings must be discussed, linked and compared with other existing empirical studies.

Summary, conclusion and recommendation

In this part, the researcher provides a summary of the whole study including the research problem, methodology, main findings, conclusion and recommendations. This part also involves checking whether the objectives of the study have been achieved. Any conclusion drawn and recommendations made should result from the study. The researcher presents his or her recommendations for improving the situation and for further studies.

Supplementary pages (end matters)

Bibliography and appendices: The bibliography and appendices are presented at the end of the report. Bibliography involves a list of references consulted when writing the research

report. References are a list of all reading materials cited in the report. Appendices are a list of attachments for referring when reading the report. A list of appendices include copies of research tools, research permits and other information, which could not be included in the main document.

Activity 1.3

In groups, do the following:

(i) Choose any geographic topic for research within your area;

(ii) Develop three specific objectives;

(iii) Develop research tools for data collection;

(iv) Conduct a simple research in a form of a project;

(v) Write a research report; and

(vi) Present the report in class.

Ethical considerations

In any research, the researcher must observe ethical issues during data collection. Ethical issues include receiving research clearance from the authorities. The researcher must ensure confidentiality of respondents or informants. Moreover, the researcher would protect the respondents physically and psychologically while informing them about the aim and nature of the research and the inherent risks if any.

Furthermore, the information collected should not be used for the purpose other than the intended one. Another ethical issue is that the researcher should be honest and respectful to the respondents.

Uses of research findings and recommendations

The following are some of the uses of the research findings and recommendations:

(i) They are useful in advancing knowledge which improves and develops the society;

(ii) They enable the researcher to identify the needs of the society;

(iii) They help formulate new or improve government policies, laws and principles which govern the citizens' socio-economic development;

(iv) Through research findings, a researcher can identify possible areas for further research;

(v) Market for various products can be sought by conducting research to identify areas with high and low demand for goods and services; and

(vi) They help to find solutions to problems facing society such as diseases, drought, famine, social inequalities, unemployment, and environmental degradation.

Revision exercise

Section A

Choose the letter of the correct answer:

(i)   Identify the first stage of conducting a geographic research among the following:
- (a)   Data presentation
- (d)   Data collection
- (b)   Research design
- (e)   Data analysis
- (c)   Identification of the geographic research problem

(ii)   Edvan at Panda Hill Secondary School had an interest in conducting a geographic research on challenges street-children face in cities. What will be the last stage for his research?
- (a)   Data collection
- (d)   Data analysis
- (b)   Data presentation
- (e)   Data processing
- (c)   Report writing

(iii)   Which stage of research enables the researcher to identify the needs of the society?
- (a)   Research output
- (d)   Research input
- (b)   Research methodology
- (e)   Research design
- (c)   Problem identification

(iv)   Which of the following are the major types of variables in a research process?
- (a)   Qualitative and quantitative
- (b)   Dependent and independent
- (c)   Null and alternative
- (d)   Dependent and quantitative
- (e)   Alternative and independent

(v)   Identify the two main types of hypotheses among the following:
- (a)   Alternative hypothesis and positive hypothesis
- (b)   Null hypothesis and negative hypothesis
- (c)   Dependent hypothesis and independent hypothesis
- (d)   Null hypothesis and alternative hypothesis
- (e)   Directional hypothesis and non-directional hypothesis

Section B

Answer the following questions:

(i)   What do you understand by the following terms as used in a research report?
- (a)   Introduction
- (c)   Research methodology
- (b)   Literature review
- (d)   Recommendations

(ii)   Ms. Joan is a teacher at Mtakuja Secondary School who intends to conduct field research on the impact of settlement growth on Mtakuja Secondary School:
- (a)   Identify the steps she would follow to conduct the reaserch.
- (b)   Mention at least three advantages of that research to that community and the school.
- (c)   Give five possible challenges to that research.

Section C

Answer the following essay questions:

1.   To get solutions to the problems people face in their daily lives pertaining to environmental issues, an expert should conduct a geographic research. With six points, explain the importance of doing that research.

2.   Explain the advantages and challenges of the following research methods:
- (a)   Survey
- (c)   Focus group discussion
- (b)   Interview
- (d)   Observation

3.   Suppose you want to conduct a geographic research on waste management in your society and your interest is to know waste management practices by residents, design a questionnaire which will enable you to get relevant information or data for your research or study.

4.   Why is it necessary for a researcher to consider ethical issues when conducting a geographic research?

5.   Flora is a Form Four student at Airwing Secondary School but her home place is in Mbarali District where she used to observe several conflicts between farmers and pastoralists. One day she heard through the Radio that, a farmer was killed by the pastoralists in her home village. She decided to conduct research about the conflict. Elaborate four possible research tools she would use during data collection.

Chapter Two

Climate and natural climate regions

Introduction

The natural climate regions are classified according to the amount of temperature and rainfall distribution. Although in each region the overall characteristics of the climate may appear the same, there are some variations that may occur locally. In this chapter, you will learn about the concepts of climate and natural climate regions, geographical factors affecting the climate as well as the natural climate regions of the world. In addition, you will learn to link each climate with its respective economic activities, vegetation and animals, and how to solve climatic problems. The competencies developed from this chapter will help you to plan and carry out several socio-economic activities based on the climatic conditions of particular areas.

The concepts of climate and natural climate regions

Climate refers to the average weather conditions of an area recorded for a long period, usually thirty (30) years or more. Climate provides an integrated picture of atmospheric conditions of a large area for a long time. The world's climate is neither uniform nor static. Climatic conditions vary from one region to another throughout the world. Temperature and rainfall (precipitation) are two most important elements determining the climate. These elements vary from one place to another.

Natural climate regions refer to the areas with specific temperature, rainfall, relief, natural vegetation, soil type and cultural environmental conditions which are more or less similar. From an ecological point-of-view, the naturally occurring plants (flora) and animals (fauna) of the regions are likely to be influenced by geographical and geological factors, such as soil and water availability in a significant manner. Thus, most of the natural climate regions are homogeneous ecosystems. Human impact can be an important factor in shaping a particular natural climate region.

Types of world climate and their characteristics

Classification of climate of the world is done to understand how a combination of different climatic elements determine a specific type of climate. There are various systems for classifying the climate globally. However, the Köppen Climate Classification System is the most accepted and widely used system for classifying the world's climate. This system was developed by Wladimir Köppen in the 1900s and is named after him. In 1900 and afterwards, he continued to revise his system until he passed away in 1940. According to the Köppen Climate Classification System, global climates are often divided into five types as elucidated by Michael Pidwirmy in 2014: Tropical, dry, temperate, cold and polar climates. These divisions of the climate consider a variety of factors such as altitude, atmospheric pressure, wind patterns, latitude and geographical characteristics, for example, mountains and oceans.

Tropical climate

Tropical climate is a non-arid climate in which the mean temperature is above 18°C throughout the year. This type of climate is experienced within $23\frac{1}{2}$ °S and $23\frac{1}{2}$°N of the Equator. Tropical climate is characterised by high average temperatures and heavy rainfall. Temperatures in tropical climate are between 21°C and 32°C, and remain relatively constant throughout the year.

Variations in different seasons are dominated by rainfall. Tropical climates cover only two seasons which are the dry season and the wet season. The annual rainfall is around 762 millimetres. This type of climate is found in areas such as central Africa, some parts of South America as well as northern and eastern Australia. Biomes that have tropical climates include rainforests and savannas.

Dry climate

This type of climate experiences very little rainfall and has, therefore, no permanent source of streams. Dry climates are also marked by a wide range of daily temperatures ranging from 32°C to 35°C. A dry climate is divided into semi-arid and arid zones. These zones have three main characteristics: Very low precipitation, high evaporation rates that typically exceed precipitation, and wide temperature swings, that is both daily and seasonally. Dry climates are found mostly between 15° and 35° North and South of the Equator and large continental regions of the mid-latitudes, particularly in the western parts of North America, Australia, southern parts of South America, central and southern Africa and much of middle Asia. Under this type of climate, the primary characteristic is low and unpredictable precipitation. The lowest rainfall is about 150 millimetres occurring in arid or desert areas where the precipitation average is less than 35 millimetres per annum. Moreover, some deserts may

go several years with no rainfall. A dry climate often has greater evaporation than precipitation. This results in a climate that lacks ground moisture due to low average rainfall and rapid evaporation. For example, arid regions in the Middle East have an average rainfall of less than 20 millimetres every year whereas the annual evaporation rate is more than 200 millimetres. This is ten times that of precipitation. Extreme evaporation contributes to dry and coarse soils that support little plant life. Semi-arid regions with slightly more precipitation will support some grass and shrubs. This climate has significant variations in seasonal and daily temperatures. This climate is found in some parts of central Tanzania.

Temperate climate

Temperate climate is also known as *mesothermal* or *middle latitude climate*. It is found between 30° and 60° North and South of the Equator. Summers tend to be quite warm with little rainfall of about 610 millimetres a year. Winters are moderately wet. Temperate biomes include sub-tropical regions, mediterranean areas and marine or maritime regions. These zones generally have wider temperature ranges of between 17°C and 24°C throughout the year and more distinct seasonal changes than tropical climates, whose variations are often small.

In temperate climates, latitudinal positions, sea or ocean currents, prevailing wind direction, continentality (how large a landmass is), and altitude influence temperature changes.

Cold climate

The cold climate zone lies between 40° and 65° North and South of the Equator and the poles. It includes the Arctic and Antarctic such as parts of Russia and Alaska. Mountain tops have their own cold climate no matter where they are located. Above the tree line, mountains have a climate similar to that of near the poles. At lower altitudes the climate becomes less cold. Cold climate, also known as *snow, microthermal* or *continental climates*, have a moderate rainfall of about 231 millimetres and high seasonal variations in temperature. These climates tend to be found in central regions of land masses and have an average temperature of above 10°C in their warmest months. In the winter, the coldest month has an average temperature of below -3°C.

Polar climate

Polar climate is found across the continents that border the Arctic Ocean, Greenland and Antarctica. This climate region has year-round cold temperature. It is characterised by lack of a true summer. Parts of the world where a polar climate exists include northern Canada, Siberia, and Antarctica. Weather in these areas is very cold for most of the year and land is covered by thick sheets of ice. Large blocks of permanent ice

and tundra are what make these regions distinctive.

During the winter, the regions are entirely dark and extremely cold whereas during the summer, days are long but receive a very small amount of insolation, which makes summers cool as well. The average temperature of the warmest month is less than 10ºC. The annual temperature ranges between -40°C and 0°C. The region is dry with less than 25 millimetres of precipitation annually; most precipitation occurs during the summer. The Polar climate regions experience only four months of temperature above the freezing point. They also tend to have months of little daylight.

Geographical factors affecting climate

Climate of a particular place can differ when compared to another. There are various geographical factors causing these variations in climate.

Latitude

Latitude is the angular distance north and south of the Equator. Latitudes do affect the temperature of a particular area, due to the Earth's inclination; the mid-day Sun is almost overhead within the tropics but sunrays reach the Earth at an angle outside the tropics. Areas within and near the Equator are hot because sunrays directly reach the Earth's surface and hit the smallest area. Temperature, thus, tends to decrease from the equatorial regions towards the poles. This is because sunrays travel over longer distance before they reach the Earth's surface at the polar areas. Moreover, the more the area is hit by sunrays the higher the temperature of the area. Figure 2.1 shows how latitudes may affect temperature:
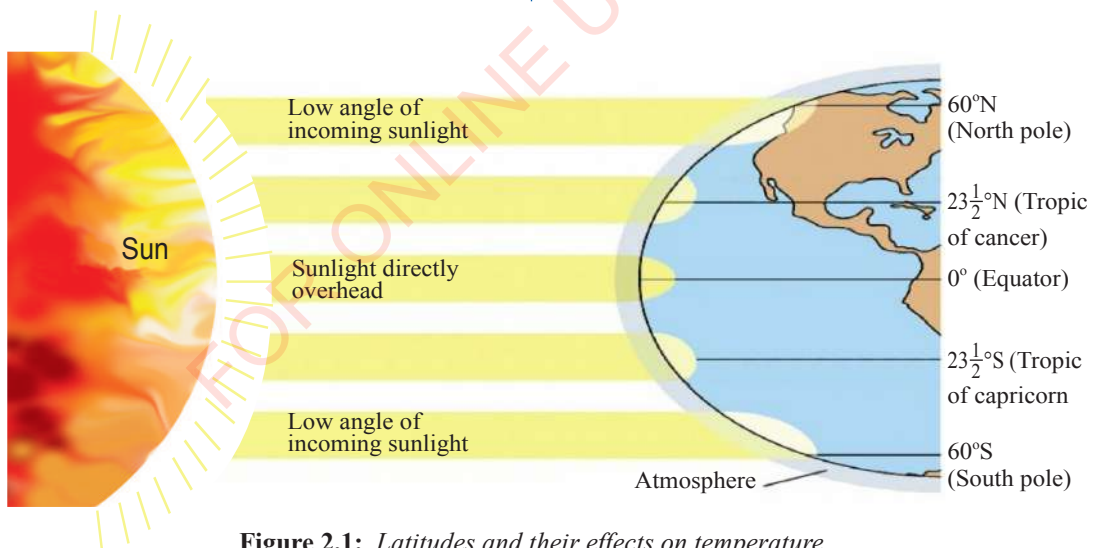
Figure 2.1: *Latitudes and their effects on temperature*

Source: *https://latitude+affect+the+amount+of+solar+radiation+direct+ sunlight*

Altitude

Altitude is the height of a point above mean sea level. Earth's atmosphere is mainly heated through conduction from the surface. As such, places near the surface are warmer than those far from the surface. Temperature, therefore, decreases with height above the sea level at the rate of 0.6°C per 100 metres of height. The higher you go, the cooler it becomes because temperature falls. Normally this happens in the first layer of the atmosphere known as troposphere. This rate of decrease in temperature with altitude (lapse rate) is not constant as it varies from one place to another as well as from one season to another. As such, East Africa is cooler than the Congo Basin area though they fall within the same latitudes. Figure 2.2 shows the temperature at different altitudes.
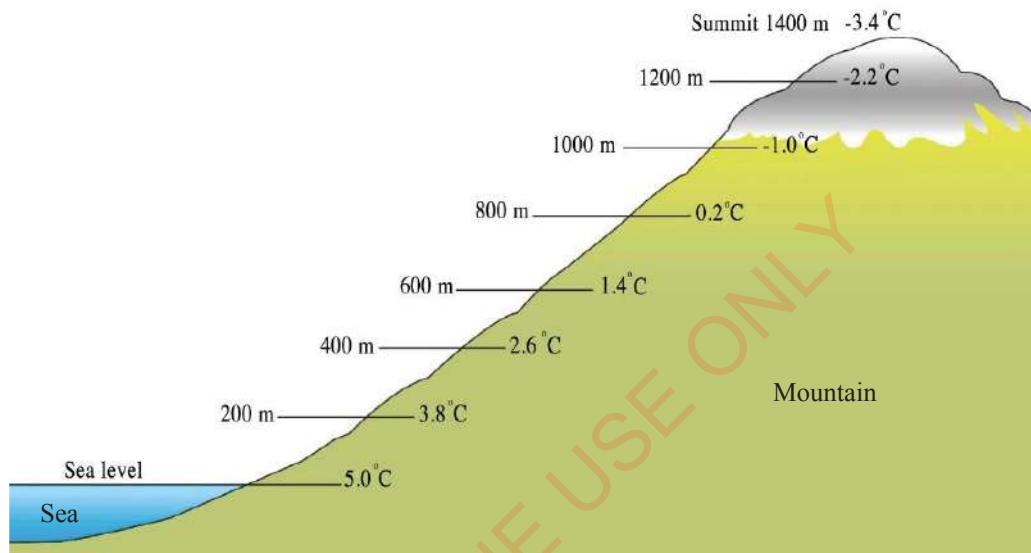
Figure 2.2: *Temperature variation at different altitudes*

One would expect higher temperature at higher altitudes, but this is not what happens. Water vapour and dust in the atmosphere at lower altitudes prevent the heat from escaping back into space. At higher altitudes, there is very little vapour or dust, so there is a rapid transfer of heat through the air which results in the fall of temperature of the particular air.

Distance from the sea

Heating properties of land and water surface vary considerably because they react differently to solar radiation. The land surface heats and cools faster than the water surface. This is because in water there are fast moving mobile matters and redistribution of heat occurs mainly through turbulence. On the land surface, there is less presence of mobile

matters and redistribution of heat is done through molecular heat conduction and proceed by moving from particle to particle.

Normally, water surfaces reflect a lot of light because they are flatter. Some of the light, however, penetrates deep into the water causing a large volume of water to be heated. When water moves with circulating currents, it helps to disperse the heat to the land surface. The specific heat of water is greater than the specific heat of land surfaces. Therefore, it takes more heat to raise up the temperature of water.

Onshore winds bring warmth to coastal regions during the winter. This warming influence is confined to a narrow coastal belt because the warm air rapidly loses its heat on the colder land. During summer, land surface is warmer than the water surface and the air over the land is, therefore, warmer than that of over the sea. For that reason, coastal regions are cooler than inland regions during the summer.

Prevailing winds

Prevailing winds are winds that blow consistently in a given direction over a particular region on Earth. This is caused by several factors such as uneven heating from the Sun and the Earth's rotation.

Winds tend to transfer heat and moisture over the land. If winds are warm and blown from a hot area, they will raise

temperatures. If winds blow from cold areas, they will lower the temperature of a local area. For example, local winds such as *Sirocco* and *Mistral* tend to influence changes in temperature.

During the day, the Sun heats up both the ocean and the land surface. Land, however, absorbs solar radiation faster than water does. Land, thus, absorbs much of the Sun's energy as well. Because water heats up more slowly than land, air above the land will be warmer than the air over the ocean. The warm air over the land will rise throughout the day, causing low pressure on the land surface. Over the water, high surface pressure will be formed because of the cold air. As a result, the air will sink over the sea or ocean. Winds will, therefore, blow from the higher pressure zone over the water surface to lower pressure zone over the land, hence causing a sea breeze. Strength of the sea breeze will vary depending on the temperature difference between the land and the sea or ocean.

At night, the situation operates in reverse. The air over the sea or ocean is now warmer than the air over the land. The land loses heat quickly after the Sun goes down and the air above cools too. This can be compared to a tarmac road. During the day, the tarmac road heats up and becomes very hot to walk on. At night, however, the tarmac road loses its heat and becomes cool. The ocean, however, takes time to lose its heat after the Sun sets. This causes the

low surface pressure to shift over the sea or ocean during the night and the high surface pressure to move over the land. This causes a small temperature inversion between the sea or ocean surface and nearby land at night. Consequently, the wind blows from the land to the sea or ocean hence creating a land breeze. Figure 2.3 shows how the land and sea breezes affect the temperature of the coastal areas:
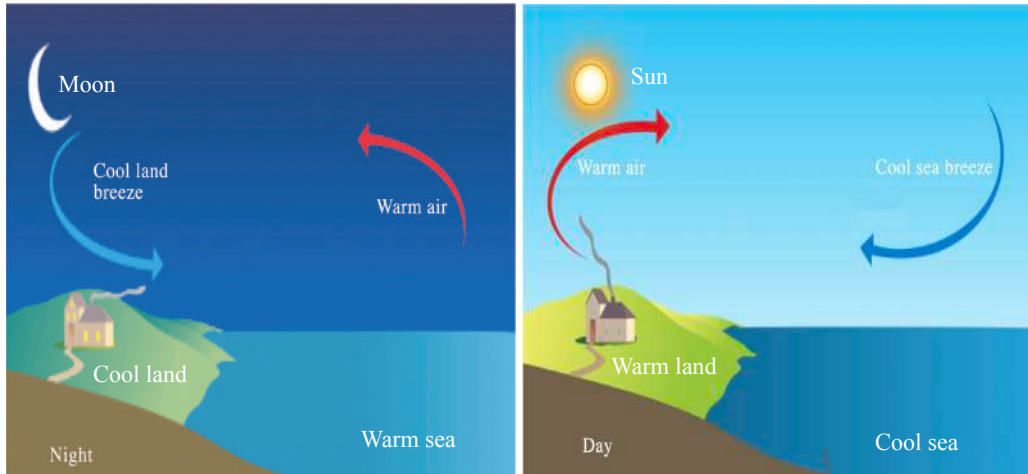
(a) Land Breeze   (b) Sea Breeze

Figure 2.3: *Land breeze and sea breeze and their effect on temperature*

Source: https://www.difference-between-land-breeze-and-sea-breeze.

Ocean currents

An ocean current is a continuous and directed movement of sea water generated by a number of forces acting upon the water which includes winds, temperature of the sea or ocean, the shape of coastline salinity and density differences of the sea or ocean.

Coastal areas are influenced by warm or cold ocean currents. Both ocean currents and winds affect temperature by transporting their heat or coldness to adjacent regions. Warm currents raise temperatures while cold currents lower the temperature of land surfaces when the winds are onshore. Warm currents move towards the pole carrying tropical warmth into the high latitudes, for example, the Brazil warm ocean current. In tropical latitudes onshore winds, crossing warm ocean currents blow this warmth and moisture to the land to raise both the temperature and precipitation. Cold ocean currents have less effect on temperature because they usually lie under off-shore winds, which give rise to mist or fog along the coast, for example, the Benguela cold ocean currents. Figure 2.4 shows how ocean currents affect temperature:
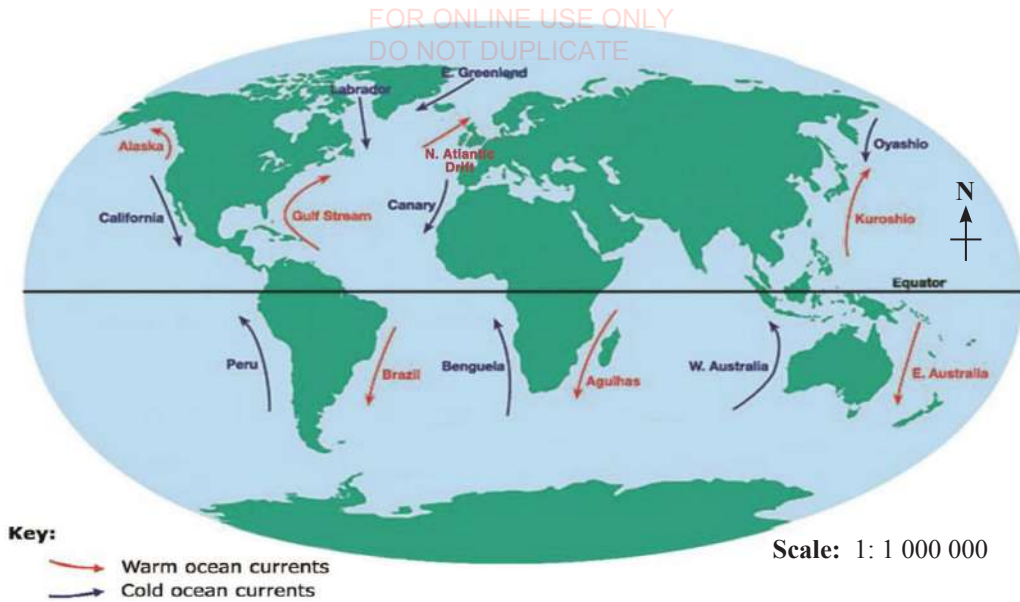
Figure 2.4: *Ocean currents and their effect on temperature*

Source: https://qph.fs.quoracdn.net/main-qimg-83f780d8eabbcd8661f837eeb7ca014a

Aspect

Aspect refers to the direction in which a slope faces the Sun. Figure 2.5 shows how aspect affects temperature. For example in the Northern Hemisphere, southward facing slopes are warmer than northward facing slopes because the northward slopes never receive direct sunshine as this region never gets overhead Sun. The southward slopes, on the other hand, are warmer and, therefore, carry moisture winds which bring rainfall to this area whereas the northward facing slopes experience dry winds with no moisture and, hence, no rainfall.
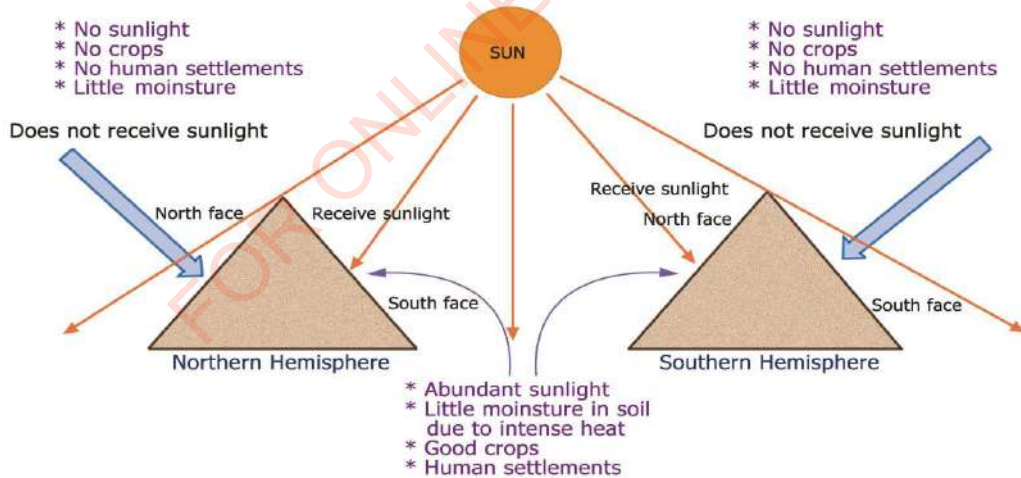
Figure 2.5: *Aspect and its effect on temperature*

Source: https://www.pmfias.com/temperature-distribution

Vegetation

Vegetation affects the temperature of a particular place significantly. Areas with dense forest cover, such as the Congo and the Amazon Basin receive less insolation towards the Earth's surface. Due to this, they are often cooler than areas in open spaces.

Soils

Light soils reflect more heat than darker soils, which are better heat absorbers. Such soil differences may cause slight variations in the temperature of the region. Dry soils such as sands are very sensitive to temperature changes, whereas wet soils such as clay retain much moisture and tend to warm up or cool more slowly.

Human influence

Human activities such as settlements, agriculture, industries and construction of dams influence climate change as people tend to clear forests, drain water and cultivate wetlands. These activities lead to climate change. For example, as population increases, land use increases as well. Consequently, trees are cut down in large numbers for socio-economic activities such as farming, settlement, lumbering or timber production, fire-wood and charcoal production. These activities leave the land bare and expose it to the agents of soil erosion, such as running water and winds. It also affects hydrological cycle systems, hence leading to drought in an area.

Temperature

Temperature is the degree or intensity of heat present in a substance or object. Temperature is expressed in a comparative scale measured by a thermometer or simply perceived by a touch.

Temperature on the Earth's surface varies from one place to another. Places near the Equator experience high temperature throughout the year whereas places near the poles experience cold temperature throughout the year.

In the context of Geography, temperature is a mean temperature. It can be the daily or diurnal mean temperature, mean monthly temperature, and mean annual temperature. It is important, therefore, to understand the following concepts of temperature:

Daily mean temperature: This is the average of the maximum temperature and minimum temperature recorded during a day.

Mean monthly temperature: This is the average of temperature of a month obtained by taking the sum of daily temperature of a calender month divided by the number of days in a month.

Mean annual temperature: This is the average of maximum and minimum temperatures of a year. It is the average between the coldest and the hottest months in a year.

Annual range of temperature: This is the difference between the temperature of the hottest month and that of the coldest month in a year.

Diurnal range of temperature: This is the difference between the hottest and coldest parts of the day i.e., maximum day and minimum night temperatures.

Atmospheric pressure

Atmospheric pressure is the pressure within the atmosphere. It is the force exerted on a surface by the air above it as the gravity pulls it to the Earth. Therefore, it is also important to understand the following related concepts of atmospheric pressure:

Depression or cyclone: This is a large scale air mass that rotates around a strong centre of low atmospheric pressure (L) in anti-clockwise direction north of the Equator and in a clockwise direction to the south. Cyclonic winds move across nearly all the regions of the Earth except the equatorial belt and are generally associated with rain or snow. Cyclones are characterised by inward spiraling winds that rotate about a zone of low pressure. Figure 2.6 is an example of a cyclone:
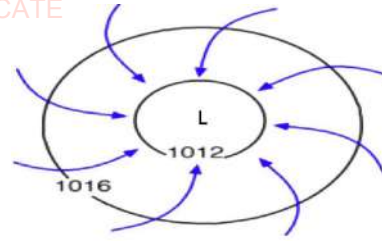
Figure 2.6: *Cyclone*

Anticyclone: This is a system of winds that rotate clockwise about the centre of high atmospheric pressure (H) in the Northern Hemisphere and anti-clockwise in the Southern Hemisphere. As air sinks, no clouds or rain are formed. This is because when air sinks it becomes warm and it cannot hold more water. This situation causes settled weather conditions during the summer. There is a clear sky and high temperature. Figure 2.7 illustrates an anticyclone:
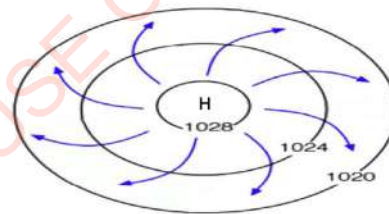
Figure 2.7: *Anticyclone*

Inter-Tropical Convergence Zone (ITCZ): This is a low-pressure belt, which is found between two trade wind systems. The ITCZ is known by sailors as the doldrums or the calm zone or area because of its monotonous and windless

weather. It is an area where the northeast and southeast trade winds converge. Trade winds converge in this region resulting in heavy rains, which are accompanied by lightning and thunderstorms. The ITCZ moves northwards and southwards following the apparent movement of the Sun. Figure 2.8 shows the Inter-tropical convergence zone:
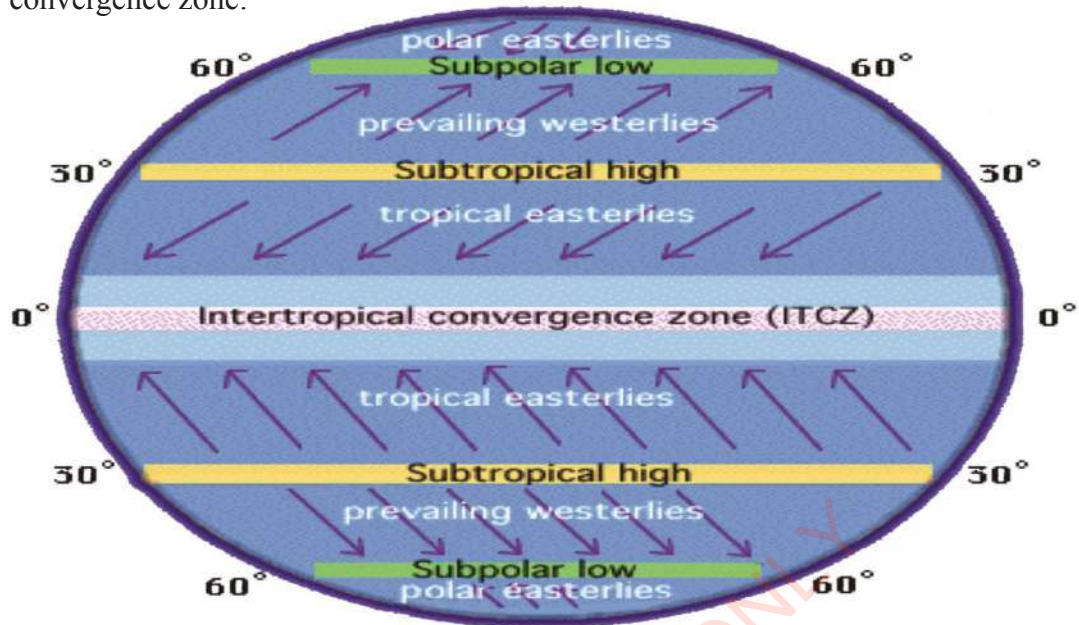
Figure 2.8: *Inter-tropical convergence zone*

Source: *https://www.google.com/search?q=inter+tropical+convergence.*

Rainfall

Rainfall may be defined as the droplets of water falling from the atmosphere after condensation. When water vapour rises, it cools at a high altitude until dew point is reached. A dew point is the temperature rate at which the atmosphere is saturated with water vapour. Condensation takes place to form clouds after a dew point has been reached. Moist air contains small particles of matter called nuclei that are made of dust, salt, ice and soot. Large water droplets join the nuclei to form raindrops. The following are types of rainfall:

Convectional rainfall: This occurs when the energy of the Sun heats the surface of the Earth causing water to evaporate to form water vapour. When the land heats up, it warms the air above it, hence raising the currents of air so high in the atmosphere where it cools down very fast, condenses, becomes saturated and falls as heavy rain. This type of rainfall is very common in regions with equatorial climate where there is constant high temperature and humidity. Figure 2.9 shows formation of convectional rainfall:
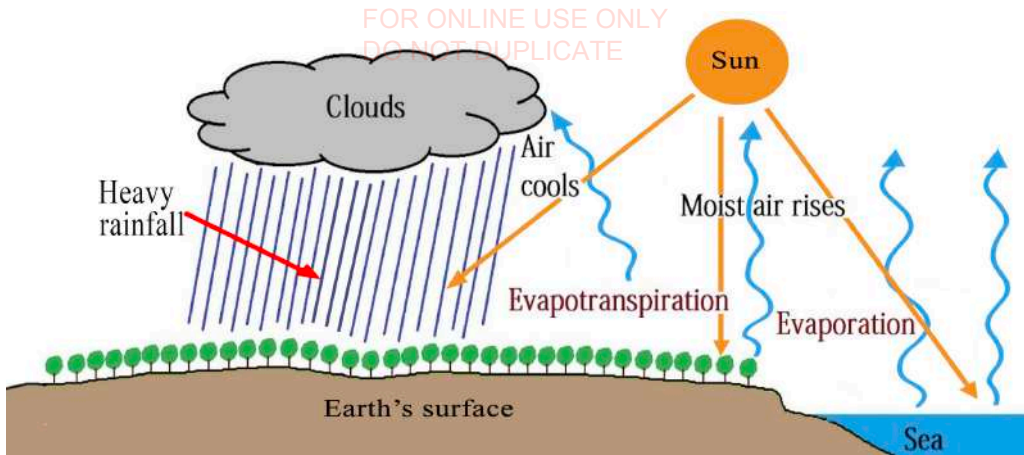
Figure 2.9: *Convectional rainfall*

Source: *https://www.google.com/search?q=convectional+rainfall+diagram*

Relief or topographic rainfall: Occurs when moisture carrying winds are forced to rise over mountains lying along a coast at right angles to onshore winds. Presence of mountains acts as a barrier to the movement of moist air, hence forcing air to rise. The ascending moist air cools and condenses to form clouds which bring rain on a windward side. After crossing the mountain, the winds lose most of the moisture and cool down and dry. As such, no rain or fog may occur on the leeward side. Figure 2.10 shows the formation of relief rainfall:
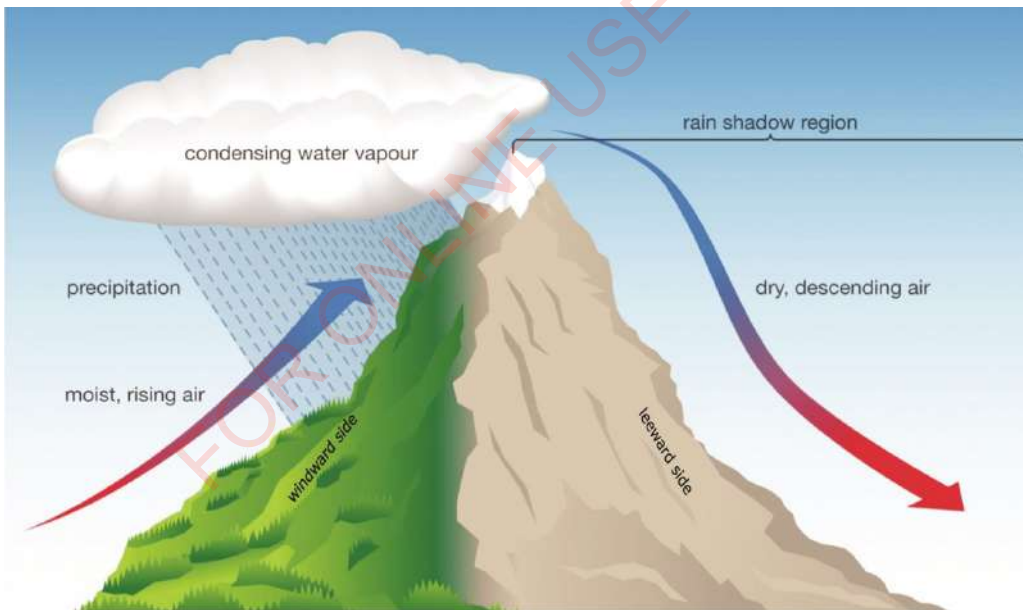
Figure 2.10: *Relief or topographic rainfall*

Source: *https://cdn.britannica.com/condensation-precipitation-rain-shadow-effect-lift.jpg*

Cyclonic or depression rainfall: It is formed when masses of warm air are forced over and chilled by wedges of cold air. The line where the two air masses meet is known as a "front" which explains why sometimes this type of rainfall is known as "frontal rainfall". The collision of two air masses of different characteristics can cause some air to rise; as a result, it leads to the occurrence of rainfall. Here the warm air is forced to ascend or rise over cold air, resulting in moisture and heavy rains. Figure 2.11 shows the cyclonic rainfall:
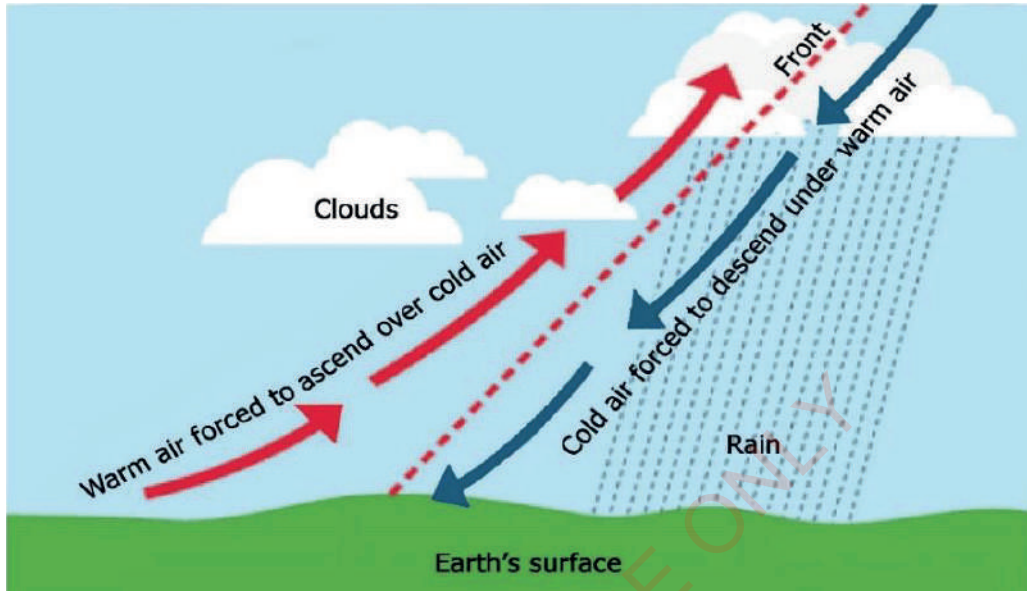
Figure 2.11: *Cyclonic/ frontal or depression rainfall*

Source: *https://i0.wp.com/civilnoteppt.com/wp-content/uploads/2020/02/frontal-rainfall.*

The winds that may cause cyclonic or depression rainfall are:

Sirocco winds: Hot winds with clouds of desert dust blowing from the Sahara Desert northwards across the Mediterranean Sea into Italy. They are so humid that they bring unpleasant, irritating heat and dryness.

Mistral winds: A mass of cold air which blows southwards from the Alps and Central Massif across the Mediterranean Sea into Northern Africa.

Harmattan winds: Dust-laden winds blowing southwards to the Coast of West Africa from the Sahara Desert.

Activity 2.1

In groups, discuss the geographical factors affecting climate in your area. Then, present those factors in class using diagrams where necessary.

Natural climate regions of the world

A natural climate region is a part of the Earth with relatively similar climate, vegetation, geology, animal species and human activities. The regions can be categorised as hot, cold, wet or dry. Whereas some areas receive rain throughout the year, others receive rain in some months of the year only. Natural climate regions are classified based on the climatic characteristics such as distinct temperature and rainfall. On this basis, the Earth's surface can be divided into fourteen (14) natural climate regions as follows:

(i) Equatorial

(ii) Tropical grassland (Savannah)

(iii) Tropical maritime

(iv) Tropical (Hot) desert

(v) Tropical monsoon

(vi) Mediterranean

(vii) Warm temperate eastern margin (China type)

(viii) Warm temperate eastern interior (Steppe type)

(ix) Cool temperate west coast margin (British type)

(x) Cool temperate eastern margin (Laurentian type)

(xi) Cool temperate continental (Siberian type)

(xii) Cool temperate interior

(xiii) Polar (Tundra climate and Ice cap climate)

(xiv) Mountainous

Equatorial climate region

Location and coverage

The equatorial climate region, which is also known as the equatorial climatic belt extends from 0° to 5° of latitudes North and South of the Equator. In some parts of the world, however, it extends up to more than 10° North and South of the Equator. Areas experiencing equatorial climate include:

(a) The Congo Basin (Central Africa);

(b) The Amazon Basin (South America);

(c) The Highlands of East Africa (which has a modified equatorial climate due to higher altitude). In East Africa the modified equatorial climate is experienced around the Lake Victoria basin, specifically the Islands within Lake Victoria, Northern region in Pemba (Zanzibar) at Ngezi forest.

(d) The Coast (Gulf) of Guinea (West Africa);

(e) South–East Asia mainly in India, Sri Lanka (Ceylon), Malaysia, Singapore and Indonesia, also from Myanmar (Burma) to Vietnam;

(f) The Southern Ivory Coast;

(g) The South, Western and South-Central Ghana;

(h) Western Coastal Nigeria;

(i) Eastern Coastal Madagascar (Malagasy Republic); and

(j) Younde (Cameroon).

An equatorial climate region has an equatorial type of climate. Figure 2.12 shows areas within equatorial climate:
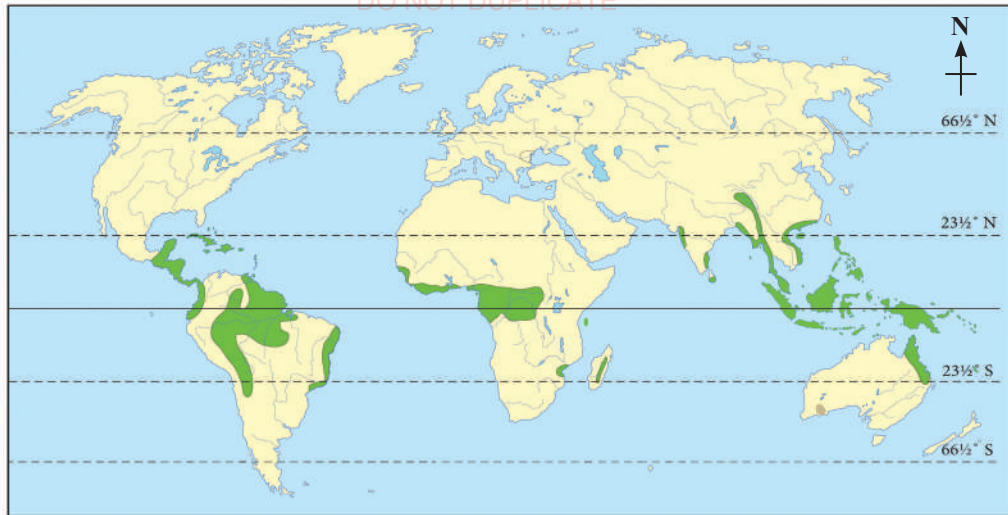
Scale: 1: 1 000 000

Key:
■ Equatorial climate regions

Figure 2.12: *Equatorial climate regions*

Climatic characteristics

There is considerable uniformity in temperature throughout the year; the mean monthly temperatures are always around 24ºC to 27ºC with very little variation; there is no winter because the length of day and night is more or less equal over the year and the Earth's rotational velocity is maximum at the Equator. The diurnal and annual ranges of temperature are small, normally not more than 3ºC. Moreover, this type of climate is characterised by heavy rainfall (normally convectional rain) that is well distributed throughout the year. For example, the total annual rainfall ranges from 1 500 to 2 500 millimetres. Furthermore, it receives double rainfall peaks coinciding with the equinoxes. Cloud cover is heavy with seldom clear sky day. Figure 2.13 and Table 2.1 illustrate the climate of Younde, Cameroon, one of the places located within the equatorial climate region.

Table 2.1: *Climatic data for Younde (Cameroon)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	25	25	24.6	24.5	24.2	24	24	24	24	24	24.4	24.5
Rainfall (mm)	49	69	150	230	206	114	64	84	194	226	150	50
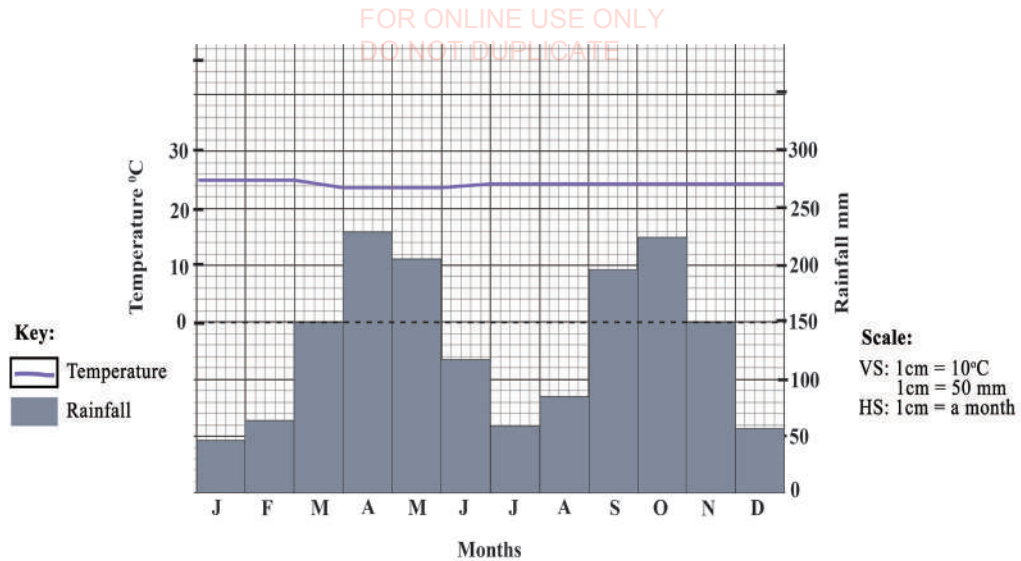
Figure 2.13: *Climate of Younde, Cameroon*

Vegetation

This type of climate supports a luxuriant type of vegetation and the tropical rain forest. Moreover, it comprises a multitude of evergreen trees that yield tropical hardwood such as mahogany, ebony, greenheart, rosewood, cabinet wood, and dyewoods. The lianas, epiphytic and parasitic plants are also found in this type of climate. Trees of single species are scarce in such vegetation (see Figures 2.14 and 2.15):
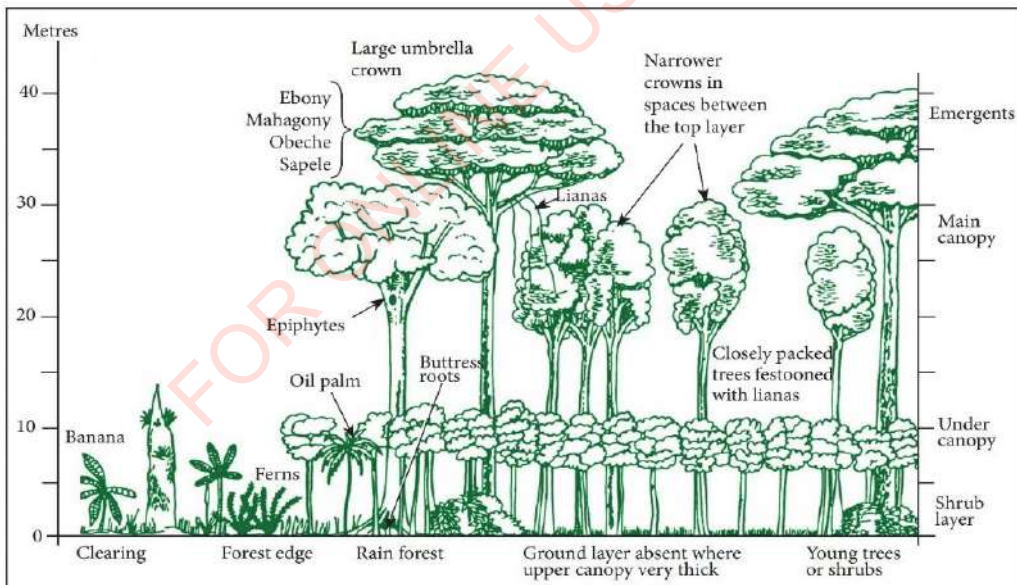
Figure 2.14: *Equatorial rainforest*
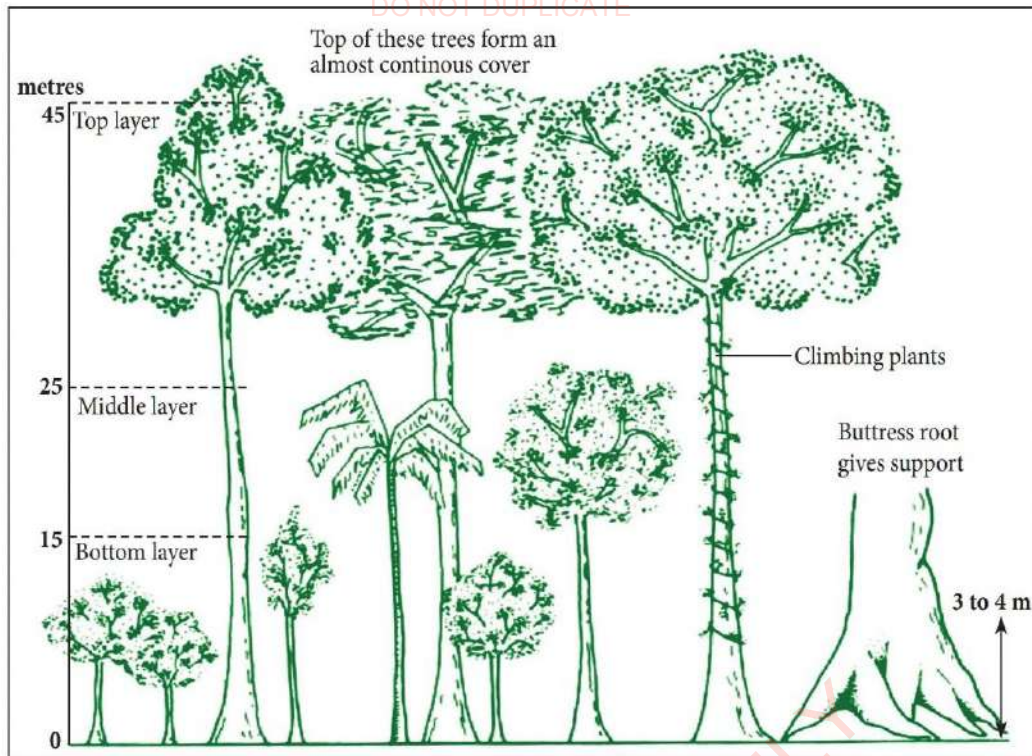
Figure 2.15: *Equatorial rainforest with layers*

Human activities

The equatorial regions are generally sparsely populated, but several socio-economic activities are conducted as listed below:

Agriculture: In some areas where population is dense like South of Nigeria and the Islands of Java in Indonesia, the natural vegetation has been removed. The area is mainly used for growing crops such as rubber in Malaysia and Indonesia, oil palm in Malaysia, Nigeria and the Democratic Republic of Congo, cocoa in Ghana, and sugar cane in Cuba. Other crops include maize, groundnuts, yams and bananas.

Lumbering: Since most valuable trees such as mahogany, ebony, and rosewood are found in equatorial forests, lumbering is one of the major activities in the region.

Fishing and water transport: Fishing takes place in large rivers such as the Amazon, the Congo and their tributaries. Rivers also serve as a means of inland

water transport for both people and goods, especially timber and logs.

Hunting and food collection: Hunting and food collection are practised mainly by forest dwellers such as the pygmies of the Congo Basin. They obtain traditional medicines, firewood, fruits, honey and meat through hunting. Animals that are found in the equatorial region include tree dwellers such as gorillas, chimpanzees and monkeys; river dwellers such as crocodiles and hippopotamus and open space dwellers such as lions, hyenas, zebras, tigers and elephants. There are also birds and insects of various kinds.

Equatorial areas have not been fully developed because of a number of reasons. The common ones are: It is difficult to establish lines of communication because of rapid vegetation growth; there is usually heavy rainfall throughout the year that leads to loss of soil nutrients through leaching, thus, making it unproductive and less supportive to vegetation; and the presence of pests and insects which cause diseases that infect human beings, livestock and crops. Examples of these

insects are tsetse-flies, which cause sleeping sickness (trypanosomiasis) in human beings. People can get this disease when an infected tsetse-fly bites them. If the disease is not treated, it can cause death. Also, it can cause nagana (animal trypanasomiasis) among livestock.

Tourism: Tourism activities take place due to the attractive environment of the equatorial climate such as thick forests and wild animals like chimpanzees, leopards, monkeys, crocodiles, gorillas and hippopotamus.

Tropical climate regions or tropical grasslands

Location and coverage

These regions are found between 5° and 15° North and South of the Equator. Tropical regions are well developed in Africa (West Africa, Sudan, East and Central Africa), Brazilian Plateau, Venezuela, and North Australia. In Tanzania, Serengeti grassland is an example of tropical grassland climate region. Figure 2.16 shows the location of the Savannah climate or tropical climate regions.
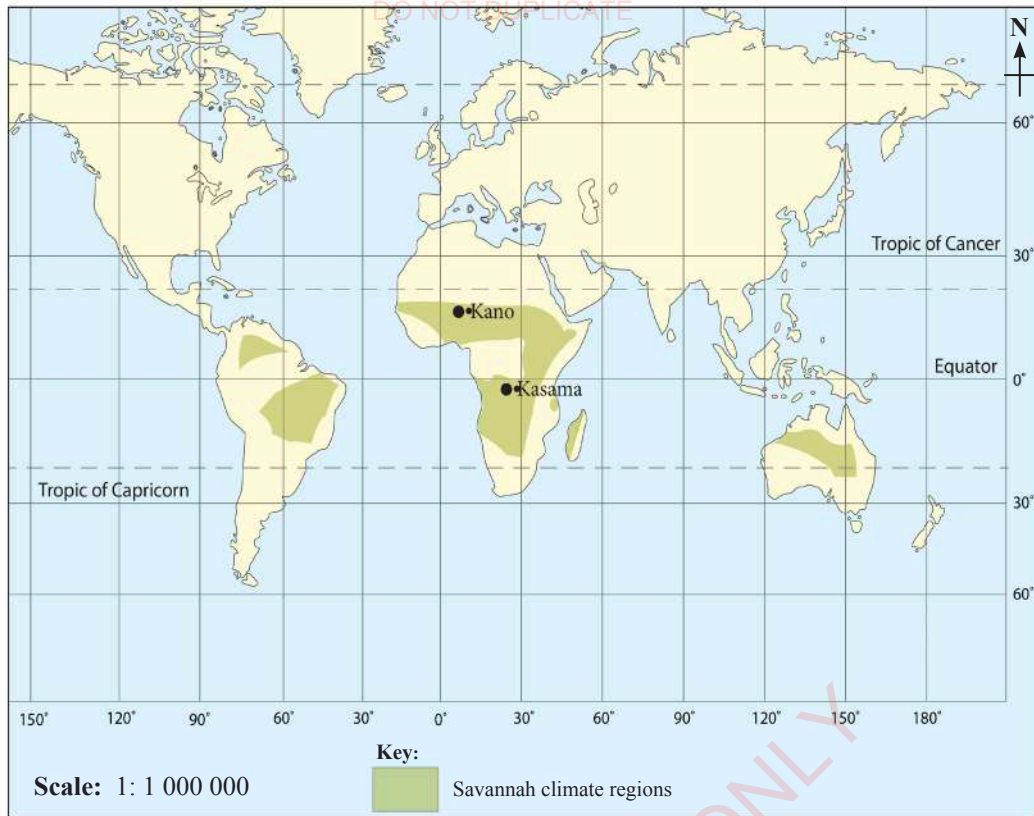
Figure 2.16: *Savannah climate regions*

Climatic characteristics

The Savannah climate is characterised by distinct wet and dry seasons. It also has a high mean temperature throughout the year of between 19ºC and 27ºC. The annual range of temperature is between 3ºC and 8ºC. Extreme diurnal range of temperature is one of the characteristics of the Sudan type of climate and the total annual rainfall ranges from 500 millimetres to 1 500 millimetres. Figures 2.17 and 2.18, Tables 2.2 and 2.3 show the climatic data (tropical grassland) for Bulawayo and Cuiaba, which are in tropical climate regions.

Table 2.2: *Climatic data for Bulawayo (Zimbabwe)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	21.7	21	20.6	18.9	16.0	13.9	13.9	16	20	22.2	22.2	22.2
Rainfall (mm)	149.7	101.6	78.7	17.8	7.6	0	0	0	2.5	22.9	83.8	147
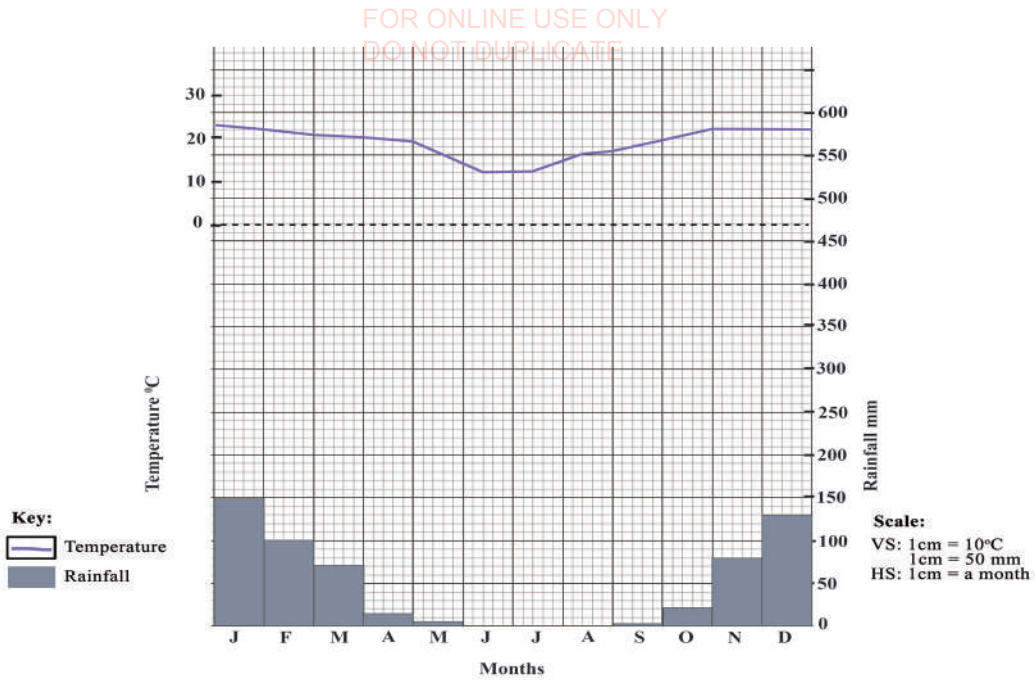
Figure 2.17: *Temperature and rainfall distribution for Bulawayo (Zimbabwe)*

Table 2.3: *Climatic data for Cuiaba (Brazil)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	27.2	27.2	27.2	26.7	25	23.9	24.4	25.5	27.8	27.8	27.8	27.2
Rainfall (mm)	248	211	211	101.6	53	7.6	5	28	50.8	114	149.9	205.7
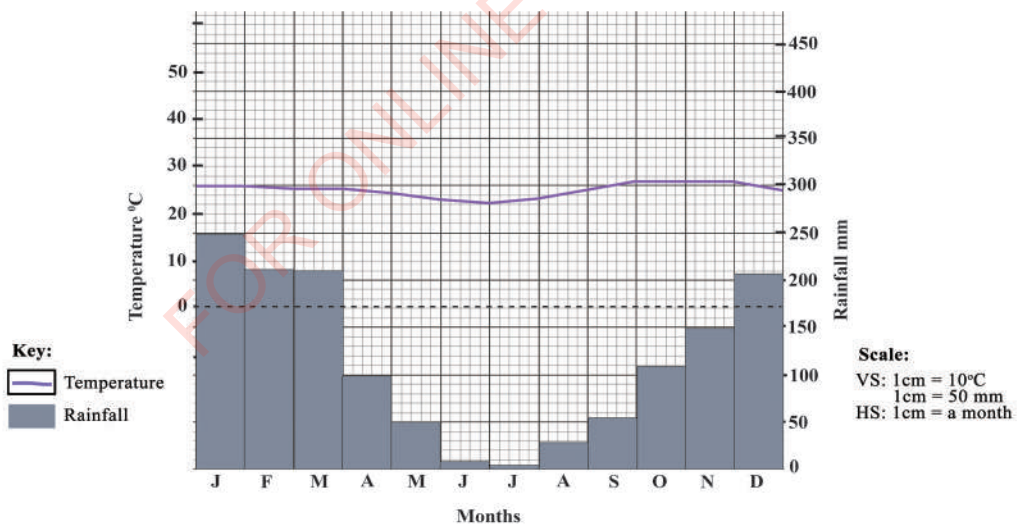
Figure 2.18: *Temperature and rainfall distribution for Cuiaba (Brazil)*

Vegetation

In terms of vegetation, this climate is characterised by tall grass often reaching two metres high and scattered trees, which are mainly found near water courses. The vegetation consists mainly of thorny bushes, low shrubs, and thorny trees. They are also characterised by grasslands, which have different names depending on their locations, for example, they are called Campos in Brazil and Savannah in Africa and Australia. Most of the grass tends to turn brownish during the dry season. The roots remain dormant. When the rains come, they produce new shoots and leaves. Additionally, the trees can survive in the dry season in various ways. For instance, some store water in their trunks like the baobab trees and some trees shade off their leaves to prevent loss of water. Moreover, most of the trees have long roots, which can reach the layers of moist soil several metres below the Earth's surface. Other trees such as Acacia develop an umbrella-shaped crown, which provides shade around the trunk and roots. This helps to conserve soil moisture.

Economic activities

People in the tropical grasslands engage mainly in the following economic activities:

Crop production: Crops are of two types: Food and cash crops. Some food crops are maize, millet, beans, rice and groundnuts whereas cash crops include sugarcane, coffee, bananas, cotton, sisal and tobacco. Some crops, for example sisal, cotton, tobacco and sugarcane are grown in plantations.

Generally, agriculture is not that much well developed in the Savannah region, with the exception of river basins where the network of rivers supply water for farming through irrigation. The following reasons are behind low agricultural development in most of Savannah areas:

Rainfall is unreliable and, in some places, insufficient. Drought incidences existence of pests (example, tsetse-flies), diseases and harmful birds, which harm crops, affect crop production. Moreover, quelea birds affect crop productivity as they fly in huge flocks in search of early maturing cereals, annual wild grass and grains. Rice farms in Mbarali-Mbeya are frequently affected by quelea birds.

Furthermore, loss of soil fertility due to scanty vegetation influences soil erosion by allowing the agents of erosion such as wind and water to erode the soil. This affects agricultural production. Soil erosion due to heavy occassional rainfall also affects transport and communication systems due to frequent destruction of infrastructures such as roads, railways and power lines. Crop production is also affected by occasional heavy rains. As this climate region is

characterised by sparse population, it hinders crop production due to a shortage of labour.

Livestock-keeping: Another economic activity that is practised in tropical climate regions is nomadic pastoralism, whereby livestock-keepers move from one place to another in search of water and pastures. Extensive grassland (Savannah) provides a good environment for keeping cattle, goats and sheep. A good example can be drawn from the Maasai of East Africa, who mainly engage in livestock-keeping. The Maasai are nomadic. They maintain large herds of cattle, goats and sheep which graze on the grasslands of Kenya and Tanzania. Figure 2.19 shows livestock-keeping in one of the Savannah areas. Sudan is the leading country in livestock-keeping in Africa. It ranks first in Africa for having the largest number of cattle, sheep, goats and camels. Additionally, it is the third country in Africa for poultry production and the fifth country for donkey keeping. In 2019, Sudan's official sources estimated 41 million cattle, 51 million sheep, 43 million goats and 4.9 million camels. In addition, there were 7.5 million donkeys and 784 thousand horses. In Brazil, the Campos (grassland) are used for rearing cattle for commercial purposes.

Figure: 2.19: *Livestock keeping in savannah areas*
Source: *http://apps.tsn.go.tz/public/uploads/images/cattlle-helders.jpg.*

Hunting and gathering activities: Hunting and gathering activities are also carried out in this area due to the availability of wild animals, birds, fruits, eggs and honey from the forest.

Tourism activities: Tourism is one of the world's fastest growing industries and a major source of national income, foreign exchange and employment opportunities for many countries. Tourism activities are common in tropical or Savannah climate region because the grassland is home to a variety of exceptional animals such as elephants, giraffes, zebras, leopards, tigers, hyenas, jaguars, lions, buffaloes, rhinos and hippos. In Tanzania, there are many national parks, including world ranking tourist attractions such as the Serengeti, Nyerere, Ruaha, Mikumi and Gombe. Figure 2.20 exemplifies a tourism activity in the Savannah region:

Figure: 2.20: *Tourism activity in the Savannah region*
Source: *https://www.safaris-uganda.com/6-days-tanzania-luxury-safari*

Activity 2.2

Go around the area you live in (village or town). Then, describe its climatic conditions and outline feactures that may attract tourists to the place. Present your description in class.

Tropical maritime climate region

Location and coverage

A tropical maritime climate region is a region experiencing tropical climate that is primarily influenced by the ocean, mainly islands and coastal areas situated between 10° and 25° North and South of the Equator. It covers the lowlands of Central America, the West Indies,

East coastal lowlands of Brazil and East Africa, East Madagascar, the coast of Queensland (Australia) and Manila in the Philippines. Figure 2.22 shows the tropical maritime climate regions. In Tanzania, the tropical maritime climate region includes some parts of Zanzibar Islands.

Climatic characteristics

Though the mean annual temperature is fairly high, the summer and winter seasons are sharply differentiated due to northward and southward movements of the Sun. There are two main seasons in a tropical maritime climate: The wet and the dry seasons. The total annual rainfall varies from 1 000 millimetres to over 2 000 millimetres depending on location. The temperature ranges from 21°C to 29°C. The trade winds blow all year round and are moist, as they pass over warm seas. The onshore trade winds blow throughout the year and bring rain almost every day except in the hot seasons. Table 2.4 and Figure 2.21 present the climatic data (Tropical maritime climate) for Manila in the Philippines.

Table 2.4: *Climatic data for Manila (Philippines)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	26.8	26.3	25.9	26.2	25.9	25.8.3	25.8	25.8	25.9	25.5	25.6	25.4
Rainfall (mm)	22	12	10	49	247	298	642	551	541	297	200	100
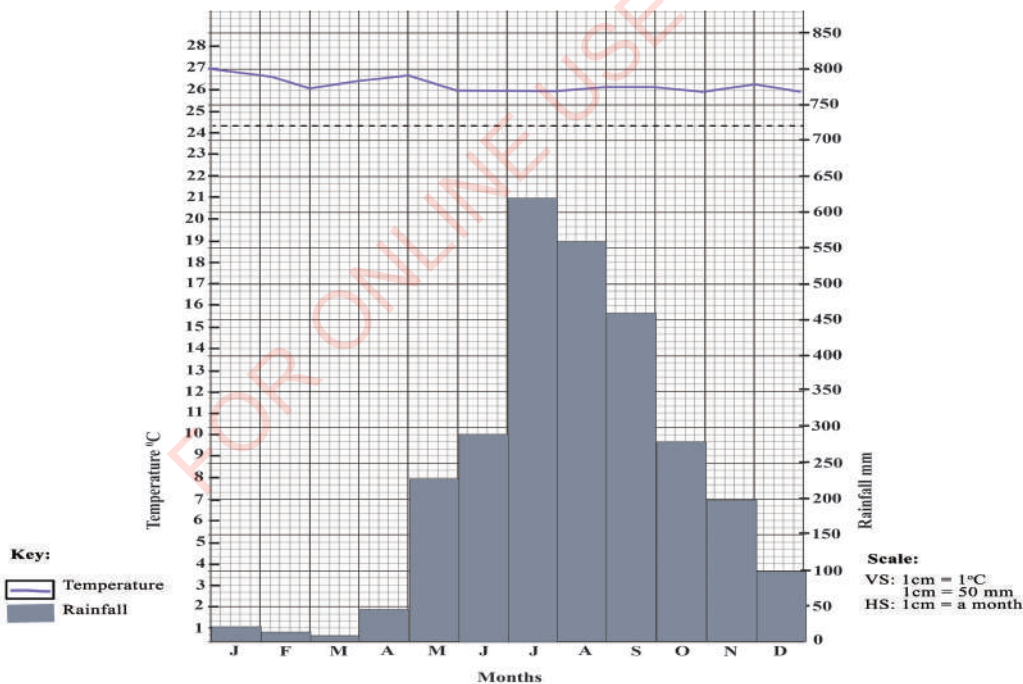
Figure 2.21: *Temperature and rainfall distribution for Manila in the Philippines*

Vegetation

Trees are normally deciduous. Forests are open and less luxuriant. Also, most of the forests yield valuable trees such as teak. Other kinds of trees are sal, acacia and eucalyptus.

Economic activities

People mainly engage in agriculture, especially in the production of food crops such as rice. This is done in almost all tropical marine regions. They also engage in the production of cash crops such as sugarcane which is grown annually on large plantations in most parts of the West Indies, South Africa (especially in Natal) and Queensland (North-east Australia). Another cash crop produced is coffee especially in Eastern Brazil.

Tropical monsoon climate region

Location and coverage

These areas are located in Southern Asia where strong seasonal or monsoon wind blows strongly onshore during the hot season and offshore for the rest of the year. The word 'monsoon' means season in Arabic. This type of climate is found in South East Asia (from Pakistan, India and Bangladesh to Southern China and the Philippines) and Northern Australia. This type of climate is mostly found in India (see Figure 2.22 which shows the tropical monsoon climate regions):
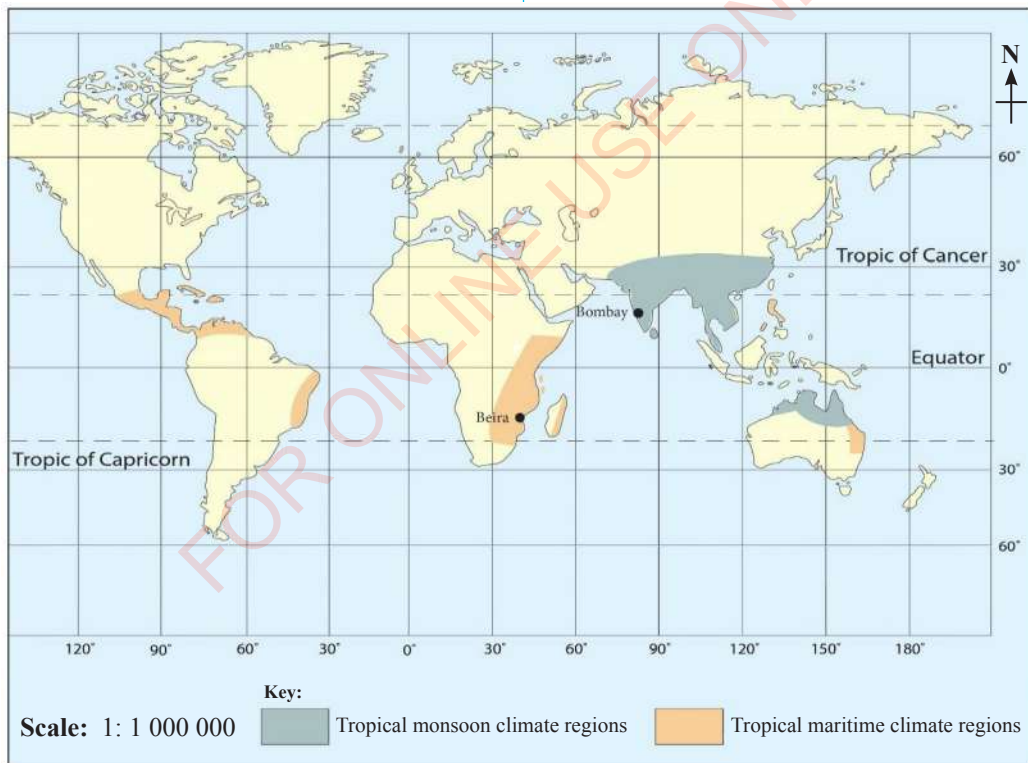
Figure 2.22: *Tropical monsoon climate and tropical maritime climate regions*

Climatic characteristics

Seasonal reversal of winds is the chief feature of the monsoon climate region. In summer, the winds blow from the sea to the land. This is when land heats up and an intensely low pressure zone develops over the land surface, hence attracting strong moist winds from the sea which bring in a lot of rain. The rain densely falls within a short season of just four months from June to September. During winter, the land is cooler, hence leading to the development of a high pressure zone. At this time, wind blows from the land towards the sea, leaving the area dry.

There are three seasons in the tropical monsoon: The cool, the hot and the wet season. The cool season starts from November to February. It is a dry season. When the offshore North East Monsoon winds blow, days get progressively hot. From April to June the maximum mean daily temperature in Bombay in India, is over 30°C because of the near overhead mid-day Sun. During this time, there are almost no winds. As said earlier, the rainy season is from June to September. During this period, the on-shore South West Monsoon winds bring heavy rainfall. The patterns of the season in the tropical monsoon climate are similar to those of the savannah climate, except that the total rainfall is higher, hence bringing with it the wettest rainy season. The total rainfall is similar to that of areas with an equatorial climate where rain falls throughout the year. However, in areas with a monsoon climate, rain is mostly experienced in about five months.

Vegetation

Vegetation in the monsoon lands varies considerably depending on the amount of annual rainfall received. In the wettest areas, for example, in Myanmar (Burma) and Sri Lanka, vegetation consists of dense evergreen forests. Because of the long dry season the forest is less luxuriant than rainforests, and many trees are deciduous, and lose most of their leaves in the dry season. The trees are more widely spaced, hence allowing a thick undergrowth to flourish, particularly, dense thickets of bamboo. Rapid growth takes place in the hot and wet seasons wherein trees soon become covered with leaves. The trees are tall, often as high as 30 metres and not close together as in equatorial rainforests. Where the rainfall is not so high and because of the very long dry seasons, the vegetation is mainly made of woodland and scrubs, similar to that of the Savannah.

Human activities

Intensive cultivation of food crops is practised due to fertile soils and adequate rainfall. Sometimes, water from lakes and rivers is used for irrigation schemes. There is cultivation of cash and food crops usually on plantations or estates. Cash crops include sugarcane, cotton and jute. Food crops include wheat,

millet, maize, and sorghum, which are grown in dry areas. Paddy is the most commonly cultivated food crop. In the highland areas of many tropical monsoon regions, tea is an important plantation crop. The farmers are mainly concerned about climatic variations which occur from year to year, particularly the availability of rain. Another concern is how to increase agricultural production to keep up with the rapid population growth and improve living conditions.

Tropical desert climate region

Location and coverage

Tropical deserts, are located in the western margins of the continents in the Trade Wind Belt roughly between 20° and 30°N and S of the Equator. Figure 2.23 shows the tropical desert climate regions:
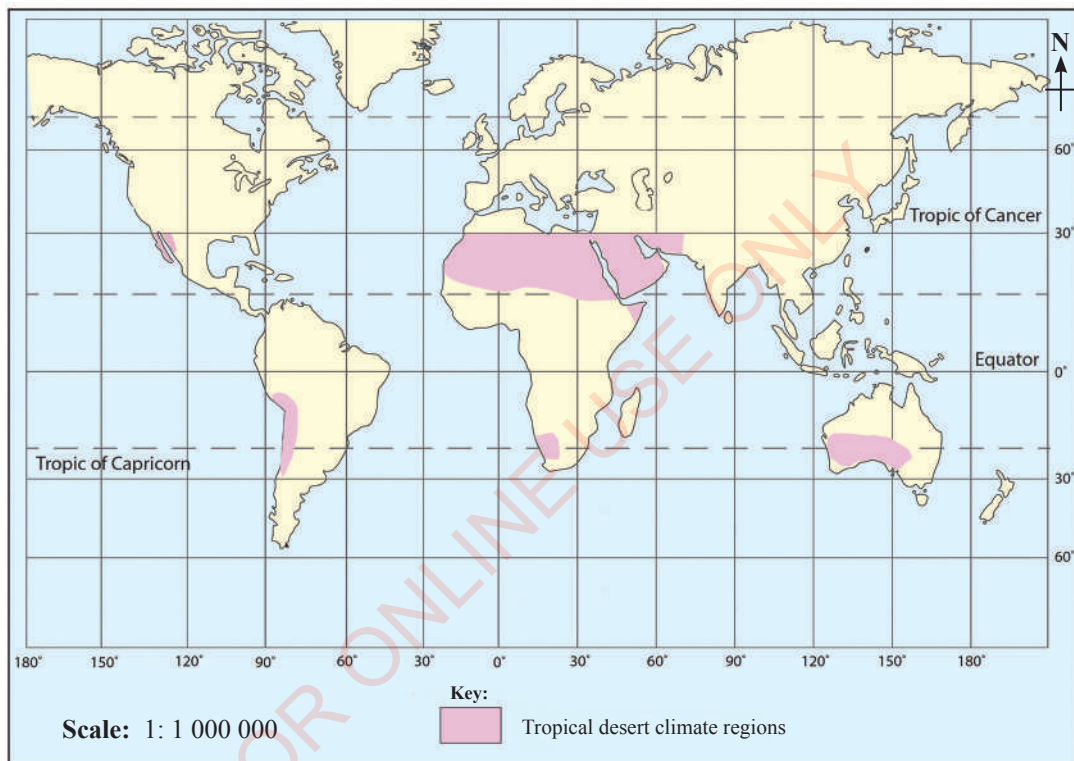
Figure 2.23: *Tropical desert climate regions*

However, the only exception is the desert belt in North Africa, which extends from the west coast right across the continent and to South-West Asia. The main reason for this is because the trade winds affecting the Eastern part of North Africa blow from the landmass of South-West Asia. By the time they reach this area they are dry. Also, the presence of high mountains in the Eastern part of the continent prevents moist winds from reaching the west coast with moisture. By the time the winds reach the west coast, they are dry and are blowing off-shore. The areas having this type of climate include the Sahara, the Arabian and Iranian, the Australian, the Kalahari, the Namib, the Atacama and the Californian deserts. In some cases, for example in the Sahara, strong winds such as the harmattan, may blow across the desert carrying loads of sands and dust. Such storms are called *simoom*.

Climatic characteristics

Temperature in the tropical desert ranges from 35˚C in the hot season to 10˚C in the cool season. Absence of cloud cover contributes to high diurnal range of temperature. During day time, temperature ranges from 38˚C to 49˚C. At night, loss of heat is rapid and temperature can fall to 15˚C in the hot season and to 5˚C in the cool season. It rarely rains in this region. Annual rainfall is below 250 millimetres. In some deserts, rain may fall only once in five to six years. This type of rainfall is heavy and collects into streams of running water, which may form channels. When such channels are dry, they are called *wadis*. A wadi is an Arabic term traditionally referring to a valley. In most of the regions clear sky favours the passage of insolation during day time and outgoing radiation from the Earth during night. Therefore, the diurnal range of temperature is high. Figure 2.24 illustrates how cloud influences climate. Also, Figures 2.25, 2.26, 2.27; and Tables 2.5, 2.6, and 2.7 show the climatic data (tropical desert climate) of In Salah (Algeria), Lima (Chile) and Windhoek (Namibia).

(a)   During the day

Loss of earth radiation is checked by clouds

Cloud absorbs and reflects a great amount of solar radiation

Clouds

Out-going earth radiation

Hot   >26.7°C

Earth's surface

(b)   At night

Cloud prevents excessive loss of earth radiation. It acts as a blanket

Clouds

Out-going earth radiation

Hot   >21°C

Earth's surface
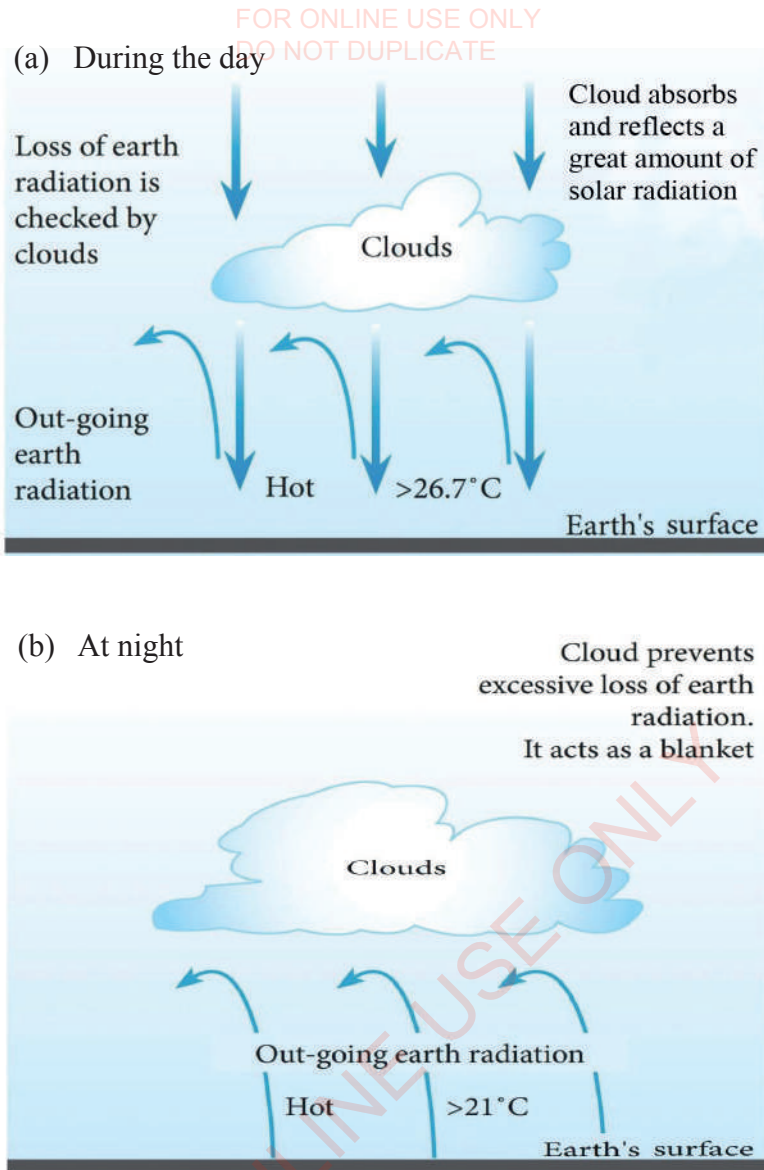
Figure 2.24: *Influence of cloud cover on climate*

Activity 2.3

Read various sources of materials in the library or the internet on why the temperature range in the desert is higher than in the equatorial climate regions. Write down the reasons and present your findings in class.

Table 2.5: *Climatic data for In Salah (Algeria)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	13.3	10	20.0	25	28.9	35	35	35	32.8	26.7	19.1	15
Rainfall (mm)	2.5	2.5	0	0	0	0	2.5	0	0	5.0	2.5	15.0
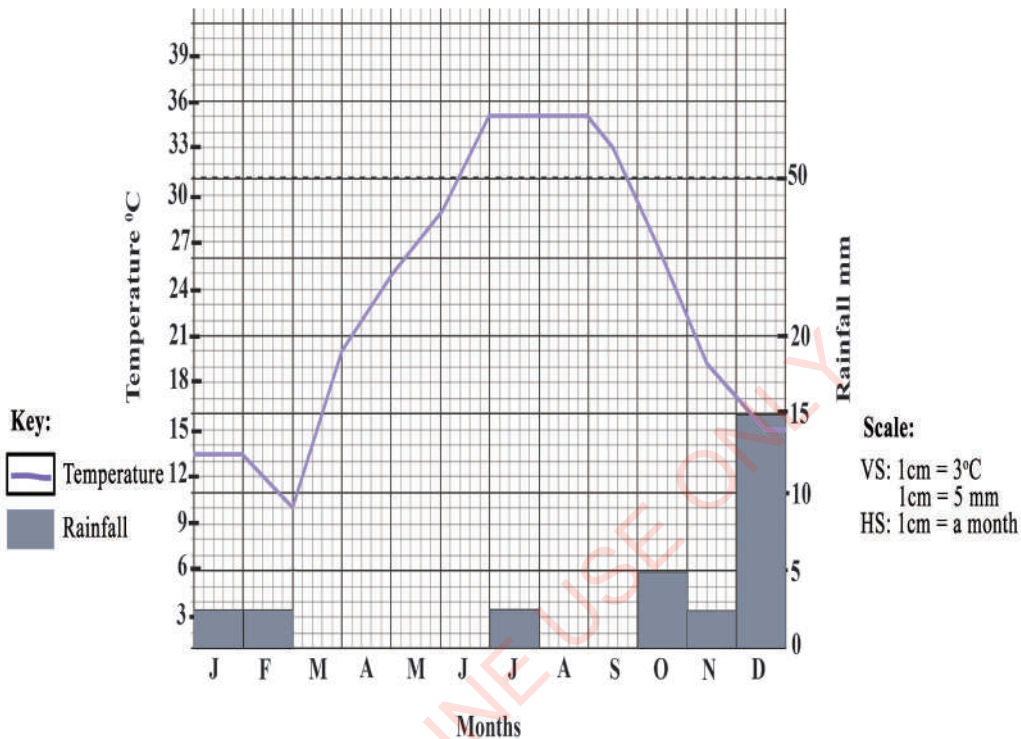
Figure 2.25: *Temperature and rainfall distribution for In Salah (Algeria)*

Table 2.6: *Climatic data for Lima (Chile)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	21.7	22.8	22.8	21	18.9	16.7	16	16	16	16.7	18.9	21
Rainfall (mm)	0	0	0	0	0	5	7.6	12.7	12.7	2.5	0	0
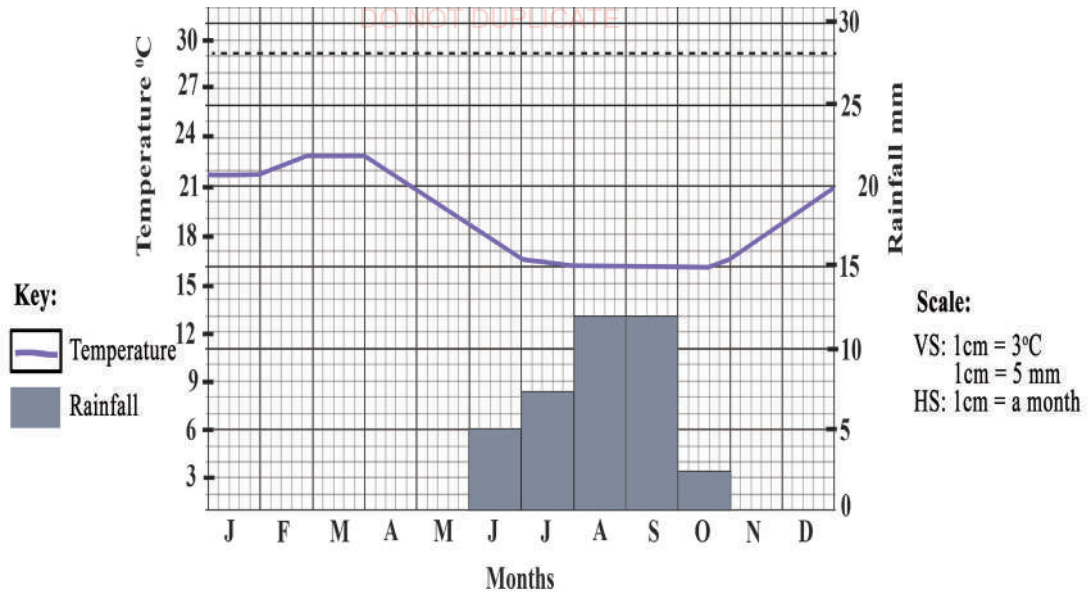
Figure 2.26: *Temperature and rainfall distribution for Lima (Chile)*

Table 2.7: *Climate data for Windhoek (Namibia)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	23.3	22.8	21.1	18.9	15.6	13.3	12.8	15.6	18.9	20.6	22.2	23.3
Rainfall (mm)	68.6	68.6	81.3	43.2	10.1	0.0	0.0	0.0	2.5	10.1	25	49
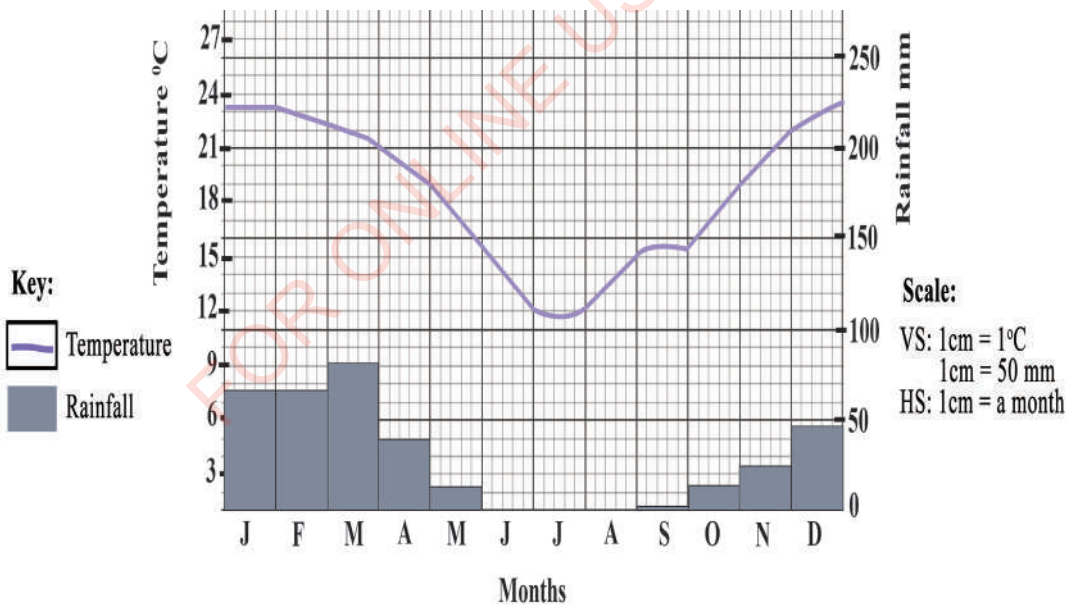
Figure 2.27: *Temperature and rainfall distribution for Windhoek (Namibia)*

Activity 2.4

Use different sources of information to find out how people survive in desert regions. Present your findings in class.

Vegetation

Vegetation in the desert region is scanty. It mainly consists of thorny scrub bushes and cacti because of receiving little or no rainfall. Vegetation found in hot deserts develop certain characteristics that help them to withstand high temperatures and lack of moisture. These characteristics include the presence of long tap roots that help to tap underground water; few or absence of leaves so as to reduce loss of water by transpiration; tough, waxy or needle-shaped leaves to minimise transpiration; many plants produce seeds that remain dormant for years, but germinate when rain falls; they also store water in leaves, stems or root nodules. Figure 2.28 shows a cactus plant:

Figure 2.28: *Cactus plant*
Source: https://www.google.com/search?q=cactus%20plants&tbm

Economic activities

The following are major economic activities, which take place in tropical desert regions.

Crop production: Whenever water is available as in the oases and along river courses, agriculture is practised near these water sources. Cultivation is only possible when there is a constant supply of water. For example, the lowlands of the valleys

of the Nile, the Tigris and Euphrates are intensively cultivated for both food and cash crops. It has only been possible through canal irrigation. Main crops grown in such areas are date-palms, wheat, vegetables, fruit trees, millet, sugarcane, rice, cotton, tobacco, vines, and tomatoes.

Animal keeping: Animals kept in the tropical desert region include goats, sheep, donkeys and camels, which are especially under nomadic herding. Figure 2.29 shows camels as one type of the animals kept in desert areas.

Figure 2.29: *Camels in the desert*
Source: *https://www.google.com/search?q=camels+in+desert+areas.*

Hunting and gathering: Some people or ethnic groups from desert areas get their food from hunting and gathering or collecting nuts, honey and fruits, such as dates.

Handicraft and trading activities: Other activities in the region include mat weaving, tent and rope making, as well as trading activities.

Mediterranean climate region

Location and coverage

This is located between 30˚ and 45˚ in the Northern Hemisphere and between 30˚ and 40˚ in the Southern Hemisphere. The climate is best developed around the shores of the Mediterranean Sea (the Maghreb, Spain, Italy, Greece, Egypt and Israel); in South Africa (Cape Province); the western sides of North and South America (Central Chile and Central California) and South-Western Australia as shown in Figure 2.30:
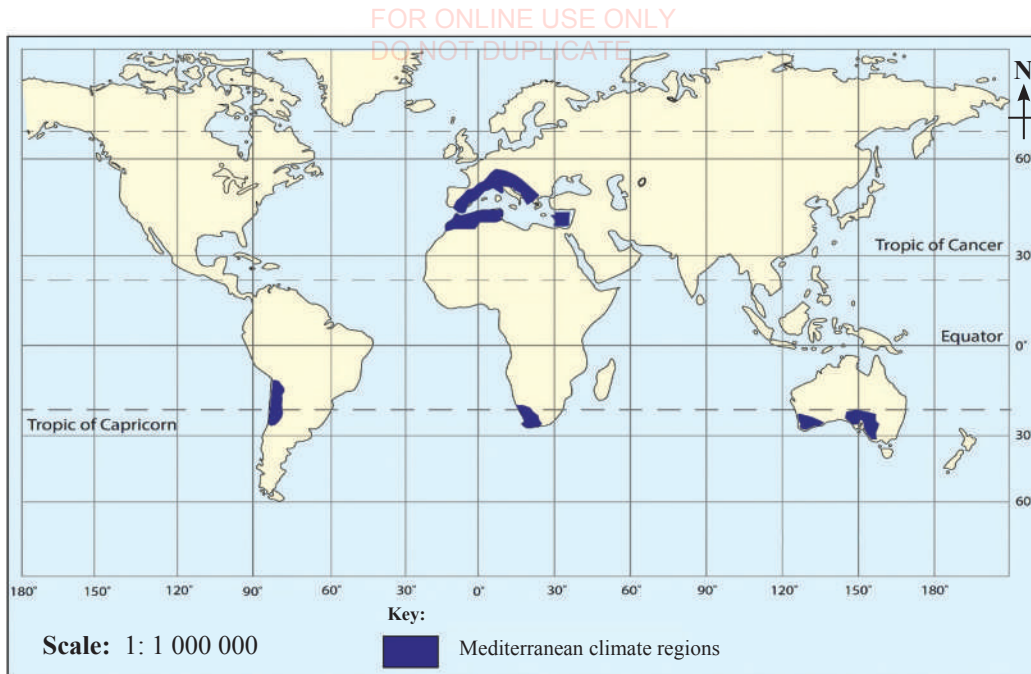
Figure 2.30: *Mediterranean climate regions*

Climatic characteristics

All regions with mediterranean climate have relatively mild winters. Summer temperatures, however, are variable depending on the region. For instance, Athens in Greece experiences rather high temperatures in the summer (48ºC has been measured several times in Eleusina) whereas San Francisco in the United States has cool, mild summers due to the upwelling of cold subsurface waters along the coast.

Since all regions with mediterranean climate are near large water bodies, temperatures are generally moderate with a comparatively small range between winter lows and summer highs.

In the winter, temperatures range from mild to warm depending on the distance from the open ocean, elevation and latitude. During summer, regions of the mediterranean climate are dominated by subtropical high-pressure cells causing no or little rainfall. During winter, the polar jet stream and the associated periodic storms reach the lower latitudes of the Mediterranean zones, hence bringing rain with snow at higher elevations. As a result, areas with this climate receive almost all of their annual rainfall during the winter season and may go to the summer without having any significant precipitation. Rainfall in this climate is relatively low and the annual total rainfall varies from 500 millimetres to 760 millimetres; and temperature ranges from 21ºC in summer to about 10ºC in winter. Figures 2.31 and 2.32; Tables 2.8 and 2.9 show the climatic data for mediterranean climate of Valparaiso (Chile) and Athens (Greece).

Table 2.8: *Climatic data for Valparaiso (Chile)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	17.8	17.2	16.1	14.4	13.3	11.1	11.1	11.7	12.2	13.9	15.6	16.1
Rainfall (mm)	0.0	0.0	22.9	2.5	68.6	151	134.6	86.4	10.2	12.7	7.6	0.0
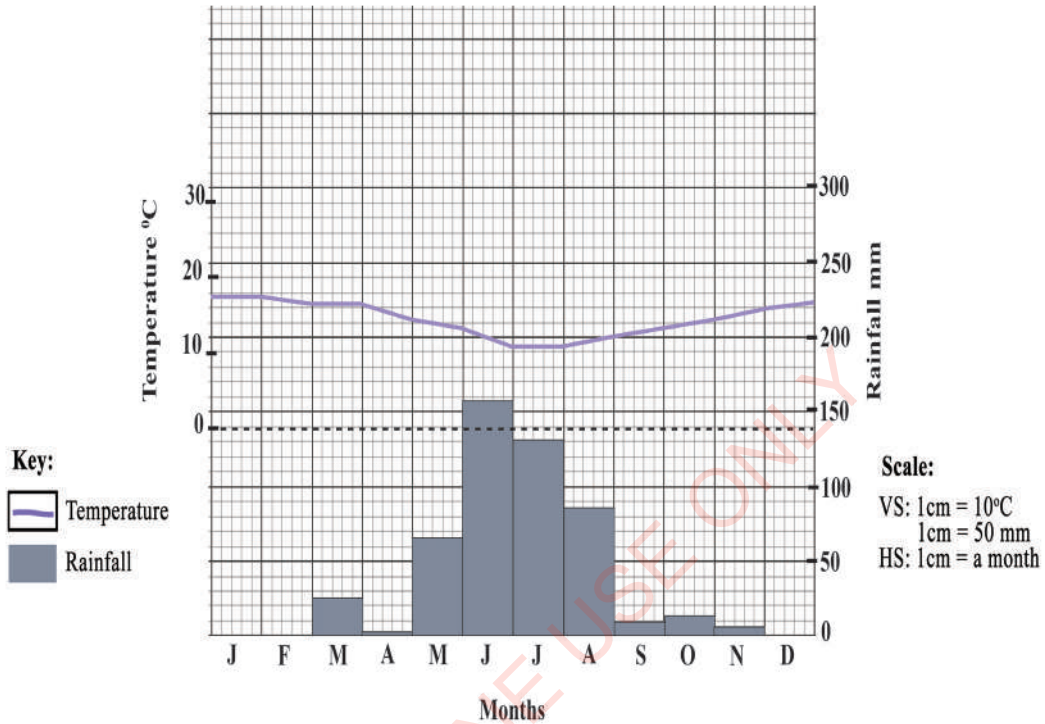
Figure 2.31: *Temperature and rainfall distribution for Valparaiso (Chile)*

Table 2.9: *Climatic data for Athens (Greece)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	9.5	9.7	11.2	14.8	19	23.5	26.4	26.4	23	18.9	14	11.2
Rainfall (mm)	50.1	38.1	33.0	20.3	20.3	17.8	7.6	10.2	15.2	43.2	73.7	61
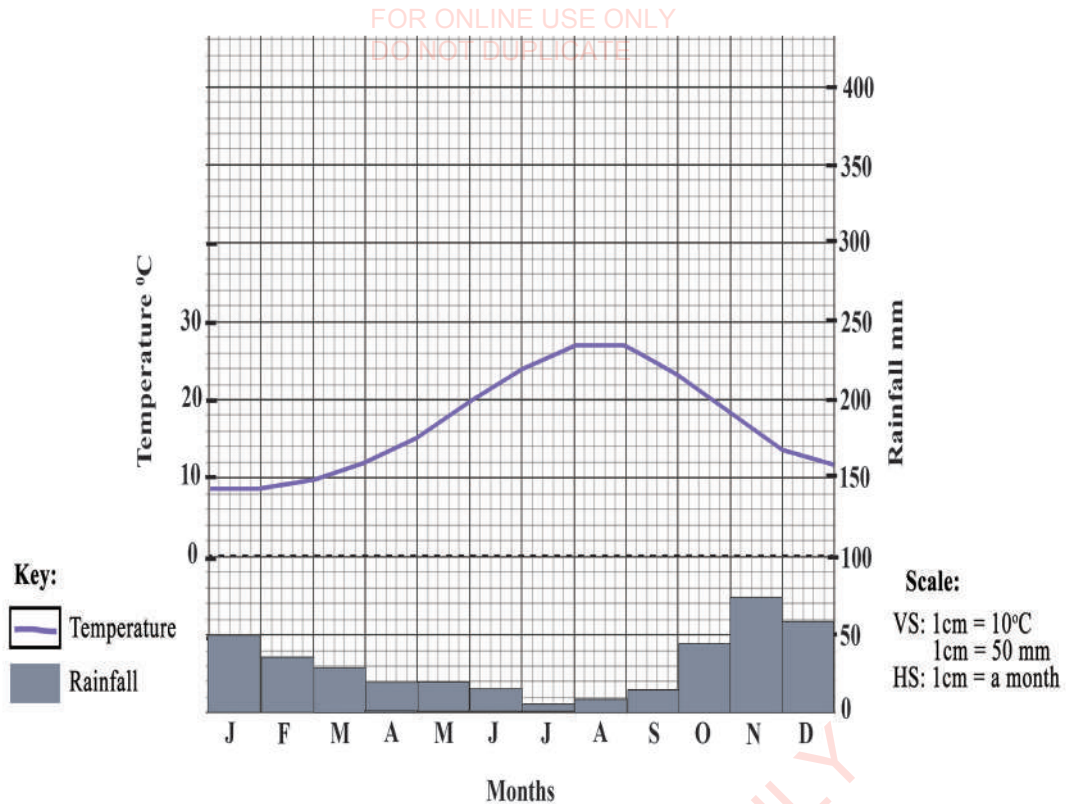
Figure 2.32: *Temperature and rainfall distribution for Athens, Greece*

Human activities

People in the Mediterranean region cultivate cereal (grain) crops and citrus fruits. Cereal crops include wheat, barley, rice and maize whereas citrus fruits are oranges, lemons, peaches, apricots, plums, pears, grapes, limes, olives and cherries. Crop production has given rise to specialised industries such as wine-making, flower milling, fruit canning, food canning and food processing. Apart from crop production, animal keeping is also practised in this region. Animals such as goats, sheep, jack rabbits and lynx are kept.

Warm temperate eastern coast margin climate region (China type)

Location and coverage

This type of climate is located on the eastern side of the continents. It is found between latitudes 23˚ and 35˚ North and South of the Equator. Countries, which experience this type of climate, include Central China, South-Eastern Japan, South-Eastern USA, Southern Brazil, and the Eastern part of the Pampas in Argentina, South-Eastern Africa and South-Eastern Australia. Figure 2.33 shows the warm temperate eastern coast margin.
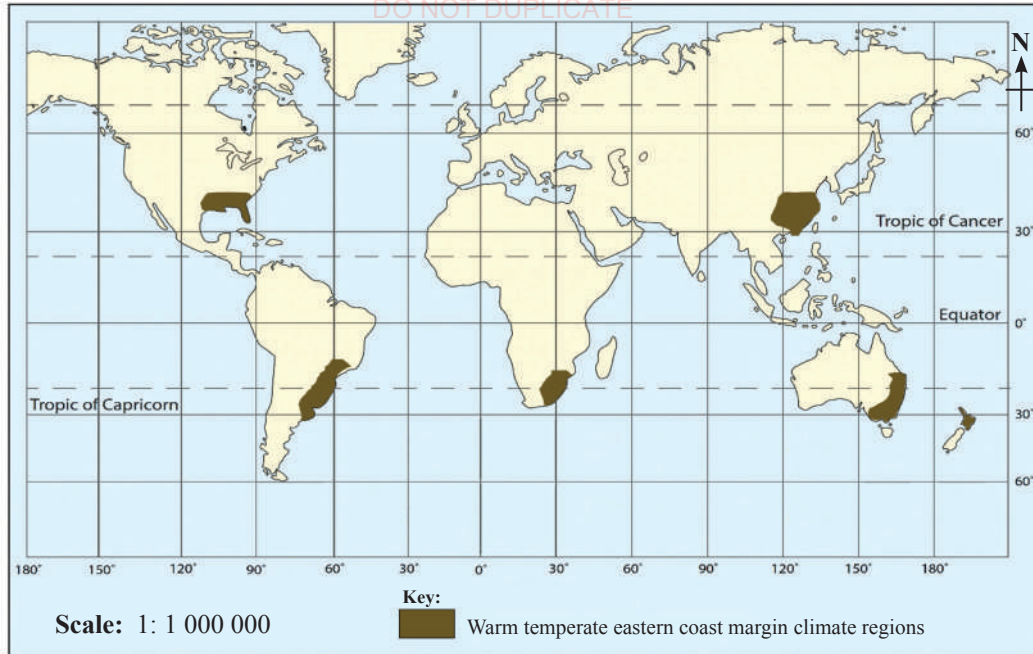
Figure 2.33: *Warm temperate eastern coast margin climate regions*

Climatic characteristics

The warm temperate eastern coast margin climate is typified by a warm moist summer and a cool dry winter. The temperatures in this region are about 26ºC in the summer and 13ºC during winter and are strongly modified by maritime influence. This climate is also characterised by little relative humidity especially in the mid-summer when temperature increases. For instance in Natal, annual rainfall is more than moderate, ranging from 635 millimetres to 1 524 millimetres. Moreover, the region receives a total rainfall of about 1 000 millimetres annually. The warm temperate eastern margin climate supports a wide range of crops. It is dominated by a fairly distribution of uniform rainfall throughout the year. Normally, it is dominated by convectional and topographic rain in summer and cyclonic rain in winter. The region also experiences local storms such as typhoons and hurricanes. Figures 2.34, 2.35 and 2.36; Tables 2.10, 2.11, and 2.12 show the climatic data (Warm temperate eastern coast margin) for Tokyo, Charleston and Durban (Natal).

Table 2.10: *Climatic data for Tokyo (Japan)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	13	13.5	14.2	14.9	16.4	20.5	23.9	25.5	21.6	15.9	15	13.1
Rainfall (mm)	50.8	66	109.2	134.6	146.9	160	142.2	116.8	190.5	182.9	109.2	58.4
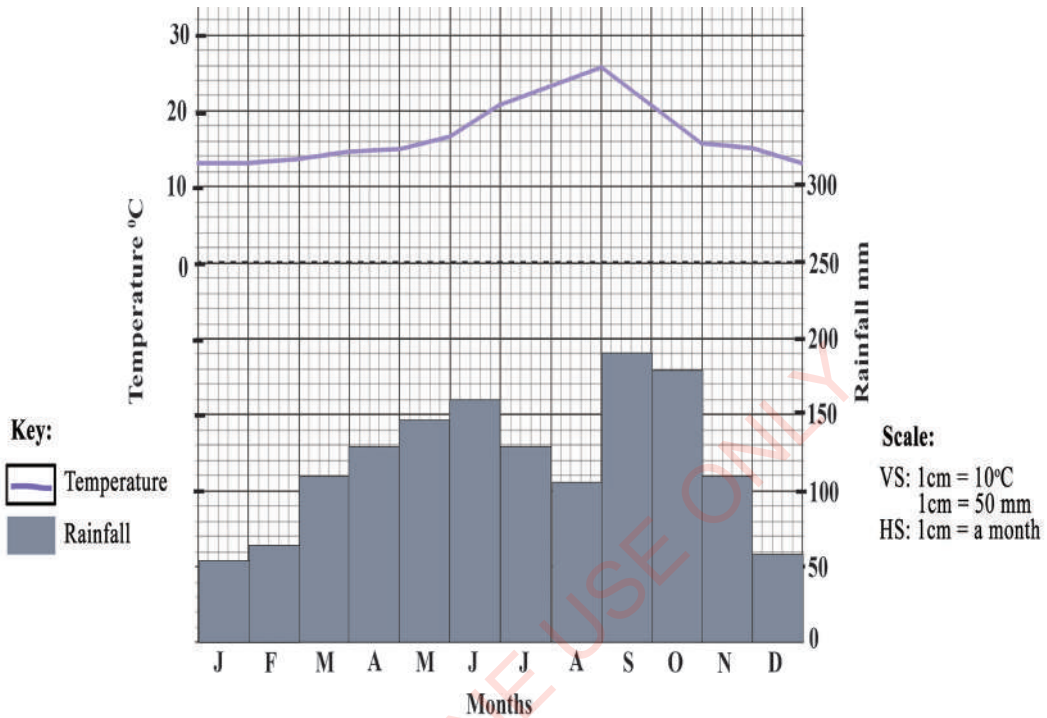
Figure 2.34: *Temperature and rainfall distribution for Tokyo, Japan*

Table 2.11: *Climatic data for Charleston (USA)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	13	13.4	14.4	18.3	22.8	26.1	27.8	27.2	25	20	14.4	13.2
Rainfall (mm)	73.7	81.3	86.4	71.1	83.8	119.4	182.9	167.6	129.5	81.3	58.4	71.1
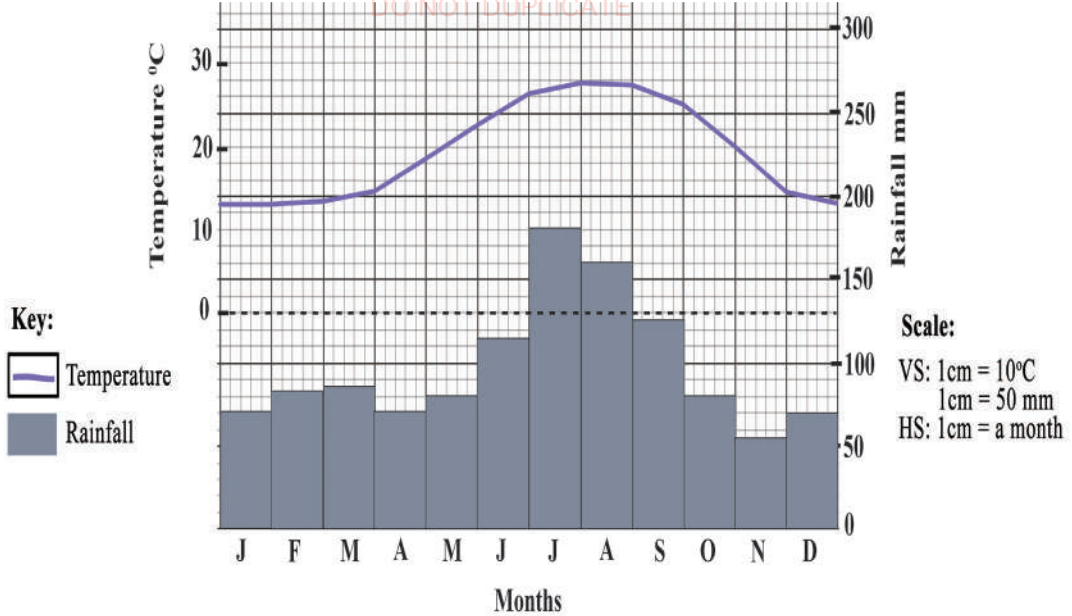
Figure 2.35: *Temperature and rainfall distribution for Charleston, USA*

Table 2.12: *Climatic data for Durban (Natal), South Africa*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	25	25	24.4	22.2	20	18.3	18.3	18.9	20	21.1	22.8	23.9
Rainfall (mm)	116.8	114.3	116.8	76.2	50.8	17.8	20.3	50.8	94	124.5	111.8	114.3
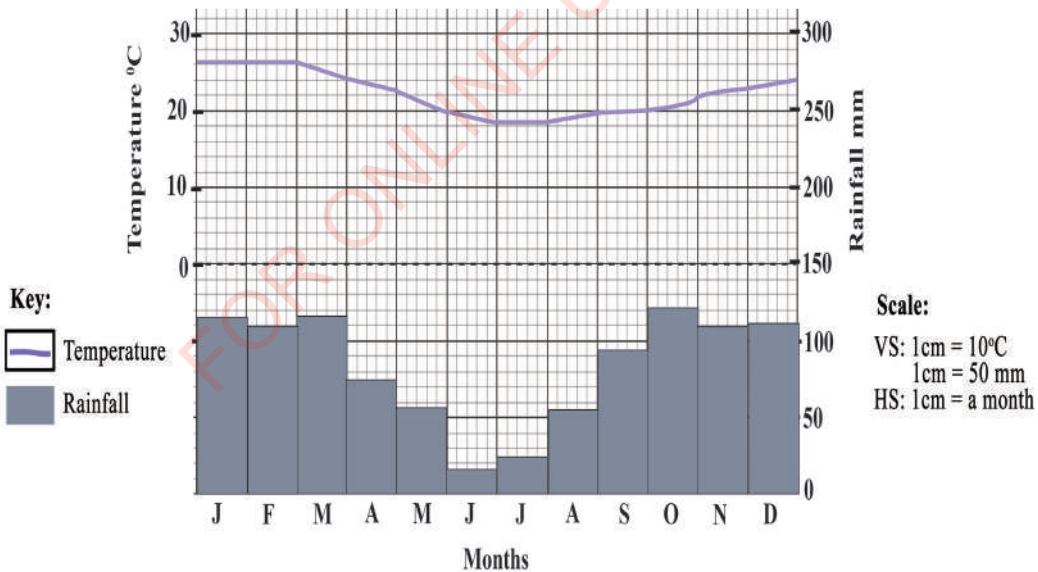
Figure 2.36: *Temperature and rainfall distribution for Durban, South Africa*

Activity 2.5

Study the climatic data in Table 2.11 and answer the following questions:

(i) Which month experiences the highest rainfall?

(ii) What is the average temperature in this area?

(iii) Which month experiences less rainfall?

Vegetation

Warm humid climate without dry or cold seasons supports fairly ever green forests. However, the forests are not as dense as tropical forests; neither do they shade leaves like those in the cool temperate zones. There is a variety of plant and tree species which are evergreen with broad leaves, deciduous trees in lowlands and coniferous in the highlands. The common trees found in this area include oak, maples, camphor, magnolias, beech, camellias, palm trees and eucalyptus. Space between the trees allows the growth of shade, tolerant plants such as ferns, bamboos and flowering shrubs.

Human activities

Crop production: The moderate temperature and rainfall in this region make it suitable for growing crops throughout the year. In China, for example, paddy is grown partly under irrigation. Paddy farming relies heavily on human labour and it is grown for subsistence. Rice (paddy) is a staple food in China. In South-East of the USA maize, rice, sugarcane, tobacco, cotton, groundnuts and citrus fruits are important crops. Most of the maize produced in the USA is mainly used as food for cattle and pigs. In Natal (South Africa), maize is grown as a food crop whereas tobacco, cotton and sugarcane as cash crops. In the Eastern side of Southern Africa, sugarcane is the main crop produced but, in some areas, it is watered by an irrigation system. Presence of moderate forests in some parts enables lumbering to take place too.

Animal keeping: Cattle and sheep are reared in vast numbers. Areas where animals are kept on commercial scale often in ranches are Argentina, South America and Australia. In South-East Australia, the main economic activity is dairy farming. The region produces a large quantity of milk, butter and cheese for local consumption and export.

Warm temperate interior climate region (Steppe type)

Location and coverage

This region is located between 20˚ and 35˚ North and South of the Equator. Specifically, it is found in North America in the grasslands of the Prairies in Canada, western Oklahoma and Texas in the USA and Northern Mexico.

In South America it is found in the grasslands of Argentina, called the Pampas and Asia in the Steppes of the former USSR. It is also found in the Veldt of South Africa, the downs of New South Wales, the Murray-Darling and Victoria in Australia and also, the plains of Hungary and the plains of Manchuria in China as Figure 2.37 illustrates:
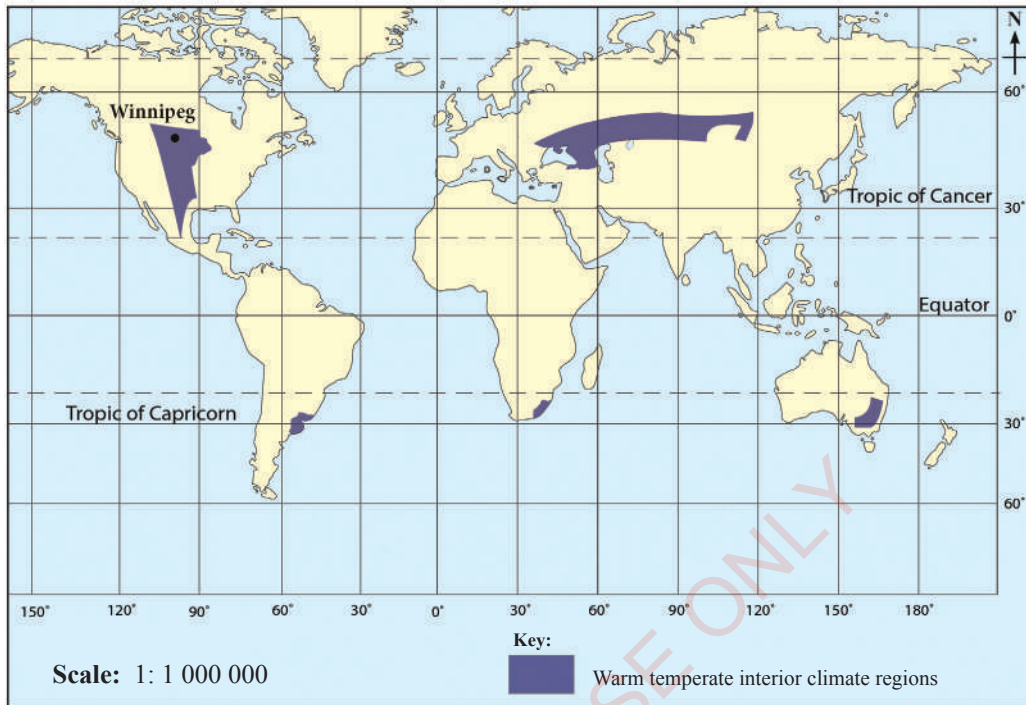
Figure 2.37: *Warm temperate interior climate regions*

Climatic characteristics

The warm temperate interior climate region experiences significant extremes of temperature because it is not moderated by water bodies. Its summers are very hot with 29°C temperature whereas winters are very cold, below 0°C.The annual range of temperature is, therefore, high. Rainfall is of a convectional type falling in spring and early summer. Annual rainfall varies from 250 millimetres to 700 millimetres depending on the location or distance from the sea. It decreases with the increase of distance from the sea. A good deal of the rain is brought by the South-East Trade Winds to the southern continental regions during summer months. Hence, the interior part is relatively drier than the areas near the coast. Figures 2.38, 2.39, 2.40 and 2.41; Tables 2.13, 2.14, 2.15 and 2.16 show the climatic data (Warm temperate interior region or Steppe type) for Winnipeg (Canada). Omaha (USA), Bourke (Australia) and Barnaul (Russia).

Vegetation

Due to moderate rainfall, the dominant vegetation in the warm temperate interior region are grasslands. Grass heights vary considerably depending on the amount of rainfall received per annum. Grass is often taller in wet areas and shorter in relatively dry areas. Trees grow along water courses only. The grassland regions have specific names in particular regions, for example, the Downs (Australia), the Veldt (South Africa) and the Pampas (Argentina).

Human activities

Crop production: The temperate grasslands are the most important areas in the world for the production of wheat. Farms are extensive and highly mechanised. Wheat is used for baking bread and making pasta (spaghetti and macaroni). Maize, vegetables and fruits are important products in the region, especially in the Veldt of South Africa. The major problem of this area is extensive cultivation of land, which leads to soil erosion particularly in the marginal land. This calls for improved cropping techniques, which can be employed to reduce soil erosion.

Animal keeping: Animal husbandry is another important human activity taking place in the region. The most common animals kept in the region are cattle and sheep. Beef cattle are the most prominent. Beef is exported as frozen or canned to other countries. Sheep are mainly kept for their wool in Australia and South Africa. Merino is the most common sheep breed in the region. In wetter areas and where rainfall is well distributed throughout the year, sheep are kept for mutton.

Activity 2.6

Study the climatic data from Tables 2.13 to 2.16, then calculate the annual temperature ranges of any two areas of your choice. Explain how the temperature range differs from that of the warm temperate eastern coast margin regions.

Table 2.13: *Climatic data for Winnipeg (Canada)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	-19.4	-18.3	-9.4	3.9	10.6	16.7	18.9	18.2	12.2	5	-4.4	-13.9
Rainfall (mm)	22.9	20.3	33	40.6	55.9	93	91	55.9	48.3	35.6	25.4	22.9
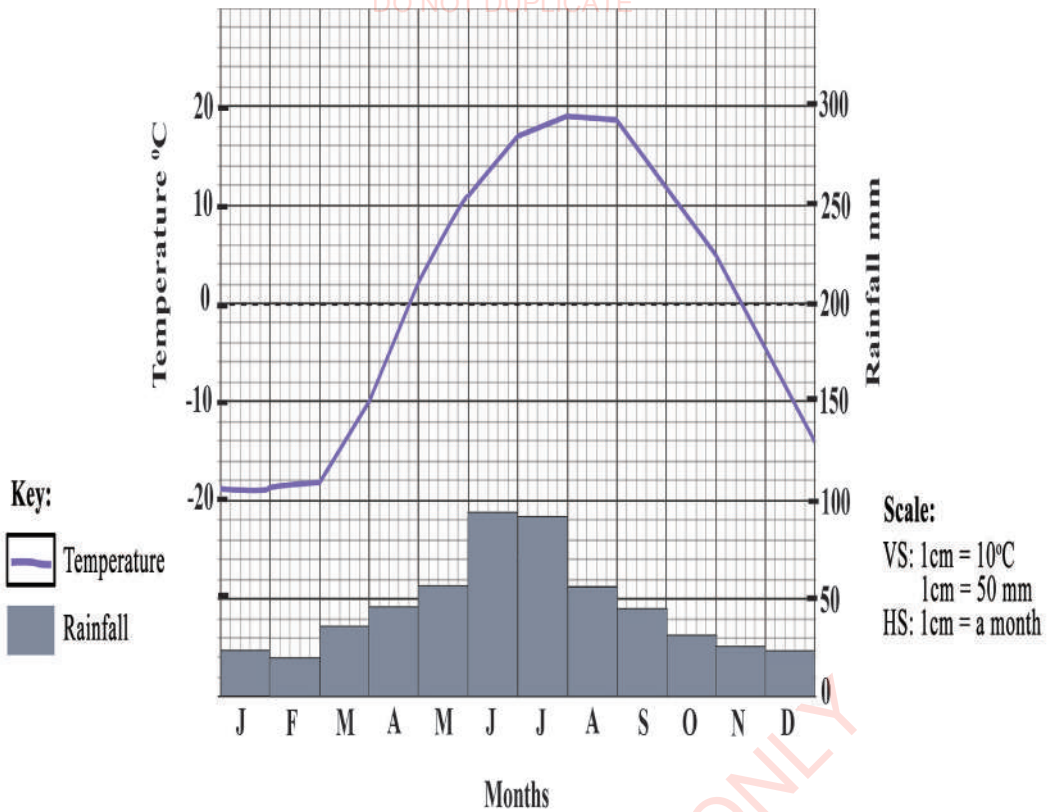
Figure 2.38: *Temperature and rainfall distribution for Winnipeg (Canada)*

Table 2.14: *Climatic data for Omaha (USA)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	-6.7	-4.4	2.2	10	16.7	22.2	24.5	23.3	18.9	12.2	3.3	-2.8
Rainfall (mm)	15.2	20.3	85.6	76.2	111.8	132	11.8	86.4	76.2	63.5	25.4	22.9
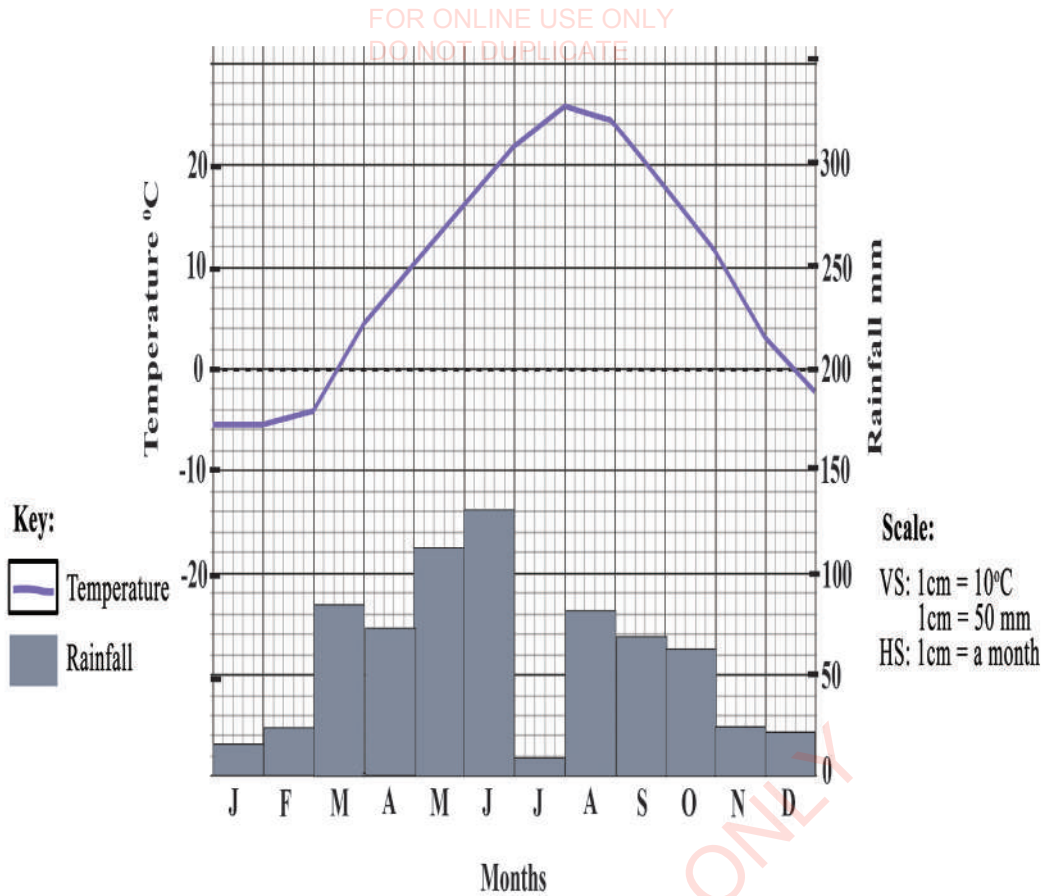
Figure 2.39: *Temperature and rainfall distribution for Omaha (USA)*

Table 2.15: *Climatic data for Bourke (Australia)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	29	29	25	20	14.4	12.2	10.6	13.3	17.2	21.1	24.4	27.8
Rainfall (mm)	51	49	40.6	35.6	27.9	25.4	22.9	22.9	25.4	27.9	33.0	27.9
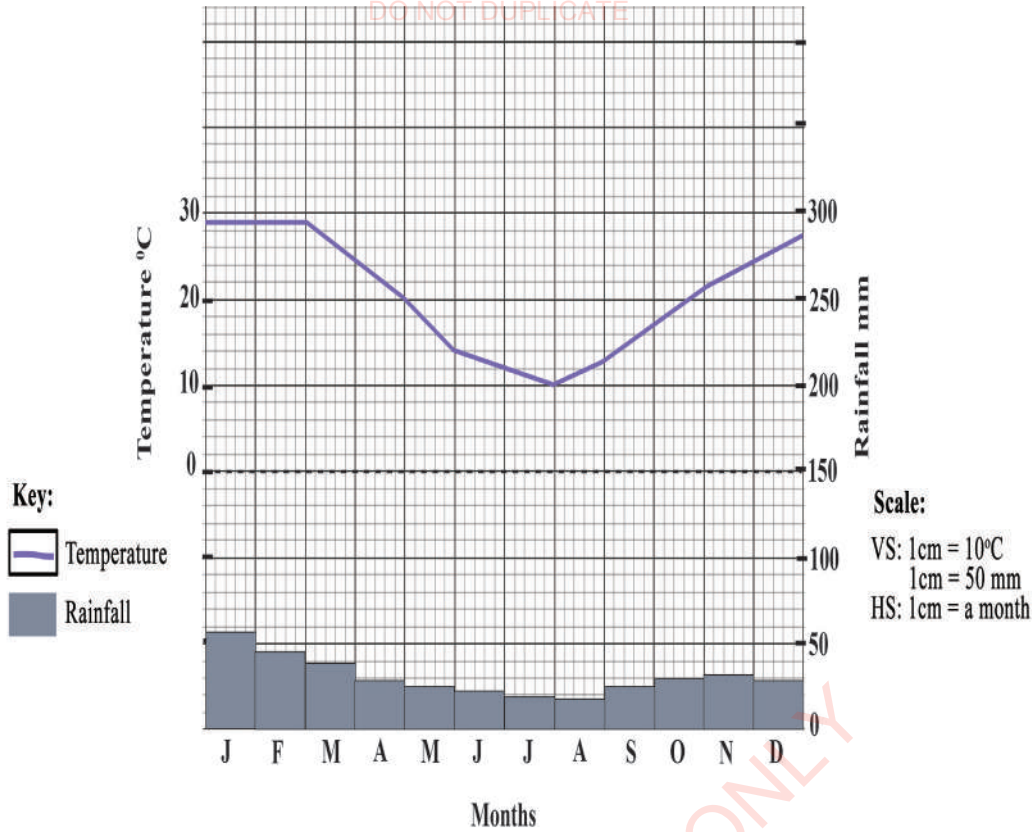
Figure 2.40: *Temperature and rainfall distribution for Bourke (Australia)*

Table 2.16: *Climatic data for Barnaul (Russia)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	-18.9	-17.2	-10.6	0.5	10.5	16.7	19.9	16.1	10	1.7	-8.9	-15.6
Rainfall (mm)	7.6	5.0	7.6	10.2	25.4	35.6	45.6	40.6	22.9	22.9	17.8	15.2
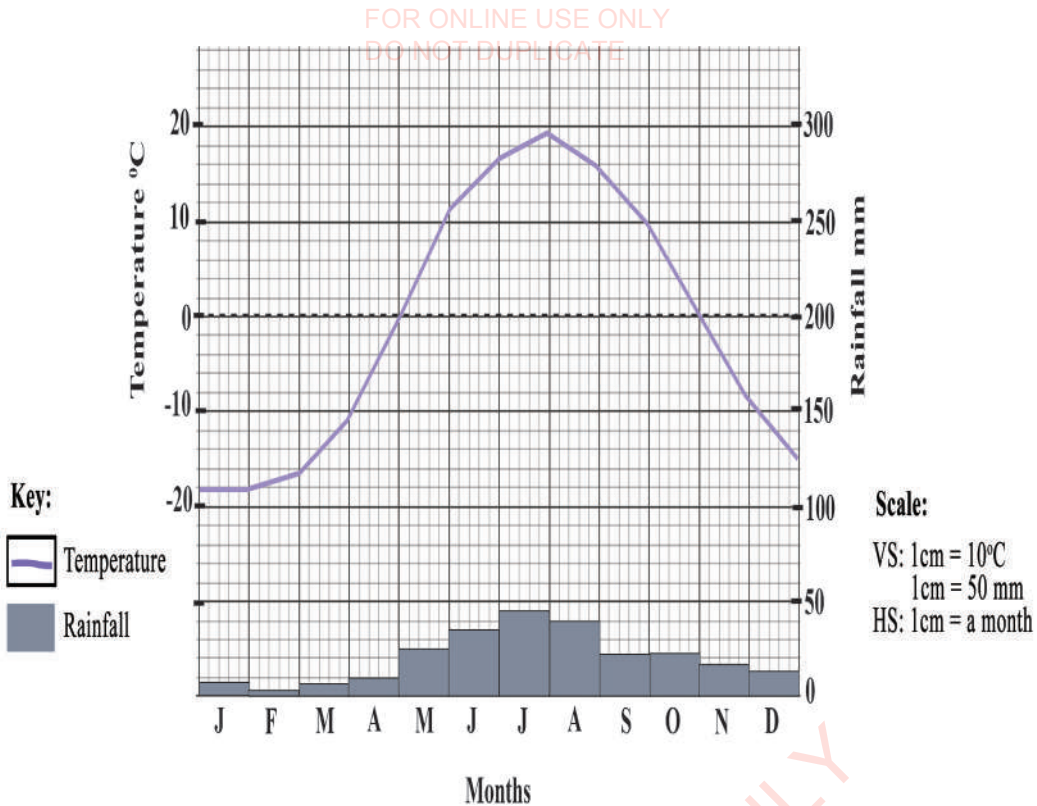
Figure 2.41: *Temperature and rainfall distribution for Barnaul (Russia)*

Cool temperate western coast margin climate region (British type)

Location and coverage

The region is located on the Western sides of the continents between 45° and 60° North and South of the Equator. It lies within the westerly Wind Belt, which prevails onshore throughout the year. Areas covered by this type of climate include North America, particularly North-West USA and British Columbia in western Canada, Southern Chile in South America, North-West Europe from Northern Spain, through France, to the Benelux countries, the British Isles, Germany, Denmark and Norway, Tasmania, Australia and the South Island of New Zealand. Figure 2.42 shows the cool temperate western coast margin climate regions.
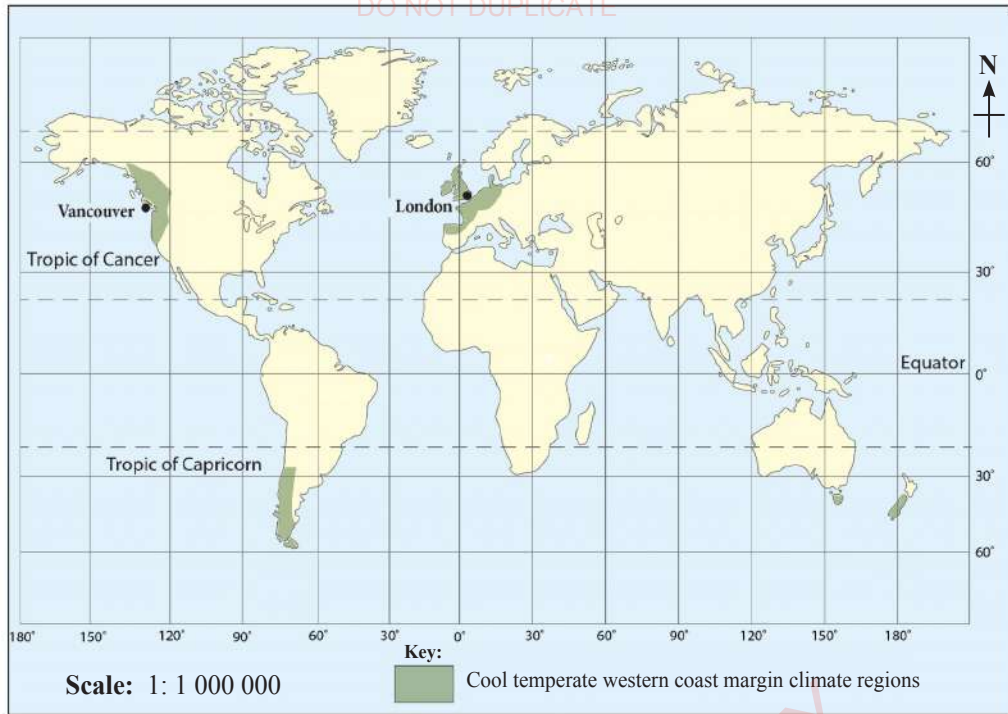
Figure 2.42: *Cool temperate western coast margin climate regions*

Climatic characteristics

The region has a warm summer and mild winters. Winter temperature ranges from 2˚C to 7˚C whereas summer temperature ranges from 13˚C to 15˚C. In Valentia, South-West of Ireland the winter mean temperature in January is about 7˚C whereas the annual temperature range is 8˚C. In Berlin-Germany, the mean temperature in January is about -1˚C whereas in summer the mean temperature is 18˚C. The annual range of temperature is 19˚C. Normally, climate in the coastal region is influenced by the ocean. It is characterised by westerly winds, which blow over warm ocean currents. As they blow, they tend to raise the temperature of the coastal areas. As the distance increases from the coast to the interior regions, the temperature decreases.

Rainfall in this region is well distributed throughout the year with a maximum rainfall during winter. Total annual rainfall is about 760 millimetres although in mountainous regions it may go up to 2 500 millimetres. The region receives both cyclonic and topographic rainfall. Summers are not very warm; winters are abnormally mild.

The British type of climate has an adequate rainfall throughout the year. Since the rain-bearing winds come from the west, the western margins have the heaviest rainfall. The amount tends to

decrease eastwards with an increasing distance from the sea. Tables 2.17, 2.18, and 2.19 illustrate the climatic data for cool temperate of western coast margin. Also, Figures 2.43, 2.44 and 2.45 show the cool temperate western coast margin climate for Sitka (Alaska), Valentia (Ireland) and Dunedin (New Zealand).

Table 2.17: *Climatic data for Sitka (Alaska)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	-0.2	1.2	2.5	5.2	8.1	10.7	12.7	13	10.9	12.7	3.4	1.9
Rainfall (mm)	193	165.1	142.2	139.7	104.1	86.4	106.7	180.1	256.5	309.9	241.3	228.6
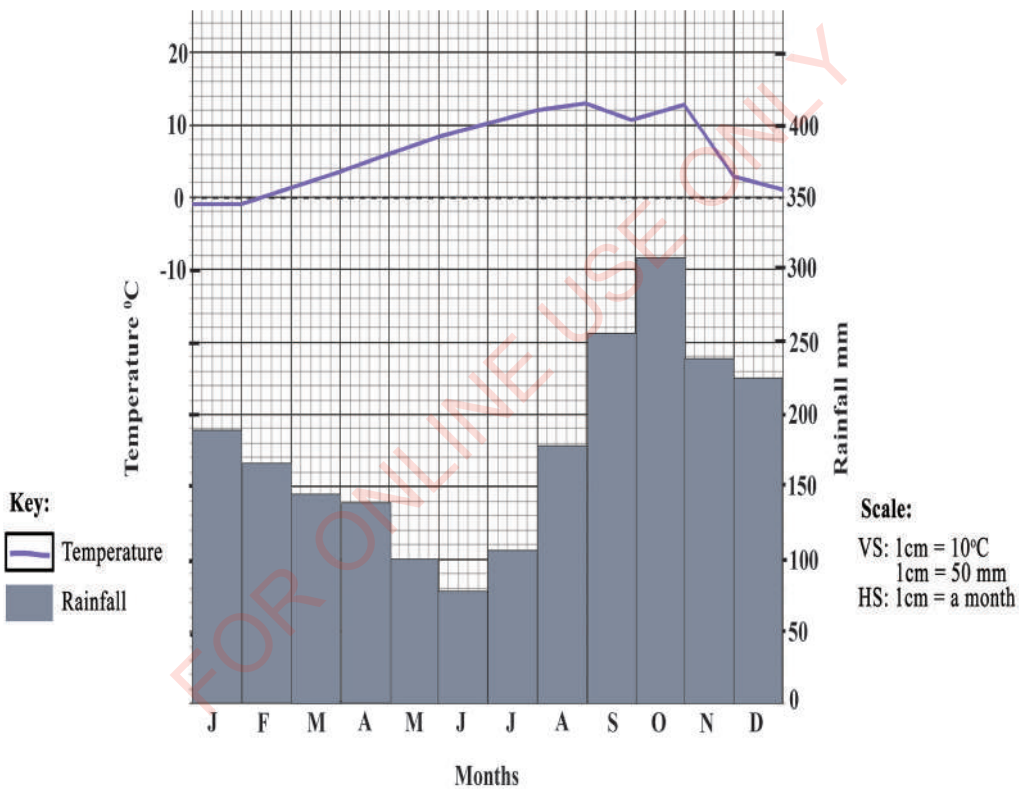
Figure 2.43: *Temperature and rainfall distribution for Sitka (Alaska)*

Table 2.18: *Climatic data for Valentia (Ireland)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	7.2	6.7	7.2	8.9	11.1	13.9	15	15	13.9	10.6	8.9	7.2
Rainfall (mm)	142.2	124.5	104.1	99	78.7	88.9	94	129.5	116.8	139.7	139.7	165.1
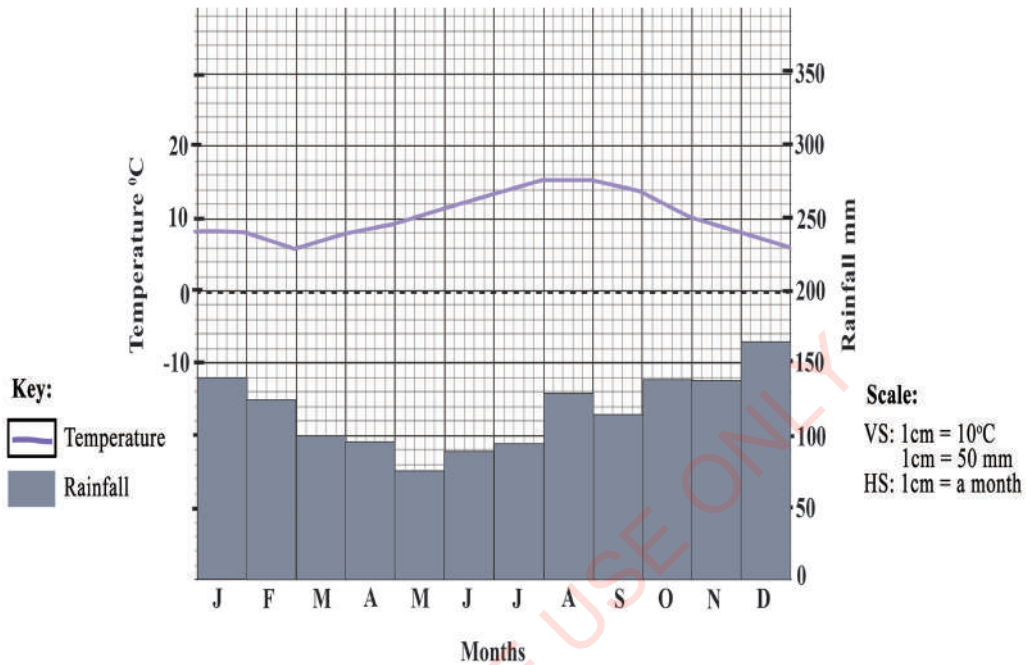
Figure 2.44: *Temperature and rainfall distribution for Valentia (Ireland)*

Table 2.19: *Climatic data for Dunedin (New Zealand)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	14.4	13.9	12.8	10.6	8.3	6.7	5.6	6.7	8.3	10.6	11.7	13.3
Rainfall (mm)	81.3	58.4	66	68.6	86.4	76.1	73.7	88.9	61	61	73.7	83.8
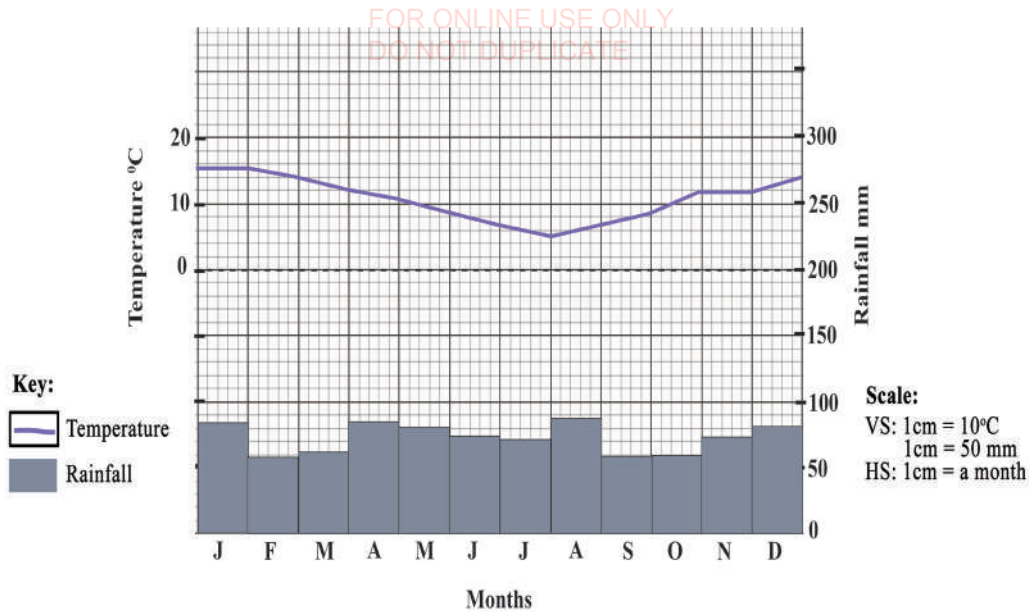
Figure 2.45: *Temperature and rainfall distribution for Dunedin (New Zealand)*

Vegetation

The most common vegetation in this type of climate is broad-leafed deciduous trees. Most of it have been cleared for farms. In Spring, trees develop new leaves and shade them during Autumn. The common tree species available include the oak, elm, ash, birch, beech, poplar, and hornbeam. The wetter areas, on the other hand, are dominated by willows, alder and aspen species; other species such as chestnut, sycamore, maple, and lime are found elsewhere. Deciduous hardwoods are mainly used for fuel and industrial purposes whereas eucalyptus are extensively harvested for lumbering.

Activity 2.7

Study the climatic data of Sitka and Valentia. Then, calculate the temperature range for each town. Comment on the results and then make a class presentation.

Human activities

Crop production: Intensive agriculture is practised in these areas due to limited land and advanced agro-technology. The main crops grown are mainly wheat, barley, oats, vegetables and fruits, especially apples.

Lumbering: Lumbering is an important economic activity in the region, particularly in British Columbia.

Animal keeping: It is practised in less industrialised areas. In Tasmania and New Zealand, sheep rearing for wool and mutton is an important activity. Dairy farming is also an important activity, especially in Western Europe. Dairy cattle are fed on pastoral lands with specially grown grass, which increases the quality and quantity of milk. Cattle are also fed with cereals such as maize, barley, sorghum and millet. Important dairy products include butter, cheese, cream and skimmed milk.

Manufacturing: Most of the areas especially in Europe and North America are industrialised. As such, many people engage in industrial activities. Fruits processing industries, especially apples are commonly found throughout the region.

Cool temperate eastern margin climate region (Laurentian type)

The cool temperate eastern margin climate region is an intermediate type of climate between the British and the Siberian types of climate. It has features of both the maritime (marine) and continental climates as Figure 2.46 illustrates:
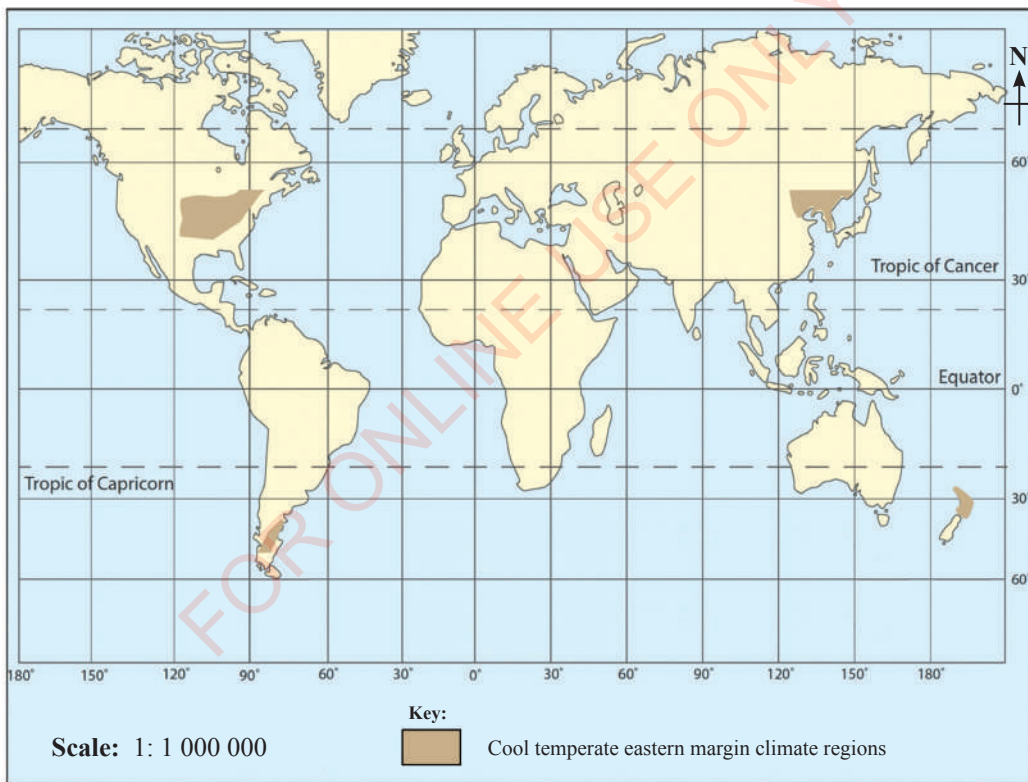
Figure 2.46: *Cool temperate eastern margin climate regions*

Location and coverage

This region is located on the eastern side of the continents of North America and Asia, between 35˚N and 50˚N, and South of 40˚S. Some of the areas experiencing this type of climate include Maritime provinces of eastern Canada, Manchuria in northern China, Korea and northern Japan. Figures 2.47 and 2.48; Tables 2.20 and 2.21 show climatic data for cool temperate eastern margin climate for New York (USA) and Vladivostok (Russia).

Table 2.20: *Climatic data for New York (USA)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	-0.5	-0.5	3.9	9.4	15.6	20.6	23.3	22.8	19.4	13.3	7.2	1.7
Rainfall (mm)	91.4	88.9	96.5	83.8	83.3	88.9	106.7	111.8	88.9	86.4	78.7	88.8
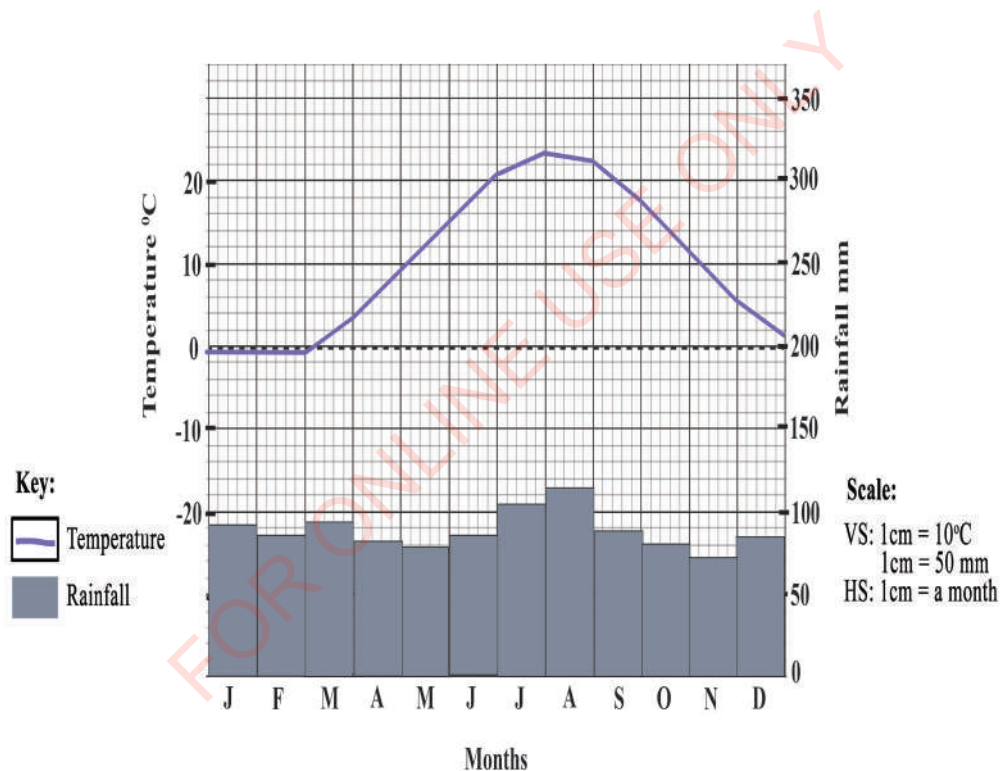
Figure 2.47: *Temperature and rainfall distribution for New York (USA)*

Table 2.21: *Climatic data for Vladivostok (Russia)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	-13	10	-3.1	4.4	9.5	13.3	18.1	20	16.5	9.2	-0.5	-9.6
Rainfall (mm)	7.6	15.2	30.5	50.8	71.1	76.2	109.2	118.8	45.7	27.9	12.7	56.9
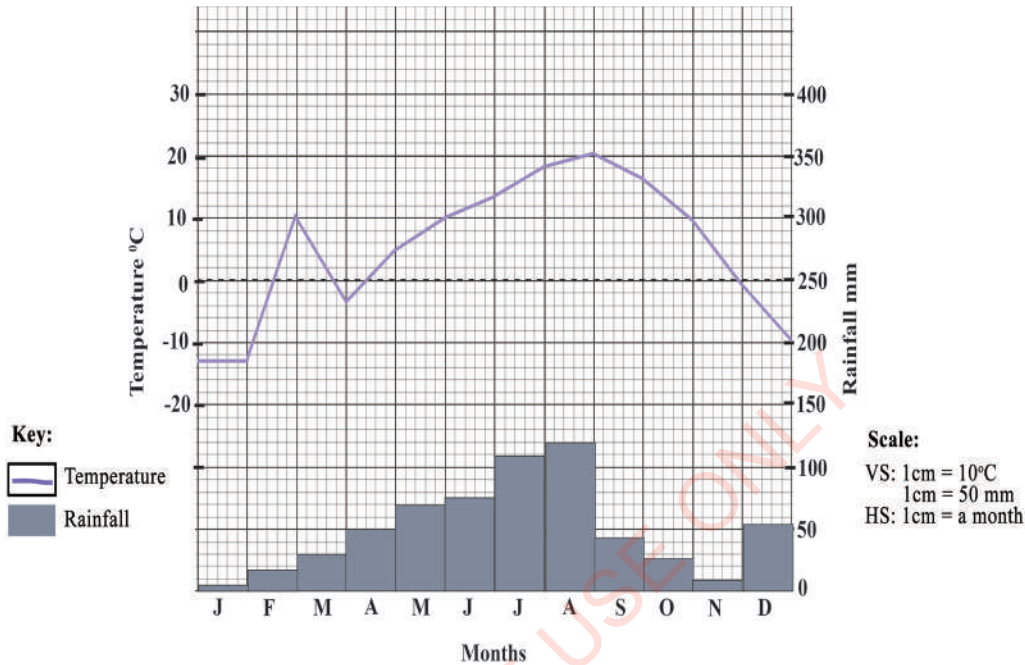
Figure 2.48: *Temperature and rainfall distribution for Vladivostok (Russia)*

Climatic characteristics

Winter temperatures range from -13°C to -7°C and Summer temperatures from 15°C to 24°C. The annual temperature is therefore high. The average temperature range in this climate is about 24°C whereas that of the Western margin is about 11°C. Cold winds blowing from the interior towards the sea in North America and Asia during Winter lower the temperature. In North America, these winds bring heavy rainfall because they gather moisture as they pass through the Great Lakes. The Labrador cold currents (North America) and Kuril or Oyashio cold currents (Asia) further reduce the temperature along the coast. The West Coast in the same latitude is influenced by warm ocean currents. Precipitation in form of snow and rain in North America

and North Japan occurs throughout the year and is fairly distributed. In North Eastern Asia, there is Summer rainfall except in northern Japan and northern Korea where heavy snow-fall occurs in winter. Annual rainfall varies from 530 millimetres to 1 000 millimetres. Rainfall is both conventional and cyclonic.

Vegetation

Vegetation in this region consists mainly of coniferous forests, but in the South-East of Northern Hemisphere, deciduous trees flourish. Examples of this vegetation are the maple of eastern Canada and the oak and beech of Asia.

Human activities

Crop production: The main economic activities are farming and manufacturing industries. Mixed farming is practised in the North-East USA whereas growing of fruit trees, especially apples is important in Nova Scotia in Canada. In Asia, crops grown are wheat, maize, millet and soya beans.

Animal keeping: Sheep rearing is an important activity in Patagonia, which is located in the south-eastern part of South America. Rainfall is very low and grasslands are poor. Both mutton and wool are produced.

Lumbering: Lumbering is also practised especially in deciduous and coniferous forests of Northern and South Eastern Canada. Lumbering industry employs many people in this region as they engage in cutting down trees, planting, and transporting them to the mills. Lumbering contributes to the development of paper industries in the region. Canada is the third largest exporter of pulp and paper products in the world.

Activity 2.8

Study carefully the climate of cool temperate western coast margin climate region and cool temperature eastern margin climate region then, write down the main differences and similarities in climate and economic activities. Present your findings in class.

Cool temperate continental climate region (Siberian type)

Location and coverage

This climate is located in the Northern Hemisphere along latitude 60° North stretching across the continental interior of Northern Siberia, North America and Alaska through much of Canada. In Eurasia, it stretches from Europe, especially in Sweden, Finland and Eastern Europe eastwards through much of Russia as presented in Figure 2.49:
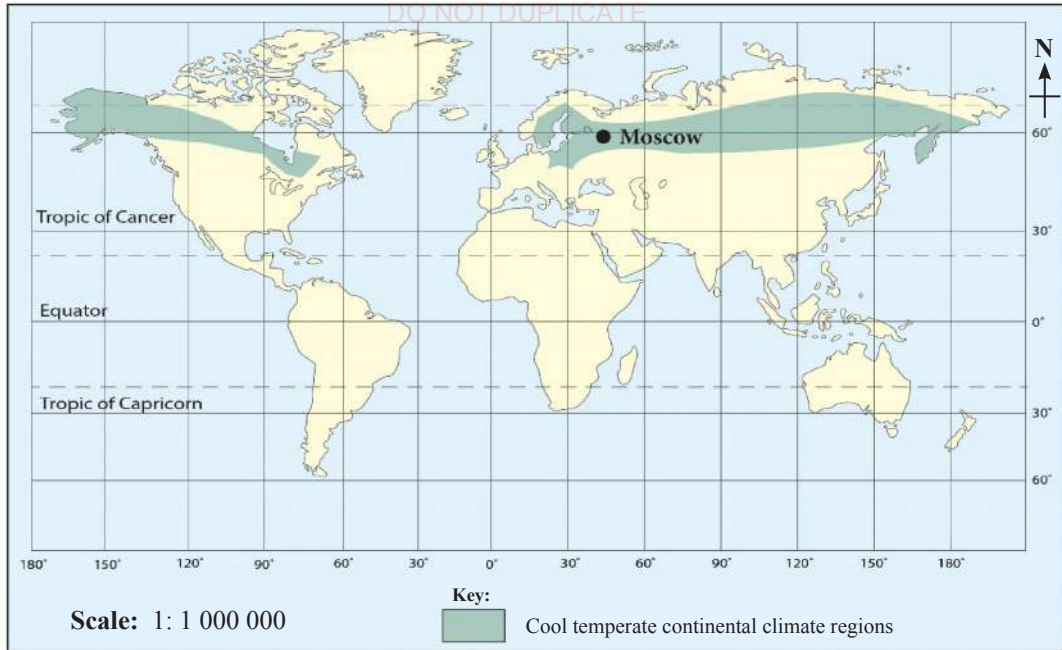
Figure 2.49: *Cool temperate continental climate regions*

Climatic characteristics

Generally, the region experiences mild summers with about 20˚C but winters are very cold at about -15˚C. In Winter, the cold, dry winds from the Arctic region blow from the North-West, bringing with them very low temperatures. In Canada, Winter temperatures are not as low as in Siberia because the continental effects are modified by a relative distance from the ocean. This distance contributes to warmer summers and cold winters.

In both Canada and Siberia, days are longer than nights in Summer but in Winter the nights are longer than days. Winds blow in from the sea and, therefore, bring rainfall to the coastal regions during Summer. During Winter, winds blow out to the sea and the winter precipitation is in form of snow. Figures 2.50 and 2.51; Tables 2.22 and 2.23 show climatic data for cool temperate continental climate for Dawson (Canada) and Arkhangelsk (Russia).

Table 2.22: *Climatic data for Dawson (Canada)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	-30.5	-23.9	-15.5	-1.7	7.8	13.9	15	12.2	5.5	-3.8	-17.2	-25
Rainfall (mm)	20.3	20.3	12.7	17.8	22.9	33	40.6	40.6	43.2	33	33	27.9
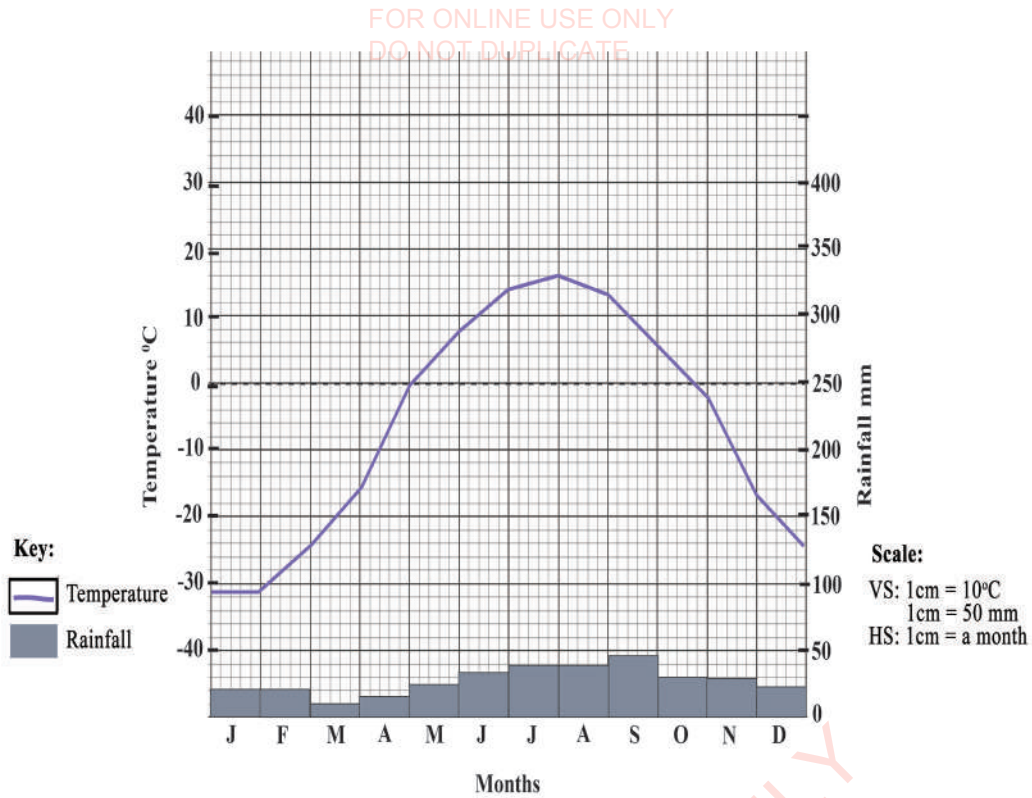
Figure 2.50: *Temperature and rainfall distribution for Dawson (Canada)*

Table 2.23: *Climatic data for Arkhangelsk (Russia)*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	-13.9	-12.8	-7.8	-1.1	5.0	12.2	15.5	13.9	8.3	1.1	-5.5	-11.7
Rainfall (mm)	20.3	17.8	20.3	17.8	25.4	38.1	55.9	53.3	50.8	38.1	27.9	20.3
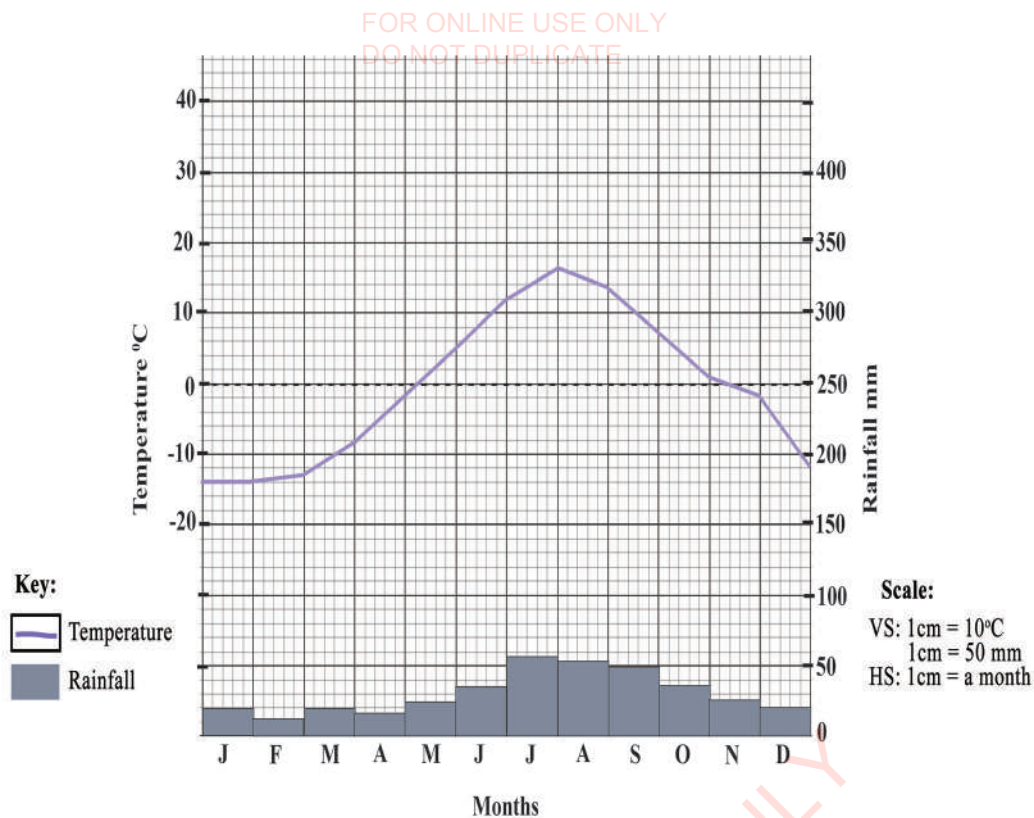
Figure 2.51: *Temperature and rainfall distribution for Arkhangelsk (Russia)*

Vegetation

The coniferous forest of Taiga extends over large areas of Alaska, Northern Canada, Scandinavia and Russia. There are very few species of trees. For instance, in Sweden the dominant species are spruce, pine and birch. The conifers are evergreen. They have small leaves with thick cuticles aimed to reduce the rate of transpiration. The trees have long tap roots to give them stability against strong winds. They also have shallow roots to absorb surface moisture in Spring. There is little undergrowth because of leaf fall, many months of darkness and frozen ground in Winter.

Human activities

The region is sparsely inhabited because of severe long and cold winters. Crop production is not common because of short summers.

Lumbering: The main activity in this region is lumbering. Exploitation of the forests is easy because the trees are of similar type and the frozen ground provides an easy means of hauling the logs. The logs are dragged to the river and when the ice melts the logs are dragged by the river to the mills. Soft wood is used to produce paper and newsprint.

Crop production: Agriculture is practised in the cleared areas but people do not rely on agriculture for their livelihood. Examples of crops produced are cocoa and coffee production.

Hunting: Trappers hunt animals such as the squirrel, fox, egmine, skunk, beaver, and matern for their valuable furs.

Polar climate region

Polar climate regions are characterized by a lack of warm summers, an average temperature of less than 10 °C every month, cool summers and very cold winters, which result in treeless, glaciers, or a permanent or semi-permanent layers of ice.

Regions with polar climate cover more than 20% of the Earth's surface. Most of these regions are far from the Equator, and in this case, Winter days are extremely short and summer days are very long.

Types of Polar climate region

There are two types of polar climate regions: Tundra and ice cap climate regions.

Tundra climate regions

Location and coverage

Tundra comes from Finnish word *tunturi*, meaning treeless plain. These regions are found beyond latitude 60° North and

South of the Equator that means within Arctic and Antarctic Circles. Particularly, they occur in North America extending from Alaska through Northern Canada to southern Greenland, Northern Norway, Finland, Eastwards through Northern Russia and Antarctica as shown in Figure 2.52.

Climatic characteristics

A Tundra climate is characterised by having at least one month whose average temperature is just above 0˚C. Summer temperatures fall below 10˚C, whereas the Winter temperatures are very low, usually under -18˚C. Summer days are long and winter days are very short. Winter are very windy and precipitation takes place during snowfall. The snowfall is normally accompanied by strong winds. Annual precipitation is very low, generally below 250 millimetres. These areas are, therefore, known as cold deserts.

Vegetation

A Tundra region has very little vegetation because the growing season is very short, less than two months annually. The Eurasian Tundra is inhabited mainly by the Lapps, Sanoyeds and Yakuts. Because of scanty vegetation, there are few varieties of animals and birds. These include the arctic fox, arctic hare, lemming (a small mouse), reindeers, seals, whales and walrus. The vegetation

includes mosses and lichens. There are also few flowering plants and shrubs, which produce flowers and fruits quickly during Summer.

Human activities

On the Tundra, human activities include residential, recreational and industrial activities. Many of the permanent residents of Tundra regions are indigenous people, such as Alaska's Aleut and Inuit ethnic groups, and rely on subsistence hunting and gathering to survive. Recreational opportunities such as hunting and wildlife viewing are available for visitors to the Tundra. The recently innovated activities of oil, gas and mining industries have been a subject of controversy as they cause damage to the delicate Tundra ecosystem.

Tundra is a very popular destination for visitors from all over the world because of its low population density, amazing wildlife and glorious prospect. People travel to the Tundra to enjoy activities such as fishing, hiking, hunting, camping, wildlife viewing, and photography.

Animals such as the polar bears, grizzly bears, wolves, arctic foxes, seals, small rodents and caribou or reindeers, as well as migratory birds of all sorts, make the Tundra a fascinating destination for outdoor recreational activities.

Ice cap climate regions

Location and coverage

Ice cap region is mainly found in Antarctica and the land around the Arctic Ocean, especially Greenland as shown in Figure 2.52.

Climatic characteristics

Temperature in the Ice cap region is permanently below 0°C, hence there is a permanent snow cover. Blizzards are very frequent. All places in ice cap climate have at least one day of twenty-four hours (24 hours) of daylight in mid-Summer and twenty-four hours of total darkness in mid-Winter.

Vegetation and animals

There is very little surface life in ice cap climates. Vegetation cannot grow on ice except in the warmer fringes that occasionally peak above freezing. Even then it is confined to mosses and lichen which is a mixture of a fungus and algae. However, the fringes of ice caps do have a significant animal life. Most of these animals feeds in the surrounding oceans. Popular examples include polar bears in the northern pole and penguins in Antarctica.

Human activities

The Ice cap climate is characterised by low temperature, short summers and frozen soils in which crop cultivation is hardly possible. Some other activities, such as animal keeping, fishing and hunting take place in the region. Handicraft has become an important industry in the region. Bones and sinews serve as needles and threads respectively, for making cloth. Because of the extreme cold, everyone wears a fur hood over the head and face, fur gloves and fur boots. In addition, fur sweaters and heavy overcoats are also worn.

There are no permanent settlements because the inhabitants have to move from one place to another in search of pasture for the reindeers. People live in tents made of animal skins. For example, the Eskimos of North America engage mainly in hunting and fishing. Their main food is fish and fat (blubber). The Eskimos use clothes made of fur and polar bear skins. In Summer, they live in tents made of wood and deer skins. In Winter, they live in houses made of ice blocks. These houses are called *igloos*. They use canoes called *kayaks*, *large boats* and *sledges drawn* by a team of *strong dogs* for transport.
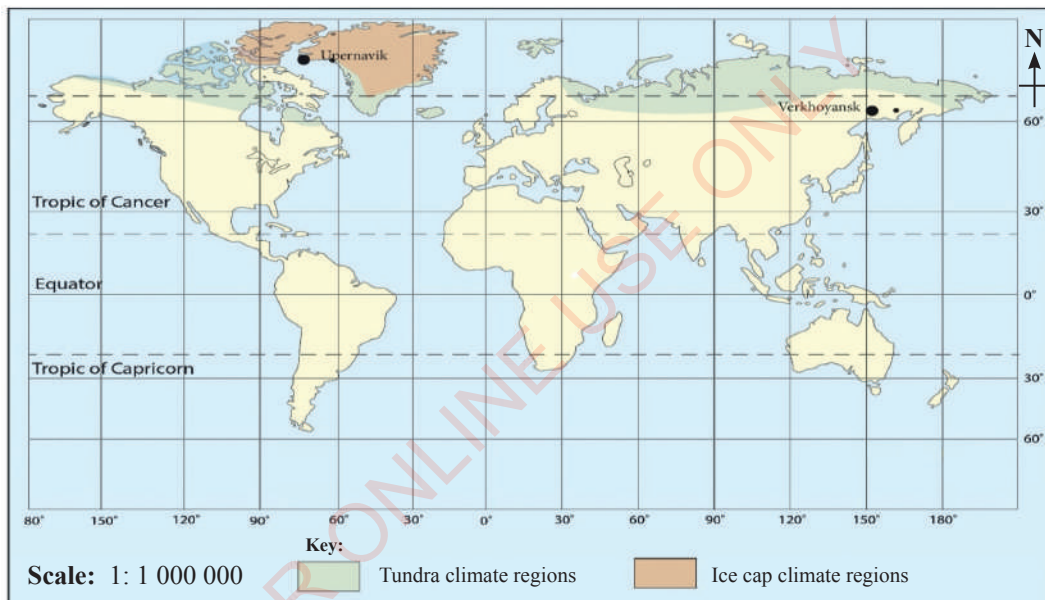
Figure 2.52: *Polar climate regions (tundra climate and ice cap climate regions)*

Activity 2.9

From your general knowledge, discuss in groups the adaptation mechanisms of people and animals in polar regions. Also, discuss the possible effects of global warming on the polar regions, then present your answers in class as guided by your subject-teacher.

Mountainous climate region

Location and coverage

The main mountainous areas in the world are found in North and South America, Southern Europe, Central Asia, Eastern Australia and North-East Africa. It is best developed in regions of young fold mountains such as the Rocky Mountains, the Andes, and the Himalayas as shown in Figure 2.53. In Tanzania, Uluguru and Udzungwa mountains experience mountainous climate.
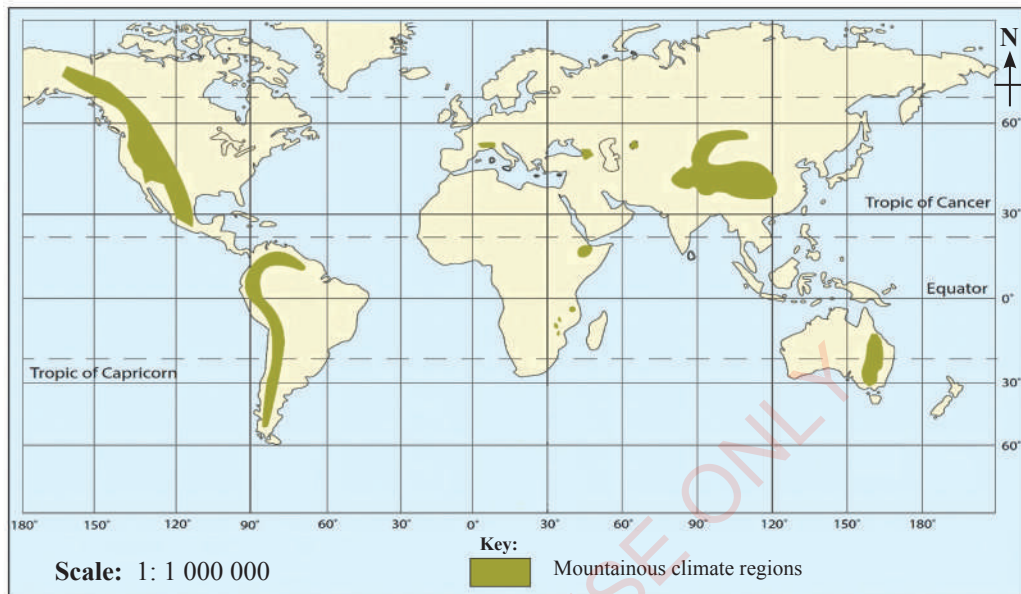
Figure 2.53: *Mountainous climate regions*

Climatic characteristics

Generally, temperature decreases with an increase in altitude whereas precipitation increases with altitude but the air in the high mountain regions is free from dust and, therefore, cannot absorb much temperature. In fact, air is always cool whose daily range temperature is small. As you move from the bottom to the top of the mountain, there is a temperature belt like those extending from the Equator to the poles. This phenomenon in which colder air is at the bottom of valleys and warmer air is above is called *temperature inversion*. Local winds develop in most mountainous regions. In the Rockies, these local winds are called *Chinock* whereas in Switzerland they are known as *Forn*.

Vegetation

The vegetation varies with altitude. At the base, there are Steppe grasslands, which are open grasslands with very

little bush. On the lower slopes of the mountain where the rain totals are high, there is a thick forest. However, the trees in these areas are not as large as those in equatorial forests. The common trees are bamboos. Above the forests, open mountain (oralpine) grasslands, moss and lichens grow on bare rocks and stony surface. At the highest-level glacier ice is formed. Figure 2.54 shows the influence of a mountain on vegetation:
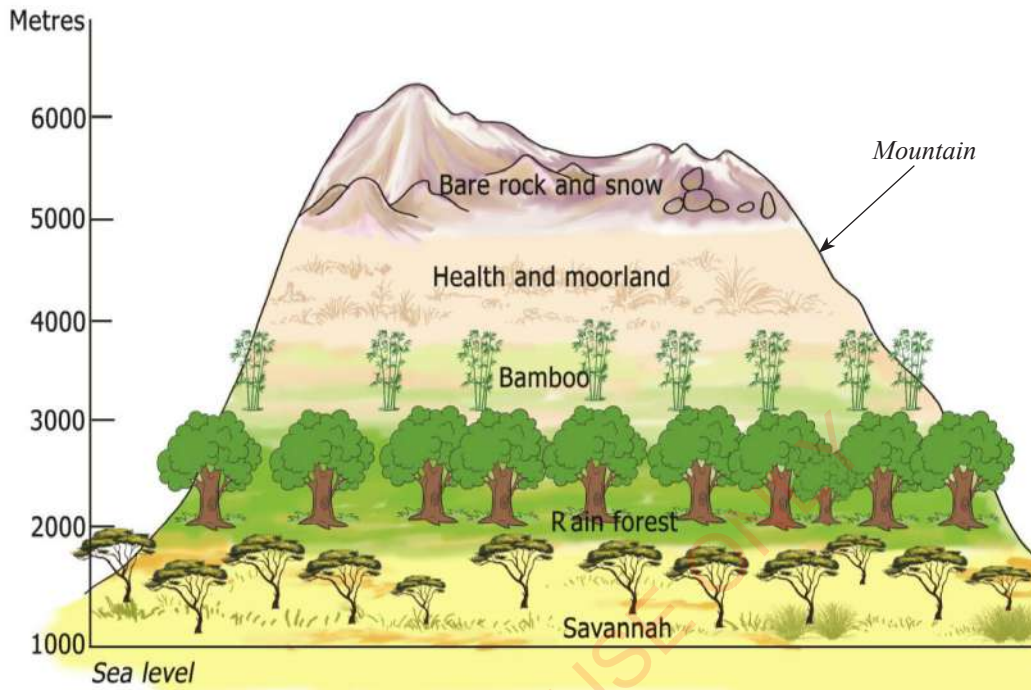
Figure 2.54: *Influence of a mountain on vegetation*

Human activities

Tropical highlands form the best areas for agriculture. Crops produced in this region include tea, coffee and pyrethrum, which require high and well distributed rainfall. Tea is grown in the East African Highlands, Sri Lanka, Southern and Northern India. Arabica coffee is grown in Ethiopia and Central America. In temperate latitudes highland areas are used mainly for grazing cattle and sheep. Such areas are South Island of NewZealand and the British Isles. Mountainous regions often attract tourists who go to tourist sites to admire the mountain scenery and climb the mountains. This attracts skiers for sports and naturalists for research reasons. In East African Highlands, the best farming land lies on the slopes of volcanic mountains such as Mount Kilimanjaro and on plateaus which lie between 1 000 metres and 2 600 metres above sea level.

These highlands produce cash crops such as coffee, tea, pyrethrum, and a variety of important food crops such as bananas, beans, cocoyam, fruits, and vegetables.

Relationship between human activities and climate

Climate plays a crucial role in people's activities. Most of these activities depend on temperature and rainfall. These two elements may create favourable conditions to one activity and unfavourable to another. The major economic activities influenced by climate include agriculture, lumbering and livestock-keeping. The following sections describe some selected human activities.

Livestock-keeping: Different livestock survive in different climatic conditions. In the open Savannah in Africa, Brazil and Venezuela, sheep and goat keeping is carried out. In temperate regions, livestock for beef and dairy cattle, sheep, pigs and poultry are very important. In the Tundra region, nomadic people herd reindeers.

Lumbering: This activity is found in both the equatorial and temperate climates. In equatorial regions of constant high temperature and heavy rainfall, trees grow to great heights and provide hardwood, for example, mahogany, iroko, iron wood and mangrove are found along the coast of tropical oceans. In temperate regions, where it is cool for most part of the year, coniferous forests are found hence making lumbering a major activity.

Crop production: This activity is practised in most parts of the world. The difference depends on the type of agriculture or farming and the kind of crops grown. In equatorial regions a variety of crops such as cassava, yams and rice are grown for food consumption in small scale.

Other crops are grown on a large-scale and are mainly for export. These include rubber, oil palm, cocoa, coffee, sugarcane and tobacco. In the Savannah, agriculture is practised but it is very much affected by unreliable rainfall, pests, diseases, poor soil quality poor transport and communication.

Crops grown include wheat, maize, millet, sorghum and rice. In the temperate regions, crops grow in a short period because summers are short. Examples of such crops include wheat, barley, oats, root crops and fruits.

In very cold climates, soil is sub-frozen for most parts of the year. This prevents agriculture from taking place. Nomadic activities are common.

Ways of solving climatic problems

There are several ways of solving climatic problems in our societies. Some of those ways are as follows:

Use renewable energies: This entails changing our main energy sources from wood fuels consumption to clean and renewable energy. For example, the use of solar, wind, geothermal and biomass energies could be a solution to the existing climatic problems in societies. Use of renewable energies decreases pollution and saves money as well.

Use sustainable and environmentally-friendly means of transportation: Our means of transport must be aligned with environmental requirements and reduce their carbon footprint. It is essential to re-consider our means of transport from the design stage towards environmentally-friendly transportation. For example, electric trains and buses are environmentally-friendly which travel long distances in a relatively short time. Also, people are advised to use public transport instead of private cars or taxis.

Waste management and recycling: The simplest solution to reducing waste is to align our production methods to our consumption patterns. The recycling process must also be considered in our consumption habits while limiting industrial emissions and wastes.

Limiting overfishing and unsustainable development along the coast: Oceans and seas are the largest storage of greenhouse gases and are an exceptional support system for life on this planet. Limiting overfishing, promoting sustainable development activities in coastal areas and the consumption of environmentally-friendly products is essential to protect waterbodies, especially seas and oceans.

Eat for a climate-stable planet: The decisions we make about food can have a profound effect on the environment. Here are some simple ways for making your diet more climate-friendly. Opt for more plant-based meals and less meat and dairy products. Example, beef, lamb and cheese have some of the largest carbon footprints of all the food products. Thus, buy organic and local food whenever possible, do not waste food, and grow your own food. You can also help save the planet Earth by eating insects.

Provide environmental conversation education to people: Solving climate change requires us all to work together. We cannot do that without finding a common ground with those who may not share our perspectives. Since people often trust peers, family members and loved ones more than they do experts, scientists and environmental organisations, you can talk to people about climate change in ways they can understand you. You are more likely to open people's minds on the causes of environmental pollution and tentative measures to environmental conservation.

Protecting forests and planting new trees: Planting trees on private and public land will help to absorb carbons out of the air. Trees planted in and around rural and urban areas can also provide shades during sunny and Summer days.

Take initiatives and get involved politically: Meet with your elected government officials and voice your concerns and demand solutions to an existing issue that is contributing to climatic problems. This is one of the efficient ways of bringing about change from the bottom-up. Also, vote (if your age allows you to vote) for knowledgeable and dedicated leaders that will deal with climatic problems and pass legislations that address these issues towards a green future environment.

End production and sales of vehicles that run on fossil fuels: Within a few decades, we are likely to witness a worldwide transition away from vehicles that run on petroleum and diesel toward ones that use electricity. However, there is a lot of uncertainty about how quickly it would happen. Therefore, governments have to hurry it along by phasing out the production and buying of petroleum and diesel vehicles and help the consumers to buy electric vehicles instead. In 2017, both China and India, along with few European countries, announced the plans to end sales of petroleum and diesel vehicles. China is hustling towards that goal by providing incentives to manufacturers of electric cars and buses, as well as subsidies to consumers who buy electric vehicles.

Revision exercise

Section A

Choose the correct answer among the alternatives provided:

(i) You are asked to help a Form Two student who failed to identify the types of forest found in low temperatures. What type of forest would you suggest among the following?
   (a) Tropical rain forest
   (b) Equatorial forest
   (c) Mediterranean forest
   (d) Coniferous forest
   (e) Deciduous forest

(ii) Mrs. Joseph had a chance to visit South-East Asia for a study tour and she experienced seasonal reverse of wind in the area. Identify the type of climate in the area.
   (a) Tropical maritime
   (b) Tropical continental
   (c) Equatorial
   (d) Tropical monsoon
   (e) Desert

(iii) The Amazon and the Congo basins are regions characterised by the same geographical background to human activities, climate, vegetation, and relief. What could be the general term for these regions?
   (a) Natural vegetation
   (b) Natural climate region
   (c) Natural well
   (d) Natural resources
   (e) Natural landscape

(iv) One of the following is a set of some factors affecting climate
   (a) Ocean currents, altitude, sleet and barometer
   (b) Distance from the sea, rainfall, clouds cover and latitude

(c)   Prevailing winds, latitude, rainfall, hygrometer and aspect

(d)   Altitude, temperature and the Earth's rotation

(e)   Humidity, dew point, atmospheric pressure, and rain gauge

(v)   The tourists reported enjoying the temperature of Ihefu wetlands in Mbeya at 1 500 metres above sea level, which is 32ºC. They also planned to travel from Ihefu to Unguja in Zanzibar, which is at the sea level. What might be the temperature experienced by the tourists in Zanzibar?

(a)   23 ºC   (b)   0.6 ºC   (c)   9 ºC

(d)   41 ºC   (e)   19 ºC

Section B

Answer the following questions:

(i)   Mention countries where the following crops are grown-sisal, citrus fruits, and cocoa.

(ii)   What name would you give to the climate region you live in? Give reasons for your answer.

(iii)   Why is the climate important to human beings (think of crops, livestock, communication and the distribution of population).

(iv)   Study the following climatic data recorded at Malenga weather station and then answer the questions that follow:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (˚C)	26	26	25	25.2	24	24	24	24	24	24	24.6	24.8
Rainfall (mm)	41.1	66.8	140	220	205	113	63	81	191	221	130	50

(a)   Calculate the mean annual temperature for the station.

(b)   Present the temperature and rainfall distribution in a simple graph.

(c)   Comment on the weather condition of the area.

(d)   Identify the type of climate of this station.

Section C

Match the descriptions of climatic region in Column A with correct corresponding type of climate in Column B:

Column A	Column B
(i) The vegetation consists of deciduous forest in lowland and coniferous forest in highlands.	(a) Equatorial climate region
(ii) This is the cold climate of the world.	(b) Mediterranean climate region
(iii) Natural vegetation is very scanty and consists of mostly thorny scrubs bushes and cacti.	(c) Polar climate region
(iv) It is found between 5˚ and 20˚ North and South of Equator.	(d) Warm temperate eastern margin climate region
(v) Rains often come in the afternoon and are accompanied by lightning and thunder storms.	(e) Tropical desert climate region
	(f) Tropical maritime climate region
	(g) Tropical grassland climate region

Section D

Answer the following essay questions:

1. With examples, use six points to explain why irrigation is necessary for crop cultivation in some parts of the world.

2. Climate has led to a significant influence on the current expansion of human activities. Using six points, explain the importance of studying climatic conditions of the world.

3. Vegetations do not grow well in desert areas because of harsh conditions. With five points, explain how such vegetations adapt to survive in desert.

4. "Having a good climatic conditions and high fertile soil doesn't necessary mean a better livelihoods for people". Using six points, support this statement.

Chapter Three

Human population

Introduction

In this chapter, you will learn the concepts of human population, human population distribution, human population change, human population data, population problems and population policy. The competencies developed from this chapter will help you to understand human population as an important phenomenon in planning and developing for socio-economic activities in the society.

The concept of human population

Human population refers to the number of people living in a certain area at a given time. It is a development process because it is not only the number of people that matters, but also how a population utilises the resources available to achieve both economic and social development. Services such as education, health, water supply and electricity are required for a particular human population to achieve economic and social development.

The importance of studying human population

Studying human population is important for socio-economic and development. The knowledge of a population is essential in planning for socio-economic development. For example, by knowing

the number of school age groups, the government can plan for the number of classrooms to build, teachers to employ and other education requirements. In medical services, if the ratio between the patients and the doctors or hospital beds is known, it is easy to balance the requirement to improve medical or health services. The study of population is important because it helps to know the characteristics of human population, for example, size, composition and structure of the population. It also enables the government to know the number of skilled and unskilled manpower. In addition, the study of the population enables the government to establish measures to reduce mortality rates, which may lead to loss of manpower if not well-managed.

Characteristics of human population

Human population has a variety of characteristics that define its nature. The following are some of the characteristics of human population:

Population size: A population size refers to the sum of people in a defined administrative area at a given point of time. It may cover the world, a country, region, district, ward or a village. For instance, the world population by 2020 was 7.8 billion; according to 2012 census the population size of Tanzania was about 45 million. By January 1st, 2020, the population size of Tanzania was estimated to stand at 57.6 million people.

Population distribution: Population distribution refers to how people are spread out across the Earth's surface.

Population density: Population density refers to the number of individuals per unit area usually quoted per square kilometre or square mile. If a population size increases and all the individuals remain in the same area, then the population density increases as well. If the size of the population in a particular area decreases, the density also decreases. Population density can be affected by the number and degree of utility of resources available in the area. According to the 2012 population and housing census. In arid regions, as in central Tanzania, population density was as low as 50 people per square kilometre, and over 3 000 people per square kilometre in cities such as Dar es Salaam. The lowest population density was in Lindi with 13 people per square kilometre and 12 people per square kilometre in Katavi Region.

Population structure: This refers to the composition of population as determined by the number or proportion of males and females in each age group.

Human population distribution

Usually, population distribution is uneven due to physical, socio-economic, demographic and political factors.

Some areas are highly inhabited whereas others are less inhabited and some are not inhabited at all. The concept of uneven population distribution applies in this situation. Generally, the world population distribution can be categorised into three main groups as described below:

Densely populated areas: These are areas which are inhabited by a large number of people. These areas mostly have plenty of food with favourable climate and fertile soils which percieved to have plenty of livelihood opportunities that attract people to live in. A good example of densely populated areas are urban areas of Mbeya, Arusha, Mwanza and Dar es Salaam on Tanzania Mainland; Urban-West Region in Unguja, Urban area of Wete and Chakechake in Pemba-Zanzibar.

Moderately populated areas: These areas are inhabited by a moderate number of people. These areas receive moderate rainfall and have limited resources, which can support the life of inhabitants. Examples include some districts of Iringa, Tanga, Kilimanjaro, Tabora and Morogoro Regions are characterised by moderate population distribution.

Sparsely populated areas: These are areas which have fewer people. Usually, they are found in rural areas. These areas have few resources, infertile soil and hostile climate for human beings. Examples of such areas are rural areas of Pwani, Manyara, Dodoma and Singida, which are sparsely populated.

Factors affecting human population Distribution

No single factor is solely responsible for concentrated or scanty population distribution and growth. Most of the factors described in this chapter are interrelated and often act collectively. Factors that can influence population distribution fall under three major categories: Physical, human and biological factors. There factors either encourage or discourage people from living in an area.

Physical factors

Physical factors include climate, relief, soil, vegetation, natural hazards (disasters), water resources, minerals and energy resources.

Climate

Climate is the major factor, which influences population distribution in the world. Areas with reliable rainfall attract large number of people to inhabity thus high population. Desert and semi-desert areas, on the other hand, have low or no population at all because of very low amount of rainfall. In East Africa, the amount of rainfall has a great influence on population distribution. The population is denser when rainfall is moderate and well distributed as it favours agriculture as the major livelihood activity. For example, the well-watered Southern and Northern highlands of Tanzania, the coastal areas of Tanzania and Kenya, the Central Highlands of Kenya, the Lake Victoria basin, South Western Uganda and the areas around Mount Elgon are areas of high population densities. Aridity has made many areas of East Africa uninhabitable. About 50 percent of land in East Africa has high temperature and low rainfall for crops and animal husbandry as well as human settlement. In Tanzania, regions like Singida and Dodoma, especially the rural areas have sparse population distribution because of semi-arid climate.

Relief

The highland or mountainous areas of East Africa such as the upper slopes of Mount Kilimanjaro, Mount Kenya and Mount Ruwenzori are extremely cold

because of altitude. Low temperature and the steep slopes make the area unconducive for human settlement. Steep slopes also make the construction of infrastructure such as roads and housing difficult and expensive. Moreover, there is limited soil development and fertility since soil is washed down by rainfall. These areas have sparse population distribution.

Where slopes are gentle or flat, there is high population because the soil is well-developed and fertile to facilitate crop production. Gentle slopes allow agro-mechanisation to take place. Also, gentle slopes make it easy to develop settlements. For example, Dar es Salaam attracts many people to live there because of its gentle slope. However, some highland areas receive adequate rainfall because of their altitude and the direction of moisture transferred by strong winds. In addition, highland areas are free from floods. As such, they attract more people than other areas. If flat river valleys, flat plains, deltas and volcanic areas have fertile soils, thus atracting a large number of people to inhabit there.

Vegetation

Rich vegetation such as grasslands influences the formation of deep soil and reduces soil erosion. Such factors enhance the cultivation of both food and cash crops. Areas with such vegetation have a moderate population distribution.

Soils

Soils have a great influence on population distribution as they determine where people settle. Soils, which are thin, infertile and highly leached, discourage development of settlement because they cannot support agriculture. This may lead to a moderate or sparse population distribution in a particular area. A deep-weathered soil found mainly in volcanic areas tends to attract a huge population. This results into a dense population distribution in a particular area. Such areas include the highlands of Kilimanjaro, Meru, Pare, Usambara, Rungwe, and Kasulu in Tanzania.

Mineral resources

People are mostly attracted to create settlements in mining areas. They migrate to such areas with the availability of minerals so that they can earn income for their livelihood. Examples of such areas include Mwadui diamond mines in Shinyanga, Geita gold mines in Geita and Mirerani tanzanite mines in Manyara. These areas have dense or moderate population distribution.

Water resources

Water supply is essential for human survival and development. People are always attracted to establish settlements along areas with water resources such as natural springs, rivers, lakes, seas or oceans. The reason behind is to have easy access to water for domestic and other socio-economic activities. For example,

irrigation and fishing activities depend on water resources. Coastal areas of Tanga, Dar es Salaam, Pwani, Lindi and Mtwara are popular for fishing activities. Mwanza, Mara, Simiyu, and Kagera (Lake Victoria), Mbeya, Njombe, and Ruvuma (Lake Nyasa), Songwe (Lake Rukwa), Rukwa (Lake Tanganyika and Lake Rukwa) and Kigoma (Lake Tanganyika) are examples of potential areas for irrigation and fishing. Water resources result in a dense population distribution.

Natural hazards

People usually avoid settling in areas, which are frequently affected by natural hazards. These natural hazards include earthquakes, floods, droughts and volcanic eruptions. For instance, some parts of Kilosa in Morogoro are mostly affected by floods, hence discouraging people from settling there.

Biological factors

Pests and diseases have a considerable influence on population distribution. In Tanzania, areas affected by Tsetse-flies, black-flies, and mosquitoes discourage human settlements. Western and Southern areas of Mpanda and Liwale Districts are among the areas affected by pests. Normally, pests cause sleeping sickness, trachoma and malaria. Areas that experience these problems tend to have low population density. Other areas such as Dodoma and Singida suffer from eye-related diseases due to these pests.

As a result, they have sparse population distribution.

Human factors

This category includes historical, political, economic and social factors. The following factors show the influence of human beings on population distribution.

Historical factors

Historical events such as civil wars and invasions which, to a large extent, cause insecurity, lead to depopulation because people move away and become refugees elsewhere. Civil wars threaten human life and also cause starvation. In areas hosting refugees, the number of people increases, hence increasing population. Dense population increases pressure on resources. During the colonial period, people were recruited as labourers and moved from their original homes to other places. This affected population distribution. The impact of labour reserves during the colonial period on population density and distribution has been notable in Tanga, Tabora, Bagamoyo, Kilwa, Songea and Kibondo in Tanzania.

Political factors

Areas with political stability and peace attract high populations. People tend to avoid areas with political crises, which become sparsely populated. Political instability in some areas of Sudan, South Sudan, Somalia, Democratic Republic

of Congo, Rwanda and Burundi has discouraged many people from living there. Areas, which are politically unstable, generally have low population density.

Furthermore, shifting a capital city of a nation to a new area can also affect population density. For example, the decision made by the Government of Tanzania to relocate the capital city of the United Republic of Tanzania from Dar es Salaam to Dodoma has affected the population distribution in Dodoma. Inevitably, the population in Dodoma is increasing.

Economic factors

Economic activities such as industrial, mining, trade and service centres influence population distribution. These areas generate various employment opportunities and sources of income. These areas normally have a dense population distribution. In Tanzania, urban areas especially city or town centres have a dense population compared to rural areas. Urban areas of Unguja in Zanzibar, Dar es Salaam, Arusha, Mbeya and Mwanza on Mainland Tanzania are densely populated.

Commercial agriculture also affects population distribution. Tea estates in Njombe and Rungwe - Mbeya, as well as coffee estates in Kilimanjaro and Arusha have influenced the population density and distribution in these regions.

Availability of transport by airways, roads, pipelines, railways and waterways facilitates the movement of goods and services to reach areas of need easily. Areas with good transport and communication systems tend to attract a large number of people. For example, areas with railway stations attract a large number of people to live nearby.

Social factors

Areas with improved social services such as health, education, clean water and electricity supply tend to attract people to establish settlements compared to areas with inadequate supply of social services. For example, Dar es Salaam, Mwanza, Tanga, Arusha, Dodoma and Mbeya cities, tend to attract a large number of people due to the availability of good social services and amenities.

Human population change

Population change refers to the increase or decrease of the number of people in a certain area in a specific period. It is a change in the population size, composition and distribution of a given area over time. A positive change, which refers to an increase in population size while a negative change entails a decrease in population size. A positive change in population is also known as population growth. Main factors that influence population change are fertility, mortality, and migration. The world population increased from 4.1 billion in 1977 to 7.8 billion in 2020. The increase

was not uniform. Rapid population increase mostly happened in developing countries due to high fertility whereas most developed countries experienced a small increase due to low fertility. Some even experienced negative change in their population sizes, for instance, Bulgaria and Lithuania between 1990 and 2020.

Factors influencing human population change

Determinants of human population change are fertility, mortality and migration.

Fertility

Fertility is the reproductive capacity of a woman to conceive a child. Sub-fertility is the low level of fertility. The inability of a woman to conceive is called infertility. The reproductive period of a woman is referred to as the child-bearing age, which ranges from 15 to 50 years. More often than not, it ends at the age of 49 years. There are several measures used in fertility analysis. These measures are as follows:

Crude Birth Rate (CBR) is the number of live births per thousand of the total population in a year. It is obtained by using the following formula:

$$CBR = \frac{\text{Total live births in a year}}{\text{Mid-year population}} \times 1000$$

For example, if the mid-year population of Tanzania in 2012 was 40 000 000 people while the total live births were 1 500 000 then, crude birth rate would be:

$$CBR = \frac{1\ 500\ 000}{40\ 000\ 000} \times 1000$$
$$= 37.5 \approx 38$$

Therefore, the CBR is 38. The result shows that 38 live births could occur out of 1 000 people in a given year. A Crude Birth Rate of more than 30 is considered high and a less than 18 per 1 000 people is considered low. Hence, a Tanzanian CBR of 2012 was considered to be high. This has implications for government spending on education and health. The goverment needs to increase the budget for education and health services.

General Fertility Rate (GFR) refers to the proportion of children born alive per thousand women in the reproductive period in a year. It is obtained by using the following formula:

$$GFR = \frac{\begin{array}{c}\text{Number of live births in}\\ \text{a stated period (one year)}\end{array}}{\begin{array}{c}\text{number of women aged}\\ \text{15-49 in the same period}\end{array}} \times 1000$$

Assume the number of reproductive aged women (15-49) in Tanzania was 2 700 000 in 2012 whereas the number of live births in the same year was 180 000. Calculate the GFR in Tanzania for 2012.

$$GFR = \frac{180\ 000}{2\ 700\ 000} \times 1000$$
$$= 66.6 \approx 67$$

Therefore, the GFR is 67. This result shows that 67 children could be born for every 1 000 women. This is also a high GFR. It increases the cost of

the provision of health, education and nutrition services for born children and the productive aged women.

Child-Woman Ratio (CWR) is the number of children 0 – 4 years of age per 1 000 women of child bearing age (15-49 years). It is obtained by using the following formula:

$$CWR = \frac{\text{Number of children}}{\text{Total number of women}} \times 1000$$
$$\text{(0-4 years of age)} \over \text{15-49 years of age}$$

Assume the number of children under age 5 (0-4) in 2012 was 3 153 122 whereas the number of women of reproductive age (15-49) was 3 771 496.

Calculate the CWR for that period.

$$CWR = \frac{3\ 153\ 122}{3\ 771\ 496} \times 1000$$
$$= 836$$

Therefore, the CWR is 836. The result shows that 836 under five children could be born per 1 000 to women of child-bearing age. This high CWR arises because the CWR for least developed countries is 710 relative to developed countries whose CWR is below 300. Hence, the higher the number of women of child bearing age, the more the under five children are likely to be in a country.

Mortality (Death)

Mortality refers to the occurrence of deaths in a population. Mortality rates can reveal much about the living standard, the health status of a population and the availability of health services. Mortality rates are calculated as follows:

Crude Death Rate (CDR) is the number of deaths per thousand of the total population in a specified geographic area in a year. It is obtained by the formula:

$$CDR = \frac{\text{Number of deaths in one years}}{\text{Total mid-year population}} \times 1000$$

For example, if we use the same figure of 40 000 000 for total population and 1 000 000 deaths in a year, then crude death rate is calculated as following:

$$CDR = \frac{1\ 000\ 000}{40\ 000\ 000} \times 1000$$
$$= 25$$

Therefore, the CDR is 25. This result shows that 25 deaths were likely to occur out of 1 000 people in a given year. This is a high crude death rate. It indicates that the governement has to spend more resources on health and nutrition services to reduce the death rates.

Infant Mortality Rate (IMR) is the number of deaths of infants under one year of age (0-11 months of age) per 1 000 live births in a given year. Infants (children under one year of age) are at high risk of death than any other age group. It is obtained by using the following formula:

$$IMR = \frac{\text{Number of death of children} < 1 \text{ year of age in a year}}{\text{Total live births during that year}} \times 1000$$

In 1993, country X had 548 000 live births and in October, 1993 it registered 74 528 deaths to children under 1 year. The IMR is calculated as follows:

$$IMR = \frac{74\ 528}{548\ 000} \times 1000$$
$$= 136$$

Therefore, the IMR is 136. The result indicates that 136 infants under 1 year of age were likely to die out of 1 000 live births. This is high IMR as compared to developed countries whose IMR is below 10. It shows that the government has to invest more in maternal health services.

Child Mortality Rate (CMR) is the number of deaths of children (that is 1-4 years of age per 1 000 children 1-4 years of age). It is a sensitive indicator of the health status of a community. It is obtained by the following formula:

$$CMR = \frac{\text{Number of deaths of children 1-4 year of age in a year}}{\text{Number of live births in that year}} \times 1000$$

The number of under five deaths in country D in 2010 was 74 528 while live births were 420 000. The CMR would be:

$$CMR = \frac{74\ 528}{420\ 000} \times 1000$$
$$= 177.4 \approx 177$$

Therefore, the CMR is 177. The result shows that 177 children were likely to die before reaching the age of five. This implies that the government has to invest more in health, nutrition and maternal services for children.

Migration

Migration is the movement of individuals or group of people from one place to another, which involves permanent or temporary change of their usual residence. A migrant is a person who moves and crosses a certain administrative boundary to another.

Migration may involve immigration (in-migration). Immigration is an international movement of people to a destination country where they are not natives. These people are *immigrants*. Emigration (out-migration) is a process of people leaving a country to settle permanently in another country. These people are called *emigrants*.

A person who has moved completely to another region inside the country is a *migrant,* one from outside the country is a *diasporan*.

Migration affects the size of population, age and sex structure and level of urbanisation. One of the measures of migration is called Net Migration Rate (NMR). It is obtained by using the following formula:

$$NMR = \frac{\text{Number of Immigrants – Number of Emigrants}}{\text{Total number of population}} \times 1000$$

When NMR is negative it means more people are leaving the country than moving into it. If NMR is positive it means more people are moving into the

country than leaving it. In 2010, data show that 100 000 people emigrated from country X while 200 000 people immigrated to the same country. This country X had a population of 800 000. Calculate the NMR of that country.

$$\text{NMR} = \frac{200\ 000 - 100\ 000}{800\ 000} \text{ X } 1000$$
$$= 125$$

Therefore, the NMR is 125. The result reveals a positive net migration. The positive results show that more people immigrated into country X than those who left it. In other words, the country receives more people, more labour force and new skills than it loses. However, the increase in population raises costs for the provision of social services and employment by the government.

Characteristics of migration

Migration is selective in nature because not all people in a population of a given area move. Under certain circumstances, some groups may have more desire to move than others. For example, the youths migrate more frequently than the adults. Also, males are more migratory than females. Human migration is a two-way process as each movement in one direction has its compensation movement in the opposite direction. Furthermore, during migration the number of opportunities is inversely proportional to the number of intervening factors. In other words, if there are few opportunities more people

are likely to move to other areas with available opportunities. Also, human migration is inversely proportional to distance. Distance increases the extent of migration decreases. Indeed, people are more likely to move from Morogoro to Dar es Salaam than from Kigoma to Dar es Salaam because Morogoro is nearer Dar es Salaam than Kigoma.

Causes of migration

The movement of human population is influenced by the push-and-pull factors. Push factors are those that force people to move to a new destination whereas pull factors are those which motivate humans to move and settle in a particular area. Both the pull-and-push factors can be environmental, economic, social, political or biological. The description of these factors is provided in the following sections:

Pull factors for migration

Environmental factors

Climate: Good climate of moderate temperature, and optimum rainfall attracts people to migrate to that area. For example, areas with favourable climate in Southern Highlands of Tanzania such as Mbeya, Iringa, and Rukwa attract people to move there to engage in farming activities. Thus, climate supports agriculture and agriculture supports life.

Soils: Areas with fertile soils are suitable for agriculture, thus attracts people to move to those areas. For example, the

slopes of Mount Kilimanjaro and the Usangu valley in Mbeya have fertile soils that motivate people to move or go to those areas for agricultural purposes.

Relief: A land with gentle slopes and deep soils, which are well-drained attracts people because these areas are free from soil erosion and support agricultural activities. Gentle and low-land topography support the practice of various human activities such as agriculture and industrialisation. Example, many people settle in the gentle slopes of urban areas of Morogoro, Mbeya, Iringa and Mwanza.

Natural resources: Resources such as minerals attract many migrants. The availability of minerals offers employment to people as a source of income. Also, the availability of minerals provides other opportunities such as trading activities. For example, areas such as Mirerani in Manyara, Geita in Geita Region, Chunya in Mbeya have attracted a large segment of the population to move to these places and settle there.

Biological factors

Areas, which are free from pests such as tsetse-flies, snails and mosquitoes attract people to move to those places. Farmers tend to migrate to areas with little or no plant and animal diseases and pests. For example, the areas affected by tsetse-flies are deserted by livestock-keepers because tsetse-flies transmit a disease known as *tripanosomiasis* to human beings and *nagana* to livestock.

Economic factors

The availability of income or job opportunities attracts people. This is evidenced by rural-urban migration. Urban areas offer more opportunities in industries, trade and government offices. Such opportunities are less available in rural areas. For example, people prefer to move from rural to urban areas such as Dar es Salaam for various opportunities. Others move from urban to other urban areas in search of more economic opportunities. Movements of street vendors such as *Machingas.* These are petty street traders who move from one place to another place selling different products) can be explained by economic factors.

Social factors

This refers to the availability of goods and improved social services. Social services such as electricity, clean and safe tap-water supply, medical services, entertainment, education, transport and communication networks have been motivating people to move from one area to another. Also, the presence of social amenities attracts people to different places.

Political factors

Countries or regions, which are politically stable, attract people.

Refugees, tourists and immigrants have been going to regions or countries, which are secure and politically stable. For example, many Burundians have entered Tanzania as refugees. The political stability of Tanzania has attracted them to stay peacefully. Also, resettlement schemes established by the government attract people as they are furnished with social amenities. Resettlement schemes are established to solve the problems of population pressure on resources or under-utilisation of resources.

Push factors for migration

Environmental factors

Poor climatic conditions: Shortage of rainfall, extremely high or low temperatures (severe hot or cold temperature) force people to move away. This is because poor climate is not favourable for agriculture and pastoralism. Unfavourable climate may force people to move elsewhere. This is a cause of climate-induced migration, also called environmental migration. An example of this type of migration in Tanzania is common among the Sukuma and Maasai who migrate to different parts of the country such as Kilosa (Morogoro), Usangu valley (Mbeya) and Rufiji (Lindi) in search of green pastures.

Infertile soils: Infertile soils do not support agricultural activities. Soil that is not suitable for agriculture especially those that were once fertile and then got exhausted, force people to move away. Some people in some places of Dodoma and Singida where soils are largely infertile have been moving away from those areas to places with fertile soils such as Iringa and Morogoro.

Unfavourable relief: Areas with steep slopes and thin soil or lowland areas, which are frequently flooded tend to push people away to areas, which are suitable for both agriculture and settlement.

Decline in mineral deposits: Areas whose minerals have been exhausted force people to move away from those areas. This is because when the minerals get exhausted, economic opportunities also get lost. Areas with exhausted mineral reserves push people away.

Natural hazards: Areas vulnerable to hazards like earthquakes, volcanic eruptions, floods and storms (Tornadoes, hurricanes and cyclones) are not suitable for human habitation. Such hazards force people to move away from their places. These natural calamities are dangerous as they can cause loss of property and people's lives. Example, some parts of Kilosa, Mvomero, Gairo, Bunda, Mugumu, Turiani, Jangwani, Msimbazi and Kawe are frequently flooded during heavy rains.

Presence of pests and diseases: People move away from areas affected by pests such as tsetse-flies and diseases to areas with no or few diseases and improved

health conditions. For instance, farmers may move away from areas frequently invaded by pests such as armyworms, red locusts, and termites to other areas which are suitable for agriculture.

Economic factors

Limited income opportunities can force people to move from one place to another. Many people are forced to move from rural to urban areas due to limited opportunities for income generation in the rural areas. Lack or shortage of trading opportunities and employment opportunities are among the economic push factors of rural-urban or urban-urban migration. Example, street vendors, move from different rural areas in Tanzania in search of economic opportunities.

Social factors

Lack of social services: Lack or shortage of social services such as electricity, water supply, medical services or transport can force people to move from one place to another, especially from rural areas to urban centres or from one urban centre to another.

Social conflicts: Social conflicts such as family conflicts, witchcraft and civil wars (insecurity) force people to leave a place. For example, many Burundians, Rwandese and Congolese migrated to Tanzania in the 1990s because of civil wars and genocide in their countries.

Classification of migration

There are two types of migration, namely international and internal migration. These types of migration can be in form of permanent, temporary, voluntary or involuntary (forced) migration.

Internal Migration

Internal migration is temporary or permanent movement of people within the country without crossing international boundaries. Rural-urban migration is a good example of an internal migration. Internal migration may be categorised as rural-urban migration, urban-rural migration, rural-rural migration and urban-urban migration. Among these types, rural-urban migration seems to have a considerable impact on urban areas as compared to others. This will be extensively discussed as compared to others. After all, the impacts of rural-urban migration are felt in both urban and rural areas.

Types of internal migration

Rural-Urban Migration

This is the movement of people mainly young and energetic people from rural areas to urban areas in search of non-agricultural opportunities. The pulling factors can be economic and social amenities such as medical services, education, electricity, water supply, efficient transport and entertainment. Availability of employment opportunities is the key factor

Impact of rural-urban migration

Negative impacts of rural-urban migration

In the place of origin (rural areas), rural to urban migration can affect rural areas in several ways including; decline in population size and the economy in the rural areas occurs as the work force migrates to urban areas. The decline in agricultural production due to a shortage of labour may lead to food scarcity, breaking of family and cultural bonds, as members of families move to urban areas.

In the destination areas (urban areas), rural-to-urban migration can lead to urbanasation which, in turn, exerts pressure on services such as housing, healthy, education, transportation and water supply. Urbanisation may lead to the growth of shanty towns and slums. Urbanisation also causes high unemployment rates as percieved opportunities cannot accommodate high numbers of people. Furthermore, it leads to environmental pollution because of excessive generation of waste, poor waste management, and poor sewage disposal. Other effects include cultural loss due to the interaction of people from different areas with different cultural backgrounds, moral decay including prostitution, corruption, burglary, drug abuse, theft, rape, and homosexual practices. Industrial development may also suffer because of shortage of raw materials for production sustainability. Emergence of street-children in towns caused by prostitution or poor marriage bonds is also another effect. These negative impacts occur mostly when migration is not managed or guided by laws and policies.

Positive impacts of rural-urban migration

In the place of destination (urban areas), rural-urban migration leads to increased supply of labour for production in economic activities. Competition for job opportunities in urban areas make increased labour force available cheaply. Also, rural-to-urban migration leads to expansion of markets for goods produced from different economic activities. Furthermore, it can lead to an infusion of technology that people from rural areas come with. This technology can help to develop appropriate industrial technology.

In the place of origin (rural areas), migration to urban areas creates room for environmental conservation by reducing the problem of high population growth or population pressure in rural areas. If well-planned, rural areas may benefit from the introduction of new skills and investments such as schools, health facilities, and or factories.

Measures for addressing problems of rural-urban migration

Several measures can be applied to address problems associated with rural-urban migration. These measures include

the reduction of income differences between rural and urban areas; creation of satellite towns in rural areas, which aim to reduce population in towns or cities; stimulating economic development; and improving and providing enough social services in rural areas that will discourage people to leave.

Since agriculture the main source of rural income, improvement in markets and prices of agricultural produce can motivate most of youth to stay in rural areas. Also, transportation and communication systems should be improved to facilitate the movement of goods, people and services to rural areas and vice-versa.

Furthermore, decentralisation of industries and financial institutions to provide enough and quality socio-economic services in rural areas is important as this can be a source of employment for young people who other wise move to urban areas to look for job and gainful opportunities.

Urban-rural migration

Urban-rural migration is the movement of people from urban to rural areas; this is common among retired and unskilled urban people. It is rare in developing countries especially in Africa, but common in developed countries where people prefer to settle in the countryside.

People migrate (move) from urban to rural areas to avoid air and noise pollution in urban areas. Some retired people also migrate to rural areas since they find it difficult to cope with challenges of urban life. Other reasons are related to voluntary repatriation whereby unskilled urban migrants who cannot secure jobs in towns decide to return to rural areas to engage in agricultural activities.

Lack of space in urban areas to locate industries and large-scale economic sectors can also lead to re-location in rural areas, thus urban-rural migration. In addition, criminal acts of vandalism, hooliganism and burglary, frequent conflicts among tenants and social tensions can force people to move from urban to rural areas.

Negative impacts of urban-rural migration

In the receiving or destination areas, urban to rural migration has several negative impacts or problems. One of the problems of urban to rural migration is conflicts with residents of rural areas especially on land uses and ownership. Other problems are related to an increase in land and house prices. House rent is likely to go higher and, hence, lead to the problem of housing in rural areas. This development in the rural areas can also cause land degradation and deforestation, moral deterioration due to interference of culture and decline in agricultural activities since most of the arable land turns into residential areas and industrial centres. Other problems may include

the increase in air pollution, noise and water pollution in rural areas. Also, such a drift may cause an increase in crimes and other immoral behaviours in rural areas which are common in urban areas such as robbery, drug abuse, prostution and corruption.

In the place of origin (urban areas) where these migrants come from, urban-to-rural migration reduces the labour force, drains skills because sometimes people moving from urban areas are educated and experienced retired people.

Positive impacts of urban-rural migration

Urban to rural migration has several benefits or positive impacts on places of destination (rural areas). Despite the problems associated with urban-to-rural migration, the process is also advantageous as it can stimulate the utilisation of resources in rural areas. Diffusion of technology from urban to rural areas is another advantage. Moreover, rural areas are supplied with labour force to work on under-utilised lands, for example, in Kilombero, Ifakara, Dakawa, Kyela, Kahama, and Rufiji Basin.

In the place of origin (urban areas), urban-to-rural migration has various benefits (positive impacts). It reduces population pressure in towns and leads to improvement in the environment especially hygienic conditions. Also,

urban to rural migration reduces the burden facing the government in terms of providing social services even to the people who do not work or produce. The movement may also reduce the problem of beggars in urban centres.

Rural-rural migration

Rural-rural migration is the movement of people from one rural area to another. People move to areas which are more economically, socially and technologically advanced. Also, when the area is more peaceful and has fertile land many people tend to migrate to such an area. A person may be pushed to migrate to another village due to exhaustion of the soil, running away from enemies and other constraints. A village with viable socio-economic infrastructures attracts migrants.

Negative impacts of rural-rural migration

These types of movement affect places of origin (where migrants come from) significantly by reducing the labour force because young people migrate more than the elderly. Also, when these people migrate to other places, the income in the areas they leave drops.

In the place of destination (receiving places), it results in a shortage of social services, and may contribute to chaos over a limited means of wellbeing or livelihoods.

Positive impacts of rural-rural migration

In the receiving areas (places of destination), this type of migration offers several benefits. It adds labour and a market for goods and services produced. It also enhances social interactions and intermarriages between different ethnic groups and communities. In the place of origin (areas they leave), this type of migration is also beneficial because migrants send money back home. They also go back home with new skills and knowledge. Such migration also reduces pressure on limited sources of livelihoods such as land.

Urban-urban migration

Urban-urban migration is the movement of people from one urban area to another. For example, one can move from Zanzibar, Mwanza, Mbeya, Iringa, Dodoma, Tanga, Arusha, Tabora and Morogoro to Dar es Salaam and vice-versa.

People can migrate from one urban area to another due to environmental hazards, conflicts and or to access better opportunities interms of health, political and education services.

Negative impacts of urban-urban migration

In the places of origin, this type of migration faces similar impacts as other types of migration. Such impacts include reduced labour force and reduced market. Also, in the receiving places, shortage of social services, unemployment, pollution, theft, and immoral life like prostitution are some of the resultant impacts.

Positive impacts of urban-urban migration

Positively, places of destination feel the same impacts as other types of migration. These include an increase in labour force, market, innovation and entrepreneurship as well as expansion of urban areas. In the places of origin (urban areas), migrants contribute to the economy of their area of origin in terms of creating investments and providing services.

International migration

International migration involves the crossing of national or international boundaries and change of residence for any period longer than six (6) months. International migration can be categorised into immigration and emigration. Emigration refers to the act of a person leaving one's own country to go and live in another country. Such a person is called an emigrant. Immigration is the act of a person coming into a foreign country to stay. Such a person is called an immigrant. International migration is caused by economic, social or political factors, for example, searching for better employment opportunities.

Consequences of international migration

International migration may have positive or negative consequences as described below:

Negative consequences of international migration at the place of origin

When migration occurs, the place of origin can be affected by depopulation, labour shortage, drain of skills (brain drain) and technology leading to poor exploitation and utilization of resources. There can also be a decline in the production process due to underutilisation of resources, resulting in increasing poverty, and hence low life expectancy.

Positive consequences of international migration in the origin countries

Population migration solves the problem of high population. The government can decide to move people from densely areas to sparsely populated areas by establishing resettlement schemes or villages in other areas with low population. Planned migration can facilitate the provision of services and labour mobilisation. The mobilised labour can make full utilisation of the resources available such as land for the development of various economic opportunities, including the establishment of industries. It also attracts remittances (money), new skills, technology and exchange programmes

Negative consequences of international migration in the destination

In the destination areas, there occur problems of highly populated and overcrowded areas, hence leading to pressure on limited resources and social services such as medical services, education, and markets. Consequently, low life expectancy can follow. The movement can also cause an increase in crime, drug abuse, prostitution, burglary, and killings. Destination areas may also be affected by the spread of diseases such as HIV/AIDS, Ebola and Covid-19; environmental degradation due to over-exploitation of resources and poor environmental management; and inadequate economic and social services such as medical services, markets, and poor housing. Other effects include transport problems due to congestion, and traffic jams, occurrence of uncontrolled informal sectors such as food vending, wood carvings, kiosks and drug and human trafficking; and increase in the number of beggars.

Positive consequences of international migration in the destination

Population migration promotes the supply of labour for exploiting or harnessing idle resources such as minerals, land, and water bodies. Also, people who migrate possess different skills in various technologies and environmental management. These can be spread to the migration destinations and facilitate the utilisation of local

resources. Furthermore, migration can lead to the expansion of markets for local goods and services in the destination areas.

Effects of human population change on an individual and a nation

In many developing countries, rapid population growth has become a serious problem, which slows down plans aimed to improve the standards of living of the existing population. These problems include:

Shortage of food supply: Increase in population size may increase the demand for food due to growing population. It means, more food has to be produced to feed the additional population. This may also push the prices of food up.

Increase in government expenditure: When the population increases, the government spends more on providing improved social services such as education, health, electricity, water supply and security.

Increased unemployment rates: Population change may create an unemployment problem. Increased population may cause higher demand for employment opportunities. Therefore, more socio-economic opportunities have to be created to absorb the rising population. In many cases, opportunities created do not keep pace with the increased demand of employment. As a result, unemployment rate increases.

Increased pressure on resources: Rapid population growth in developing countries increases pressure on resources. Indeed, population increase exerts pressure on the resources available. When the pressure is higher, resources may fail to accommodate the rising demand of the society.

Poverty: When the number of unemployed or under-employed people is large, people tend to have low income, hence leading to poverty. The consequence of poverty is low level of education, malnutrition, poor sanitation and poor health. These later weaken the labour force and employment ability.

Depression of elders: In many developed countries there is low population growth because of low fertility rate. This creates a serious problem for individuals and the nation. Individuals, who do not have children, lack family support in old age, hence leading to depression which is closely associated with suicide. At the national level, low population growth leads to a shortage of labour because many people retire without replacement, which consequently compromises national economic growth. The few working class people have to pay higher taxes to meet the demands of the society, hence leading to low purchasing power in the society.

Population structure

Population structure is the composition of a population as determined by the

proportion of males and females in each age group. Population structure varies from one country to another. Population structure is usually illustrated by a population pyramid. Population pyramids are graphical representations of the age and sex characteristics of a specific population. For example, a population pyramid of a developing country will usually show a wide base, which represents a younger population. A pyramid of a developed country will show a wide top but narrow base, which shows low fertility and more elderly citizens or higher life expectancy. Figure 3.1 shows a hypothetical example of a population pyramid of a developing country:
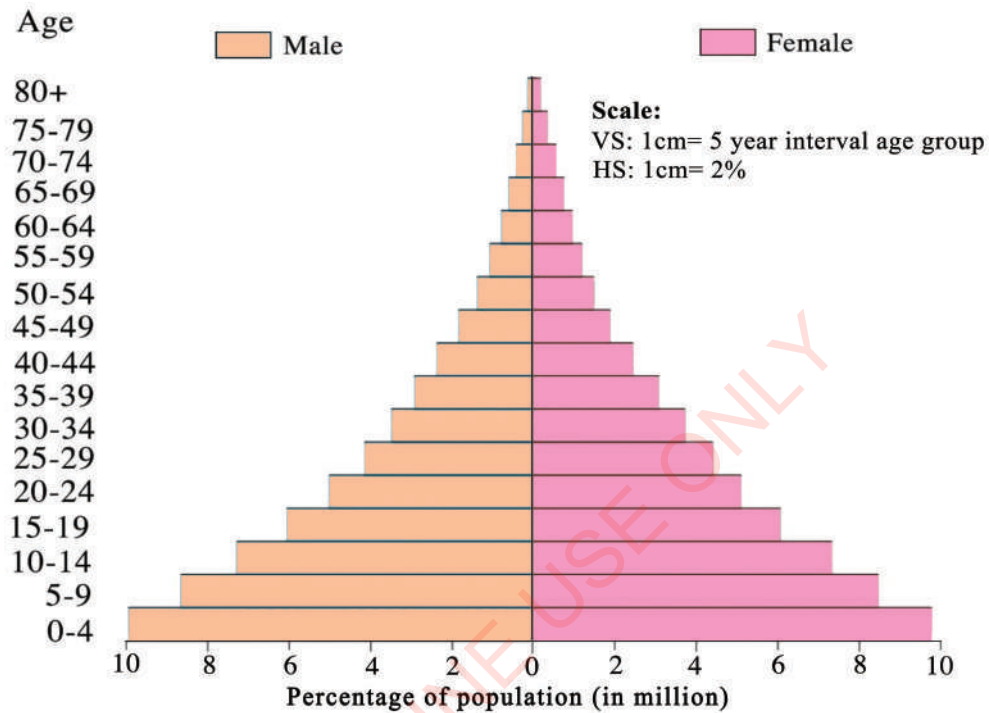
Figure 3.1: *Population pyramid of a developing country by age group*

From the graph above the following should be noted:

(i) The graph has a broad base reflecting a very large proportion of children as a result of high fertility rate or birth rate.

(ii) The pyramid narrows rapidly towards higher ages because of high mortality rate and low life expectancy.

Types of population pyramids

Population pyramids are also referred to as age-sex pyramids. They are called pyramids because they are usually shaped like triangles, though other population pyramids take other shapes. Population pyramids usually have males on the left-hand side and females on the right hand side. There is also a vertical line in the middle of the graph that separates males

from the females. There are three types of population pyramids, namely, the *expansive*, *constrictive*, and *stationary* population pyramids.

Expansive population pyramid

An expansive population pyramid shows larger numbers or percentages of people in younger age groups. It is characterised by a broad base and a narrow top. Populations with this shape usually have a high percentage of the population in the younger age groups due to high birth rates coupled with lower life expectancies as the hypothetical example in Figure 3.2 illustrates. Usually, each age group is smaller in size than the one below it. The upper age groups are narrow because of high death rates due to poor health services. These types of population pyramids are typical of developing countries such as Tanzania, Kenya, Uganda, Malawi, Burundi, Niger, Angola, Mali, Mozambique and Zambia. This shape shows a population that is growing rapidly and has a higher mortality rate at older age or low life expectancy.
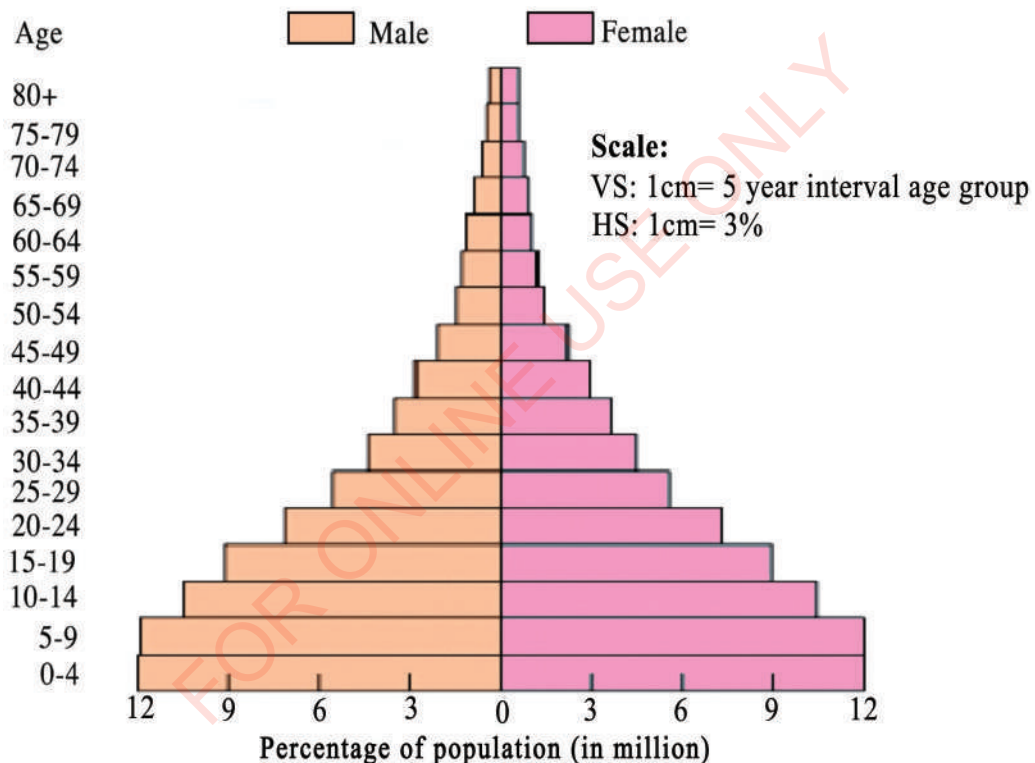
Figure 3.2: *Expansive population pyramid*

Constrictive or regressive population pyramid

This population pyramid portrays the population of a country which has a low fertility and a high level of social and economic development. This pyramid describes a population, which consists of many elderly people and shrinks or narrows at the base. The pyramid looks like a beehive with a narrow base and wide top due to low birth rate but high life expectancy. There is a lower percentage of younger people. A constrictive population pyramid shows declining birth rates, since each succeeding age group is getting smaller and smaller. Hence, population is not growing rapidly. It is usually experienced in developed countries such as the United Kingdom, the United States, Japan, Norway, and Denmark. Figure 3.3 shows a hypothetical example of regressive population pyramid:
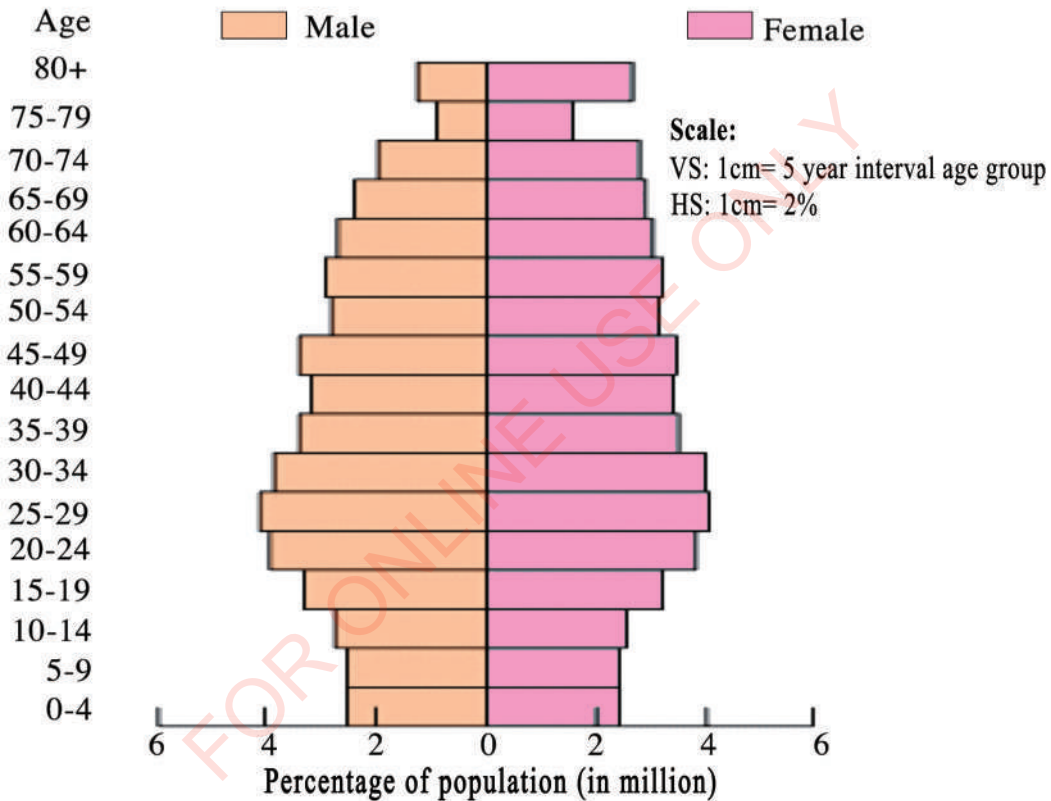
Figure 3.3: *Regressive population pyramid*

Stationary population pyramid

This population pyramid reflects a population of a developed country whose age groups have an almost equal percentage from its lower parts of the young to the upper parts of older citizens, hence leading to the bulging of the population pyramid in the middle. This is due to the improved social services, especially health services and immigration. This type of population pyramid shows somehow equal proportion of the population in each age group. There is neither decrease nor increase in population but there could be immigration into the country; the population is stable. This is mostly found in developed countries where birth and death rates are almost equal. For example, Austria and Scandinavian countries have this type of population pyramid. Figure 3.4 provides a hypothetical example of a stationary population pyramid:
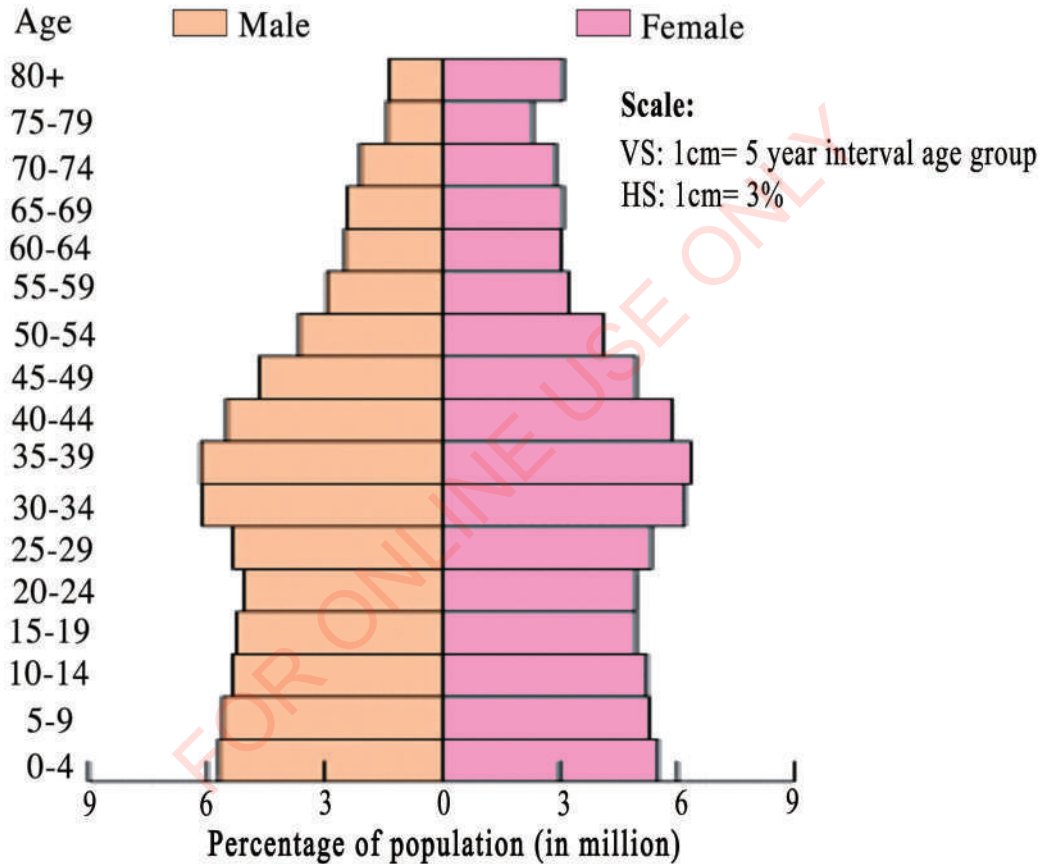
Figure 3.4: *Stationary population pyramid*

Activity 3.1

In groups, use the statistics of any two East African countries to describe their population size, composition and structure. Present your findings in class.

Population structure is important since it provides information on age and sex distribution of a population of a place. It can also highlight the extent of development of the population. The population structure can inform the planning for employment patterns as well as public expenditure. Moreover, it can be used to calculate sex and dependency ratios as described below:

Sex Ratio (SR): This refers to the number of males per 100 females in a given population. SR can be calculated for the whole population or for a particular age group. It is obtained by dividing the number of males by the number of females. The following formula is applied to calculate sex ratio:

$$SR = \frac{\text{Number of males}}{\text{Number of females}} \times 100$$

For example, the registers for district A in 2000 recorded 1 600 males and 2 100 females. The sex ratio will be:

$$SR = \frac{1\ 600}{2\ 100} \times 100$$
$$= 76.2 \approx 76$$

Therefore, SR is 76. The result shows that there were less males than females in district A. A sex ratio of above 100 indicates an excess of males whereas one of below 100 indicates an excess of females. However, in developing countries such as Tanzania, normally the number of females exceeds that of males. Factors, which influence sex ratios at birth, are related to the mortality rate of the population because mortality rate is higher among male children than females, both before birth and shortly after birth. Because males have a higher death rate than females, after the first few years of life females tend to out-number males in each successive age group. Wide variations in sex ratios between regions, and between rural and urban centres are due to migrations and child preference. Generally, men migrate more in search of jobs and income opportunities than women. Thus, areas of outmigration tend to have less men than women, and migration receiving areas tend to have more men than women.

Dependency Ratio (DR): This refers to the ratio of people in the non-working ages to those in the working ages. Dependency ratio is, therefore, the ratio of dependants (people younger than 15 or older than 64) to the working-age population (15-64). The non-working group is unable to meet their own basic needs (food, shelter and cloth). The working group, thus, has to support the non-working group, which is either the population of young or old people. Dependency ratio is obtained by applying the following formula:

$$DR = \frac{\text{Population 0 to 14 years} + \text{65 years and above}}{\text{Population 15-64 years of age}} \times 100$$

For example, a community has 41 650 children aged under 15 and 6 800 people aged 65 and above. The total population is 85 000. The DR will be calculated as follows:

(a) Add the number of children aged under 15 with those aged above 65 (non-working people).
41 650 + 6 800
= 48 450

(b) Minus the number of non-working ages from the total population to get the number of working population.
85 000 – 48 450
= 36 550

(c) Apply the formula of calculating DR which is as follows:

$$DR = \frac{\text{Population 0 to 14 years} + \text{65 years and above}}{\text{Population 15-64 years of age}} \times 100$$

$$DR = \frac{48\,450}{36\,550} \times 100$$

$$= 132.5 \approx 133$$

Therefore, DR is 133. The result shows that the non-working population is higher than the working population. This DR is higher than the one obtaining in developed countries whose DR is below 30.

Looking at Figure 3.1, one may note that the dependency ratio is very high.

Its base is broad; it comprises a large group of economically inactive population (non-working class) aged 0 to 14 years. This leaves a relatively low proportion of the population in the potentially economic active age groups of between 15 and 64 years. The impact of this demographic characteristic is that, the government will be required to spend more financial and other resources to provide essential needs to the large proportion of dependants. Dependants usually drain the surplus value generated by the small working population. As such, the little that remains is not enough for investing in productive sectors. A high dependency ratio is worsened by the new entrants into the labour force aged 15 to 19 years not being effectively absorbed into the productive sector. This is because of few job opportunities attributable to the underdevelopment or low level of industrialisation and agriculture as well as the failure to exploit fully the natural resources of a place. This condition also contributes to problems of migration, unemployment and under-employment in cities and other problems associated with urbanisation.

Activity 3.2

Visit a nearby government office, find out how the provision of social services such as education and health services match with the increase of population in the area. Write a short report and present it in class.

Human population data

Population data refers to economic, social and demographic information of the population.

Sources of population data

There are two main sources of population data:

(i)   Primary sources (example, census and sample surveys);

(ii) Secondary sources (example, Vitals registers).

Primary sources of population data

These are sometimes known as basic sources of population data.

Census

Census refers to the process of collecting, compiling, analysing and publishing demographic, economic and social data of all the people in a country or a territory within a specified time.

This category includes periodic national census like those held in Tanzania after ten years. For example, in Tanzania population census was taken in 1978, 1988, 2002 and 2012. The next one is expected in 2022.

Characteristics of census

Universality with specified territory: Census covers the whole country or territory and all the people residing in the country including those who are outside the country.

Periodicity: Census must be taken at regular intervals of, for example, every ten or five years. Census held after every five years is known as a *quinquennial census* and census that is held after every 10 years is known as a *decennial census*. In Tanzania, census takes place after every 10 years, thus referred to decennial census.

Specificity: Censuses must be specified for a certain country or territory or category of people in the country and for a certain purpose like General Elections or socio-economic planning.

Simultaneity: Censuses should take place at the same time or specified time throughout the country or territory. This helps to produce comparative and logical census. In Tanzania, the 1967, 1978, 1988, 2002 and 2012 censuses were taken on the 26th and 27th night of August in each year.

Individual enumeration of all the people: A census must involve the counting of the number of people in a specific country or territory and every individual should be listed separately together with their personal characteristics, such as sex, age, education, marital status number of children and occupation.

Types of census

De jure

This type of census allows for the counting of people according to their place of residence. Permanent members

of the household are enumerated or registered or counted. This type of census treats people as static while in actual sense, they are dynamic. In a de jure system, all legal emigrants such as ambassadors and their co-workers, experts and people working or studying out of their countries are included in the information collected.

De facto

This type of census allows people to be counted wherever they are on the day of enumeration. It involves counting all the people who had stayed in the household during the night of enumeration regardless of whether they were permanent members of that household or not. One challenge of the de facto system, is that foreigners can be included as citizens and, thus, information is supposed to be carefully documented to avoid errors. In addition, under de facto system those who are out of the country cannot be included in the census records of that year.

Objectives of population and housing census

The main objectives of the population and housing census includes enumeration of the population and households in the country; acquisition of demographic information necessary for calculating population estimates, data collection and production of information for government ministries and local authorities for budgeting purposes. Other objectives include collection of socio-economic information and production of information, which serves bodies, organisations and other elements in the field of education, economy, business and research.

Stages in conducting census

The first stage: The initial stage involves stating the purpose of the census and its methods. Moreover, the goal of a census should be defined. Also, it involves the development of methods and means for achieving the goals of the census.

The second stage: This stage focuses on data collection by making direct contact with residents and administrative sources such as government officers. Data collection methods such as interviews and observations as well as the administration of questionnaires are used simultaneously. That is why census is termed as a research process. Data collection is both an intensive and extensive stage aimed to obtain good results. To obtain high quality data, there must be publicity and campaign to sensitise and mobilise the co-operation of the public. Also, census officers should apply a high level of research skills in the field operation.

The third stage: It involves processing, estimating, analysing, production, publication and distribution of census data. It also involves receipt of information, identification and

correction of errors, editing of the data collected, imputation of missing data and calculations of estimates.

Importance of population census to a country

Human population census is important as census results describe the main characteristics of a population as well as the level of socio-economic development of a country. It provides a complete account of all the members of the country by sex and age. The age-sex structure is important for socio-economic planning and development. Also, it enables getting detailed statistics on the size, nature and distribution of the labour force. Furthermore, census determines the literacy and illiteracy ratio of the population in relevant groups, for example, youths and adults; it provides the distribution of the literate population in different groups. Thus, it helps to determine the nature of manpower available.

Census provides information on the household such as occupancy, types of ownership and availability of household facilities. Moreover, census provides both specific and general information essential in government planning and decision-making. It also helps the government to know the number of people living in the country and the structure of the population to plan for both economic and social development. Furthermore, it helps to determine the

number of taxable adults to estimate the amount of revenue expected from the sector. In addition, census helps or enables the country to forecast her future and social services such as medical and educational needs. Census enables the government to determine the standard of living of the people in the country.

Challenges of population census

Population census encounters a lot of challenges. Generally, censuses are costly since they need a lot of resources and time, for example, preparation of stationery, recruiting and paying the enumerators and other officers, and buying other facilities such as motor vehicles. They also involve training manpower, providing food, covering transport expenses, payment of salaries and wages to various categories of people. These categories include those working with the media such as radio, television and newspapers. The media are important in creating awareness among the people on the importance of the census. Another challenge is that, some important information may miss, especially for those who were absent during the enumeration process.

People remaining at home may not know the actual particulars of those who were absent. In addition, nomadic or semi-nomadic complicate the enumeration process. Example, the Maasai and Sukuma who are nomadic pastoralists do not stay in one place may not be fully

accounted for. There is also a risk of mis-reporting some information about age, number of children, employment, level of education and others.

Remoteness of some places (settlements) is an obstacle to enumerators, as some areas cannot be reached easily. Obstacles such as mountains, large rivers, thick forests and wild animals such as crocodiles, lions, and buffalos make some areas not easily accessible. Due to these limitations, sometimes enumerators give estimations which may end up, giving wrong information especially for areas with civil wars which make counting difficult.

Sample survey

Primary data of population can be obtained through sample surveys and inquiries.

A sample survey is a process of registering or enumerating people in a selected area of residence such as a district. In Tanzania, a district can be regarded as a sample. That sample represent places of similar characteristics. The selection of the sample can be random if the population is heterogeneous or non-random if it is homogeneous. In Tanzania, a heterogeneous population is common in urban areas such as Dar es Salaam. Homogeneous population is common in rural areas, such as Mtwara rural.

Importance of sample survey of population

Sample surveys facilitate the collection of data since all major challenges are noted in advance. Therefore, the actual measures are taken before the census. Also, a sample survey is cheap and quick but very essential in planning because few selected areas are chosen as samples and the generalisation is made. More details can also be gathered than in the actual census because the major focus (or concentration) of all census experts is on the sample areas. In addition, the interviewers (researchers) can be intensively trained for sample survey. As such, the information collected will be detailed as per pre-set objectives. Sample surveys can also be used in the projection of population growth trends before the actual census.

Disadvantages of sample survey

With a sample survey, the information collected can be biased if the sample is not representative.

Secondary sources of population data

The secondary sources of population data include tally tapes, published reports and statistical data that can be obtained from libraries and demographic resource centres. Other sources include documentation of various institutional records such as village records, which

record data on residents of particular villages. These sources need to be carefully examined before use because they may be outdated or inaccurate, but useful in a establishing trends or projections.

Vitals registration

Vitals registration systems deals with records of Vitals events such as births, deaths, marriages, divorces and migrations. Vitals registration is also called civil registration. Vitals events are collected, compiled and the resulting statistics are called Vitals statistics. In Tanzania, we have the Registration Insolvency and Trusteeship Agency (RITA) and the Immigration Department. These are institutions with mandates of registering Vitals information.

Vitals registration systems also deal with the production of birth and death certificates, passports, identification cards (ID), work permits, residence qualifications and citizenship.

Uses of Vitals statistics

Vitals statistics show how dynamic the country's population is. Mortality, fertility and immigration can be observed even before a country-wide census.

Vitals statistics can be used by the government for planning of various services such as medical and education facilities.

Vitals statistics provide insight into family issues such as rates of divorces and marital issues.

Interpretation of population data

The data collected using all these methods are called raw data. These data cannot be used for any significant purposes as they have not been processed, analysed, interpreted and documented.

The population data can be presented in form of tables or graphs showing age groups and the number of males and females. Data presented can also show whether the population is in rural or urban areas.

Information which can be derived from population data include household composition by sex, heads of household, family size, education level of household members and housing characteristics. This information is significant as it helps the government to plan for the construction of infrastructures and facilities such as sources of drinking water, electricity and sanitation facilities.

Activity 3.3

In groups, visit a Ward Executive Office and conduct an interview on "what are the developmental plans which require population data in that particular Ward?" Present your findings in class.

Uses of population data

Population data can be used for different purposes. The main users include government ministries, local authorities, private and public research bodies. Every country needs basic information of its residents for the purpose of planning, development and improvement of the residents' quality of life. Good planning needs reliable, up-to-date, accurate and detailed information on the state of the population in the country.

Decision-makers use population data as a basis for formulating policies in various fields such as education, health, housing, development, transport and communication and other services. Population data is also needed in channelling budgets to the local authority; acquiring information on employment and wages by occupation which may direct young people in their decision to choose a field of study. The data are also used for conducting research for the purpose of acquiring commercial information to serve as a basis for market research, assessment of demand for products, services and supply of personnel.

Population and resources

Population and resources are inter-related since they both affect each other. Human life depends on the availability of resources and human being has some impact on the existence and sustainability of resources. So, the population size, distribution and structure depend on the availability of the resources to sustain it. Techniques of production used are important aspects when considering the relationship between the population and resources available. On this basis, the area can be described as having optimum population, high population, or low population, depending on the extent to which the resources are used.

Optimum population

A country has more people not because of the big number of inhabitants but the extent to which the resources available match with the population in that country. A country has an optimum population if the number of people matches with the resources available and their utilisation. Likewise, if people are too few to develop all the resources of the area, the country is under-populated.

The concept also refers to the population in which the number of people balances with the resources available. In this state, the population optimally works with all the resources. Therefore, there will be higher per capita income, higher standard of living, and quality life. Optimum population can be maintained if the exploitation or development of other forms of employment keeps pace with an increase in population.

Impact of population on resources

The impact of population on resources occurs when there are too many people in relation to the resources and technology locally available to maintain an "adequate" standard of living. Some parts of Brazil, India, Bangladesh, and Ethiopia have a large number of people. As a result, they suffer from insufficient food supply to sustain their population.

High birth rates and immigration can cause resources-related problems such as scarcity of fertile land. These are influenced by an immediate factor of low education and having a big number of children as a source of social prestige or assurance for family labour in the future. Migration can also affect the population in an area.

Population issues or problems

Population issues are studied in relation to the country's natural resources, the level of technology and production. The major population issues include:

Unemployment and high dependency: This is a serious problem in most of the developing countries where the active working population exceeds employment opportunities available. As a result, many youths are unemployed.

Also, unemployment might be caused by lack of a skilled labour force to meet the demands of industries. Unemployed people cannot meet their basic needs such as food, shelter and clothing.

Unemployment usually frustrates and stresses many youths. In fact, some youths end up committing various crimes to earn a living. For example, young people may engage in prostitution, theft and illicit drug trafficking.

Population pressure: Too many people in a place create pressure on resources. For example, high population may cause land competition, over utilization and over exploitation of non-renewable resources. Resource conflicts create an insecure atmosphere for a society to live.

A large number of people usually increase pressure on the limited resources available such as land, hence leading to land degradation and exhaustion of minerals; and forest resources which can lead to forest degradation, which can slow down the resource-based development.

Shortage of urban social services: Urbanisation creates an ever-increasing demand for urban services such as the supply of clean and safe tap water, transportation, electricity, recreation centres, and waste disposal facilities. Provision of these services may not keep pace with population growth in urban areas.

Shortage of food resources: Population growth creates more demand for food. Food production, distribution and consumption are, thus, critical for any population. It is challenging to feed the

growing number of people. Therefore, incidences of hunger, malnutrition and dependence on food imports are common in areas with rapid population growth.

Environmental pollution: As people struggle to use the little resources available to meet their basic needs, they also generate waste. The waste, which people produce, needs proper management. If not properly disposed of or recycled, waste can lead to pollution and attract organisms such as bacteria, which are harmful to human health.

Poor housing: Due to a large number of people, provision of housing may pose a challenge. In consequence, housing conditions become poor and overcrowded. This situation can accelerate building in unplanned areas, which finally develop into squatters and slams. This problem is common in Dar es Salaam, especially at Manzese, Mburahati, Buguruni and Vingunguti. This problem also exists at Tomondo and Jang'ombe in Zanzibar, and Mabatini in Mwanza.

Ageing population: In developed countries, birth and death rates are slightly low. This implies that the number of young people compared to old people is relatively small. Another implication is that there is high life expectancy. As old people increase in the population, more health care and other facilities are needed to take care of them, hence increased costs to the government.

Natural hazards: Population can be directly affected by some natural hazards. This hazards adversely affect property and may cause deaths. Such natural hazards include volcanic eruptions, earthquakes, floods, tsunamis, and storms, especially, in poor countries with denser population, such as Bangladesh, the natural hazards become so severe.

Emigration and immigration: People migrate from areas with high population to areas with low population density where there is no pressure on resources. For example, some people move from the Southern foots of Mount Kilimanjaro to other parts of Tanzania such as Morogoro and Tanga. Emigration reduces the labour force in the place of origin whereas immigration increases the demand for social services in the areas of destination.

Decline in life expectancy: The life-span declines because of problems such as poor health services and poor nutrition. Ignorance of people, poor sanitary conditions and lack of financial resources also contribute to the decline of the life-span.

Increase in crimes: As a result of unemployment, incidences of crime increase. For example, in areas with high population density, robbery, theft, drug abuse and killings are common. Beggars can also increase due to unemployment. This is a common problem in major towns or cities such as Dar es Salaam, Mbeya and Mwanza.

Congestion: This occurs especially in less developed countries due to rapid population growth. High population density can create a problem of congestion in the streets, hospitals, markets, schools and transport because of poor infrastructures and excessive use of private cars that lead to traffic jams during picking hours.

Activity 3.4

In groups, discuss how population pressure affects environmental resources in your area. Suggest measures to solve this problem. Present your findings in class.

Measures to address population issues or problems

Various problems have been identified relating to population in both developing and developed countries. Most of the problems impact on resources and the environment. Therefore, to solve these problems, there is a need to boost efficiency in resource use. For example, developing countries need to use energy-saving stoves which use less amounts of charcoal or wood and reduce number of trees cut for fire-wood and charcoal production. In addition, emphasis should be placed on the use of alternative sources of energy such as solar, gas and electricity to minimise pressure on environmental resources.

Another measure is to control rapid urbanisation by managing rural-urban migration. This can be done by improving rural conditions through enhanced social services, creating more income generating activities and protecting the environment. This will motivate rural population to stay in the rural areas. Moreover efforts should be made to improve the agricultural sector. This can be done by improving agricultural extension services including the supply of inputs, improvement of transportation infrastructures and ensuring the availability of markets to agricultural products.

More development opportunities should also be created in urban areas as well as in rural areas through the establishment of industries and by encouraging investors in different economic sectors. Entrepreneurship skills should be emphasised and provided to motivate self-employment. Provision of education on family planning, nutrition and hygiene to the population should also be emphasised. Importation of skilled labour from other countries is another option in countries facing a crisis of the ageing population.

Population Policy

A population policy is a set of measures taken by the state to influence demographic change. A population policy is also a statement aimed to deal with population-related issues such as

population size, composition, growth and distribution. Also, the United Nation's Economic Commission for Africa (UNECA) defines a population policy as measures and programmes designed to contribute to the achievement of economic, social, demographic, and political goals.

Population policies are deliberately developed or modified through institutional arrangements and or specific programmes through which a government directly or indirectly infuences the demographic change. Since population is dynamic, population policy should be continually updated.

A population policy provides guidelines aimed to strengthen the process of integrating population variables in the preparation and implementation of socio-economic development plans. The policy considers the relationship between population and development as well as its impact on environmental conditions. A population policy can be explicit or implicit as described below:

Explicit Population Policy

An explicit population policy refers to a document or clear statement issued by the government and its commissions, which spells out its rationale, objectives, goals, target policy programmes and implementation plan. The main intention of issuing the policy is to control population growth and raise the people's standard of living in the country.

Explicitly, laws are well-stipulated and strictly reinforced. This type of policy is practised in China, Sweden and England.

Implicit Population Policies

These are laws, regulations or statements which may have indirect effect on population growth. Whether the policy is explicit or implicit, it has the ultimate aim of influencing a country's population size, composition, distribution and growth.

Tanzania's Population Policy

In Tanzania, the National Population Policy was adopted in 1992 and was followed by programme implementation in 1995. The National Population Policy was reviewed in 2006. The main objective of the policy was to reinforce national development by developing the resources available to improve the quality of life of its people. Special emphasis is placed on regulating the population growth rate, enhancing population quality and improving the health and welfare of women and children. The primary concerns of the National Population Policy are how to safeguard the interest of the people and the satisfaction of the basic needs and bring socio-economic progress.

Goals of Tanzania's national population policy

The overriding concern of the policy is to enable Tanzania to contribute to the following.

(i) Sustainable development and eradication of poverty;

(ii) Improved availability and accessibility of high-quality social services;

(iii) Attainment of gender equity, equality, women empowerment, social justice and development for all individuals; and

(iv) Harmonious interrelationships among the population, resource utilisation and the environment.

National Population Policy and family planning

With specific reference to family planning, the goals of the policy are to strengthen family planning services, promote health and welfare of the family, the community and the nation, and eventually reduce the high population growth rate. Other specific objectives related to population regulation include making family planning services available to all, encouraging child spacing of at least two years, and supporting family life education programmes for youths and family planning for men and women. In Tanzania, both governmental and non-governmental organisations under the co-ordination of the Family Planning Unit (FPU) in the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) provide family planning services.

Strategies

To achieve the policy objective, the government intends to integrate population variables in development planning. Population variables include age, sex, education, migration, fertility level, life expectancy and mortality. Some of the government strategies include creating mass awareness on the relationship between population, resources, environment, poverty eradication and sustainable development. In addition to agricultural production, the government promotes non-agricultural production in rural areas, for example, lumbering and fishing; encourages the private sectors and the local community to be actively involved in initiating. Furthermore, the government implements and finances population programmes in addition to building the capacity of planners at district, regional and national levels in mainstreaming population issues in development plans with a gender perspective.

Since population growth has a bigger influence on the development of the country, the government employs strategies which consider population and employment. These strategies include creating an environment that will attract investors, promote self-employment opportunities in the informal sector, provide labour market information to employers and job seekers, foster labour for intensive industrial development and

promote viable family formation while ensuring gender equality.

Activity 3.6

In groups, read the Tanzania's National Population Policy and then discuss its achievements, constraints and limitations. Present your discussion in class.

Case studies

Population policy in Nigeria

Nigeria is the most populated country in Africa. It is the sixth populous country in the world in 2021. Her first population policy was launched in 1998 and revised in 2004. The population of Nigeria was last recorded at 178.8 million people in 2015. The policy intended to improve the quality of life and standard of living for Nigerians, reduce infant and maternal mortality rates and the spread of HIV/AIDS. The policy also intended to reduce fertility rate from 6 or above to 4 children per family. Marriage age was also set at 18 years for women and 24 years for men. Furthermore, family planning services were extended to areas that were not previously covered. In addition, the policy advocates for the restriction of pregnancies to those age 18 to 35 years. Programmes were incorporated in development policies, for example, sexual and reproductive health, HIV/AIDs, poverty reduction plans and expenditure framework.

Population policy in China

China is the most populous country in the world. Out of five people living on planet Earth, one is a Chinese. This large population suffered from diseases, drought, low income, poverty, poor living conditions and high levels of emigration. To solve these problems, the government of China had to come up with a policy which was meant to deal with population growth. Thus, in 1979, the anti-natalist one child per family policy was introduced by government aiming at reducing natural increase of population to zero by the year 2020 and hence avoid the population growth beyond 1200 million people. The government aimed at providing the citizens with free education, better housing, pension and family benefits.

To enforce the policy, the families which had a second child could not have these benefits. They also faced fines of up to 15% of the family income and women who had second pregnancy were forced to abort. Furthermore, marriage was set to 22 years for males and 20 years for females. People intending to marry were required to apply for permission from the state and as well as when they intended to have a child.

Population policy in Germany

Germ any is one of the highly industrialised countries in the world. In such countries, death rate is low due to

improved social services. At the same time, birth rate is kept low through family planning which includes the use of contraceptives, sterilisation, abortion and other incentives introduced by the government for controlling families to be as small as possible.

In addition, increased industrialisation and mechanisation led to the need for fewer labourers. Also, a high cost of living created less desire for large families. Furthermore, the need for more education meant people were spending more time on education. Empowerment of women enabled women to follow their own careers rather than just be child-bearers and home-makers. These actions have led to an ageing population. It is estimated that by 2060 the German population will shrink by 20 percent to 65 million people. The birth rate of 1.36 children by woman means that Germany will witness the size of working population plunging to 27 percent, roughly 36 million people. Thus, the government is now encouraging people to reproduce. Couples, who are ready to bear children receive bonuses from the government. Other incentives given to these couples include housing benefits, state maternity allowances and a wide variety of regulations and subsidies, hence making large families more attractive and affordable. Also, large families get tax breaks or relief.

Population Policy in the United Kingdom (UK)

Britain is the home of the industrial revolution; it witnessed a high natural increase in population between 1760 and 1880. This economic prosperity led to a decline of death rate due to improved social services. In 1980, Britain adopted an explicit population policy. The policy is still in use. Birth control programmes were introduced to slow down the population increase. The birth rates were kept low through family planning through the use of contraceptives, sterilisation, abortion, and government incentives for smaller families. Lower birth rates were influence of by increased industrialisation and mechanisation which led to the need for fewer labourers.

Also, education and empowerment of women, motivated woman to engage in their own careers rather than solely be child-bearers and confined to the kitchen. The impact of birth control in UK is an increase in the ageing population. The ageing population may later create labour supply shortages since the old people would not be able to work effectively or produce well.

Activity 3.7

In groups, compare the family planning strategies in the Tanzania National Population Policy with the strategies in the policies of other countries such as Nigeria and China. Present your findings in class.

Revision exercise

Section A

Match the descriptions of population concepts provided in List A with their corresponding concepts in List B:

Column A	Column B
(i) The composition of a number of males and females.	(a) Population distribution
(ii) The spreading of people in a geographical unit.	(b) Population size
(iii) Determined by mortality, fertility and migration of people.	(c) Population change
(iv) Information pertaining to people living in a geographical unit.	(d) Population structure
(v) Statement dealing with a population issue in a specific country.	(e) Population pressure
	(f) Population policy
	(g) Population data

Section B

Answer the following questions:

Define the following terms:

(a) Population

(b) Migrant

(c) Immigrant

(d) Emigrant

(e)　　Pull factors

(f)　　Push factors

(g)　　De facto

(h)　　Sample survey

(i)　　Diaspora

Section C

Answer the following essay questions:

1.　　"The population distribution in Tanzania is uneven." Elaborate this statement by using five points.

2.　　"Migration in a country can be either an asset or liability." Verify this statement by using five points.

3.　　"Some societies believe that having a large number of children in a family is a source of labour force." Argue against this statement by using six points.

4.　　By using six points, describe how rapid population growth affects the environment of a place.

5.　　By using six points, explain why rural-urban migration is strictly discouraged by the Government of Tanzania.

6.　　"Ageing population in developed countries is considered as a curse phenomenon." Explain five reasons behind this statement.

7.　　Highlight any five population issues affecting the development of any developing country of your choice.

8.　　"Migration is caused by both pull-and-push factors." Justify the statement by using six points.

9.　　Describe five effects of population change on an individual and the nation.

10.　　With five reasons, explain why Dar es Salaam is highly populated in Tanzania?

Chapter Four

Settlements

Introduction

In the previous chapter, you learnt about human population. Particularly, you learnt about how to examine the factors behind human population growth and its consequences. You also learnt about factors that influence human population distribution. In this chapter, you will learn the concepts of settlements and the growth of settlements. The competencies developed from this chapter will help you to understand how settlements affect production activities in a society.

The concept of settlements

A settlement is a place with housing units where people live and carry out their activities. This involves any form of habitat from a small building to large towns where people live. It may consist of a homestead or a few houses, or it may cover several square kilometres. It may also contain shops, schools, factories, government buildings and entertainment centres. A settlement can either be temporary or apermanent establishment eventually. Temporary settlements may become permanent. An example of a temporary settlement is a refugee camp. Some refugee camps have over time become permanent settlements.

Characteristics of a settlement

Settlements are characterised by various features. These features may be described in terms of a site, location, size, pattern and function and whether the settlement is permanent or not.

Site and location of a settlement: Each settlement has a site and a location. Site refers to the place or land on which a settlement is built. It is about the landforms and arrangements of an established settlement. Some sites may be on highlands whereas others may be in lowland areas. Location or situation means the position of the settlement in relation to other things in the region.

Site and location are important criteria in differentiating one settlement from another.

Size of settlement: Settlements are of different sizes. They range from a single house in a remote area to many houses in a city. This feature of a settlement describes a settlement in terms of population size and housing units. On the basis of the size of population, settlements may be of different sizes ranging from villages, towns, municipality, and cities to mega cities.

Temporary or permanent settlements: The time taken by inhabitants to live in a particular area also helps to characterise human settlements. Based on time, settlements are either temporary or permanent. A temporary settlement is the one where people live for some time and migrate to other places. An example of a temporary settlement would be a refugee camp or a mining centre. Permanent settlement is when people establish stationary habitats for a long period.

Factors determining a site and location of settlement

There are different factors determining a site and location for settlement establishment as follows:

Availability of water sources: Availability of water is one of the factors, which influence a settlement development on a particular site. There are sites that tend to be established in areas with sufficient supply of water. They are closer to sources and supply of water. Indeed, sources of water such as rivers and springs are determinants of development of settlement sites. Areas with water or located near water sources are also called wet areas. In wet areas, however, settlements are established on slightly gentle slopes to avoid flooding.

Security and defensive: Security and defence are other factors determining and characterising the site and location of a settlement. Sites established based on these factors are known as defensive sites. Examples include Migombani, Kibweni, Chukwani and Vitongoji military camps in Zanzibar. Other examples include Makongo and Kurasini in Dar es Salaam, Ihumwa in Dodoma and Itende in Mbeya. Some of these sites have been established on high grounds for inhabitants to see their enemies from a distance. Others are established adjacent to river meanders to provide protection for people living on the other side. These settlements are dominant in areas characterised by inter-ethnic strife and inter-regional conflicts. In developing countries, these settlements were also dominant during the colonial periods when most ethnic groups established their settlements in mountainous areas for security reasons.

Aspect: This refers to the direction of the land or site in relation to the Sun. Energy from the Sun is important for growth of plants, drying of clothes,

lighting, warmth and other productive activities. Most of settlements are located in sites that receive enough sunlight. For example, many settlements in the Northern Hemisphere are located on the South facing sides of valleys where sunlight is reached.

Shelter: This refers to the availability of physical features that cover and protect a settlement from wind or rain. Areas that are near forests provide good sites for establishing of settlements. They offer protected against wind. They also, provide building materials such as timbers.

Trading centres: Often, settlement develops in areas with trade and commerce potentially. Such areas are near the confluence sites, heads of estuaries, navigation points and areas where natural routes meet. Also, areas where roads and railways meet are potential areas for establishing settlements. The points facilitate the movement of people, goods and services to attract trade. Darajani and Chakechake in Zanzibar; Kariakoo and Mwenge in Dar es Salaam, Mwanza, Arusha, Tanga, Mwanjelwa and Sokomatola in Mbeya, Nanenane and Nzuguni in Dodoma are good examples of such trading centres.

Resources: Availability of various natural resources such as minerals, forests and fertile soils favour the development of a settlement. Most of early human settlements not only in Tanzania but also in other developing countries concentrated in areas endowed with resources. Human beings require resources to meet their needs. For example, the growth of settlements in Geita and Chunya is associated with availability of gold deposits. Areas that are closer to Sao Hill forest are also good sites for settlement and timber factories.

Climate: Climate of a place may attract or discourage settlement development. Areas that receive adequate rainfall for agricultural production may attract family settlements. Areas, which are too cold, or with inadequate rainfall discourage people from establishing settlements. Cold places in the North poles discourage people to live.

Types of settlement

There are two major types of settlements: Rural and urban settlements. The characteristics, which designate a settlement as either rural or urban include population size, density and major activities carried out in the area.

Rural settlement

The basic unit of rural settlement is a homestead. Rural settlement comprises villages and hamlets, which may be linear, nucleated or dispersed. In Tanzania, about 80 percent of the population live in rural areas. The main economic activity in the rural settlement is agriculture, which involves crop production and livestock keeping. Other activities include fishing, lumbering, bee-keeping and hunting.

In terms of location, rural settlements are located outside the towns or cities. Rural settlements are also characterised by under-developed social services. In most rural areas, houses and buildings are scattered due to farming activities.

Urban Settlement

This type of settlement refers to a town or an urban area. Urban settlement is characterised by a continuous construction of buildings, people of mixed ancestry and kinship. An urban settlement is called town, or city. These settlements have dynamic boundaries as their sizes change over time due to population increase. Population increase is a result of factors such as migration, high birth rates and changes in the boundary of a settlement that increase the size of an urban area. The urban population in Tanzania increased roughly 22 million people in 2020, Which represented 37 percent of the country's total population.

The main economic activities in urban areas are non-agricultural activities. They include trade and industrial activities. Examples of urban settlements in Tanzania includes cities such as Dar es Salaam, Arusha, Mwanza, Mbeya, Dodoma and Tanga; town centres such as Makambako, Rujewa, Mafinga, Vwawa, Kibaha, Kahama, Tunduma, Gairo and Babati. Generally, urban settlement has a high population density whereas rural settlement has low population density.

Settlement patterns

A settlement pattern is the distribution of human activities and houses across the landscape. It also refers to the shape of settlement. The houses may be planned or redesigned; buildings may be remodelled; functions may change, but a settlement continues in space and time. There may be some settlements, which are stable and permanent or unstable and are occupied for short periods.

Types of settlement pattern

Settlement is categorised according to the how houses are located or arranged in a particular area. There are three types of settlement patterns as follows:

Nucleated settlement pattern

This type of settlement pattern is also known as a clustered or compact pattern. It consists of dwellings and other buildings, which are near to each other. Compact refers to concentration of many buildings in a single place with several land uses. They are connected by roads or footpaths or both. This type of settlement is common in urban areas. Nucleated settlement develops as a result of the availability of social services such as schools, hospitals, dispensaries, industrial plants, hotels, trading and mining centres in an area. Other reasons which may lead to the development of nucleated settlement are

limitations of land for building, security, water and availability of natural resources such as minerals. Figure 4.1 shows an example of a nucleated settlement:

Figure 4.1: *Nucleated settlement pattern*
Source: https://www.mwanza.de/images/stories/fotos/growing-city.png

Linear settlement pattern

A linear settlement pattern is a type of settlement pattern with buildings developed along specific linear features such as roads, rivers, coastlines, an escarpment or a zone where water is near the surface. These features create a linear-structured pattern of settlement. Therefore, a linear settlement may be in a form of a straight or curved line, and its population density is usually moderate. Linear settlement is influenced by the following factors: Presence of rivers that may be a source of water for the people and other uses that attract people to settle. Existence of these sources of water enables them to perform their activities such as farming. Also, the presence of transportation infrastructure such as roads and railways attracts people to these settlement. Their existence simplifies the movements of goods, services and people. The presence of a coastline enables people to conduct tourism activities or fishing, thus, being another factor contributing to emergence of a linear settlement. For example, people have established their settlements on the Indian Ocean coast such as east coast of Zanzibar. Also, people have done so in the Lake Victoria and Lake Nyasa to engage in fishing activities. Linear settlements are also influenced by a suitable terrain such as the foot of an escarpment where people can cultivate. Figure 4.2 shows an example of a linear settlement pattern established along a road infrastructure.

Figure 4.2: *Linear settlement pattern*

Source: *https://wp-content/uploads/2020/08/tanzania-green-spaces1.jpg*

Dispersed settlement pattern

Dispersed (scattered) settlement pattern usually consists of houses with a scattered form (i.e., homesteads are isolated). Dispersed settlements are often associated with extensive farming. The houses may be separated by physical features such as valleys, rivers, ridges and escarpments. Houses are separated from one another by farms. There are various factors, which may lead to the development of this pattern of settlement. Availability of land for settlement and farming as compared to the demand, leads to the development of this pattern. Also, low population size can result in such a settlement pattern. Low population makes people have various choices of where to settle. Another factor is infertility of soil and bad weather conditions. These two factors force people to migrate from one point to another in search of fertile soil, and reliable temperature for areas with farming. These factors contribute to scattered settlement. This pattern of human settlement is also influenced by topography, landforms and means of transport that may enhance or constrain interaction. Where various landforms such as mountains and hills exist, scattered settlement are likely to occur because interactions between different sites are limited. Also, where means of transport are poorly developed, scattered settlement can dominate. Additionally,

low availability of water resources and security assurance contribute to the occurrence of this pattern. This pattern of settlement is common in rural areas. Figure 4.3 presents an example of a scattered settlement:

Figure 4.3: *Dispersed settlement pattern*

Source: *https://upload.commons/thumb/6/61/Mbalizi_Mbeya_Tanzania*

Activity 4.1

In groups, observe the settlement pattern of the area in which you live, and then draw a diagram showing the settlement pattern that matches with your observation. Present the findings in class.

Functions of settlement

These are activities and services that occur in a particular settlement. Settlement can be identified by the dominant functions or activities or services performed in that settlement. Therefore, a settlement is described by using terms such as agricultural centre, communication centre, market centre, administrative centre, mining centre, educational centre, transport centre, religious centre as well as recreational centre. All these clusters indicate a dominant function or activity of a settlement. It is through these functions and services that a settlement offers to communities and the country that make a settlement important.

Some settlements developed over a long time. As a result, their current functions have diverged from the original intention. When the settlement first began to develop, the city of Dar es Salaam

was a small fishing village. Although today fishing is still one of the important activities carried out in Dar es Salaam, it is not the dominant feature that defines the city of Dar es Salaam. There are other dominant activities performed by most of the residents which identify this city. One thing to bear in mind is that all settlements or centres have dominant functions of one sort or another. However, most of the settlements or centres have additional functions, which give them distinctive characteristics. Settlements or centres are classified according to their dominant functions and activities such as trade, administration, defence, or culture. These settlements or centres are hereby explained according to their functions.

Administrative centres

These centres mostly the administrative functions of perterm government are performed. These functions include planning, enacting laws and by-laws, directing lower authorities of the government and implementing some policies and plans from higher authorities. They may also serve as headquarters of all regions and as district councils. For administrative centres to perform these functions, they must contain public buildings, offices, banks, and post offices. An example of national administrative centre in Tanzania is in Dodoma (The capital city of Tanzania).

Defensive centres

These centres are established to provide services for defence and security of a region or a country. In these centres, security facilities and labour force are placed. Many settlements or centres have armies, navies, and air forces. Originally, these settlements or centres were chosen for their natural shelters and because of having easily defendable harbours and strategic positions, for example, Migombani, Jozani, Masingini, Kiwengwe, Amani Juu, Kibweni, Chukwani, Vitongoji, Kinyasini, and Ngezi forest in Zanzibar; Kisarawe, Bagamoyo and Chalinze in Pwani Region, Kigamboni in Dar es Salaam, Ngerengere in Morogoro Region, Manyovu in Kigoma Region, Mikindani in Mtwara Region, Itende in Mbeya city, Ihumwa and Msalato in Dodoma city and Nachingwea in Lindi Region, just to mention a few. These settlements are established because of their strategic locations such as being located at a border, in reserve forests, near mountains, and water bodies. Establishment of these centres has contributed to the nature and growth of these settlements and the nearby towns.

Cultural and religious centres

These centres have unique cultural and religious history or record. Many settlements or centres have cultural functions such as provision of education, arts, galleries and museums, for example Dar es Salaam, Bagamoyo, Kilwa, and Zanzibar. Also, there are places for

entertainment such as theatres, cinema halls, and film-making industries such as Bongo Movies in Tanzania, Hollywood in California, and Nollywood in Nigeria. Religious centres where people go for religious reasons such as Mecca in Saudi Arabia, Jerusalem in Israel, and Vatican city (Rome) in Italy, exemplify the presence of religious functions associated with settlements. Others are characterised by the history of the dominant traditional and national leaders. For example, Songea in Tanzania has been named because of the name of the traditional leader, Chief Songea Mbano. Their uniqueness and influence contributed to the government's decision to establish and preserve these centres.

Fishing centres

These centres are mainly dominated by fishing activities although there are other activities performed there. Most of the people engage in fishing for their wellbeing. Examples of fishing centres in Tanzania are found in the coastal areas of Zanzibar, Dar es Salaam, Bagamoyo, Tanga, Mtwara and Lindi. Others are in areas around Lake Victoria in Mwanza, Mara and Kagera and those on Lake Nyasa, especially some villages in Kyela and Ludewa District. There are also fishing villages on shores of Lake Tanganyika. Fishing is important because it provides employment, food and income to inhabitants.

Mining centres

These centres are dominated by mining activities. Most of the residents in these settlements or centres engage in mining activities. Mining settlements or centres grow due to the mining activities. These settlements or centres include: Kahama, Mwadui, Mirerani and Geita. These settlements are important for people surrounding these mining sites; they offer employment opportunities and serve as sources of income. Some people in coastal areas collect salt on the Indian Ocean coast, for example, at Ununio area in Dar es Salaam, Unguja and Pemba in Zanzibar. In such settlements, minerals have been useful in creating a unique identity of such settlements. For example, Geita and Chunya are known as gold centres, Mwadui is known as a diamond centre whereas Mirerani is known as a tanzanite centre.

Industrial centres

These settlements or centres are marked by mixed manufacturing industries. These centres or regions are established by the government for industrial production. These settlements or centres are mostly found in urban areas, for example, Dar es Salaam, Mbeya, Dodoma and Pwani. Such regions have developed as a result of the establishment of industries. In Dar es Salaam areas such as Kawe, Kipawa and Vingunguti were designed for industrial production whereas in Mbeya city, Iyunga was designed for industrial purposes. In Pwani Region,

Visiga and Kibaha are designed for industrial production. In Zanzibar, there are Mahonda and Maruhubi (Unguja), while Dodoma city has Kizota and Nkuhungu as areas designated for industrial production.

Trading centres

These settlements are areas where trading activity is dominant. In these settlements, most of the people engage in trade as their main economic activity. In these areas, shops, stores and warehouses are established. Such towns are found either along the coast, near a river or along a lake. At the regional level, the dominance of trading activities characterises these settlements. Examples of trading centres include the Kariakoo business centre, Kisutu central market, Magomeni central market, Mlimani city mall in Dar es Salaam; Chief Kingalu central market in Morogoro; Mwanjelwa central market and Kabwe shopping centre in Mbeya; Rocky city mall in Mwanza and Job Ndugai central Market in Dodoma. These trading centres or settlements are mostly found in urban areas.

Resorts and tourist centres

These centres cater for recreational needs of people in surrounding areas, for example, Dar es Salaam, Bagamoyo and Arusha on Tanzania Mainland; Unguja and Pemba in Zanzibar. These settlements or centres have ancient buildings, entertainment venues, sports facilities and natural features that attract tourist activities. Such centres are important for providing employment, generating foreign currencies and for recreation purposes. Figure 4.4 shows an example of a cultural heritage centre, which is one of the famous tourist centres in Arusha.

Figure 4.4: *Cultural heritage centre in Arusha*

Source: *https://africantourer.com/attraction/cultural-heritage-centre-arusha*

Residential centres

Settlements or centres, which fall under this category are located in suburbs and small towns or villages on the outskirts of cities. Residential settlements or centres are characterised by a large proportion of their land devoted to housing. Also, these centres are facilitated by roads and railways. These areas are characterised by mixed activities of agricultural and non-agricultural activities. In rural areas, residential areas are near farms whereas in urban areas, these are normally planned in peri-urban areas or integrated with other activities. In fact, in urban areas, residential areas are established alongside commercial activities.

Financial centres

These are centres where most of the financial institutions and services are located. In these centres, financial services such as loans, banking, savings, Automated Teller Machines (ATMs) and insurances are accessed. Some cities such as Dar es Salaam, Arusha, Mwanza, and Mbeya have developed into important financial centres. Banks and insurance companies are mostly found in these cities. As compared to rural settlements, financial services are mostly located in towns. City centres where most of financial services are located can be regarded as financial centres.

Satellite centres

These are small or medium-sized and self-contained towns established in areas near larger towns to reduce congestion in larger towns or cities. Other reasons for establishing satellite centres are to redirect future growth of the city, to control migration of people from rural to major towns and to reduce the problem of unemployment and shortage of social services in urban areas by motivating people to live in these newly-established centres. Establishment of these centres or towns needs to go hand-in-hand with the provision of social services, employment creation, and security assurance. Examples of satellite centres established or planned by the government are found in Tunguu and Fumba in Unguja-Zanzibar; Kibada (Kigamboni) in Dar es Salaam, Hombolo in Dodoma, and Iwambi in Mbeya. Unfortunately, most of these centres in Tanzania have not yet developed as planned.

Importance of settlements

The nature of site, location and functions of a settlement determine its importance. A well-established and planned settlement, be it rural or urban based, offers various socio-economic and environmental benefits to people living in a particular settlement. The importance of a planned settlement is explained as following:

Better provision of social services

Better planned settlement provides an opportunity for governmental and non-governmental organisations to provide social services to the people such as

schools, water supply, hospitals, sports and games. These services tend to develop properly in planned settlements for the benefit of the people. Also, planned settlements support the establishment of transport facilities such as roads, railways, and airports to enhance the flow of goods, services and people. In areas with planned settlements, the problem of congestion of people and traffic jams is avoided. Figure 4.5 shows a bridge as one of social services in Dar es Salaam created to smooth transportation and ease congestion.

Figure 4.5: *The Nyerere bridge in Kigamboni, Dar es salaam*
Source: https://www.ippmedia.com/en/news/nyerere-bridge

Enhancement of security

When people are in organised and planned settlements, defence and security tend to be improved. Planned settlements offer security guarantees and protection of people with their property. Indeed, in planned settlements, streets are well-arranged, street lights are installed and buildings are constructed in a way that they do not leave spaces for thieves and robbers to hide. Unplanned settlements, on the other hand, lack all these characteristics.

Economic development

Planned settlements are associated with improving economic development because of the benefits they offer for undertaking economic activities. When people settle in a planned settlement, it is easier for the diffusion of economic development to take place. For example, development occurs in areas with financial centres, industries, and marketing centres. Planned settlements have production and transport costs reduced and save time for supplying

of goods, services and people. Hence, planned settlements increase revenues and income for the country. Examples of modern marketing centres, which contribute to economic development, are the Kariakoo business centre, Mlimani city mall, Kisutu and Magomeni central markets (Dar es Salaam), Chief Kingalu central market (Morogoro), Mwanjelwa central market and Kabwe shopping centre (Mbeya), Rocky city mall (Mwanza) and Michenzani (Zanzibar).

Provision of open and green spaces

Planned settlements support the establishment of open and public spaces. These settlements are established together with planting of trees and establishment of recreation areas. Trees are beneficial as they release oxygen.

Reducing the problem of pollution

A settlement that is well-planned, has areas for waste management. In planned settlements, waste stabilisation ponds, drainage systems and dumpsites are well-established, hence reducing pollution in the settlement.

Reducing the occurrence of hazards

A settlement that is well-planned reduces the occurrence of hazards such as fire outbreaks that cause deaths and destruction of property. This is because in planned settlements, systems for mitigating the occurrence of fires are in place.

Activity 4.2

In groups, read Geography materials either online or hard copies found in library. Then identify three towns in East Africa, and discuss their functions. Present your findings in class.

Growth of settlements

Factors influencing the growth of settlements

There are various physical, biological, cultural and socio-economic factors that influence the growth of settlements. These factors motivate or discourage people to establish human settlements or migrate to other areas.

Physical factors

Physical factors refer to naturally occurring factors, resources or conditions that influence the formation and growth of human settlements. The common physical factors, which contribute to the growth of settlements are presented as follows:

Climate

Climatic elements, especially rainfall and temperature, motivate or favour some human activities. People prefer to settle in areas with good climatic conditions, depending on whether a country is developed or developing. Many settlements are found in areas with reliable rainfall. Such areas are suitable

for crop farming and livestock rearing. High temperatures together with very low rainfall do not support crop farming and livestock-keeping. Such areas do not attract many settlements. Areas with sufficient rainfall and good temperature favour the establishment of settlements, especially in developing countries such as Tanzania.

Soils

Fertile soil with good quality may influence settlement growth. Rich volcanic soils found in the East African highlands support agriculture which, in turn, attracts dense settlements. Sand and clay soils, which are deficient in minerals, cannot support agriculture and settlements. Productive soils (volcanic soil) found along the slopes of Mount Kilimanjaro support agricultural activities and settlement.

Topography

High mountain peaks and ranges, broad and rolling plains with rivers, both big and small, low-lying swamps and highest mountains influence settlements. Fairly flat land simplifies cultivation. Meanwhile, the presence of rivers and streams for irrigation and fishing activities attract people to settle. Highlands and steep slopes, on the other hand, do not attract people to establish settlements because they increase the costs of building materials and construction.

Water sources

Rivers, springs and lakes with fresh and clean water attract settlements since water is important for human beings, plants and livestock. Water is used for drinking, cleaning, fishing, washing and other economic activities such as irrigations, hydro-electric power generation and navigation. As a result, many settlements are located near springs, rivers and lakes with fresh water. For example, the growth of Kigoma and Mwanza is linked to the availability of water from Lake Tanganyika and Lake Victoria, respectively. Also, coastal areas such as East African coast of the Indian Ocean attract settlements for fishing and trade. These settlements include Tanga, Dar es Salaam, Mtwara, Lindi, Bagamoyo and Zanzibar. Swamps and marshes, on the other hand, do not attract settlements because they are infested with insects, pests and bacteria such as mosquitoes and snails that spread malaria and bilharzia, respectively.

Mineral and energy resources

Most of settlements in Tanzania have developed in areas where natural resources are found. The resources, which attract settlements include minerals and energy. People create settlements near mining centres to get employment and earn income. Such settlements include Mwadui (Diamond), Geita (Gold), Chunya (Gold) and Kahama (Gold). Many people have migrated to these

settlements because of availability of minerals. Also, areas with energy resources such as the natural gas on Songo-Songo Island in Kilwa District in Lindi Region and at Mnazi Bay on the shores of the Ruvuma Basin in Mtwara Region have attracted many people for settlement.

Vegetation

Vegetation is the total plant cover over an area. Dense or thick vegetation discourage settlement. Thick vegetation covers like that of the rain forests with big roots discourages the establishment of settlements. Dense forests increase the costs for land clearing before constructing buildings. Also, Miombo woodlands infested with tsetse-flies are not suitable for human settlements. Moderate vegetation, on the other hand, attract people to settle.

Biological factors

There is a close link between biological factors and settlements as they could influence or hinder settlement of people in different areas. These biological factors include pests and diseases. Areas, which are free from pests that cause diseases, attract settlements whereas those with pests such as mosquitoes and tsetse-flies are generally avoided for settlement. For example, Mbeya, Njombe and Iringa (highlands) have a cool climate which attract settlement compared to some central regions such as Singida with areas that are attacked by tsetse-flies. People avoid to settle in areas that are prone to tsetse-flies.

Human factors

These are factors that show the role of humans in influencing the growth of settlements. The role of humans in settlements development depends on the activities they perform and their culture. The human factors that influence the growth of settlements include social, economic, historical, cultural, and political factors as follows:

Social factors: Social services such as health, education and water supply have pulled people from their original places to live in areas where such social services are easily available and accessible. The availability of more primary and secondary schools, universities, hospitals as well as safe and clean water contribute to the growth of settlements. Dense settlements occur because more people move to these centres in search of livehood opportunities.

Economic factors: Economic opportunities are among factors influencing the growth of settlements. Economic opportunities such as employment and trade motivate some people to migrate to those settlements. Normally, settlements are established in

places that offer economic opportunities. Migration of people from rural to urban areas is mainly due to prospects for employment and training opportunities. Urban areas in market centres usually have dense settlement. Mining and industrial activities attract people to these areas, hence leading to the growth and expansion of settlements. For example, Arusha, Dar es Salaam, Tanga, Shinyanga, Mwanza and Mbeya have been growing very fast due to the availability of various economic opportunities such as agriculture, mining, tourism, trade, and industrial activities.

Historical factors: Historical factors and events influence the way settlements are formed. These events could be wars, disasters and hostility. Hostility from neighbouring ethnic groups or communities forced some people to establish their settlements on strategic sites such as hill tops, plateaus or Islands. In the past, people were attracted to remote mountainous areas, lands or spurs because such areas provided natural defendable settlements. For example, the Hehe in Iringa established their settlements in mountainous areas due to their hostility to the Germans. Also, during slave trade in Africa, some areas were depopulated when people fled to other places to avoid being captured by the slave traders. Moreover, inter-

ethnic wars forced people to move from their original settlements. These wars forced some people to live in areas near rivers and mountains for security reasons.

Political factors: The nature of political ideology influences the types and patterns of settlement. This is done through policies, plans and programmes established by the government. Settlements may be established on political grounds. The best example is the establishment of Ujamaa Villages in Tanzania in the early 1970s which had a crucial impact on settlement. To-date, the Human Settlement Development Policy of 2000 in Tanzania establishes that, human settlements should be classified as, villages, towns, municipalities, cities and mega-cities. Political unrest can also cause displacement of people in one area and establish new settlements. Places such as Sudan, South Sudan, Eastern part of the Democratic Republic of Congo, Somalia, Rwanda, Burundi and Northern Uganda have experienced long periods of civil wars. These areas have long tracts of land that are not settled because inhabitants have fled to other countries or have been internally displaced.

Cultural factors: Culture refers to the total way of life of people including their beliefs, arts, morals, values and

activities. Such cultures influence the way people establish their settlements. Communities involved in farming activities settle in areas, which are agriculturally productive. Communities of fishermen and honey collectors settle in areas that support and sustain their livelihoods. Religious centres attract worshippers from different parts of the world. Some people, however, often move away from areas which are believed to have superstitions or witchcraft beliefs.

Negative and positive impacts of urban growth

In the previous sections, types of settlement (rural and urban) and their factors for growth have been described. However, the growth is occurring rapidly in urban settlements or areas. Understanding the negative and positive impacts of urban growth is important.

Urban growth is the physical, economic and demographic growth of towns. It refers to the growing concentration of socio-economic activities and physical expansion in towns. Urban growth is related to urbanisation, which is the process of increasing population in towns.

Positive impacts of urban growth

Urban growth and urbanisation contribute to development of a settlement and the country at large

if well-planned and managed. Urban growth and urbanisation are linked to socio-economic development due to their positive impacts on the settlements and country's overall development.

Reducing costs for service provision

In areas where people have concentrated in one location, the costs of providing social services are reduced. Shorter distances also simplify the provision of social services provided by the government. Also, concentrating social services together leads to the sharing of resources among different service providers, for example, the Tanzania National Electric Supply Company (TANESCO) and urban water authorities share some infrastructures in the provision of social services.

Promoting market for urban goods and services

An increasing number of people in urban areas promotes access to the market for goods that are produced in towns. Growing population size also offers market for various entrepreneurial activities. This is different from rural areas where settlement is scattered.

Promoting innovations

Growth of towns enhances competition and innovations among people. Urban areas are generally innovation centres because they facilitate the creation of new skills, and knowledge, which are beneficial for

the development of settlements and the country at large.

Negative impacts of urban growth

High number of people

Overcrowding in towns and cities is caused by rural-urban migration, increase in birth rate and decline in mortality rates. People migrate from rural areas to urban areas, especially when crop production and livestock-keeping are under performing. Also, poor social services and living conditions discourage people from staying in rural areas. Such a situation contributes to rapid urbanisation and increases pressure on resources or services in urban areas.

Increase in urban crimes

Urban growth promotes urban violence, political instability, crimes and aggressive behaviours. This intensifies poverty for the jobless. Consequently, they are forced to engage in immoral activities. This occurs when the jobless engage in illegal activities to earn a living.

Health problems

Urban growth contributes to public health problems. The movement of people to urban areas increases demand for health services, making them inadequate. This goes with poor provision of sanitation services, hence leading to the spread of diseases. These poor conditions worsen public health problems especially speed of communicable diseases such as cholera, water borne and tuberculosis, and other airborne diseases.

Growth of towns is also associated with the spread of sexually-transmitted diseases in urban centres. Immoral behaviours such as prostitution contribute to the spread of diseases such as HIV/ AIDs.

Environmental Pollution

Urban growth is associated with increase in industries and economic activities. Industrial production and economic activities contribute to land, water, noise and air pollution. Figure 4.6 shows an example of a factory emitting smoke into the air. Environmental pollution has adverse impact on human health. For example, noise pollution caused by factories, motor vehicles, locomotives and aircraft as well as noise from night clubs and loud music systems may lead to partial or permanent hearing impairments. Polluted air, water and land contribute to water and air borne diseases.

Figure 4.6: *A factory emitting smoke*
Source: *https://www.google.com/search?q=factory-emitting-smoke*

Traffic congestions

Urban growth contributes to increased number of motor-vehicles and users in towns, which have adverse impacts on the environment. Poorly-planned roads and traffic control systems have resulted in frequent and persistent traffic congestion in urban areas which result in traffic jams. Figure 4.7 shows an example of a traffic jam in Dar es Salaam.

Figure 4.7: *Traffic jams in Dar es Salaam*
Source: *https://www.google.com/search?q=traffic+jams+in +dar+es+salaam*

Shortage of Social services

Rapid population growth may lead to inadequate provision of social services such as water supply, electricity supply, education and health facilities. As the population increases in the urban centres social services are also affected as they cannot support the increasing number of people. This creates congestion in schools, health centres and water facilities. For example, people in Dar es Salaam and Dodoma face inadequate provision of social services as a result of population increase. The problem usually occurs when the provision of social services does not keep pace with population growth.

Street families

Street families are a common phenomenon in urban centres. They are composed of unemployed men and women with children who live on the streets as beggars because of either being neglected or for their other reasons. This is common in many of the regions of Tanzania, particularly the cities of Dodoma, Mwanza, Mbeya, Tanga, and Dar es Salaam.

Growth of slums and squatters

Unmanaged urban growth contributes to the growth of slums and squatter settlements. An increasing number of people in urban areas increases demand for accomodation. This forces more low income people to establish settlement in unplanned areas or areas planned for other land uses. Some build substandard houses in flood-prone areas. This contributes to the growth of squatter settlements. In squatter settlements waste disposal, all forms of environmental pollution, and crimes increase. Squatter settlements include those located in Tandale in Dar es Salaam, Mabatini in Mwanza, Chang'ombe and Swaswa areas in Dodoma; Mwanakwerekwe, Tomondo and Jang'ombe in Zanzibar. The same problem is evident at Kibera in Nairobi, Kenya. Figure 4.8 provides an example of a slum and squatter settlement in an urban area.

Figure 4.8: *Slum and squatter settlement in an urban area*
Source: https://www.ippmedia.com/en/challenges-human-settlements-highlighted.

Activity 4.3

In groups, discuss how you can advise the Government of Tanzania to solve the problems of negative impacts of unplanned settlements in urban areas. Present your findings in class.

Strategies to solve the negative impacts of urban growth

There are numerous negative impacts related to urban growth, which need to be monitored or addressed to improve urban life. The specific ways for solving negative impacts related to urban growth include the following:

Creation and implementation of settlement policies and plans: The government should introduce and implement policies that will encourage people, particularly in Tanzania, to build houses in planned areas. Also, the decentralisation policies should be in place to discourage the unnecessary movement of people from rural to urban centres. For example, headquarters of all ministries have moved to Dodoma. Thus, many people have migrated to Dodoma as workers in the ministries or to be close to services. With decentralisation, this problem of population pressure in one area could be minimised if people would access services in their perspective social areas. Vertical construction of buildings should be encouraged in towns and cities to minimise overcrowding of sub-

standard houses and shortage of houses. Construction of flats (storey) buildings or houses by urban dwellers can reduce unnecessary overcrowding.

Provision of social services: Deliberate measures should be taken to improve services in rural areas that push people to move to urban areas. Such services include educational, health, transport infrastructure, market centres, water supply, electricity, and communication facilities. The improvement of these services in rural settlements could motivate people to remain in their areas and thus, minimise the problems associated with population pressure in urban centres. To minimise urban-urban migration, balanced provision of services should be emphasised to reduce gaps in accessing services among urban centres.

Improvement in access to financial services: Formalisation of informal sectors and provision of loans to both villagers and dwellers in informal urban settlements to curb the problems of unemployment are some of the strategies for dealing with urban problems. For villagers, such benefits could make them settle and remain in their places of origin and reduce the rate of young people moving to towns or cities. For urban residents, especially in squatter settlements, they can establish some income activities and self-employment that would reduce the problem of unemployment. Such strategies also

entail the formation of self-help groups and associations to access financial services, reducing interest rates and using alternative assets as collaterals for accessing loans.

Control of wastes disposal and sewage systems: The government should establish some strategies for controlling wastes disposal and sewage systems in the squatter settlements. For example, it can establish some waste collection points and bins, extend the sewage systems and waste stabilisation ponds to serve people living in informal settlements as well. Also, it can provide environmental education to influence urban dwellers to embrace pro-environmental behaviours.

Allow private sectors to provide services: Non-Governmental Organisations (NGOs), Community-Based Organisations (CBOs), and Faith-Based Organisations (FBOs) have potentials to contribute to the reduction of challenges to urban growth. These organisations may be involved in mobilising communities in the provision of community-related services such as water and sanitation rather than depend entirely on the central and local governments to provide all the services. These organisations may help the government to raise awareness among youths in rural areas on the importance of staying in rural areas and engaging in agriculture and other productive ventures instead of moving to urban areas. The private sector may

be involved in raising awareness among people on the dangers of engaging in crimes and drug abuse. These measures would also curb the growth of street families in urban areas.

Improvement in infrastructure and transport systems: Road traffic systems should be extended to other small and medium-sized towns to manage traffic jams. Also, the establishment of fly-overs, interchanges and well designed round-abouts at crossing roads can reduce traffic jams. Investment in public transport should be emphasised to reduce congestions, especially in urban areas such as Dar es Salaam, Arusha, Dodoma, Tanga, Mbeya, and Mwanza. Moreover, the government must discourage the use of private transport and encourage the use of public transport. People should also be encouraged to use non-motorised transport and develop the habit of walking on foot to nearby work places or to get socio-economic services.

Control of building in towns: The government should also simplify procedures for accessing building permits and ensure that house construction is done according to the conditions in the permit. Also, there is a need for urban authorities to control the density of buildings and also increase supply of surveyed plots. Doing so could lead to the construction of buildings according to established plans. The relevant authorities should also plan for more

public spaces, gardens, playgrounds and sports field.

Application of family planning methods: Rapid urban growth is also influenced by uncontrolled population growth due to high birth rates. In the context where resources are inadequate and not equally distributed, family planning methods should be adopted to control the fertility rate. The government should, therefore, encourage people to use family planning strategies to reduce high birth rates, which cause rapid urban growth.

Activity 4.4

Visit a nearby government authority, ask them about how they deal with settlement growth. From their experience and expertise, suggest any solutions to problems related to settlement growth that are applicable in your area. Present your findings in class.

Revision exercise

Section A

Answer the following questions:

(i)   What are the main characteristics of a settlement?

(ii)   Why do we associate the existing environmental problems with urban growth?

(iii) With the aid of relevant examples, describe the political and socio-economic activities taking place in the following regions:
    (a) Dar es Salaam
    (b) Mwanza
    (c) Arusha.
    (d) Dodoma
    (e) Mbeya

(iv) Distinguish between urban and rural settlements.

(v)   Describe the following settlement patterns:
    (a) Linear
    (b) Nucleated
    (c) Dispersed

Section B

Answer the following essay questions:

1. As a Regional Planning Officer, you have been assigned to analyse the settlement patterns found in your region. With relevant examples, describe the settlement patterns in your region or the region of your choice.

2. Apart from building entertainment centres in rural areas as one of the ways for attracting people to remain there, suggest five ways of solving the existing problems related to urban growth.

3. Identify six cities in Tanzania and describe six functions of settlement for each one of them.

4. "Socio-economic problems and urban population growth are two sides of the same coin." With six points, comment on this statement.

5. Describe the influence of the following factors in the settlement growth:
   (a) Climate
   (b) Topography
   (c) Drainage systems
   (d) Security and defensive sites
   (e) Soils

6. Assume you are in an urban planning team, how would you advise the Government of Tanzania to overcome the challenges associated with urban growth? Give advice by using at least six points.

7. You have met five Form Two students debating that the current modification of infrastructures in Dar es Salaam is a wastage of public funds as long as the capital city is officially in Dodoma. Based on the settlement functions of Dar es Salaam city, explain how you would convince them on the importance of developing its infrastructures.

8. What are the possible five human factors which may influence the development of nucleated settlement pattern?

Chapter Five

Environmental issues and management

Introduction

In recent years, there have been discussions on the relationship between human activities and the influence they have on the environment and climate change. In this chapter, you will learn about the concept of environment, importance of the environment, environmental problems and environmental conservation. The competencies developed from this chapter will help you to ensure proper management and conservation of the environment.

The concept of environment

An environment refers to external conditions surrounding an organism; It has a bearing on its behaviour or activities. The environment comprises living things and non-living things. A living thing could be a person, an animal, plant or other micro-organisms. Non-living things include gases (oxygen, nitrogen and carbon dioxide), liquid (water bodies), solids (soil and rocks), and energy (sunlight). The environment can be divided into four basic components: Atmosphere, Hydrosphere, Lithosphere and Biosphere.

Living organisms on Earth depend on the environment for life. It is, therefore, essential that the environment is well-managed and conserved to make life sustainable and productive for all components of the environment.

Importance of the environment

The following descriptions present the importance of the environment:

It supports life: The environment plays an important role of maintaining life support systems. Such life systems include nutrient cycle and production of oxygen, soil formation, water cycle, provision of habitats and other forms of life supporting systems. Those systems are important for supporting all living organisms. For instance, a constant

supply of oxygen is crucial for life. The environment contains all resources which are responsible for sustaining life of living organisms.

It provides socio-economic services to the societies: The environment provides products such as food, building materials, medicines, fuels and others for daily social and economic needs in the societies. Food and water demands from the environment increase as the world population increases. A healthy environment is important for the provision of food and water to human beings whereas a degraded environment will lead to the decline of the essentials of life. The availability of water and vegetation is also important for the survival of wild and domesticated animals.

It is a source of natural resources: The environment contains a variety of natural resources such as forests, soils, animals, and minerals. Natural resources can be exploited by people for various social and economic development. For example, minerals such as gold, tanzanite, diamond and others contribute to the growth of the country's economy. Furthermore, the environment is a source of medicinal plants for treating different diseases.

It regulates ecosystem services: The environment regulates services provided by the ecosystem. This is an important characteristic of the environment. The regulating services include air and water

purification, climate modification, and carbon sequestration. Environmental regulation is important for controlling the balance of environmental services.

It promotes tourism: The geomorphic landscape, drainage features, plants (flora) and animals (fauna) in their natural settings are beautiful to look at and, therefore, attract local and international tourists. Through tourism, the environment acts as an essential source of income for individuals and the nation as a whole. Therefore, good sceneries should be preserved for the present generation and posterity. For example, national parks such as the Serengeti and Mikumi in Tanzania have different species of trees, wild animals, and insects which attract tourists.

It provides cultural services: The environment has cultural values. Some areas are conserved for cultural heritage and serve as an icon of a particular community or nation. The environment also contains areas which are preserved for traditional rituals and religious activities. Management of cultural heritage and spiritual sites is important for social and economic development. For example, Nyumbanitu forest in Njombe is important for these cultural services.

Environmental problems

Environmental problems are harmful effects caused by environmental hazards and human activities. As human beings

struggle to satisfy their needs, they affect the environment. Improvement in science and technology has posed some threats and environmental problems that require attention. Common environmental problems include environmental harzads, deforestation and forest degradation, loss of biodiversity, pollution, desertification, floods and climate change.

Deforestation and forest degradation

Deforestation is the long-term or parmanent loss of forest cover and implies transformation into another land use. Forest degradation is the reduction of the forest qualities, which lead to loss of forest capacity to provide important goods and services to people and nature. Forests are important to the human population as they provide direct and indirect benefits. The direct benefits include foods, fire-wood, charcoal and building materials. Also, forests provide habitats for birds and wild animals. Indirect benefits include services such as climate modification and pollination.

Recently, forests have been declining and degraded due to human activities and climate change. Deforestation and forest degradation are among environmental problems, particularly in the tropical countries where many of the forests are found. For example, it is estimated that the annual forest loss from deforestation is 483 859 hectares over the period of just a decade (2002-2013) in Tanzania.

Causes of deforestation and forest degradation

There are several causes of deforestation and forest degradation. These include agricultural expansion, fuelwood harvesting, charcoal production, and population growth.

Agricultural expansion: Clearance of forested land for agricultural activities is one of the main causes of deforestation. As human population grows, there is an obvious need for more food. This leads to clearance of more land for farming. In Tanzania, between 70 and 80 percent of the country's deforestation is due to clearing of land for both subsistence and commercial farming. Some farmers practise shifting cultivation for production of major agricultural cash crops. For instance, sesame farmers in Lindi Region practices shifting cultivation, which affects forests. In some societies, shifting cultivation is also conducted as an adaptation measure to climate change to maintain crop production. Nomadic cattle rearing is another factor causing deforestation and forest degradation.

Fuelwood harvesting and charcoal production: Demand for wood materials, including fire-wood, charcoal and building materials has caused pressure on deforestation, forest degradation and fragmentation in many countries. Most people in both rural and urban communities in developing countries depend on fire-wood and charcoal as

their main sources of domestic energy. They also demand poles and timber as building materials. Such a huge demand has triggered the extraction of large quantities of forest resources, thereby causing deforestation.

Population growth: The increasing population has accelerated the consumption of forest resources in both rural and urban areas. Resources such as fire-wood, charcoal and poles used in urban areas are extracted in rural areas. Increased population means increased human exploitation of natural resources including soil, minerals, and water. The result is overuse, which consequently causes forest degradation. Population growth provides a ready market for wood products, hence triggering more utilisation of forest resources. Also, population growth has increased the demand for land for establishing settlements.

Forest fires: This can be naturally occuring or initiated by human beings. When fires are not controlled or properly managed, they can be problematic. Each year, millions of acres of forests around the world are destroyed or degraded by fire. Most forest fires are caused by human. Fire can be initiated when hunting wild animals, collecting honey and clearing land for agriculture. Naturally occurring fires might be caused by lightning. Generally, when fires break out they destroy the biological diversity of forests, water cycles and soil fertility within the forests.

Effects of deforestion

Drought: Cutting down of trees can lead to disturbance in hydrological cycle. Trees help in rain formation through transpiration.

Loss of biodiversity: This results in the extinction or disappearance of native species due to loss of habitats or food.

Increased greenhouse gases: When trees are cut down the ratio of greenhouse gases in the atmosphere increases, thus leading to global warming. Trees are good absorbers of carbon dioxide.

Land degradation: Deforestation increases the rate of soil erosion because bare areas are heavily affected by surface runoff.

Fuel wood scarcity: The availability of fuelwood such as charcoal and fire-wood become difficulty because of massive and uncontrolled cutting of trees. Due to this shortage, the price of fuelwood may rise as well.

Measures to reduce deforestation and forest degradation

Afforestation and reforestation: Afforestation involves planting of trees on a new piece of land whereas reforestation refers to the action of replacing trees that have been cut down with others on the same open land.

The use of alternative sources of energy: When other sources of energy are used apart from fuelwood they reduce the use of forest as a source of charcoal and fire-wood. Use of alternative energy such as biogas and solar power could help ease pressure on forests.

Enforce forest laws and regulations in the society: Employing rules or laws to prevent the unnecessary cutting down of trees. Example, the Tanzania Forest Act No.14 of 2002 controls the use of forest products and reduces forest destruction. If this law is fully implemented, it will ensure the existence of forests and reduce the emission of greenhouse gases in the environment.

Recycle and re-use forest products: When forest products are recycled or re-used, the demand for new raw materials from the forest, for instance, notebooks, shipping bags will go down as recycling reduces the need for new raw materials.

Controling population growth: This will reduce the demand for forest resources including building materials, fuelwood, land for agriculture and settlement, which can cause deforestation.

Control wild fire: Prohibiting the initiation of fires in forests or areas near forests also requires frequent patrols for early detection of wild fires.

Loss of biodiversity

Biodiversity refers to the variety of species of organisms on the Earth's surface or its variety and variability of life on Earth. Loss of biodiversity is largely caused by human activities that take place on the Earth's surface. These activities may lead to the loss of various species on the Earth. The loss can be in terms of numbers of the given species or loss of the entire species, a process called extinction. Extinction of biodiversity is caused by natural and human factors.

Natural causes: These include floods, drought, lighting, windstorms, pests and diseases, landslides, earthquakes as well as volcanic eruptions. Occurance of these hazards also contribute to loss of biodiversity.

Human causes: These include constrution activities for (roads, airport, railways or dams) and agriculture activities as Figure 5.1 illustrates. Other human causes include poaching, pollution, draining of wetlands, introduction of exotic species or invasive species as well as climate change. Also, clearing of land for construction activities, crop production and animal keeping. For example, in Tanzania, large areas of Ruvu (Pwani), Kongwa (Dodoma), Kalambo (Rukwa), Mkata (Morogoro), Uvinza (Kigoma), Misenyi, Kitengule and Kikulula (Kagera), Usangu (Mbeya), Mzeri (Tanga) have been cleared to establish national ranches.

Figure 5.1: *Deforestation*
Source: *https://cdn.climatechangenews.com/files/2014/09/Amazon_deforestation*

Pollution: This involves the addition of toxic elements in the water, air or land which may cause death of species. For example, when chemical elements from industrial waste or mining are poured into water systems, it may cause the death of aquatic species. Also, oil leakage from tankers may cause the death of fish and other marine organisms. Chemicals used in agricultural activities also kill some species living on land and in the air.

Overfishing: Overfishing refers to excessive fishing that may depletes some species of fish from water bodies at a rate that the species cannot replenish, thus causing those species to be underpopulated. Such illegal fishing does not comply with the rules and regulations governing the harvesting of fish from water bodies.

Illegal fishing may cause loss of biodiversity due to the use of dynamites, which can result in the destruction of the breeding areas for fish, for example, coral reefs. With illegal fishing, even the smallest fishes that are not supposed to be fished are harvested. Illegal fishing is sometimes caused by using illegal fishing tools including prohibited fishnets and dynamites. This behaviour affects the fishing industry.

Poaching: Illegal killing of wild animals leads to the disappearance of some animal species such as hyenas, warthogs, antelopes, giraffes, zebras, elephants, and rhinos. For instance, in the Serengeti National Park poaching is substantial problem because wildlife species such as rhinos, elephants, buffalos and many others are killed by poachers for ivory, wild meat, and as trophies.

Draining of wetlands: Wetland is a natural or artificial landscape flooded by fresh or salt water. For example, where the soil is water logged, the water table tends to be near the Earth's surface. There are circumstances in which humans reclaim wetlands for socio-economic development such as building houses or building of roads. Once done, some natural springs may disappear due to loss of their source. In other places, wetlands have been changed into dumping places for wastes. Wastes, which contain harmful chemicals, detergents and some residues from pesticides when dumped into the wetland, may cause deaths to various species in the area.

Introduction of exotic species or invasive species: Species that originated from a particular area when introduced to new natural environments can lead to imbalances in the ecological equilibrium. For example, the introduction of the Nile Perch caused disappearance of some of the local fish species in Lake Victoria in East Africa as the new fish species tend to eat local fish species.

Climate change: Climate change causes loss of biodiversity in different ways. An increase in temperature on the Earth's surface causes some of the species to die. Also, the rise in temperature results in the destruction of habitats for some of the species and cause shortage of foods. Climate change may cause floods when there is excess rainfall (heavy rainfall) or droughts where there is no rainfall, which can cause death of species.

The extent of loss of biodiversity
Around the world, animals and plants are threatened due to human population growth. Due to such increase, the daily demand for life necessities also increases. The large part of the world's natural ecosystems has been encroached by economic activities and settlements. Additionally, the building of roads, railways and airports has also contributed to the loss of biodiversity. Furthermore, the exploitation of natural resources such as minerals and trees for several purposes affect biodiversity. Overall, human activities create imbalances in the ecosystem.

It is estimated that the current rate of species extinction to be 100 to 1 000 times higher than natural background extinction rate. In the 20th Century alone, 477 vertebrates became extinct. The population of fresh water species have been lost by 83 percent since 1970. Also, out of 96 500 species, 27 percent are threatened by extinction globally.

In the ecosystem, organisms interact and compete, co-operate, prey and provide food. In this process, they modify non-biological aspects of the ecosystem, hence leading to the availability of nutrients, and energy source such as sunlight, water and nitrogen-fixing organisms. Ecosystem functions depend on how, organisms interact among themselves within that system. For example, if carnivorous animals are removed, prey species will grow, hence leading to a series of changes in the ecosystem. Hence some species will have greater influence than others. Figure 5.2 shows a leopard with a rabbit it has caught for its meal.

Figure 5.2: *A leopard (carnivorous) catches a rabbit (prey)*
Source: *https://www.google.com/search?q=A%20leopard(carnivorous)eats+rabbit*

Effects of loss of biodiversity

A number and types of tree species decrease because land has been degraded. Hence, medicines, vegetations and other things obtained from the environment will no longer be available. Loss of biodiversity means many economic and social activities will be affected. Once this is lost, people's culture (traditions and religions), and economic activities (lumbering, grazing of animals, fish species and tourism) will be affected.

The major effects of the loss of biodiversity are as follows: Environmental degradation, hunger or famine due to the failure of the land to produce enough food; and increase in poverty among the people due to failure in agricultural productivity.

Also, loss of biodiversity can lead to a decline in tourism activities due to depletion of some species that serve as tourist attractions.

Measures to reduce loss of biodivesity

Establishment of proctected areas: Proctected areas such as game reserves prevent people from utilising the areas without permission from the government. These areas include Usangu, Rukwa, Moyowosi, Maswa game reserves and Ngorongoro conservation areas.

Control environmental pollution: Environmental pollution may affect the survival of various species. Control of environmental pollution is a key to safeguarding aquatic and terrestrial species.

Provision of environmental education: This is important in influencing human behaviour towards conserving nature and biodiversity protection.

Control poaching and illegal harvesting: Controlling poaching and illegal harvesting, especially of sensitive species such as rhinos and elephants.

Activity 5.1

In groups, identify five environmental problems in your locality and present them in class. Include possible solutions to those problems.

Environmental pollution

Pollution is the release of harmful substances into the environment that can harm living organisms. Pollution can affect all aspects of the environment including natural, abiotic and biotic components. Pollutants are harmful substances added to water, air or soil. Pollutants can be classified as primary or secondary. Primary pollutants, on the one hand, are directly emitted from a particular source such as carbon monoxide gas from a motor vehicle exhaust pipe or sulphur dioxide released from industrial processes. Secondary pollutants such as ozone (O_3), on the other hand, are not emitted directly, but form in the air when primary pollutants react or interact.

Factors which cause environmental pollution

Environmental pollution is caused by various factors. The factors include rapid population growth, which has been a major factor behind environmental pollution. An increase of population leads to more production of wastes that pollute the environment. The development of manufacturing industries, transport infrastructure and increase of fuel vehicles emit of a lot of fumes into the atmosphere, which cause environmental pollution.

Other factors include the use of bombs and nuclear weapons. Also, unregulated use of agricultural chemicals such as pesticides, insectsides and fertilisers.

These chemicals contribute much to water pollution when washed away from farms into water bodies. Mining activities also pollute the environment by discharging untreated effluents and substances from mines into the land, water and air.

Classification of environmental pollutions

Environmental pollution can be divided into four areas: *Air pollution, water pollution, noise pollution* and *soil* or *land pollution*.

Air pollution

Air pollution is one of the most pressing environmental problems facing modern societies. Air pollution is caused by the release of excessive gases and dust into the atmosphere, which are harmful to people and other living organisms.

Causes of air pollution

The causes of air pollution are mainly grouped into two categories: Natural and human causes.

Natural causes: Natural causes of air pollution constitute volcanic eruption (which emits dusts, ashes and gaseous like Sulphur and Carbon dioxide) and wind, which raises dust and pollen to certain levels. Dust is the collection of fine particles of solid matter that are harmful to living organisms.

Human causes: Human causes involve industrial activities, which lead to emission of fumes and gases that pollute air. Also, the use of charcoal, fire-wood and fossil fuels for different purposes such as cooking, lighting, and smelting pollute the air by releasing carbon dioxide gas. Construction activities cause air pollution by releasing dust and other gases into the air. Other causes include agricultural activities which involve the use of chemicals (pesticides and insecticides), and mining activities which lead to the addition of dust and some gases into the atmosphere.

Effects of air pollution

Air pollution has various effects on the environment and human beings. Some of the effects are bad and irritating smell causing diseases (skin cancer, respiratory system disease such as bronchitis, and itching eyes), death of living organisms due to poisonous gases, therefore causing the disappearance of some species. Also, air pollution may reduce insolation since some parts of the atmosphere may be covered by layers of dusts or fumes, hence leading to inefficient photosynthesis. Air pollution also contributes to global warming as air pollutants contribute to warming and cooling of the Earth.

Measures to reduce air pollution

Air pollution cannot be completely stopped, but there are some effective,

measures that can be used to reduce it. Some of the measures include:

Planting trees, which absorb gases such as carbon dioxide. Trees need carbon dioxide to manufacture their own food through the process of photosynthesis.

By using fuel efficient engines that emit less fumes into the atmosphere, encouraging environmental-friendly technology that uses alternative energy such as electric vehicle and diversifications of industries. This approach may effectively reduce production and emission of harmful gases.

The use of alternative sources of energy, such as natural gas instead of charcoal and fire-wood can also reduce air pollution.

Enacting policies, laws and technology advancement that minimise industrial pollution into the atmosphere will also help to reduce air pollution.

Furthermore, landfilling when dumping wastes is important so that when wastes decomposes they may not emit gases such as methane into the atmosphere.

Water pollution

It is the addition of unwanted substances into water bodies and water sources. Water pollution is the contamination of water bodies such as rivers, oceans, lakes and underground water. Water pollution occurs when pollutants are directly or indirectly discharged into the water systems without adequate treatment to remove harmful compounds.

Causes of water pollution

Some causes of water pollution include the following:

Residues from agro-chemicals: The most common problem of water pollution occurs when inland water is polluted with nitrogen, phosphate and phosphorus run-offs from fertilisers used in intensive agricultural schemes.

Inadequate treatment of sewage: Most of the wastes from sewage systems are not treated especially in developing countries. Inadequately treated sewage substances deposited into the water bodies such as lakes, rivers and oceans may cause severe water pollution.

Poor industrial waste management: Drainage from urban areas, industrial and waste disposal sites are often contaminated with heavy metals or hydrocarbons. Heavy metals, for example, copper, lead and zinc may penetrate into soil and pollute underground water. Some may be carried by rain water into rivers, lakes and sea.

Thermal pollution: This is a harmful increase of temperature in water bodies such as streams, rivers, lakes or occasionally in ocean water. Common

causes of thermal pollution are discharges of water from factories and power plants. It can also occur when trees and vegetation that provide shade to streams or rivers are removed, thus, permitting sunlight to raise the temperature of the water.

Oil spills: Spill of oil is a major hazard to the marine and coastal environment. The main sources of marine oil pollution are damage of oil tanker ships through collision with other ships, explosion, flushing of tankers and leakage from offshore installations. A good example of oil spill is that which happened in the Gulf of Mexico in 2010.

Effects of water pollution

Water pollution has various effects on human and other living organisms in the environment. Untreated sewage from coastal settlements is sometimes discharged directly into the sea or ocean water. The use of polluted water has direct effects on people. Polluted water may cause diarrhoea, typhoid and when used for swimming it can cause skin diseases. Also, the concentration of heavy metal in marine food affects people who consume the food. Marine food includes fish and other edible marine organisms. For example, the discharge of mercury into the coastal water of Minimata in Japan in the 1960s caused a high concentration of mercury in fish. This resulted in the death of many people and other animal predators.

In addition, high levels of contamination with heavy metals, pesticides and pollutants from oil apparently lowers body immunity and reduces resistance to diseases. Other effects include declining levels of dissolved oxygen in water bodies, which is caused by thermal pollution in water. At the same time, warm water raises the metabolism of the organisms and increases their oxygen demand, which is already deficient. Pollution from oil affects living organisms in various ways. A layer of oil on water surface reduces the exchange of oxygen between water and air. This affects organisms in the water. Plants also suffer particularly in salt marsh areas; their roots may become coated with oil and, hence, prevent normal ventilation. Toxic substances from oil kill marine organisms such as plankton, shell fish and birds. Water pollution also leads to a decline of tourist activities due to water pollution, since tourists prefer swimming in clean water bodies.

Measures to reduce water pollution

Water pollution can be minimised by taking various measures. These measures include encouraging use of proper fishing methods instead of using chemicals, that kill fish, animals, plant species and other aquatic. The use of chemicals and fertilisers in agriculture should be discouraged while encouraging organic agriculture. There is also a need to educate people on the proper use

and conservation of water to prevent water pollution. Furthermore, control of oil spills in water bodies is required. National and international collaboration is necessary to control oil refinery in seas and spills caused by ships. Other effective measures worth implementing include recycling of wastes rather than throwing them into the water bodies; and introducing and implementing good government policies that come up with strict rules and regulations to prevent agricultural activities near waterbodies and catchment areas. Also, there is a need to control and regulate industrial discharge of waste water into water systems.

Soil or land pollution

Land or soil pollution is due to depositing of solid and liquid materials on land or underground in a manner that contaminate land systems. Soil or land pollution also refers to the addition or introduction of pollutants to the soil or land. These pollutants can be in gaseous, liquid or solid state. They are harmful to plants, micro and macro-organisms, which are important to soil fertility. Soil or land pollution affects the amount of air and water in the soil. It also changes soil structure and texture, thus leading to land degradation.

Causes of Soil or land pollution

Human activities can lead to soil pollution directly or indirectly through the following ways:

Improper drainage systems and increase of run-off: Improper drainage systems may leak into groundwater systems or be washed into local water systems and contaminate nearby land area. Excess waste deposition increases the presence of bacteria in the soil. Decomposition by bacteria generates methane gas, hence contributing to global warming and poor air quality.

Agricultural chemicals: While fertilisers increase crop yields, they also cause soil pollution that impacts on soil quality. Soil pollution is often associated with improper use of farming chemicals, such as pesticides and fertilisers. Chemicals get deep into the soil and pollute the ground water system. These chemicals are also transferred by rain and irrigation and contaminate the local water system. Pesticides applied to plants can also leak into the ground, leaving long-lasting effects. Some of the harmful chemicals found in fertilisers may accumulate above their toxic levels and poison crops.

Industrial wastes: About 90 percent of soil pollution is caused by industrial products. Improper disposal of wastes from the industries contaminates the soil with harmful chemicals. These pollutants affect plants, animals, local water supplies. Iron, steel, power and chemical manufacturing plants, which use the Earth's surface as a dumping ground, may have lasting effects for years to come.

Improper disposal of heavy metals: Improper disposal of heavy metals such as radioactive minerals can pollute land or soil. Heavy metals can enter and contaminate the soil as well as underground water. When heavy metals pollute the soils, they are utilised by plants or crops and then consumed by human beings or animals. Heavy metals are among the sources of cancer when consumed by human beings.

Improper dumping of wastes: Faulty landfills, bursting of underground bins and faulty sewage systems could also cause the leakage of toxins into the surrounding soil. The chemicals when entering the soil may affect soil formation and its quality. Also, in recent years, plastic waste has become one of the main causes of soil pollution as it takes time to decompose or disintegrate. Many people prefer to use plastic containers and bags because they can be disposed of after use. Such situation results in improper use of plastic bags that lead to the spread of plastic waste in the streets and dump sites. Scattered plastic wastes have become a serious problem in the environment and cause many environmental problems in the world.

Fuel leakages from oil plant and automobiles: Leaked oil from petrol stations and automobiles get washed away by rain and can seep into the nearby soil and cause soil pollution. As a result, the soil loses its structure as well as important nutrients found in it. Also, when oil enters the soil it may kill some species.

Measures to reduce Soil or land pollution

It is not possible to stop land pollution entirely because it is mostly a result of human activities. However, land pollution can be reduced to minimise the effects. Some of the measures to be taken include encouraging farmers to use organic-fertilisers (manure) instead of chemical fertilisers. The micro-organisms present in the organic-fertilisers help to increase soil fertility. Also, farmers should be encouraged to use organic-pesticides and fungicides (herbicides). These pesticides are environmentally-friendly compared to chemical pesticides from industries. Pesticides from industries contain toxic substances, which eventually cause soil pollution. It is, therefore, advisable to treat industrial pesticides before they are disposed of to reduce their toxicity.

Other measures include encouraging households or families to collect wastes to reduce soil or land pollution caused by landfills, especially plastic wastes.

Banning of plastic bags in Tanzania

The Government of Tanzania banned the use of plastic bags with effect from the 1st June 2019. Tanzania joined other 34 African countries in banning the use of plastic bags. It was the 3rd country in East Africa to effect the ban. All plastic

bags, regardless of their thickness, are prohibited from being imported, exported, manufactured, sold, stored, supplied and used in Tanzania. However, it is recommended that people should shift to re-usable containers such as glass, paper and cotton bags. Plastic materials, which were not banned, are plastic packaging for medical services, industrial products, for the construction industry, for the agricultural sector, for foodstuff, and sanitary and waste management. The Government of Tanzania introduced a regulation governing the banning of plastics as follows:

The government regulation, which was used to ban the use of plastic bags states: "A person who imports, exports, manufactures, sells, stores, distributes, supplies, possesses and uses plastic bags in contravention of the regulations commits an offence and shall, upon conviction be liable, in case of:

(i) Manufacturing or importation of plastic bags; the fine is between TZS 20 million up to TZS 1 billion, or up to 2 years of imprisonment, or both;

(ii) Exportation of plastic bags; the fine is between TZS 5 million up to TZS 20 million, or up to 2 years of imprisonment, or both;

(iii) Storing, supplying and distributing plastic bags; the fine is between TZS 5 Million up to TZS 50 Million, or up to 2 years of imprisonment, or both;

(iv) Selling of plastic bags; the fine is between TZS 100 000 up to TZS 500 000, or up to 3 months of imprisonment, or both; and

(v) Possessing and using of plastic bags; the fine is between TZS 30 000 up to TZS 200 000, or up to 7 days of imprisonment, or both."

Reasons for banning the use of plastic bags in Tanzania

Plastic wastes are among the main pollutants of land. As a result, governments including that of Tanzania have taken several initiatives. Specifically, Tanzania has banned plastic bags due to the following reasons:

Plastic bags pollute not only our waterbodies but also our land. Plastic bags are usually lightweight, and as such, they can be carried easily from one point to another by either water or wind. They end up being caught up in trees and fences. They also float in water bodies, thus moving to the world's oceans. Also, most of the plastic bags are made of non-renewable resources such as polypropylene, petroleum and natural gas, which are hazardous to the environment.

Another reason is that plastic bags manufactured from petroleum do not degrade. Instead, they are broken down into small pieces that are swept down and end up in water bodies, which are then consumed by aquatic organisms such as fish. Plastic bags are filled with

toxic, harmful chemicals that include estrogen-like substances. They are thus dangerous to human health as they disrupt human hormones such as estrogen and testosterone, causing a hormonal imbalance that result in severe effects on our health.

Moreover, plastic bags are banned because they are not easy to recycle. Plastic bags present a significant challenge in terms of recycling. Recycling facilities do not have the capacity to recycle plastic bags into usable items. Therefore, the actual recycling rate for plastic bags in Tanzania is around only 5 percent.

Initiatives taken by the government of Tanzania to manage plastic wastes

The government tasks the National Environment Management Council (NEMC) of Tanzania to oversee waste management at the national level. District, municipal and city authorities are also tasked with ensuring solid waste management in their respective areas. These authorities ensure the collection, transportation and disposal of wastes and the public has to pay for such services. Also, the government introduced the public cleanliness day which is on the last Saturday of each month. This has contributed to improve waste management including reducing plastic waste from the environment. Other efforts made by the government include enforcing a total ban on plastic bags under the Environment Management Regulations of 2019 while emphasing the use of alternative carrier bags. For example, industries and investors are encouraged to produce alternative bags such as paper and jute bags, as shown in Figure 5.3:

Figure 5.3: *Some of the alternative carrier bags in Tanzania*
Source: https://www.google.com/alternative+carrier+ bags+jutes+in+tanzania

The government has also engaged the private sector, Non-Governmental Organisations, and Community Based Organisations in solid waste management services. This engagement has reduced the amount of solid waste in urban areas although more efforts are still required. Also, private investors are encouraged to establish solid waste recycling systems to minimise the amount of non-degradable waste materials. This is a potential source of employment, jobs and income. Currently, there are minimal recycling activities for some types of waste materials in few towns in Tanzania. These materials include waste papers, metals, glass, plastic bottles and used tyres.

Effects of soil or land pollution

Soil or land pollution leads to health risks due to direct and indirect contact with contaminated soils. It causes huge disturbances in the ecological balance and health of living organisms on earth. Normally, crops cannot grow and flourish in polluted soil. If some of the crops manage to grow, it is likely that these crops might have absorbed toxic chemicals from the soil, which might cause serious health problems to people consuming them.

Additionally, when soil pollution affects the soil structure the beneficial soil organisms such as earthworms die. This makes soil unproductive to most of the agricultural crops. Apart from soil pollution decreasing the ability of soil to support life, it can also have an effect on predators such as birds as it forces them to move to other places in search of food. Another effect is that people living near the polluted soil tend to have higher incidences of migraines, nausea, fatigue, skin disorders as well as miscarriages. Furthermore, contaminated soil reduces soil fertility, hence decreasing crop yields. Soil pollution is in the form of increased salinity of soil and, thus, impedes agricultural production.

Noise pollution

Noise pollution refers to voluminous disorganised sound produced from different activities. Sound may also be excessive as it disturbs activities of human beings. Loud sounds tend to be harmful as they can cause partial hearing impairment and blood pressure diseases.

Causes of noise pollution

Noises produced at the household level by various equipment such as television, radio, washing machines, and games, are sources of noise pollution. Other sources include noise from commercial and industrial activities. These sounds can result in noise pollution when excessive particularly from industrial machines, construction activities and public outdoor advertisements. Transportation and communication services such as trains, motor-vehicles and airplanes are other sources of noise pollution.

Additionally, road works, thunderstorms, earthquakes, volcanic eruptions and explosion of bombs can also cause noise pollution.

Effects of noise pollution

Noise pollution has the following effects. It can interfere with people's concentration on mental work in offices, hospitals, courts or classes. Noise levels greater than 80 dB (decibels) may cause partial or permanent loss of hearing. Also, it may disrupt the learning process that may contribute to poor academic performance among students. Constant high-level noise may cause heart failure, hearing impairment, and sleeping problems. Explosive noise can be so shocking or terrible that some people may end up fainting or even dying. Another effect is that, noise pollution, sometimes, causes conflicts among neighbours. Additionally, noise pollution can discourage the development of institutions such as hospitals, rest houses or schools in an area. Also, explosive sounds from bombs can cause deafness, hearing loss, cracks in buildings and earth tremors.

Measures to reduce noise pollution

Due to the effects associated with noise pollution, the following are some measures recommended for controlling it: The use of sound-proof facilities; fitting silencers to the exhaust pipes of aircraft and motor-vehicles and applying lubricants to parts of machines; avoiding unnecessary use of explosives and staying away from railway lines, airports as well as roads. Also, recreational centres should be walled using sound-proof materials.

Activity 5.2

In groups, visit your local area and then observe the sources of environmental pollution. Present the findings of your observation with possible solutions in class.

Desertification

Desertification is a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its water bodies as well as vegetation and wildlife. It is a process of transforming arable or habitable land into a desert as a result of natural processes or human activities.

Causes of desertification

Desertification is caused by a number of human and natural factors as follows:

Human causes

Deforestation: Deforestation is the removal of the forest cover by cutting down trees for constructing roads, railways, airports, powerlines, houses, agricultural expansion, fuel-wood and grazing. Deforestation contributes to a shortage of rainfall, which may lead to

drier conditions. It also exposes soil to agents of soil erosion such as wind and running water.

Cultivation in marginal land: Some areas experience rapid population growth. As a result, arable land diminishes forcing people to cultivate the marginal land where there is a high risk of crop failure and low economic returns. This process exposes land to agents of soil erosion and the land becomes unproductive.

Overgrazing: This refers to keeping large herds of animals disproportional to the carrying capacity of the land. Overgrazing is a major cause of desertification. Plants of semi-arid areas are sparse and scattered, and yet they are eaten by large grazing animals which move in response to the patchy rainfall common in these regions. Due to limited pasture land, animals feed on almost every vegetation cover, leaving the ground bare. When rain falls, the bare ground is easily eroded, resulting in land rills and gullies. Examples of overgrazed areas in Tanzania include parts of Dodoma, Arusha, Manyara, Shinyanga and Tabora.

Poor irrigation methods: Poor irrigation methods can lead to desertification through water logging and salinization. Salinization results from alkaline soils, which contribute to the deterioration of the soil structure, hence land becomes unsuitable for plant growth, leading to soil degradation. For example, in Northern-East of China, an extensive area of semi-arid grassland is undergoing desertification due to the deterioration of the land caused by poor irrigation before the cultural revolution in agriculture.

Natural factors

Insufficient rainfall: Desertification could occur in areas where rainfall is low and unreliable. Such areas receive less than 250 mm of rain annually. However, inadequate rainfall can also be caused by human activities such as deforestation.

High temperature: Areas experiencing high temperature tend to have a high rate of evaporation. If the rate of evaporation exceeds the rate of precipitation, there would be moisture deficiency in the soil. This affects vegetation and other living organisms

Cold ocean currents: Onshore winds cross over cold ocean currents and then drop most of the rainfall over the sea and reach the land as dry wind. This effect is experienced on the western coasts of South Africa due to the influence of the cold ocean current called Benguela.

Relief barrier: Land situated on the leeward sides of the mountain are usually dry because of the rain shadow effect of the mountain.

Distance from the sea: Places located in the interior of continents are far from the effects of onshore moist wind.

Wind system: Dry wind originating from the interior of continents can contribute to desertification of the region over which they blow.

Pressure system: Regions with low humidity and descending air masses have no rainfall because rain is caused by ascending and not descending air.

Extent of desertification

About one-third of the world's land surface is arid or semi-arid. It is predicted that global warming will increase the area of desert climates by 17 percent in the next century if proper measures are not put in place. Worldwide, desertification makes about 12 million hectares of land useless for cultivation every year.

Effects of desertification

Desertification affects the quality of life of people and natural resources. The effects of desertification are as follows: It leads to soil erosion as land is exposed to agents of soil erosion. Consequently, water sources are destroyed, leading to water shortage. Also, desertification leads to loss of biodiversity. Biological species are lost due to insufficient rainfall; animal and plant species becomes extinct because of lack of water and protection from sunrays. Another effect is that desertification leads to food shortage as it reduces productivity of land hence less harvests. Food shortage affects the quality of life of people and animals.

Measures to reduce the spread of desertification

Implementation of substantive policies that lay down principles to guide the development and control utilisation of forest resources. There is also emphasis on the use of alternative sources of energy instead of depending solely on fire-wood and charcoal. The use of alternative energy, such as solar-energy, wind energy, and biogas should be encouraged especially in developing countries, Tanzania inclusive.

Other measures include educating people on conservation of the environment by introducing programmes on afforestation and reforestation, and reducing the number of their livestock (destocking) in a particular area in order to minimise overgrazing which causes land degradation and, eventually desertification. Further important measures include enacting by-laws, which prohibit setting of forests on fire and the use of poor farming methods such as shifting cultivation.

Climate change

Climate change is a long-term shift in the average weather conditions identified by changes in temperature, precipitation, winds and other elements. Since it affects a large part of the globe, sometimes it is called global climate change. Global warming is the most well-known aspect of climate change. Global warming refers

to the increase in average temperature of the Earth's surface. Changes in average temperature have implication for other climate elements such as precipitation, winds, humidity, atmospheric pressure, etc. Thus, apart from global warming, the term climate change draws our attention to climate challenges such as drought, food insecurity, and fresh water scarcity, sea level rise, changing ocean currents, hurricanes emissions and ozone layer depletion.

Causes of climate change

Climate change is mainly caused by human activities and, to some extent, by natural factors.

Human causes: Various human activities cause the occurrence of climate change. Industrial activities lead to emission into and concentration of greenhouse gases such as carbon dioxide in the atmosphere. Nearly one-third of human-induced nitrous oxide emissions result from industrial activities. Chlorofluorocarbon (CFCs) and other greenhouse gases that stem from industrial activities have a powerful warming effect due to their heat trapping abilities in the atmosphere. Furthermore, the use of fossil fuels and burning of vegetation release carbon into the atmosphere. It is estimated that about a quarter of the carbondioxide emission into the atmosphere is contributed by land use changes such as deforestation.

Other human causes are agricultural and mining activities. The concentrations of methane gases have also risen due to cattle rearing, cultivation of rice as well as release from landfills. The methane gas released into the atmosphere leads to greenhouse effects, consequently causing climate change.

The clearing of vast forested area for mining activities implies the increase in the concentration of carbondioxide in the atmosphere as forests act as the main absorber of carbondioxide. High concentration of carbondioxide in the atmosphere leads to climate change.

Transportation activities also contribute to climate change. With an alarming growth of population, the demand for transport means also increases. When vehicles, ships and airplanes are used for transportation, the emission of carbondioxide into the atmosphere also increases, hence causing the concentration of greenhouse gases, which adversely lead to climate change.

Additionally, deforestation is another cause of climate change. The permanent removal of trees without replacement for various purposes such as lumbering, extraction of logs, settlement and sports fields contribute to climate change. The absence of trees, in this regard, increases the concentration of greenhouse gases.

Natural causes: The Earth's climate can be affected by natural factors that are external to the climate system, for example, volcanic eruption, solar output and the distance from the Earth to the Sun. Changes in solar radiation, for instance, contributed to climate trends over the past century, where it was estimated that the solar output increased at the rate of 1 percent per century. This led to a global rise in temperatures of up to 10 degree Centigrade.

Another natural cause of climate change is the changes in oceanic circulation. This affects the exchange of heat between oceans and the atmosphere. Differential heating refers to changes in water temperature from the poles to the Equator because of differences in distances from the Sun to the Earth. Also, the composition of various gases in the atmosphere can cause climate change. At present, there is an increase in concern over greenhouse gases such as carbondioxide in the atmosphere, which are the main cause of global warming. Apart from the concentration of gases in the atmosphere, volcanic eruptions can be another contributory factor to climate change. Global temperatures can be lowered after a large single eruption due to increase in dust particles in the lower atmosphere, which absorb and scatter incoming radiation from the Sun before reaching the Earth's surface.

Consequences of climate change on the environment

Climate change has far-reaching implications for the environment. The rising temperatures increase the frequency and severity of weather events such as heat waves and heavy rainfall. In recent years, many countries have experienced heavy rains. Some of the rains are unpredictable, which also cause floods. For example, in December 2011, Dar es Salaam experienced the worst floods which were likely caused by climate change. An increasing trend of floods has impact on human health. Floods create swamps that support the breeding of mosquitoes, which cause malaria. Also, increasing temperatures could lead to large-scale effects such as melting of ice sheets, which cause flood disasters on low lying regions and islands throughout the world.

The disappearance of some species is another effect of climate change. Because of temperature changes, the ecosystem changes as well. In other circumstances some plants could bloom earlier than usual; insects become active. The changes in temperature leads to butteries, foxes and alpine plants moving or shifting further north to higher and cooler areas. Polar bears are becoming more at risk of extinction because of the changing temperature and massive melting of ice. The destruction of

property due to hurricanes and other storms is likely to continue because of the ongoing climate change. For example, in 2013 a strong typhoon struck one of the islands of the Philippines causing deaths and leaving thousands of people homeless and desperate.

Additionally, food production has largely declined particularly in countries, which largely depend on rain-fed agriculture. This threatens food security, and consequently malnutrition in seasonally dry and tropical regions. Because of drought, crops do not grow as required, hence agricultural yields decline. Also, flooding associated with sea level rise has a substantial impact on lowland areas and on the present habitats of mangroves on which fish depend for their nurseries. Climate change will also increase the current stress on water resources. Widespread mass losses from glacier will also reduce fresh water availability.

The climate change will have a number of implications for people as well such as lack of clean and safe water, insufficient food, risking people's health, insecure settlement due to floods and scarce resources in the ecosystem. These implications are described hereunder:

Drought

This is a state of an area facing a prolonged condition of dryness without precipitation or a long period of dry weather. Singida, Dodoma, Shinyanga,

Kondoa and Same are some of the areas in Tanzania, which are largely experiencing drought.

Causes of drought

The causes of drought are broadly grouped into two categories: Natural and human causes.

Natural causes: Wind system is one of the causes of drought. When the wind blows across narrow water mass, it causes drought as it carries less moisture for rain formation. Also, the landscape or location of the place can cause drought. Places located in the leeward side of mountains tend to experience dryness due to being in a rain shadow. Moist wind from another side of the mountain is obstructed by one side of the mountain. Additionally, natural fire can be another cause of drought. Fire resulting from natural hazards such as lightning and volcanic eruption may destruct large-scale of vegetation leaving the land bare, hence unstable. The apparent movement of the Sun and shifting of the overhead Sun to other places also lead to rainfall regime shift. When the Sun shifts to the Northern Hemisphere, dryness occurs in the Southern Hemisphere and vice-versa.

Human causes: Human activities lead to intensification of drought. Daily activities carried out by human beings such as lumbering, poor agricultural practices, poor ploughing methods, over

cultivation, setting the bush on fire and shifting cultivation lead to deforestation. Other activities such as mining, construction of dams and industrial activities contribute significantly to the increase of drought incidents.

Effects of drought

Drought has various effects on human development and the environment. Drought leads to the disappearance of vegetation and animal species. Because of the prolonged dryness, some plant and animal species with less tolerance capacities die and may disappear completely from that area. Also, drought leads to poor supply of energy and power to people who depend on hydro-electric power as the main source of energy. Water levels in dams and rivers decrease, hence affecting power generation for various human development.

Also, drought intensifies desertification development process. Desert conditions spread over towards places which were not affected by desertification. This occurs because of loss of vegetation cover and some animal species due to prolonged dryness. Decline in food production affects negatively industries which depend on agricultural produce. These industries are involved in food processing. Another effect of drought is the shortage of water supply for domestic, agricultural and industrial use. This affects sanitation, crop production and manufacturing industries.

Measures to address the problem of drought

As described earlier, there are natural causes of drought, which can be difficult for humans to prevent. However, humans can still take some measures to reduce the impacts of drought on our daily lives. Some of the measures can be conservation of forests using alternative energy resources such as solar energy, biogas, hydroelectric power and coal to control deforestation. Also, water conservation schemes such as constructing dams to create resources from which the water is used for irrigation agriculture, domestic and industrial uses, will ensure food production even during dry periods. Other measures include the conservation of water catchment areas to ensure reliable water supply and proper farming methods, which do not deplete vegetation like shifting cultivation; farmers should practise agro-forestry and bush fallowing cultivation as another way of addressing the impacts of drought.

Mass education on water conservation can also serve as a drought control measure. Farmers should be educated on how to use resources available sustainably to avoid environmental degradation which accelerates drought. In addition, there should be strict policies instituted to restrict the excessive felling of trees. Forest is one of the major factors contributing to the availability of water from all sources such as rainfall, underground and running water.

Floods

Flood refers to an overflow of water that submerges land that is usually dry. It occurs when a large amount of water covers an area that is usually dry. It occurs as a result of heavy rains that take place in highlands and flow to lowland areas.

Causes of floods

Normally floods are caused by heavy rainfall. When the area is at a low land, water accumulates and causes floods. This becomes more severe when the area is not covered by vegetation. Also, urbanisation intensifies the flood intensity because of bare lands which result from the removal of vegetation cover to replace it with buildings or because of poor infrastructure. Also, bare lands and blocking the natural drainage systems result in free movement and spread of water. Example, Kawe, Jangwani and Msimbazi valley in Dar es Salaam. Sometimes, flooding occurs as a result of collapsing of reservoirs such as dams, emergence of springs, melting of ice and bursting of water pipes.

Effects of floods

Floods have various adverse effects on human development and environment. Floods destroy infrastructure and, hence, hinder the movement of goods and services from one place to another, retarding development gained over decades in the process. Death of people and destruction of property are other effects of floods. Frequent floods in Tanzania have caused death of people and destroyed property. These floods occurred in Dar es Salaam (2011), Lindi (2020), Babati-Manyara (2019), Kilosa (2020) and Gairo (2020). Outbreak and spread of diseases especially waterborne diseases such as cholera, dysentery, diarrhoea and typhoid, which affect the health of people and sometimes cause death are other effects of floods. Also, floods may cause soil erosion, mud flows, slumping and solifluction.

Destruction of water sources through siltation of dams and other water resources causes water shortage for domestic and industrial use as well as for hydro-electric power generation.

Measures to control floods

Floods can be controlled by constructing dams across the river channels to create reservoirs, to help reserve excess water, and control floods. Frequent inspection and clearing of drainage systems, both, constructed and the natural ones is imperative. Also, Meteorological Agencies should be strengthened to provide accurate and timely alerts to people on the coming of floods. The proper management of the watersheds and catchment areas through planting trees and conserving the existing ones can help to control floods. Large amounts of surface run-offs can be stored in those areas to avoid the over-flowing of water to settlements. Moreover, proper

urbanisation policies are necessary to avoid the blocking of the natural drainage systems.

Land degradation

Land degradation refers to the deterioration of the quality of land through the loss of soil fertility, soil pollution and other natural processes like landslides.

Causes of land degradation

Human causes

Poor farming practices: These refer to excessive use of chemical fertilisers, and pesticides and over-cultivation. Monoculture may affect the quality of land or soil through exhaustion, which in time lowers its quality to support agricultural production.

Deforestation: Deforestation also accelerates land degradation. Forests play an important role in maintaining fertility of soil by shedding their leaves, which contain many nutrients. Also, forests help to bind the soil particles together. Therefore, cutting down trees will accelerate the land's loss its quality through erosion.

Mining activities: Mining activities cause land degradation. When minerals are extracted from the land many holes left behind collapse, especially in the open cast mining. For example, Bulyanhulu and Buzwagi gold mining centres in

Kahama-Shinyanga and Geita mining centre in Geita.

Industrial activities: Another cause of land degradation is industrial wastes as when dumped on the Earth's surface, they destroy soils and, thus, become unfit for agriculture and settlements. For example, the dump site located at Pugu-Kinyamwezi in Dar es Salaam.

Population pressure: Population pressure which causes excessive use of the available land resources may accelerate land degradation. This means the land will be over utilised hence become exhausted.

Acidic rainfall: Acidic rainfall, which is formed from sulphur dioxide and nitrogen oxide emitted by thermal power stations, industries, motor vehicles and burning coals, leads to an increase in acidity on land, hence causing soil infertility.

Natural causes

Natural hazards such as landslides, floods and earthquakes can also cause land degradation, as they tend to destroy the land, and leave it unfit for human use.

Effects of land degradation

Land degradation has a far-reaching consequences for human life and environment. Some of the effects include

the deterioration in the chemical and physical properties of soils, decline of biodiversity (native species), increase in hazards for human occupation, loss of land productivity and, hence, food shortage. Moreover, land degradation leads to migration of people to other places, which are still conducive for agricultural production and the cost to rehabilitate the degraded land is usually very high.

Measures to reduce land degradation

Land degradation can be reduced by practising proper agricultural methods, for example, agroforestry, the use of terraces on slopes and the use of minimal tillage to avoid soil erosion. Encouraging people to practice afforestation and reforestation can also help to control land degradation. Other measures include enforcement of laws and rules that guide the proper land utilisation to avoid its misuse and provision of mass education to create awareness to people through meetings, seminars, and the mass media.

Environmental hazards

In our environment, there are several hazards which affect the sustainability of life to living and non-living organisms. A hazard is a danger that may result in the destruction of mankind and his or her property in his or her environment. It is something which is known to cause harm to the environment. Hazards, which may affect environment, include floods, lighting, windstorms, pests and diseases, drought, earthquakes and volcanic eruption.

Our environment generally consists of physical, chemical and biological components and our relationship with the environment is always interactive. This means that when we affect our environment and our environment affects us. These interactions may expose us to environmental health hazards, that is, any environmental factor or situation which can cause injury, disease or death. There is a difference between a hazard and a risk. A hazard is something which is known to cause harm, that is, a source of danger to health, whereas a risk is the likelihood or probability of the hazard occurring and the magnitude of the resulting effects.

The conditions or the situation of making cow-dung cake near the houses for getting fuel is hazardous (or dangerous) because it facilitates the breeding of flies in our environment. The infected food is a hazard that can damage a child's health. The risk of getting an infection is very high if we live in a contaminated environment.

Categories of environmental hazards

Hazards are generally categorised into five forms as physical hazards, biological hazards, chemical hazards, cultural or practice-related hazards and social hazards.

Physical hazards

Physical hazards are those substances or conditions that threaten our physical safety. Fires, explosive materials, temperature (hot or cold), noise, radiation, spills on floors and unguarded machines are some examples of physical hazards.

Biological hazards

Biological hazards are organisms, or by-products from an organism, that are harmful or potentially harmful to human beings. They include pathogenic bacteria, viruses and parasites, and toxins (poisons) that are produced by organisms. Biological hazards are the main causes of most of human diseases. Examples of these diseases are cholera, tuberculosis, leprosy, relapsing fever and many diarrhoea related diseases. Some diseases are caused by viruses. Examples of such diseases are hepatitis B and C, HIV/AIDS, Covid-19, measles and polio. Other diseases are caused by parasites, for example, malaria, trypanosomiasis and toxoplasmosis.

Biological hazards arise from working with infected people or animals, or handling infectious waste and body fluids, as well as contact with unsafe water, food or waste. The hazards may occur at home, school, playgrounds, hospitals, in hotels, hospital laundries, laboratories, veterinary offices and nursing homes. All these places may expose someone to biological hazards.

Chemical hazards

These are present when a person is exposed to a harmful chemical at home, street or at work. The chemicals can be in the form of gases, solids or liquids. Exposure to chemicals could cause acute health effects (an immediate or rapid onset) if taken in wrongly and large quantities in a single dose; and chronic health effects (long-term effects on health) if taken in wrongly and small doses over an extended time. Detergents (powdered soap, bleaching agents), drugs (veterinary and human) and pesticides are chemical hazards that are commonly found in rural households. A person is exposed to chemicals through various ways: Through inhaling the vapours, gases or dusts; through skin contact with solvents, acids and alkalis; or through eating food and drinking water which contain chemicals.

Incomplete burning of fuel releases carbon monoxide (CO), which is a chemical hazard. When breathed in, CO binds to the hemoglobin in our blood, reducing the uptake of oxygen; the cells of the body suffer because of insufficient oxygen. This can result in severe sickness and even death.

Cultural or practice-related hazards

Culture is the knowledge, belief, art, law, morals, customs and habits that are acquired by people as members of the

society. It is also refers to common ways of life and set of thoughts and feelings shared by members of a society. Culture is also a component of the environment. Just as there are cultural practices that are good for health and environment, such as breastfeeding a child, washing hands before and after using a toilet or eating. There are also cultural practices that adversely affect health and these can be cultural hazards. There are practices that are widely practised in different areas of Tanzania, which are hazards to human health. For example, the belief that evil spirits are the source of diseases, practices of storing drinking water uncovered, open defecation, and eating without washing hands.

Hygiene and health promotion and community mobilisation are critical interventions that help to improve practices that are useful to the community. Right knowledge is needed to change human behaviour and the attitudes towards environmental conservation. This will add value to the fight against environmental problems.

Principles of hazards management

You may be asked to plan how to manage environmental hazards, in a health post, school or mill house that exists in your locality. Involvement in hazard management requires you to follow certain steps, which are explained below.

Establish the context and identify the hazard: This is the first step. You have learned that a hazard is something that is harmful to our health. You should identify the type of the hazard in as much detail as you can. You should also describe the exposure conditions and try to answer the following questions: What is the source of the hazard? Who is exposed? What pathways or activities expose a person? What part of the environment or context is involved in the transfer of the hazard to humans?

Hazard or risk analysis and evaluation: Analysis and evaluation of hazard or risks is a Vitals step. It needs a deeper appraisal in collaboration with the environmental health worker. The evaluation may require appropriate design, sampling and laboratory investigation.

Communicate and consult: When the hazards and risks have been determined, advice can be communicated on the interventions or control measures that are needed to control the hazard. There can also be consultations with relevant people and organisations.

Monitoring and reviewing: The implementation of interventions or control measures for the hazard must be followed up to determine whether they are successful. Correct measures can be applied if there is any failure. Identifying appropriate indicators for

monitoring is critical and must be done formally.

Record keeping: Keeping records and reports on hazard management is always important. These records should show the following information: The type of hazard, exposures and what control measures were taken.

Population and urban growth and their effects on environment

Population is the number of people occupying a certain geographical area. Global population growth is around 81 million annually, or 1.2 percent per annum. The rapid increase in human population has raised concerns that the planet may not be able to sustain the increasing number of people in terms of essential and necessary needs.

Causes of rapid population growth

Population change is determined by three factors which are births, deaths and migration. However, migration is a factor for population change when referring to a country but it is not a factor for population change if we refer to the world population size. The causes of world rapid population growth are: Decreased death rate due to increased food production and distribution, improved public health sources and medical technology. Another cause is increased birth rate due to polygamy and early marriages. Increased life expectancy which has enabled many

women to bear many children. Also few deaths at an infant or child stage is another cause of rapid population growth. For example, in Tanzania in 2021, life expectancy stood at 66.4 years.

Consequences of rapid population growth on environment

The rapid increase of human population is exerting pressure on the environment. The effects are as follows:

Global warming: The rapid population growth leads to global warming. Energy production through power plants and burning of fossil fuel needed to support human life increases the emission of greenhouse gases which lead to rising global temperatures.

Deforestation: Deforestation results from rapid population growth. To support the growing population, forests are cleared and destroyed at an alarming rate for agriculture and human settlements. Many countries are cutting down forests to clear land for farming, grazing for commercial purposes and for use as a source of energy to meet the demands of the available population at an alarm rate. This causes loss of biodiversity resulting in the extinction of some plants and animal species.

The depletion of non-renewable resources: Rapid population growth causes depletion of non-renewable resources as human beings continue to

put pressure on the natural resources. Increased population translates into increased demand for resources, thus resource depletion.

Pollution: Rapid population growth causes envirnmental pollution. For instance, air pollution resulting from the use of fuelwood, which are environmentally-unfriendly. Water pollution may occur due to excessive utilisation. Therefore, if the rate of utilisation is greater than the rate of its management water pollution can result.

Solid and liquid waste disposal: Rapid population growth increases the production of solid and liquid wastes. In case these are not properly managed, they pollute the environment.

Environmental degradation: In some areas, people depend on biomass fuel such as cow-dung, fodder and crop residues because of scarcity of fuel wood. If biomass is left on the farms to decompose it adds nutrients to the soil. So, by using it as a source of fuel, soil becomes less productive.

Ozone layer depletion

The ozone layer is an isotope of oxygen (O_3) whose concentration zone is in the stratosphere as shown in Figure 5.4. The ozone layer is important because it protects the Earth from the damaging effects of ultra-violet radiations from the Sun. The ozone layer absorbs such radiations. When ozone depleting-substances such as chlorofluorocarbons (CFCs) react with ozone they result in oxygen (O_2) and oxygen atom (O). Such reaction depletes the ozone layer, hence reducing its capacity to filter ultra-violet rays.
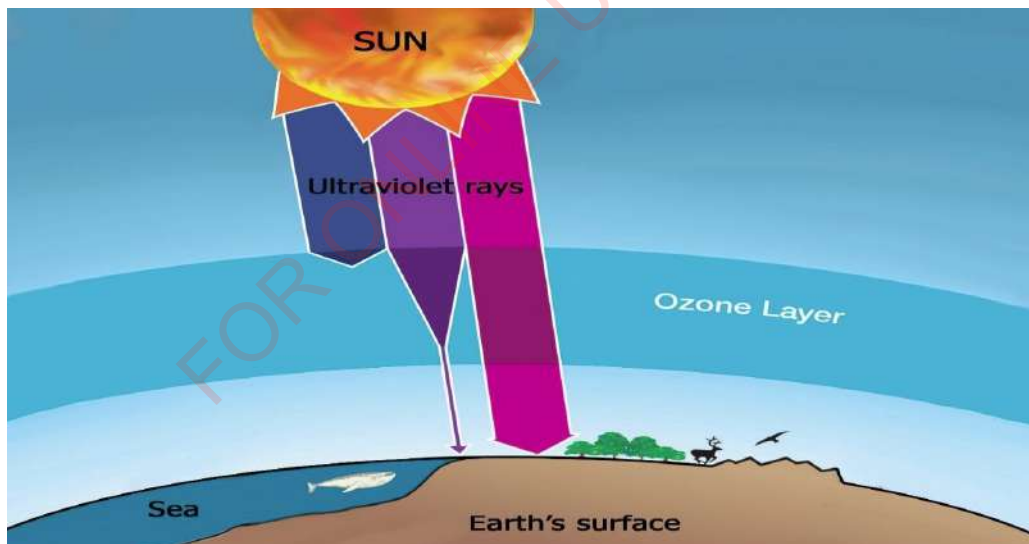

Figure 5.4: *The Ozone layer*
Source: *https://www.google.com/search?q=ozone+layer+depletion&tbm.*

Causes of depletion of the ozone layer

Air pollution with gases such as Chlorofluorocarbons, Carbon monoxide and methane deplete the ozone layer leading to the formation of holes. These holes allow free passage of ultra-violet rays from the Sun (unfiltered), hence damaging plant tissues and causing cancer in human beings.

Effects of destruction of ozone layer

When the ozone layer is destroyed, various impacts result. The increase of incidents of skin cancer is one of the effects of ozone layer depletion. Ultra-violet rays coming directly from the Sun destroy human skin tissues, hence leading to the occurrence of skin cancer and the destruction of skin pigment melanin which protects human skin from the impacts of solar radiation. Also, the Ozone layer depletion leads to the death of some plants and animal species. Overall, the unfiltered ultra-violet radiation from the Sun comes directly to the Earth's surface without being filtered because of Ozone layer depletion.

Protection of the ozone layer

Ozone layer can be protected by controlling the emission of ozone depleting substances such as Chlorofluorocarbons and Hydro-chlorofluorocarbon (HCFCs) from cars, industries, refrigerators, air conditioners, perfumes and sprays.

Environmental conservation

Conservation of environment means its protection and maintenance for sustainable use of natural resources such as minerals, soil, forests and wildlife.

Ways of conserving environment

There are several ways of conserving the environment, such as the afforestation, reforestation, destocking, re-using, returning and recycling, laws enforcement, pollution control, soil conservation as well as awareness raising education.

Afforestation and reforestation

Afforestation is a direct human-induced conservation of land that has not been forested (where there was no previous tree cover) for years to forest land by planting, seeding or human-induced promotion of natural seed resources. The forested land will minimise the exposure of the soil to agents of erosion and, therefore, conserve soil nutrients, increase soil fertility as well provide habitats to varieties of biodiversity.

Reforestation is the practice of planting trees on land to replace the removed forest cover. Figure 5.5 shows the reforestation process in one of open spaces. As mentioned in the previous section,

human beings tend to clear forests for various purposes such as agriculture, settlement, industrial development, grazing and mining. This practice leads to environmental degradation. Reforestation fosters environmental conservation because trees prevent the land from soil erosion by holding the soil together. Leaves reduce the impact of rain drops and wind on soil surface. They also provide shade, which lowers the rate of evapotranspiration of water from the soil.

Evapotranspiration is the sum of transpiration from plants and evaporation from the Earth's land and water bodies. Evaporation accounts for the canopy interception and water bodies. Transpiration accounts for the movement of water within a plant, which, subsequently, results in the loss of water vapour through stomata. Through transpiration, leaves release moisture and gases into the atmosphere, hence creating an important link in the water cycle.

Figure 5.5: *People plant trees on an open space*
Source: https://www.google.com/search?q=planting%20trees&tbm

Soil conservation

This is a way of protecting and preventing the soil from erosion either by wind or water. Ways of conserving the soil are as follows:

To control animal grazing: Overgrazing contributes to environmental problems such as soil erosion and loss of biodiversity; so controlling grazing is important. For example, organised ranches are established by enclosing certain areas for livestock and zero-grazing. Such areas are called paddocks. It is also important to reduce the number of livestock to match with the carrying capacity of a particular area with the intention of reducing pressure on pastures.

Proper methods of farming

The following are farming methods which protect soil from being eroded.

Terracing

This method is normally practised on slopes in which the land is cut into a series of wide steps (terraces), on which the crops are grown as shown in Figure 5.6. Normally, there are deep furrows between terraces which allow water to penetrate deep instead of water running off on the ground.

Figure 5.6: *Terracing method of farming*
Source: *https://rocketskills.in/terrace-farming-the-basics-to-get-started/*

Planting of shelterbelts trees

Belts of trees are planted across a flat region, which is liable to suffer from wind erosion. Trees act as wind-breakers as Figure 5.7 illustrates.

Figure 5.7: *Shelterbelt trees in a farm*

Source: *https://www.pinterest.ca/treetimeca/shelterbelt-trees/*

Crop rotation

This farming method is done by rotating different types of crops in different seasons to maintain soil fertility. Crop rotation ensures that the soil remains fertile and does not lose its texture and nutrients.

Bush fallowing

This is practised by cropping on new plots and former plots are left for some years for the purpose of restoring their fertility.

Mulching

This is the action of spreading dry grasses and leaves over the surface of the soil to prevent evaporation as shown in Figure 5.8. It also maintains soil fertility when grass or leaves decompose.

Figure 5.8: *Mulching in agriculture*

Source: *https://www.google.com/search?q=mulching+images&tbm*

Promotion of alternative sources of energy

Alternative sources of energy are biogas, solar energy, natural gas and thermal power. The use of such sources reduces the rate of cutting down trees for fuel, which consequently maintains natural plant cover. These are non-pollutants to environment. There is a need of using them for reducing the production of greenhouse gases, which pollute the air.

Protection of catchment areas

A catchment area is the area of land over which rain falls and drains into bodies of water such as rivers and lake.

We protect catchment areas for the purpose of conserving water sources, biodiversity and other natural resources. We get water for various uses from these catchment areas.

Re-using or recycling of waste materials

Another method of controlling the environmental pollution is re-using materials such as bottles, plastic bags and paper in their original form instead of throwing them away or giving others these materials for re-using them. Also, to reduce the amount of waste by buying products that are not wasteful in their packaging or use. Do not throw everything into the dustbin. So many things can be made into either the same kind of things or new products through recycling.

In Tanzania, there are recycling systems in cities such as Dar es Salaam, Mbeya, Mwanza, Tanga, Dodoma and Arusha. For example, in urban areas you can find waste collectors picking discarded plastic waste up that would otherwise litter the environment. These plastic waste materials are recycled, turned into pavement slabs, plastic flowers and other building materials. Currently, Tanzania is turning waste plastic bottles into anti-coronavirus face shields to be used in hospitals and health centres around the country.

Provision of mass environmental education

There is a need for the governmental agencies, non-governmental organisations and influential people such as religious leaders, politicians, artists and media to educate the public on environmental issues. This will contribute to improved awareness on environmental protection.

Allowing private sectors to co-ordinate matters related to environmental conservation

The government should encourage the establishment of many private institutions and organisations for co-ordinating matters related to environmental conservation in the country, some examples of public and private organisations related to environmental and conservation matters worldwide are the United Nations Environment Programme (UNEP), Sustainable Sea Trust in South Africa, Indonesian waste platform in Indonesia and the National Environment Management Council (NEMC) in Tanzania.

More researches should be carried out locally and globally on environment management and conservation practices and land rehabilitation, especially after post-quarrying and mining activities had concluded.

Activity 5.3

In groups, visit your local area and assess how the fast growing population affects environmental conservation. Present your assessment with possible solutions in class.

Revision exercise

Section A

Choose the letter of the correct answer:

(i)   Which of the following are common environmental problems?
   (a)   Loss of biodiversity, desertification and climatic change
   (b)   Afforestation, deforestation and desertification
   (c)   Economic activities, agricultural activities and human activities
   (d)   Global warming, afforestation and agricultural activities
   (e)   Desertification, afforestation and manufacturing

(ii)   Identify the atmospheric pollutants among the following gasses:
   (a)   Chlorofluorocarbons, carbon dioxide and sulphur dioxide
   (b)   Sulphur dioxide, hydrocarbons and chlorofluorocarbons
   (c)   Carbon tetra chloride, carbon monoxide and carbon dioxide
   (d)   Carbon dioxide, carbon monoxide and hydrocarbons
   (e)   Carbon chloride, carbondioxide and carbon monoxide

(iii)   Overgrazing in Tanzania can lead to environmental problems. Identify the regions most affected by the problem:
   (a)   Dodoma, Arusha and Shinyanga
   (b)   Morogoro, Dar es Salaam and Tanga
   (c)   Mwanza, Singida and Tabora
   (d)   Pwani, Mbeya and Rukwa
   (e)   Manyara, Iringa and Dodoma

(iv)   Mr Bakari is a peasant at Ifakara in Morogoro who applies proper methods of farming. Identify some proper methods of farming Mr Bakari uses which suit him:
   (a)   Terracing, overgrazing and contour ploughing
   (b)   Contour ploughing, crop rotation and mulching
   (c)   Recycling, bush fallowing and terracing
   (d)   Terracing, overgrazing and crop rotation
   (e)   Shifting cultivation, terracing and overstocking

(v)   Which of the following is not an effect of air pollution in urban areas?
   (a)   Acid rain
   (b)   Desertification
   (c)   Soil erosion
   (d)   Deforestation
   (e)   Loss of biodiversity

(vi)   Identify the sources of physical hazards among the following:
   (a)   Pathogenic bacteria
   (b)   Social-cultural practices
   (c)   Solar radiation
   (d)   Skin contact with acids
   (e)   Drug abuse

(vii) Which among the following atmospheric gases is not one of the greenhouse gases:
   (a)   Carbon dioxide
   (b)   Carbon monoxide
   (c)   Methane
   (d)   Nitrous oxide
   (e)   Chlorofluorocarbons

(viii) For a person who is storing, supplying and distributing plastic bags in Tanzania, the fine is between:
   (a)   TZS 5 000 000 up to TZS 20 000 000, or up to 2 years of imprisonment, or both
   (b)   TZS 5 000 000 up to TZS 50 000 000, or up to 2 years of imprisonment, or both
   (c)   TZS 20 000 000 up to TZS 1 billion, or up to 2 years of imprisonment, or both
   (d)   TZS 100 000 up to TZS 500 000, or up to 3 months of imprisonment, or both
   (e)   TZS 30 000 up to TZS 200 000, or up to 7 days of imprisonment, or both

Section B

Match the descriptions of the environmental problems in Column A with their corresponding environmental concepts in Column B:

Column A	Column B
(i) This is the contamination of water masses such as rivers, oceans, lakes and underground water.	(a) Global warming
(ii) This is an increase in the Earth's average atmospheric and ocean temperature that causes corresponding changes in climate.	(b) Water pollution
	(c) Deforestation
(iii) Disappearance of flora and fauna in an area.	(d) Air pollution
(iv) Activated by clearing of vegetation for farming and settlement.	(e) Desertification
(v) Removal of top or upper layer of soil in an area.	(f) Acid rain
	(g) Soil erosion

Section C

Answer the following essay questions:

1. The people of Tanzania conduct different activities to sustain their socio-economic needs for their daily life. However, some activities have impacts on the environment. With six facts, support this statement.

2. Biodiversity is very important to the environment. Using six points, examine the causes and effects of the loss of biodiversity.

3. Bad smell and hearing impairment nowadays are common problems in society. With six points, explain the causes of these problems.

4. Due to industrial development in Tanzania, environmental pollution is very common. Using five points, explain the impact of environmental pollution.

5. Urbanisation and environmental conservation are always incompatible. Justify this statement using six points.

6. "Poverty is one of the major problems facing developing countries". In the light of this statement, use six points to show the relationship between poverty and the environmental degradation in Tanzania.

7. Currently, the world encounters frequent floods, catastrophic winds and extreme temperature. This means the world climate keeps on changing. Giving six points, explain the causes of climate change.

8. Climate change has never been friendly to the environment. Verify this statement with five points.

9. As an NEMC Officer, you have been given an opportunity to conduct a seminar with the citizens on environmental pollution and mismanagement. Using six points, explain how you will advise the citizens on different ways for conserving the environment?

10. Plastic wastes pose the biggest threat to water bodies in the world, particulary in the oceans. The United Nations Environment Programme warns that by 2050, we will have more plastics in the oceans than fish if nothing is done to reverse the trend. Using any five points, explain the efforts taken by the Government of Tanzania to manage the plastic waste pollution in the country.

11. "Life is only possible if the balance between the resources available and human population is maintained by all of us. It is high time for humans to come together and work for the betterment of our environment." Justify this statement by explaining any six consequences of rapid population growth on environment for the sustainable development in our country.

12. "Fossil fuels are both energy resources for economic development and instruments of environmental destruction". Justify the statement with six points.

13. Explain six problems associated with expansion of cities on environment in Tanzania.

Glossary

Afforestation	the act of planting trees in a barren land or converting a farm land to a forest in order to use the trees for commercial purposes
Arid	having little or no rain; too dry or barren to support vegetation
Birth rate	the number of live births per thousands population per year
Census	an official survey of a population, typically involving recording various details of individuals
Climate	a long-term average weather conditions in a particular region
Crude birth rate	the number of live births occurring during the year, per 1 000 population estimated at mid-year
Crude death rate	the number of deaths occurring among the population of a given geographical area during a given year, per 1 000 mid-year population
Data	facts and statistics collected together for reference or analysis
Data interpretation	the process of analysing and determining the significance of important information such as survey results, experimental findings, observations or narrative reports
Dependency ratio	an age-population ratio of those typically not in the labour force (the dependent part) and those typically in the labour force (productive part)
Desert	a dry, barren area of land, especially one covered with sand, that is characteristically desolate, waterless, and without vegetation
Desertification	the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture
Drought	a prolong period of time during which there is very little or no rain
Ecosystem	a geographic area where plants, animals and bacteria interact
Emigrant	a person who leaves his or her own country in order to settle permanently in another country
Emigration	the act of leaving one's native country with the intent to settle elsewhere
Equator	an imaginary line drawn around the earth with equal distantance from both poles, dividing the earth into northern and southern hemispheres and constituting the parallel of latitude 0°

Fertility rate	the ratio of live births in an area to the population of that area; expressed per 1 000 population per year
Fertilizer	a chemical or natural substance added to soil or land to increase its fertility
Global warming	a gradual increase in the overall temperature of the Earth's atmosphere generally attributed to the greenhouse effects caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants
Grassland	is a land which is characterised by a continuous cover of grasses
Hurricane	an extremely large, powerful, and destructive storm with very strong winds that occurs especially in the western part of the Atlantic Ocean
Hypothesis	supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation
Immigrant	a person who comes to live permanently in a foreign country
Infrastructure	the set of inter connected structural elements that provide a framework supporting an entire structure of development
Irrigation	the artificial application of water to the land or soil for crop farming
Latitude	a geographic coordinate that specifies the north-south position of a point on the Earth's surface
Life expectancy	a statistical measure of how long a person may live, based on the year of their birth, their current age and other demographic factors including gender
Linear settlement	a form of settlement where buildings are built along the river, a coastline or a road. It usually forms a long and narrow pattern, which can be maintained even when the population grows
Livestock	domestic animals, such as cattle or horses, raised for home use or for profit, especially on a farm
Longitude	an imaginary line that bisects the globe through the North and South Poles
Lumbering	cutting forest timber for transport and sale
Migration	movement by people from one place to another with the intention of settling temporarily or permanently in the new location

Moisture	water or other liquid diffused in a small quantity as vapour, within a solid, or condensed on a surface
Monsoon	a wind system that influences large climatic regions and reverses direction seasonally
Mortality rate	a measure of the number of deaths (in general, or due to a specific cause) in a particular population, scaled to the size of that population, per unit of time
Observation	is a way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting
Overgrazing	the presence of too many animals on the land or for too long or in appropriate seasons, such that the land becomes degraded
Pasture	land covered with grass and other low plants suitable for grazing animals, especially cattle or sheep
Poaching	the illegal hunting, killing, or capturing of wild animals
Pre-testing	research carried out to evaluate tools prior to its first use
Pull factor	something that attracts people to go and live in a particular place
Push factor	a factor that leaves one with no choice but to leave a place to another place such as a town, country and region
Qualitative research approach	It is a research approach that uses description of concepts, ideas and other state of affairs. It does not use numerical data
Quantitative research approach	the systematic empirical investigation of observable phenomena via statistical, mathematical or computational techniques
Questionnaire	a data collection research tool consisting of a series of questions and other prompts for the purpose of gathering information from respondents
Radiation	the process of emitting energy in the form of light, heat, x-rays or nuclear particles
Refugee	a person who has been forced to leave his or her country in order to escape war, persecution, or natural disaster
Sample design	a procedure or plan drawn up with strategies towards obtaining a sample from a given population

Sample survey	a cross-sectional study aimed to produce summary statistics such as average, mean and percentage
Sanitation	conditions relating to public health, especially the provision of clean drinking water and adequate sewage disposal
Savannah	a grassy flat land without many trees in a tropical or subtropical region
Semi-arid	a climate or place that is partially arid, or semi-dry and has less than 200 millimetres of rain in each year
Sewage	water-carried waste, in solution or suspension that is intended to be removed from a community
Sex ratio	the proportional distribution of the sexes in a population aggregate, expressed as the number of males per 100 females
Sequestration	the process of capturing and storing atmospheric carbon dioxide
Slums	heavily populated urban informal settlements characterized by substandard housing and squatters
Soil erosion	the washing or blowing away (by wind or water) of the top layer of soil
Sparse population	a low population density in relation to the area that contains it
Squatter	a person who unlawfully occupies an uninhabited building or unused land
Thermal pollution	industrial discharge of heated water into a river, lake, or other body of water, causing a rise in temperature that endangers aquatic life
Topography	describes the physical features of an area of land
Urbanisation	the population shift from rural to urban areas, and the ways in which societies adapt to this change
Variable	an element, feature, or factor that is liable to vary or change
Vegetation	plants considered collectively, especially those found in a particular area or habitat
Vitals statistics	quantitative data concerning a population, such as the number of births, marriages, and deaths
Waste disposal	removing and destroying or storing damaged, used or other unwanted domestic, agricultural or industrial products and substances

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