

Optional Environment Science

Grade 9



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Government of Nepal
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Sanothimi, Bhaktapur

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हाम्रो भनाइ

नेपालको शिक्षालाई उद्देश्यमूलक, व्यावहारिक, समसामयिक र रोजगारमूलक बनाउन विभिन्न समयमा पाठ्यक्रम, पाठ्यपुस्तक विकास तथा परिमार्जन कार्यलाई निरन्तरता दिइँदै आएको छ। विद्यार्थीमा ज्ञानको खोजी गरी सिकाइ र वास्तविक जीवनविच सम्बन्ध स्थापित गर्ने, सिद्धान्त र व्यवहारको समन्वय गर्ने, स्वपरावर्तित हुँदै ज्ञान, सिप र क्षमतालाई अद्यावधिक गर्ने सक्षमताको विकास हुनु आवश्यक छ। विद्यार्थीमा अधिकार, स्वतन्त्रता र समानताको प्रवर्धन गर्ने, स्वस्थ जीवनको अभ्यास गर्ने, तार्किक विश्लेषण गरी निर्णय गर्ने, वैज्ञानिक विश्लेषणका आधारमा व्यक्ति, समाज र राष्ट्रको दिगो विकासमा सरिक हुने सक्षमताको विकास पनि शिक्षाले गर्नुपर्छ। विद्यार्थीमा नैतिक आचरण प्रदर्शन गर्ने, सामाजिक सद्व्यवृत्ति संवेदनशील हुने, पर्यावरणीय सन्तुलनप्रति संवेदनशील हुने, द्वन्द्व व्यवस्थापन गर्दै दिगो शान्तिको लागि प्रतिबद्ध रहने सक्षमताको विकास पनि माध्यमिक तहको शिक्षाबाट अपेक्षित छन्। यस तहको शिक्षाबाट आधुनिक ज्ञान, सिप, सूचना तथा सञ्चार प्रविधिको प्रयोग गर्ने, स्वावलम्बी र व्यवसायमुखी सिपको अभ्यास गर्ने, राष्ट्र, राष्ट्रियता र राष्ट्रिय आदर्शको सम्मान गर्ने, समाज स्वीकार्य आचरण र कार्य संस्कृतिको अवलम्बन गर्ने, सहिष्णु भाव राख्ने सक्षमता भएको नागरिक तयार गर्ने अपेक्षा रहेको छ। त्यस्तै सिपवन्त, कल्पनाशील, उद्यमशील एवम् उच्च सोच र आदर्शमा आधारित व्यवहार गर्ने, समसामयिक चुनौतीहरूको सफल व्यवस्थापन गर्नेलगायतका विशेषताले युक्त स्वावलम्बी, देशभक्त, परिवर्तनमुखी, चिन्तनशील एवम् समावेशी समाज निर्माणमा योगदान गर्न सक्ने सक्षमतासहितको नागरिक तयार गर्नु माध्यमिक शिक्षाको लक्ष्य रहेको छ। यही लक्ष्य पूर्तिको लागि विद्यालय शिक्षाको राष्ट्रिय पाठ्यक्रम प्रारूप, २०७६ को मापदण्डानुरूप विकास भएको माध्यमिक शिक्षा (कक्षा ९-१०) पाठ्यक्रम (अद्यावधिक २०८१) अनुसार कक्षा ९ को ऐच्छिक वातावरण विज्ञान विषयको यस पाठ्यपुस्तक तयार पारिएको हो।

यस पाठ्यपुस्तकको लेखन तथा परिमार्जन कार्यमा उमेशप्रसाद सापकोटा, श्री सञ्जीवनी योञ्जन श्रेष्ठ, श्री नवीन्द्रलाल कर्मचार्य र श्री लवदेव भट्टबाट भएको हो। पाठ्यपुस्तकलाई यस रूपमा ल्याउने कार्यमा केन्द्रका महानिर्देशक श्री युवराज पौडेल, विषय समितिका पदाधिकारीहरू डा. कमलप्रसाद आचार्य, श्री प्रमिला बखती, श्री मैया खड्का, श्री पुरुषोत्तम घिमिरे, श्री उमानाथ लम्साल, श्री केशरबहादुर खुलाल, श्री हेरम्बराज कँडेललगायत प्रा.डा. उद्धव खड्का, श्री सुभासचन्द्र खरेल, श्री राजेश्वर रिजाल र अन्य सरोकारवालाको विशेष योगदान रहेको छ। यसको भाषा सम्पादन श्री रजनी धिमालबाट भएको हो। यस पाठ्यपुस्तकको लेआउट डिजाइन श्री भक्तबहादुर कार्कीबाट भएको हो। यस पुस्तकको विकास कार्यमा संलग्न सबैप्रति पाठ्यक्रम विकास केन्द्र धन्यवाद प्रकट गर्छ।

पाठ्यपुस्तकलाई शिक्षण सिकाइको महत्त्वपूर्ण साधनका रूपमा लिइन्छ। यसबाट विद्यार्थीले पाठ्यक्रमद्वारा लक्षित सक्षमता हासिल गर्न मदत पुग्ने अपेक्षा गरिएको छ। यस पाठ्यपुस्तकलाई कसम्म समसामयिक क्रियाकलापमुखी, अनुभवकेन्द्रित, उद्देश्यमूलक र रुचिकर बनाउने प्रयत्न गरिएको छ। सिकाइ र विद्यार्थीको जीवन्त अनुभवविच तादात्म्य कायम गर्दै यसको सहज प्रयोग गर्न शिक्षकको भूमिका सहजकर्ता, उत्प्रेरक, प्रवर्धक र खोजकर्ताका रूपमा अपेक्षा गरिएको छ। पाठ्यपुस्तकलाई अभै परिष्कृत पार्नका लागि शिक्षक, विद्यार्थी, अभिभावक, बुद्धिजीवी एवम् सम्पूर्ण पाठकहरूको समेत महत्त्वपूर्ण भूमिका रहने हुँदा सम्बद्ध सबैको रचनात्मक सुभाषका लागि पाठ्यक्रम विकास केन्द्र हार्दिक अनुरोध गर्छ।

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INTRODUCTION TO ENVIRONMENT



Fig. a



Fig. b

According to the figures above, discuss the following questions:

1. What is the type of environment shown in fig a? Discuss.
2. What is the type of environment shown in fig b? Discuss.
3. Which may be the suitable environment (fig a or fig b)? Discuss.

1. Introduction

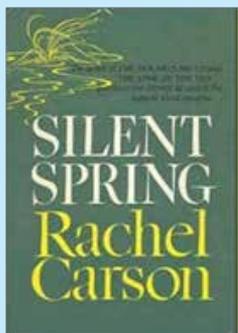
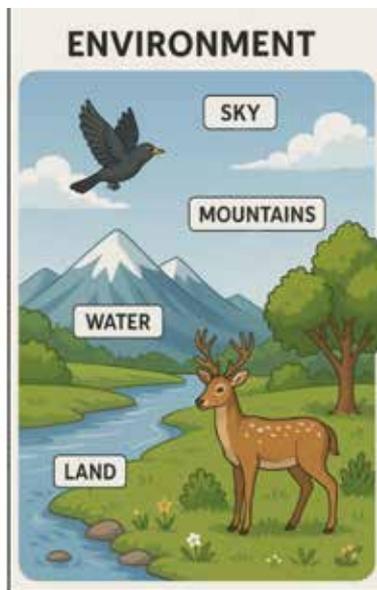
The surroundings consist of air, water, land and various biodiversity. It includes human beings as well as other living and non-living components. Thus, our surrounding consisting of both living and non-living components is called environment. All components of environment are interrelated with each other. We human beings are also interlinked with the environment socially as well as culturally.

Humans and all the living beings on the earth require adequate water, energy, food, nutrients, etc. from the environment as an essential factor to complete their lifespan. Humans need environment to make their life easier and comfortable. Likewise, increasing population, urbanization and industrialization have high negative impacts on the environment. So, the protection and conservation of the environment

is required. In this chapter, we learn about the introduction of environment and its importance, its components and the scope of environment science.

2. Concept of Environment

As discussed above, all the non-living and living components of a place are called environment. ‘Environment’ is derived from French word ‘Environner’ which means encircle or surround. There is an interrelationship between all living beings on Earth and various non-living elements such as air, water, soil, temperature, lights and more. The environment is the aggregate of animals and plants and the air, water, soil, light, heat, humidity, etc. that they require. If there is a disruption or a break in the relationship between them it affects the entire environment. If such a negative impact occurs on the environment, animals and plants can be endangered. Therefore, the existence of all life depends on sustaining the environment in its natural form.



SILENT SPRING (Rachel Carson)

Rachel Carson’s Silent Spring is generally regarded to have launched the environmental conservation movement. The book marked a milestone in environmental conservation by drawing the public’s attention to pesticide poisons and their effect on the environment and human health. Ultimately, Carson’s work served as the foundation for modern environmental conservation, interdisciplinary research, and problem-solving including natural resource conservation.

To this day, Silent Spring continues to inspire scientists, policymakers, and environmental conservationists to solve environmental problems. For example, after the publication of this book in 1962 AD, the United States of America banned the use of Dichlorodiphenyltrichloroethane (DDT) and similar kinds of poisons.

Activity 1.1: Living and Non-Living Things in My Environment

Objective: To enable students to distinguish between the living(biotic) and non-living(abiogenic) things in their surroundings. To be able to visualize the interrelationship between biotic and abiotic things (e.g., grass-cowman, water-plant-bird, etc.) through a poster.

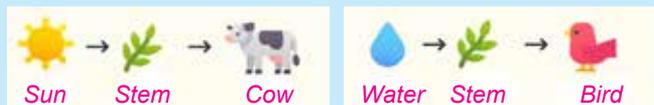
Required Materials: Notebook, Pencil, Colored pens, Chart paper, Colored Markers

Procedure: Observation: Ask students to observe environment around their home and school (e.g., courtyard, garden, playground, road, etc.) and ask them to list what they observe as shown in the table and then work in groups to create posters.

S.N	Living Things	Non-Living Things
1	Plants/Tree	Stone
2	Cow	Soil
3	Birds	Air
4	People	Water
5	Dog	Sun

Finding Relationship: Discuss the relationship between the subjects. For example, Plants get energy from the sun and release oxygen which is breathe by humans and animals, Plants and animals cannot survive without water.

Making a Chart/Poster: Students are asked to create a picture showing the relationship on a colored paper. Example,



Presentation and Discussion: Paste the prepared chart or poster in the walls of classroom or school and present it to your classmates.

Instructions to Teacher: Encourage students to perform real-world observations. Discuss the importance of environmental conservation and the balance between living and non-living things.

3. Importance of Environment

The existence of humans and other living creatures on Earth is possible because of the different elements present in the environment and the relationship between them. The environment is important for maintaining the existence of both living and non-living things. Some of its importance are as follows:

Biodiversity

Biodiversity refers to the wide variety of plants, animals, microorganisms, fungi and ecosystems they form on Earth. It helps to maintain the nature and provides human with food, medicine, raw materials, and a clean, healthy environment.

Ecosystem Services

The environment not only supports life but also provides various goods and services necessary for human survival. For instance, the food, shelter, and clothes (cotton) required by humans are acquired from the environment. Likewise, the natural resources needed for the economic growth and infrastructure of a region or a community are also derived from the environment. The environment and natural resources provide a social and cultural foundation to an area. The environment with its natural scenery and biodiversity gives beauty and recreation to people. Since different types of ecosystem services arise from the environment, it is of great importance to all humankind.

Climate Balance

The environment plays an important role in maintaining the Earth's climate balance. It helps keep temperature and weather in a balanced state by maintaining the water cycle and carbon cycle on Earth.

Human Health

The environment is related to human health. For example, a proper environment is needed to get clean air, water, and food.

4. Environmental Components

The environment is made up of living and non-living components. The non-living things in the environment are called abiotic components, and the living things in the environment are called biotic components.

Abiotic Component

The following elements are included under abiotic components:

- 1. Air:** Air is an important component of the environment. Because of air, the existence of living creatures on Earth is possible. The layer of air that surrounds the Earth is called the atmosphere (Figure 1.1). Most of the atmosphere extends up to about 500 km from the Earth's surface. However, the distribution of air in the atmosphere is not uniform. As the altitude increases from the Earth's surface, the air becomes thinner. The atmosphere is divided into different layers based on height. The layer up to about 16 km from the Earth's surface is called the troposphere. The layer from 16 km to 50 km is called the stratosphere. The layer from 50 km to 85 km is called the mesosphere. The layer from 85 km to 100 km is called the thermosphere. The layer from 100 km to 500 km is called the exosphere. About 95% of the air is found in troposphere and the remaining 5% is in the upper layer. In these layers of atmosphere processes like lightning, cloud formation, rain, hail, and dew take place.

The atmosphere is made up of a mixture of different gases. It contains about 78% nitrogen, 21% oxygen, and 1% other gases. The oxygen in the atmosphere is the life supporting gas for all living beings. Carbon dioxide is used by plants to make food. Air also helps in pollination and the dispersal of seeds in plants. Moreover, air plays a positive role in bringing seasonal rainfall and supporting the existence of living creatures. However, processes like storms and tornadoes can have negative impacts such as blowing away loose soil and dust, causing soil erosion, reducing soil fertility and bringing fire, drought and strong winds.



Figure 1.1

2. **Water:** Water is the basis of life for all living beings. About 60 to 90 percent of the weight of the various animals and plants is made up of water. Since water plays a special role in the growth, development, spread and reproduction of living beings, it is very important.
3. **Soil:** Soil is an important component for various plants and animals. Many animals live in the soil and plants obtain essential salts, minerals and water from it. Soil is made up of air, water, minerals and organic matter. It contains various elements needed by plants such as nitrogen, phosphorus and potassium. The amount of humus in the soil determines whether the soil is acidic, alkaline or neutral. Humus also helps the soil to retain water. Microorganisms like fungi and bacteria decompose the remains of living organisms in the soil by breaking them down into soluble minerals. Plants then absorb these water-soluble minerals through their roots.
4. **Temperature:** The measurement of heat or cold in any object is called temperature. Temperatures are not the same in all places on Earth. There is a relationship between living beings, plants and temperatures. Generally, living organisms can survive in temperatures ranging from -10°C to 50°C . Temperature directly affects the growth and development of living beings.
5. **Light:** The main source of light is the sun. Light affects all aspects of the environment. All living beings get energy from light. Light plays an important role in life processes such as the growth and reproduction of plants and animals. With the help of light, plants make their own food, which is then consumed by other living beings. This continues through various food chains. The size and growth of plants, the condition of chlorophyll, leaf size, and the development of fruits and seeds are determined by the availability of light. Light energy is converted into chemical energy, directly affecting life processes such as the distribution and spread of plants and animals, movement, behavior, migration and reproduction.
6. **Humidity:** The amount of water present in the atmosphere as vapor is called humidity, Water vapor in the air is invisible. Water from various sources on the Earth's surface evaporates and enters the air. Humidity is higher in areas with evergreen forests and lower in deserts and dry lands. The amount of humidity in the air is determined by factors such as the Earth's surface temperature, altitude from sea level, wind speed, and forests. Humidity plays an important role in the life processes of plants and animals. In areas with dry air, plants

transpire (release water) more quickly. Plants like orchids, moss, and fungi obtain much of the water they need from humidity.

7. **Topography:** The topography of a place plays a special role in shaping its environment and suitable plants and animals are found in those areas. In other words, which plants and animals can thrive in a particular place depends on their geographical conditions. The topography of a place is explained according to the following landforms:

Altitude: Altitude refers to how high a place is above sea level. On the Earth's surface, there are mountains, hills, flat plains and valleys. These places are located at different altitudes above sea levels. The altitude of a place affects temperature, rainfall, humidity, atmospheric pressure and wind speed. As a result, the environment varies with altitude and different types of plants and animals are found in different environments. In high mountain areas, plants like pine and fir grow and animals like yak and highland cattle live there. In the lower altitude Terai region, plants like sal and sisau grow and animals like tigers, rhinos and elephants are found.

8. **Slope:** The steepness of the land also affects the environment of a place. On very steep land, rainwater cannot stay and the area remains dry. Therefore, comparatively fewer living beings are found there. On flat land, rainwater can stay easily, allowing plants to grow and thrive. Sunlight falls at an angle on steep surface and directly on the flat surfaces, causing differences in temperature. As a result, the type of plants and animals found in these areas are also differ.
9. **Aspect:** Sunlight does not reach all parts of the Earth at the same time or in the same way. The slope of the land also affects the environment of a place. On the southern slope of a hill, sunlight falls directly, so the temperature is usually higher. On the northern slope, sunlight does not fall directly, so the temperature is lower, and the air is more humid. Different environments support the existence of different plants and animals.

Biotic Components: The living components of the environment are called biotic components. This includes all animals and plants. The presence and activities of these animals and plants play an important role in shaping the environment of a place. For example, microorganism in the soil helps by providing various minerals and nutrients needed by plants. Similarly, earthworms in the soil make it fertile and help increase production. Plants and

animals in the environment are interconnected and constantly interact with each other. These interactions can be positive or negative.

If the interaction between two or more living beings benefits one or both without harming the other, it is called positive interaction. For example, bees and butterflies pollinate plants while getting food from the flowers (fig 1.2).



Figure 1.2

If the interaction between two living beings harms one or both, it is called negative interaction. For example, when a bee stings a human, it harms the person, and the bee may die as well.

Based on nutrition, biotic components are divided into three main groups:

- a) **Producer:** Organisms that can make their own food alcohol producers. Producers take water and minerals from the soil and carbon dioxide from the atmosphere to produce starch. They use part of it for their own survival and store their remaining nutrients. In this way, the nutrients stored by self-feeding plant become available for other organisms that cannot make their own food.
- b) **Consumer:** Organisms that depend on other living beings for food are called consumers. Animals that eat producers are called primary consumers. Animals that eat primary consumers are secondary consumers and those that eat secondary consumers are called tertiary consumers. For example, grass eating insect and Locusts are primary consumers, frogs that eat them are secondary consumers and snake that eat frogs are tertiary consumers.
- c) **Decomposer:** Organisms that decompose dead living beings, breaking down their organic materials into abiotic minerals and returning them to the soil are called decomposers. For example, bacteria, fungi, etc.

1.4 Environmental Science

The environment refers to the collective state of living and non-living things around a place. Science refers to knowledge based on facts. Therefore, environmental science means the factual study of the physical, chemical and biological aspects of the environment and its components around us.

Activity 1.2: The relationship between biotic and abiotic components in our environment

Objectives: Students will be able to distinguish between the biotic and abiotic components of the environment, understand the interdependence between these components, and practically experience how environmental balance is maintained. They will also be able to develop skills through group discussions and presentations.

Required Materials: Chart paper or flex sheet, markers, tape, colored pens, camera or mobile (for taking photos), and samples of natural objects (leaves, soil, stones, water, small insects, etc.).

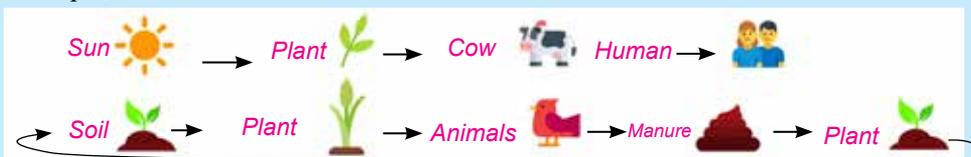
Steps of the Activity: Observation: Go around the school premises, garde, field, or home and make a list of the biotic and abiotic components you see there.

S.N	Biotic Components	Abiotic Components
1	Plants	Sunlight
2	Cow	Soil
3	Human	Water

Finding Relationships: Discuss groups and write down the relationships between these components.

1. Plants make food using sunlight, water, and nutrients from the soil.
2. Birds and animals depend on plants.
3. Water and temperature directly affect biological activities.

Visual Presentation: students use arrows to create an ecological web to show these relationships. For example,

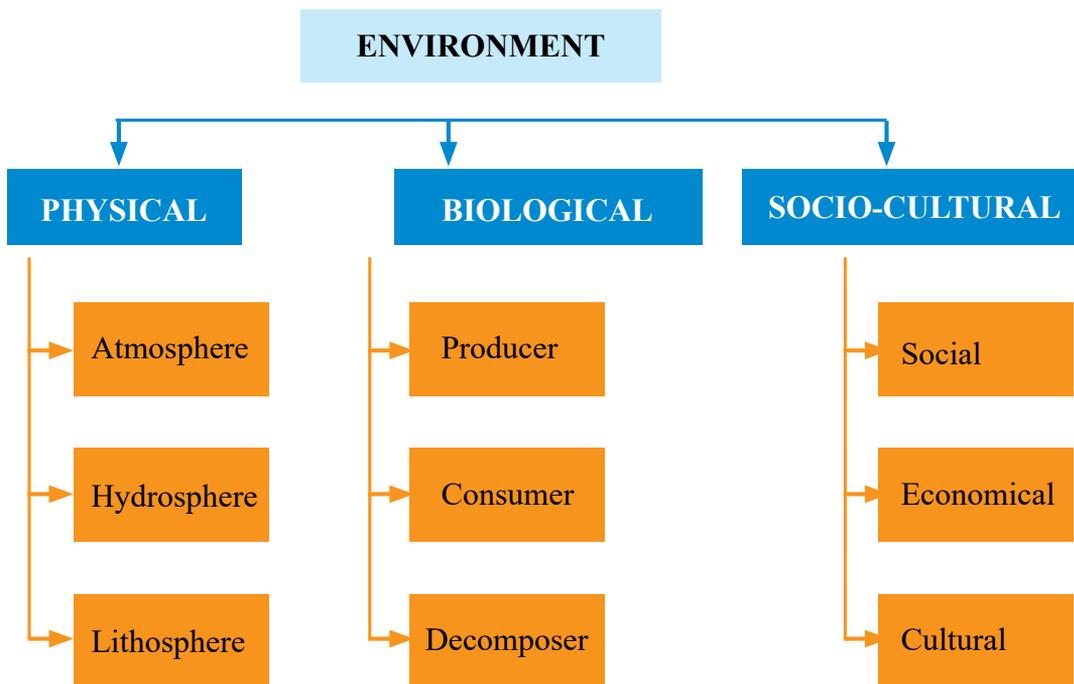


Explanation:

1. The sun provides energy.
2. Plants make food through photosynthesis.
3. Cows or goats eat these plants.
4. Humans get energy when they eat milk, meat or fruit.
5. Animal waste (manure) returns to the soil and provides nutrients for new plants.
6. In this way, the cycle continues.

Experimental Practice: Plant a small plant in a pot and take care of it for two weeks. Give regular water to one pot and no water to another. In this way, compare the effect of the abiotic component (water).

Presentation and Conclusion: Each group presents their chart or poster in the class and concludes that biotic and abiotic components depend on each other.



Discuss the questions based on the above picture:

1. How does the study of the environment help in its conservation?
2. What are the components of the environment, and how do they make life possible on Earth?
3. In your opinion, what can be the role of students in environmental conservation?

With the increase in human population on Earth, the rising demand for basic needs has put more pressure on environmental resources, causing negative effects. Due to industrialization and urbanization, the impact on the environment has increased, creating a need for environmental science to study and conserve it. Environmental science studies the components of the environment, their interrelationships, and ways to protect them. The subject is interdisciplinary in nature.

Due to the rapid development of science and technology, socio-economic changes, and a high-consumption lifestyle, natural resources are under excessive pressure, leading to their depletion. Many of these resources have reached a stage where they cannot be easily restored. Environmental problems such as deforestation, soil

erosion, loss of soil fertility, floods, landslides, avalanches, glacial lake outburst floods, and rising sea levels are increasing day by day. Similarly, water pollution, air pollution, soil pollution, and noise pollution are also growing. Such imbalances in the natural environment put the existence of humans and other living species at risk. Studying these issues through environmental science helps find solutions to protect and restore the environment.

The importance of environmental science can be presented as follows:

1. Environmental science provides knowledge about measures needed to protect the environment.
2. It helps in the conservation of natural resources.
3. Through environmental science, we can understand concepts related to climate change and pollution management.
4. It provides knowledge about biodiversity conservation and the interrelationship among various environmental components.
5. It guides the formulation of policies and regulations necessary for environmental protection.

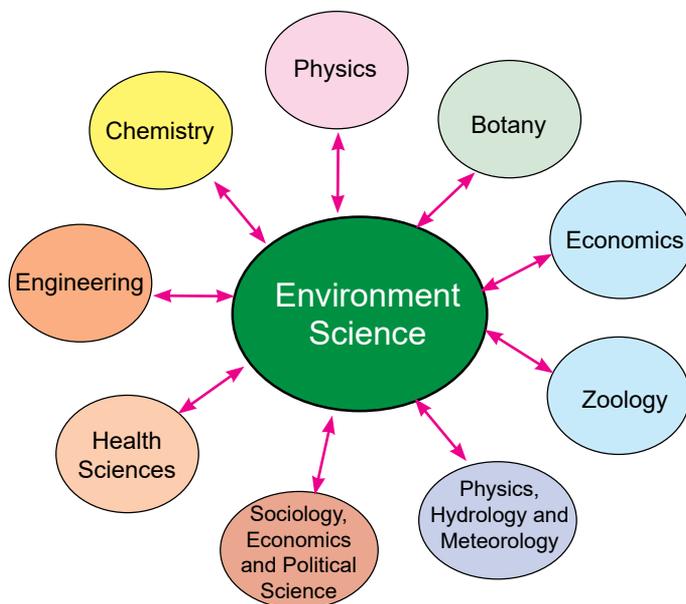


Fig.1.3

Activity 1.3

Supporting Subjects of Environmental Science

Objectives:

Students will be able to identify various subjects related to environmental science.

Understand how each subject contributes to solving environmental problems and developing presentational skills.

Required Materials

- Chart Paper/ A4 paper
- Colored pens, sketches, pencils
- Scissors
- News, pictures, or facts related to the environment (if possible)
- Tape/ stickers

Activity Process:

Step 1: Group Division (5 minutes)

Divide students into 5 to 7 groups.

Assign each group one of the following subjects:

1. Chemistry
2. Botany and Agricultural Science
3. Zoology
4. Geology, Water, and Meteorology
5. Social, Economic, and Political Science
6. Health Science
7. Physics and Engineering

Step 2: Research and Brainstorming (25 minutes)

- Each group discusses how their subject is related to environmental science.
- Find at least 2 examples or projects (eg., the role of chemistry in climate change, environmental effects in agricultural systems).
- Make a poster with main points, and include pictures, data, or creativity.

Step 3: Presentation (15 minutes)

- Each group presents their chart/ poster (2-3 minutes).
- Explain how their subject contributes to solving environmental problems.

Step 4: Review and Discussion (5-10 minutes)

- Which subjects seem the most important?
- How do all the subjects together make environmental science complete?

Exercise

1. Give very short answers to the following questions:

1. What is the environment?
2. Into which parts can environmental components be divided?
3. What are biotic components?
4. What are abiotic components?
5. List the abiotic components of the environment.
6. What is environmental science?

2. Give short answers to the following questions:

1. Mention the importance of the environment in points.

2. Give a short description of the abiotic components of the environment.
3. Describe environmental science with an example.

3. Give long answers to the following questions:

1. Identify positive relationships among living beings and explain with examples.
2. Explain negative interactions among living beings with examples.
3. Explain how studying environmental science helps in environmental conservation.
4. Explain with reasoning how the geographical condition of land affects the environment.

Project Work:

Organize a speech competition in the class on the topic “Importance of Environmental Science” and participate in it. The teacher will act as the judge for this activity.

ECOLOGY AND ECOSYSTEM



Based on the above picture, discuss on the following questions.

- What things are shown in the picture?
- Amongst the things shown in the picture, prepare a list of biological and non-biological things.
- What type of relationship is between biological and non-biological things?

2.1 Introduction

We and our surrounding environment are made up of biological and non-biological things. If you are a vegetarian, then your food includes greens, vegetables, grains, beans, fruits, etc. Some of us are omnivorous, who eat greens, vegetables, grains, beans, fruits, along with meat. The primary source of food for every organism on Earth is vegetation. Green plants, through the process of photosynthesis, take up

water and minerals from their roots and, with the help of carbon dioxide, prepare their food. This food is then available to humans and other organisms. In the environment, besides living things, non-living things are also present: air, water, humidity, heat, light, soil, etc.

An ecosystem is defined as the interaction between living (biotic) and non-living (abiotic) components in a specific area, resulting in a sustainable system. The relationships among the various components in the environment contribute to a thriving ecosystem. In an ecosystem, every element forms interconnection with others, creating dynamism. This dynamism is generated by every living organism as it interacts with the environment for its survival.

2.2 Ecology

Living beings in nature are interrelated with each other and with their surrounding environment. The science that studies the relationship between organisms and their environment is called Ecology. The word 'Ecology' is derived from two Greek words: 'oikos' and 'logos'. Here, 'oikos' means 'house' or 'habitat', and 'logos' means 'study'. Therefore, Ecology encompasses the study of organisms and their habitats. The term 'Ecology' was first used by the German scientist Ernest Haeckel in 1866. Because the study of Ecology requires the methods and principles of other subjects like chemistry, physics, biology, and mathematics, it is considered an interdisciplinary science. The living beings on Earth can be classified into different levels. Thus, the study in Ecology can be conducted by classifying organisms from the smallest to the highest level as follows:

(a) **Organism/Species:** An individual living form, from Unicellular to Multicellular, is an organism. For example, bacteria, amoeba, etc., are microscopic unicellular organisms, while birds, plants, and animals are multicellular organisms.

A group of organisms with similar shape, behavior, and genetic characteristics is called a species. For instance, a crow is one species, and a human is another species. It is estimated that there are 50 to 100 million species on Earth, but only about 1.8 million species have been identified so far.

(b) **Population:** The total number of individuals of a single species in a specific area at a specific time is called the population of that species. For example, the number of a specific fish species in a pond represents the population of that species.

- (c) **Community:** The group of two or more different species living in a specific area at the same time is called a community. For example, the various living beings, plants, and microorganisms in a pond represent that pond's community. This community can also be studied as a microbial community, a plant community, or an animal community.
- (d) **Ecosystem:** A functional system formed by the interaction between organisms themselves and between organisms and abiotic components in a particular area is an ecosystem. The various living beings and the air, water, soil, and food, etc., present in a pond constitute the pond's ecosystem.
- (e) **Biome:** A group of ecosystems with similar types of plants and animals, found in a specific type of climate, is called a biome. Such biomes are found in various places on Earth, for example, tropical rainforests, temperate deciduous forests, etc.
- (f) **Biosphere:** The unique combination of living beings, ecosystems, and the environment present in Earth's hydrosphere, lithosphere, and atmosphere forms the biosphere. In reality, the biosphere itself is a large ecosystem where biotic components obtain food and energy from abiotic components. In a natural environment, there is a great diversity of living beings. Living beings are found from sea level up to about 10 km in altitude and from sea level down to about 8 km in depth in the oceans.

2.3 Ecosystem

The system formed by the continuous interaction between living beings and abiotic components in a particular place on Earth is called an ecosystem. In an ecosystem, living beings obtain food and energy from non-living things. The Earth itself is a large ecosystem. However, based on the characteristics of the plants and animals found in a particular place, this complex ecosystem is studied by dividing it into different smaller ecosystems like forest ecosystems, desert ecosystems, grassland ecosystems, aquatic ecosystems, etc. Therefore, an ecosystem can range from a very small area like a pond or a log to a large area like a desert, ocean, or forest.



The ecosystems found in the natural environment, like forests, deserts, grasslands, ponds, rivers, lakes, oceans, etc. are all-natural ecosystems (Fig. 2.1). But the ecosystems like ponds, reservoirs, agricultural land, artificial lakes, and ponds developed by humans by modifying natural ecosystems for their own use are called artificial ecosystems (Fig. 2.2). The uniquely beautiful and diverse Himalayan lake present in Nepal's natural beauty can be taken as an example of an important artificial ecosystem. Both natural and artificial ecosystems have their own distinct characteristics, and the comparative features between these two are mentioned in Table 2.1.



Pic. 2.1: Natural Ecosystem



Pic. 2.1: Human-made Ecosystem

Table 2.1: Natural and Artificial Ecosystems

Natural Ecosystem	Artificial Ecosystem
High species and genetic diversity.	Generally low species and genetic diversity.
Sunlight is the primary source of energy.	Besides sunlight, chemical fertilizers and other nutrients are added to the soil from outside.
The food chain is long and complex.	The food chain is short and simple.
They are self-sustaining.	They are managed and controlled by humans.

Our country Nepal, despite being small in area and landlocked, possesses great geographical diversity. This geographical diversity results in varied climates across different regions of Nepal. For instance, the Terai region experiences high

temperatures, while the Himalayan region remains snow-covered year-round. Similarly, the Hilly region receives significant rainfall but without extreme temperatures, resulting in a moderate climate. This geographical and climatic diversity leads to a corresponding diversity in ecosystems. Due to such local conditions and resources, Nepal is situated between two major geographical regions: the Indo-Malayan region in the south and the Palearctic region in the north. This location is also why many types of ecosystems are found here. A total of 118 types of ecosystems have been identified in Nepal. Among these are 112 types of forests, 4 types of grasslands, one aquatic ecosystem, and one glacier/riverbed ecosystem. The distribution of these ecosystems according to geographical region is as shown in Table 2.2.

Table 2.2: Distribution of Nepal's Ecosystems by Geographical Region

S.N.	Geographical Region	Number of Ecosystems	Percentage of Ecosystems (%)
1.	Himalayan and High Mountain Region	38	32.2
2.	Hilly Region	53	44.9
3.	Middle Mountain Region	14	11.9
4.	Terai Region	12	10.2
5.	Aquatic Ecosystem	1	0.8
	Total	118	100.0

Source: Biodiversity Profile Project 1995

2.4 Components of an Ecosystem

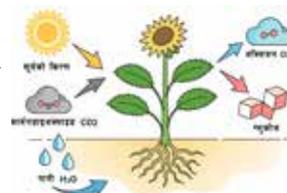
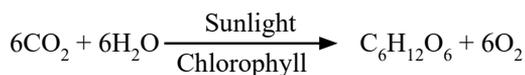
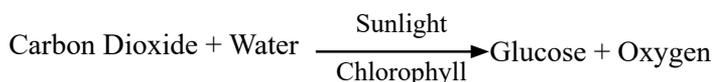
The components of any ecosystem can be classified into two groups: abiotic and biotic.

- (a) **Abiotic Components:** The non-living things present in nature play a role in the ecosystem. These non-living things are called abiotic components. Abiotic components include: Light, Temperature, Humidity, Atmospheric Pressure, Air, Water, Soil, Nutrients, Oxygen, Carbon Dioxide, etc.

(b) **Biotic Components:** All living beings (e.g., plants and animals) are the biotic components of the ecosystem. The biotic components of an ecosystem are functionally classified into three types: producer, consumer and decomposer.

(i) **Producer (Autotrophs):** Living beings that can produce their own food are called producers. Since these producer organisms produce their own food by taking necessary materials from the environment, they are also called autotrophs.

All the green plants found on land and the green plants found in water, such as mosses and phytoplankton, are the producers of that ecosystem. Green producers convert the carbon dioxide and water obtained from the environment into glucose using sunlight. This process is called photosynthesis. The photosynthesis process can be represented by the following chemical equation:



Some bacteria can also produce their own food using chemicals obtained from the environment. This process is called chemosynthesis.

(ii) **Consumer:** Living beings that cannot produce their own food and depend on other living beings for food are called consumers. Since these living beings obtain the necessary food and energy from other living beings, they are called heterotrophs. For example: tigers, lions, birds, snakes, frogs, fish, etc., are consumer organisms.

(iii) **Decomposer:** In an ecosystem, the organisms that break down the complex organic matter of dead plants and animals into simple inorganic substances, and convert them into nutrients that can be reused by producers, are called decomposers. Examples include bacteria and fungi. In this way, decomposers play a special and essential role in the nutrient recycling process.

Activity 2.1: Constructing an Ecosystem in an Aquarium

Required Materials:

1. A large glass bottle or jar
2. Gloves
3. Small pebbles and gravel
4. Fertile black soil, lichens, small branches of plants
5. Small plants and fern leaves (of various species)
6. Coal
7. Water



Figure 2.3: Ecosystem in an Aquarium

Construction Method:

1. Clean the glass aquarium thoroughly and allow it to dry completely before use.
2. Place a layer of gravel at the bottom of the aquarium, followed by a small amount of charcoal, which helps absorb impurities and reduce foul odors caused by the decomposition of biological materials. On top of this, add a layer of fertile black soil and gently press it down using your hand or a spoon.
3. Carefully plant small lichens and other suitable plants, then add approximately one cup of water. Cover the aquarium from the top, ensuring there are small openings to allow air exchange.
4. Place the prepared bottle garden in a cool location with adequate sunlight, avoiding direct exposure to strong sunlight. Observe the changes occurring inside the bottle regularly and record your observations. Remove dried or decaying leaves periodically using scissors.
5. To maintain adequate moisture levels, add water as required at regular intervals.
6. In this way, the bottle can function as a miniature greenhouse, within which a small, self-sustaining ecosystem can be developed.

2.5 Types of Ecosystems

Ecosystems can be broadly classified into two main types:

- (a) Terrestrial Ecosystem
- (b) Aquatic Ecosystem

(a) Terrestrial Ecosystem

An ecosystem formed by the interrelationship between biotic and abiotic components found on land is called a Terrestrial Ecosystem. This category of ecosystem includes: Forest ecosystems, Grassland ecosystems and Desert ecosystems. Terrestrial ecosystems are formed by the interrelationship between abiotic and biotic components. Abiotic resources include air, water, soil, humidity, temperature, sunlight, etc. Similarly, regarding biotic components, all kinds of green plants act as producers, animals act as consumers, and microorganisms act as decomposers. In this ecosystem, producers use abiotic components to produce food. Consumers eat the producers and conduct their life processes. Decomposers break down dead producers and consumers and convert the nutrients present in them into simple and reusable substances. In this terrestrial ecosystem, energy is transferred from one level of organisms to another.



Figure 2.4 Desert Ecosystem



Figure 2.5: Shuklaphanta Grassland



*Figure 2.6:
The Himalayan Ecosystem in Mustang*

(b) Aquatic Ecosystem

Approximately 71% of the Earth's surface is covered by water. Therefore, aquatic ecosystems are the largest type of ecosystem on Earth. In aquatic ecosystems, there is an interrelationship between abiotic and biotic components. Abiotic components include air, water, soil, humidity, temperature, sunlight, etc. Similarly, among biotic components, microscopic algae (phytoplankton), seaweeds, and other aquatic plants function as producers; zooplankton, fish, and other aquatic animals function as consumers; and microorganisms function as decomposers. In this ecosystem,



Figure 2.7 Wetland Ecosystem

producers use abiotic components to produce food. Consumers eat the producers and carry out their life processes, while decomposers break down dead producers and consumers and convert the nutrients present in them into simple, reusable substances. In this aquatic ecosystem, along with food, energy is also transferred from one trophic level to another. This category of ecosystem includes freshwater ecosystems such as rivers, lakes, ponds, and streams (Figure 2.7).

2.6 Food Chain and Food Web

Organisms obtain the food and energy needed for their survival and development from another level. Saprophytic microorganisms break down dead plants and animals, convert them into simple inorganic compounds, mix them into the soil, and make them reusable for plants. The transfer of food and energy from one trophic level to another in this way is called a food chain. For example, green plants produce carbohydrates, minerals, and oxygen by using sunlight through the process of photosynthesis in the presence of chlorophyll. Grasshoppers eat green plants, and frogs eat grasshoppers. In this way, food and energy are transferred from one trophic level to another. Thus, a food chain generally begins with producers. All other organisms besides producers are consumers. The different levels in a food chain are called trophic levels. A food chain can typically be represented by the following levels:

Producer → Primary Consumer → Secondary Consumer → Tertiary Consumer

In the biotic component of an ecosystem, energy is transferred from one trophic level to another through the food chain. When energy is transferred from one level to another, only about 10% of the energy is used in its life processes, while about 90% of the energy is lost.

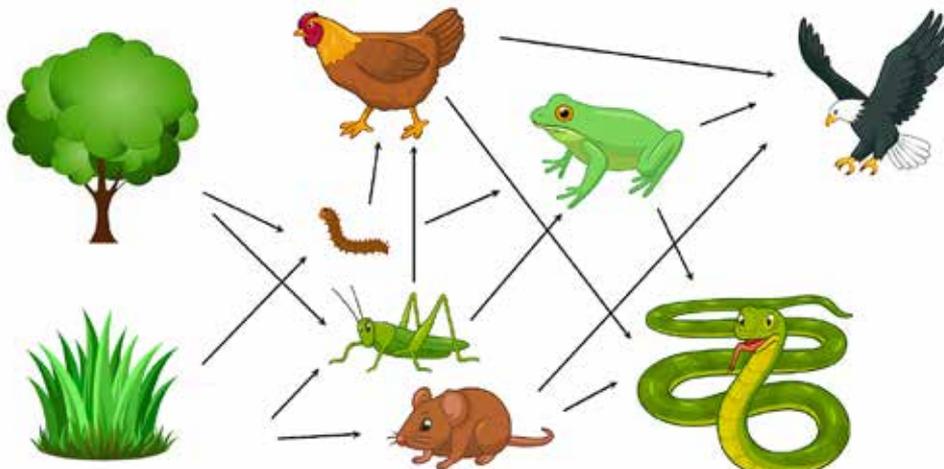


Figure 2.8 : Example of Food Web

Generally, the transfer of food and energy is not as simple and linear as shown in a food chain. Many organisms participate in different food chains simultaneously. For example, a single consumer may use multiple types of organisms as its food. Similarly, many organisms may be eaten by more than one type of consumer. For example, in the diagram above, a single organism (grasshopper) is consumed by multiple organisms (frog and eagle), forming a complex food web. In this process, many food chains interconnect to form a complex network (Figure 2.8). This complex interconnected network of food chains is called a food web.

A food chain alone cannot fully represent or stabilize any ecosystem. For example, in a forest ecosystem, if herbivores like deer eat green plants, and carnivores like lions and leopards eat those herbivores, if for some reason the deer population decreases, the lions and leopards may suffer from food shortages and decline, destabilizing that ecosystem. On the other hand, if the food web in a forest ecosystem is more complex, the ecosystem remains more stable and resilient. For example, in a forest, if not only deer but also other herbivores like rabbits and wild boar are present, the ecosystem remains stable and resilient. Thus, food webs play a crucial role in maintaining the stability and balance of an ecosystem.

2.7 Ecological Pyramid

In any ecosystem, organisms at one trophic level are used by organisms at another trophic level to carry out their life processes. Within this system, organisms at different trophic levels can be represented in the form of a pyramid, which is called an ecological pyramid. For example, producers form the base of the ecological pyramid, while primary, secondary, and tertiary consumers occupy successively higher levels.

The area of each level of this pyramid represents the number, biomass, or energy present at that trophic level. Accordingly, ecological pyramids can be studied by classifying them into the following three types:

- a. Pyramid of biomass
- b. Pyramid of energy
- c. Pyramid of numbers

a. Pyramid of biomass

Study the figure below and discuss the following questions:

- (i) At which trophic level of the pyramid is biomass the highest?
- (ii) Why does the biomass gradually decrease from the base level to the upper levels of the pyramid?

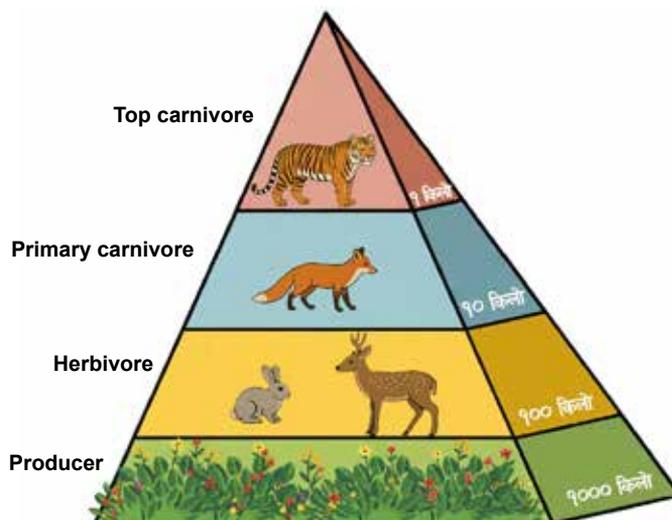


Figure 2.9: Pyramid of Biomass in a Terrestrial Ecosystem

In an ecosystem, the pyramid of biomass is constructed based on the biomass of organisms at different trophic levels. Generally, the biomass of producers is greater than the biomass of organisms at other trophic levels. In terrestrial ecosystems, because the biomass of producers is generally greater, the base area of the biomass pyramid is large, and the area of the higher consumer levels gradually decreases (Figure 2.9). However, in aquatic ecosystems, producer plants have low biomass, while the biomass at consumer levels is higher, causing the pyramid to appear inverted (Figure 2.9).

b. Pyramid of Energy

In an ecosystem, a pyramid can also be constructed from the energy present at different trophic levels. In this type of pyramid, the energy present in producer organisms is greater than the energy present in organisms at other trophic levels. Thus, the pyramid of energy shows the transfer of energy through the food chain in any ecosystem (Figure 2.10). Generally, when energy is transferred from one trophic level to another, only 10% of the energy passes to the next level.

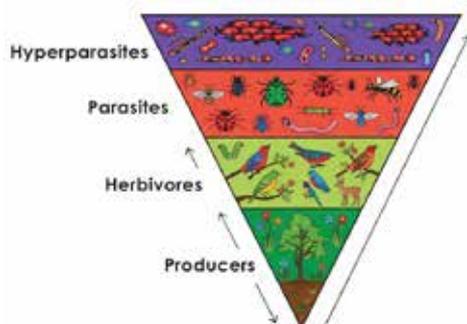


Figure 2.10: Pyramid of Energy

As energy is transferred from primary consumers to secondary and tertiary consumers, only about 10% of the energy is passed from each level to the next. Therefore, in the food chain of an ecosystem, trophic levels typically range from 5 to 6. For example, in a grassland ecosystem, if the total solar energy converted by grass is considered 100%, then only 10% of that energy is transferred to the grasshopper (primary consumer). Similarly, if the grasshopper is eaten by a frog (secondary consumer), only about 10% of the energy from the grasshopper is passed to the frog. As energy transfer continues upward, by the time it reaches the secondary consumer, only about 1% of the original energy from the producer is available for use. Thus, in an ecosystem, the pyramid of energy always takes an

upright (tapering upward) shape, because energy continuously decreases at each trophic level.

c. Pyramid of Numbers

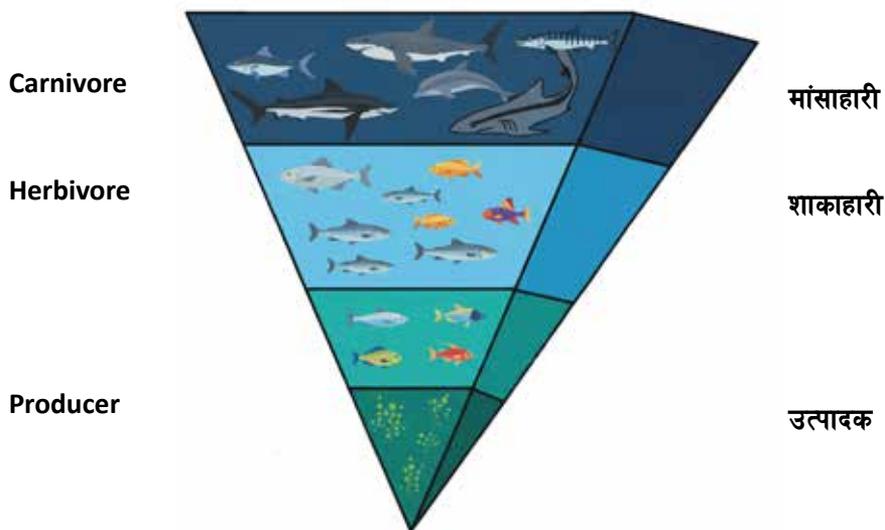


Figure 2.11: Pyramid of Numbers

A pyramid of numbers is formed by the number of organisms at different trophic levels in any ecosystem. This pyramid can be upright or inverted. In an upright pyramid, the number of organisms decreases at each successive trophic level. For example, in grassland and aquatic ecosystems, the number of producer organisms is high, and the number of consumer organisms at different levels gradually decreases (Figure 2.11). However, in a forest ecosystem, the number of producer organisms is fewer, and the number of consumer organisms at different levels gradually increases, making the shape of the pyramid inverted.

Activity 2.2: Formation of a Food Web

Materials:

- (a) A ball of wool/yarn
- b) A photograph of the sun, and various plants and animals on a flash card
- (c) A tape

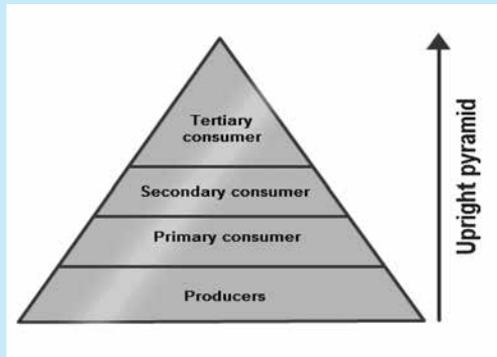


Figure 2.12: Pyramid of numbers in a grassland and pond ecosystem

Method:

- (a) All participating students should attach flash cards to their chests using tape. They should then form a circle and introduce the plants or animals shown on their cards to the group. The student holding the picture of the Sun should stand at the center of the circle.
- (b) The student representing the Sun should hold one end of a ball of yarn and pass the yarn to a student representing a plant (producer).
- (c) The student representing the producer should hold the yarn and pass the yarn ball to another student representing an animal that feeds on that plant, such as a grasshopper (a primary consumer).
- (d) The yarn should then be passed to a student representing an animal that feeds on the grasshopper, such as a frog (a secondary consumer).
- (e) Continue this process, gradually creating connections, until all students are linked together by the yarn, forming a food web.

- (f) Now consider the occurrence of a natural disaster, such as a grassland fire. The students representing grass should drop the yarn. Discuss which organisms will be affected if the grass is eliminated.
- (g) Identify animals that feed exclusively on grass. These organisms will face food shortages, and the students representing them should drop the yarn. Similarly, animals that depend on these herbivores will also be affected due to reduced food availability.
- (h) As this process continues, observe how the food web gradually weakens and ultimately breaks down, demonstrating the interdependence within an ecosystem.

Conclusion: Why should we protect every species in an ecosystem? The above activity shows that in a food web, every species is interconnected. Therefore, if one component of an ecosystem is damaged, the entire food web can be disrupted.

Exercise

1. Answer the following questions briefly:

- (a) What is ecology?
- (b) Name the scientist who first introduced ecology in practice.
- (c) What is an ecosystem?
- (d) What is meant by a man-made ecosystem?
- (e) What is an aquatic ecosystem? In how many classes can it be classified? Classify them.
- (f) What is a trophic level?
- (g) What is an ecological pyramid? How many types are there? List them.
- (h) What are abiotic components? Through which processes do organisms obtain abiotic components? Give any two processes.

2. Answer the following questions in short:

- (a) Differentiate between natural and artificial ecosystems with examples.
- (b) Write short notes on:
 - (i) Natural disaster
 - (ii) Population
 - (iii) Community
 - (iv) Habitat
 - (v) Niche
- (c) Differentiate between the following:
 - (i) Ecology and ecosystem
 - (ii) Natural ecosystem and artificial ecosystem
 - (iii) Producer and consumer

- (iv) Food chain and food web
- (v) Biotic and abiotic components
- (d) Under which trophic level should a omnivorous consumer be placed? Give reasons.
- (e) Draw an aquatic ecosystem with a pyramid of biomass.
- (f) Classify and describe a forest ecosystem briefly.

3. Answer the following questions in detail:

- (a) Show the relationship between organisms and their environment by arranging them in different trophic levels in ecology.
- (b) What are the benefits of classifying ecosystems? Explain.
- (c) Compare the ecological structure of a temperate grassland (Savannah) ecosystem with Nepal's Shuklaphanta grassland ecosystem, highlighting their similarities and differences.
- (d) Explain the relationship between a food chain, food web, and trophic level with the help of a diagram.
- (e) Describe the pyramid of biomass in an aquatic ecosystem with a diagram.

Project Work

1. Study any terrestrial ecosystem near your locality and list the possible producers, consumers, and decomposers found there. Also, prepare a diagram showing what kind of energy pyramid, biomass pyramid, and pyramid of numbers might exist there, and present it in your classroom.
2. Study any aquatic ecosystem near your locality and list the possible producers, consumers, and decomposers found there. Also, prepare a diagram showing what kind of energy pyramid, biomass pyramid, and pyramid of numbers might exist there, and present it in your classroom.

NATURAL RESOURCES



Study the given diagram above and answer the following questions:

1. List the sources of energy we can obtain from using natural resources.
2. From which natural resources can the energy sources shown in the above diagram be obtained?
3. Among the energy sources shown above, which are environment friendly and which are not environment friendly? Why?
4. What are alternative energy sources, and how do they help in making energy sustainable?

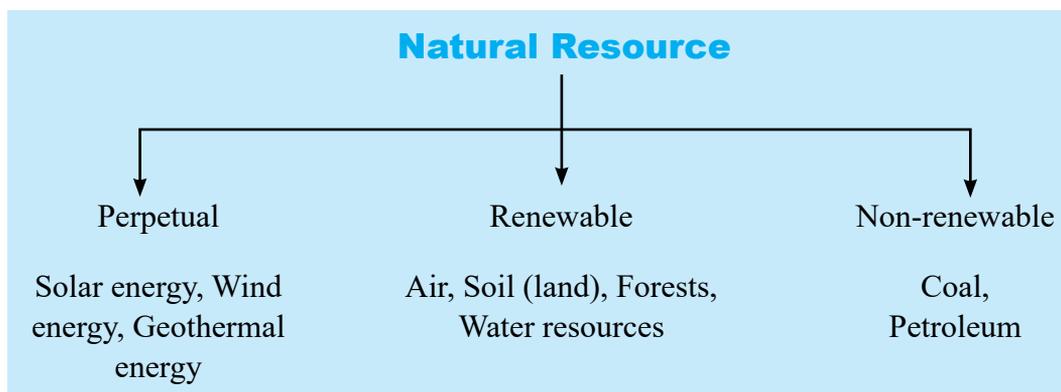
3.1 Introduction

Natural resources are substances that are naturally available on Earth, such as forests, minerals, soil, air, etc. The Earth has various biotic and abiotic resources. Biotic resources include plants, animals, and microorganisms. Abiotic resources include air, water, soil, minerals, metals, fossil fuels, temperature, sunlight, etc.

3.2 Classification of Natural Resources

Natural resources can be classified into three groups based on availability and usability.

- (a) Perpetual
- (b) Renewable
- (c) Non-renewable



(a) Perpetual Resources

These are natural resources that do not get exhausted and remain continuously available in nature. Examples: solar energy, wind energy, geothermal energy, etc.

(b) Renewable Resources

These are natural resources that can be reproduced, regenerated, or replenished over time if managed sustainably. If overused or depleted, their quantity and quality may decline, but under proper conditions, they can be restored. Examples: fresh air, fertile soil, freshwater, plants, etc.

(c) Non-renewable Resources

These are natural resources that exist in limited quantities in nature. Once used, they cannot be easily replenished or may take millions of years to form again. If overused, they get depleted and cannot be regenerated in human timescales. Examples: metallic minerals (iron, copper), non-metallic minerals (coal, petroleum, natural gas), fossil fuels, etc.

Activity 3.1

Take a study tour around the school or your home, and write down the names of the natural resources found there. Classify those natural resources in the table below:

Perpetual Resources	Renewable Resources	Non-renewable Resources

Questions for discussion:

1. On what basis have the natural resources listed in the table above been classified?
2. What are the differences between renewable and non-renewable resources?
3. Discuss the factors that are important for the sustainable use of natural resources.

3.3 Status of Natural Resources in Nepal

The availability of natural resources varies by location and environmental conditions. Different regions of the country have different types of natural resources. Below is a summarized description of the main natural resources found in our country and their management status.

(a) Land

Nepal has about 21% cultivable land and 6% uncultivable land (Ministry of Land Management, Cooperatives and Poverty Alleviation, 2023). According to the Department of Forests and Soil Conservation, 44.74% of Nepal's total area was forest land (as of 2021).

(b) Water Resources

Water is a key natural resource in Nepal. Around 2.6% of the country's total area is covered by water bodies, of which 55% is snow/glacier and 45% is seasonal rainfall. Nepal has over 6,000 rivers and 222 lakes.

(c) Minerals

Minerals are naturally occurring inorganic solids with a specific chemical composition and physical properties. In Nepal, minerals such as limestone, magnesite, zinc, copper, lead (especially in Ganesh Himal), iron, talc, etc., are found. Talc deposits are present in places like Palpa, Surkhet, Dang, Nuwakot, Dhading, Kathmandu, Makwanpur, and Lalitpur. Similarly, iron ore deposits have been identified in Syangja and Pyuthan. Zinc and copper are found in Ganesh Himal (Rasuwa) and Bajhang.

(d) Vegetation

Nepal's territory is divided into three regions: mountain, hill, and Terai. Due to varied climate and geography, diverse vegetation is found. Nepal has about 10,652 species of plants, of which about 700 species are used for medicinal purposes.

(e) Animals

Nepal's geographical diversity has also contributed to rich animal biodiversity. Despite being a small country, Nepal is rich in wildlife. Nepal is home to 185 species of reptiles, 687 species of butterflies, 113 species of dragonflies, 651 species of spiders, 78 species of amphibians, 168 species of fish, and 185 species of mammals.

Activity 3.2

Take a study tour around your community or school surroundings and list the names of the biotic and abiotic natural resources found there. Also, prepare a list according to their frequency of use, as shown in the table below:

S.N.	Biotic Resources	Usage	Abiotic Resources	Usage
1				
2				
3				
4				
5				
6				

Questions for discussion:

1. How are the natural resources listed above being used in your community, and what are the common uses of these resources?
2. Among the natural resources being used in your community, which ones are being used sustainably and which ones are being overexploited?
3. Regarding overexploited natural resources, what would you like to suggest to the community members? Present them in bullet points.

3.4 Importance of Natural Resources

Natural resources are essential components on Earth that support life, help maintain ecological balance, achieve economic growth, and preserve cultural identity. Therefore, their careful utilization and sustainable management are necessary to ensure their availability for future generations. Their importance can be presented in the following categories:

(a) Basic Human Needs

Natural resources provide essential nutrients in food, clean air for breathing, and necessary building materials for shelter. For example, fertile land for

agriculture, water, and solar energy are necessary; from forest areas, we obtain raw materials needed for construction, medicinal herbs, and resources for various uses.

(b) Economic Development

Natural resources serve as the foundation for various economic activities. Industries based on minerals, forests, and agriculture significantly contribute to a country's GDP and provide employment opportunities. Similarly, many countries use natural resources to achieve economic growth. For example, countries in the Middle East have made substantial economic progress using petroleum resources. In Nepal, natural resources like water, forests, and biodiversity are important bases for national economic development. Additionally, Nepal's natural attractions such as mountains, hills, lakes, national parks, and protected areas are key economic resources due to tourism potential.

(c) Energy Production

The energy required for our daily activities and industries is derived from natural resources. Fossil fuels such as coal, petroleum, and natural gas are major current energy sources. However, these energy sources are non-renewable, and their use has negatively impacted the global environment. Therefore, to protect the Earth's environment, it is essential to produce clean energy using perpetual and renewable natural resources such as solar energy, wind energy, geothermal energy, water, and biomass.

(d) Biodiversity and Ecosystem Services

Natural resources play a vital role in conserving biodiversity and maintaining ecosystem services. Ecosystem services, such as pollination, water purification, climate regulation, and nutrient cycling, help keep Earth's environment habitable and support human well-being.

(e) Cultural and Recreational Values

Natural resources provide us with aesthetic beauty, tourism opportunities, and cultural values. Different communities have cultural and spiritual connections with their local geography. For example, Indigenous communities like the Sherpas have traditions and cultural rituals centered around respecting

mountains and vegetation. Similarly, the Newar community in Kathmandu worships ponds and water bodies during the Gatha Muga festival.

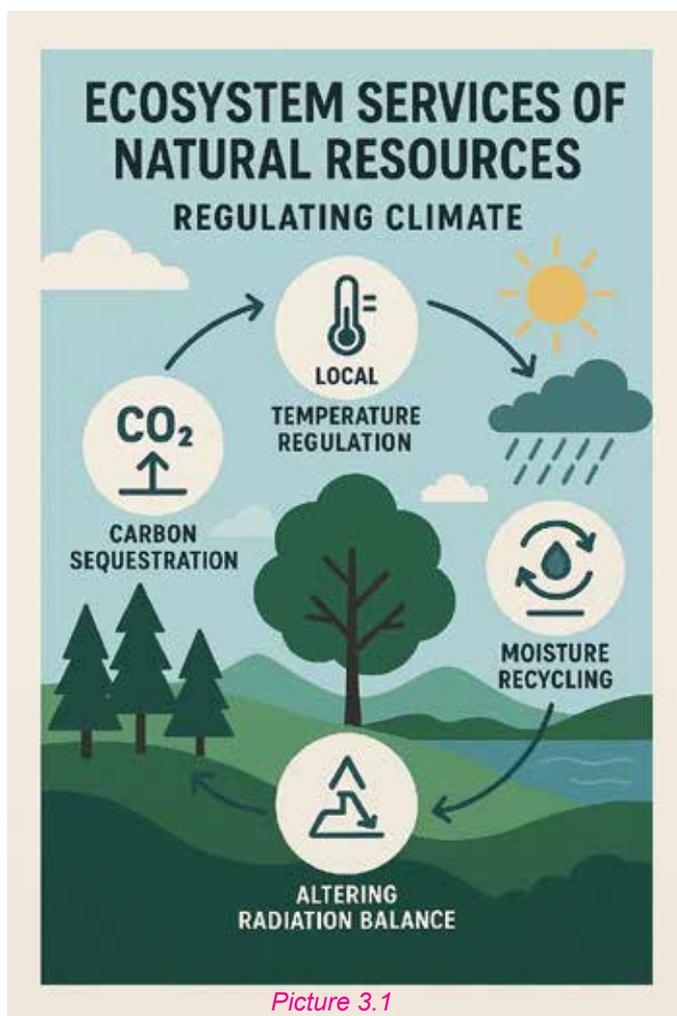
By exploring majestic mountains, natural heritage, and wildlife sanctuaries, we gain aesthetic pleasure. Additionally, we enjoy outdoor activities like hiking, trekking, camping, mountain climbing, and jungle safaris in natural areas, gaining both physical and spiritual fulfillment.

(f) Medicinal and Scientific Discoveries

Many natural resources contain medicinal properties, making them essential sources for producing medicines. Likewise, the natural environment is used as a laboratory for various scientific studies and discoveries. Through medicinal, biological, and ecological research, natural resources are used in the development of important human technologies.

(g) Climate Regulation

Natural resources play a crucial role in regulating Earth's climate. For example, forests absorb carbon dioxide from the atmosphere through photosynthesis, helping to balance the carbon cycle and mitigate climate change, thereby playing a key role in climate stabilization.



Picture 3.1

Activity 3.3: Making a Solar Cooker

Objective: To demonstrate that the sun is a major source of energy.

Materials needed:

1. Paper box, scissor, glue (Tape)
2. Small container for water
3. Aluminum foil
4. Thermometer



Figure 3.2: Sola Cooker

Method:

- (a) Take a paper box (such as a shoebox or instant noodle box). Create a flat surface by cutting open all four corners of the box.
- (b) Apply glue to the top surface of the opened box. Then, place aluminum foil onto the glued surface and reshape the box.
- (c) Now, take two bowls filled with cold water. Place one bowl inside the paper box and keep it in the sun.
- (d) While keeping the box in the sun, position the bowl so that the reflected sunlight is directed toward it, as shown in the picture. (The aluminum surface reflects sunlight effectively.)
- (e) Keep the other bowl outside the box in the sun.
- (f) Leave both bowls in the sun for about an hour. Then, measure the water temperature using a thermometer. You will find that the water kept in the aluminum foil structure has a relatively higher temperature.
- (g) Solar cookers are made based on the same principle.

Discussion: Discuss in class why the water in the container placed inside the bowl covered with plastic wrap became hotter, and draw a conclusion.

3.5 Natural Resources and Their Conservation

Humans use natural resources in their daily activities. However, overexploitation of natural resources causes ecological imbalance, which leads to environmental degradation. Therefore, while using natural resources, responsible methods must be adopted. For this, the use of non-renewable resources such as mineral oil, coal, metals, and petroleum should be minimized, and recycling and reuse methods should be promoted. Similarly, renewable resources should also be used carefully, and conservation measures must be strengthened. Here we discuss Nepal's main natural resources — their description, importance, challenges, and sustainable conservation.

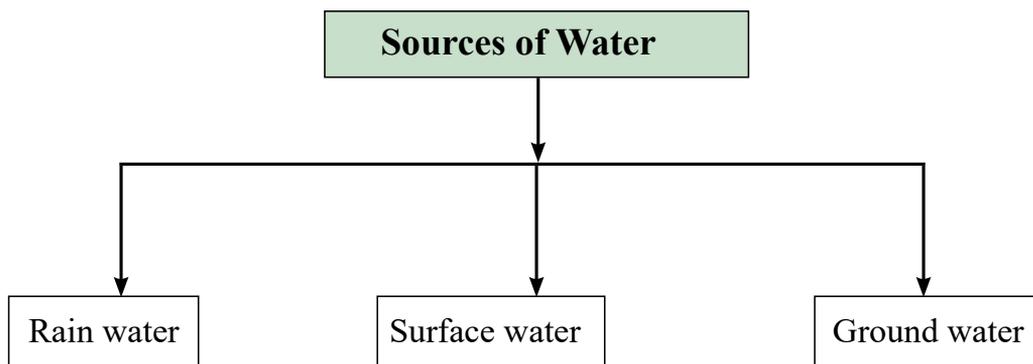
Types of Natural Resources

(a) Water Resources

The water available on the Earth is called water resources. About 71 percent of the Earth's surface is covered with water. Water resources are the major natural resources of Nepal. In Nepal, approximately 2.6 percent of the total land area is covered by water bodies. Of this, about 395,000 hectares are covered by rivers and about 5,000 hectares by lakes. Nepal has more than 6,000 rivers and streams and about 660 lakes and ponds.

Sources of Water

Water sources are classified into three categories: rainwater, surface water, and groundwater.



i. Rain water

The water on the Earth's surface is heated by the sun's heat and evaporates into the atmosphere. This evaporated vapor cools and condenses to form clouds. After that, it falls in the form of rain, snow, hail, dew, etc. This process is called the water cycle. This process continues regularly, and rain occurs. Some of the rainwater remains in surface water bodies, while some seeps underground.

ii. Surface water



Figure 3.3: Surface water - River



Figure 3.4: Surface water - Lake

Rivers, streams, springs, lakes, ponds, etc., are sources of surface water. Water from rainfall, melted snow, and surface runoff accumulates in rivers and streams. In Nepal, the major rivers include the Saptakoshi, Saptagandaki, Karnali, Kamala, Kankai, Rapti, Bagmati, etc.

Similarly, water from snowmelt, seeped groundwater, and human-made reservoirs collects to form lakes, ponds, marshes, wetlands, etc. These water bodies are also considered surface water sources. Rara, Phewa, Rupa, Begnas, Gosaikunda, Tilicho, Shey Phoksundo, Mai Pokhari, Gokyo Lake, Suryakunda, Bhairavkunda, Jagadishpur reservoir etc. are famous lakes.

A waterfall is groundwater that emerges naturally from a crack or porous underground rock to the surface. The flow of a waterfall varies seasonally. Some waterfalls flow continuously, while others are seasonal. Patale Jharana (Davis falls) situated in Pokhara, Rupse waterfall, Hyatung waterfall situated in Terathum, Pachal waterfall situated in Kalikot are some of the famous waterfalls.

(iii) Groundwater

The water stored beneath the Earth's surface is called groundwater. Wells, stone spouts, and tube wells are sources of groundwater. In the hills, during the dry season, people dig pits to access groundwater. In such places, wells are constructed to collect water. Similarly, water can be extracted from groundwater by digging ponds and installing tube wells. Handpumps are also a natural source of groundwater.

Activity 3.4

Importance of Water

Divide the students of the class into different groups, discuss the topics given in the table below, and present in class.

S.N.	Subject	Importance / Usage
1	Human well-being	
2	Cultural and recreational	
3	Environment	
4	Agriculture and food production	
5	Industry and hydropower	
6	Tourism and employment	
7	Sustainable development	

Status of Water Resources in Nepal

Nepal is one of the richest countries in terms of water resources, but there are still many challenges in its proper utilization, management, and conservation. The main aspects of Nepal's water resources in terms of management are as follows:

Utilization and Access to Water Resources

Nepal has more than 6,000 rivers, among which major transboundary rivers include the Koshi, Gandaki, and Karnali. However, only about 8% of the total water resources are currently used for irrigation, and only about 17% of the arable land has year-round irrigation access. Access to Safe Drinking Water Although about 80% of Nepal's population has access to drinking water, access to

safe and adequate water is still limited. In urban and dense settlements, a lack of safe water has increased the spread of waterborne diseases.

Climate Change and Natural Disasters

Due to climate change, Nepal is facing increasing problems such as drought, floods, landslides, and soil erosion.

Hydropower Development and International Cooperation

Nepal has focused on the development of the hydropower sector. Although Nepal has abundant potential for water resources, there are challenges in utilizing this for practical power generation, including geographical difficulties and legal implementation. These challenges can be addressed through proper planning, the use of technology, international cooperation, and the involvement of local communities.

Conservation of Water Resources

The proper use and conservation of water resources must go hand in hand. The methods for conserving water resources are as follows:

(i) Conservation of Watershed

The area where water from any mountain, river, lake, pond, or wetland collects and flows out is called a watershed. Therefore, the land surrounding any water source is its watershed. It is necessary to conserve this area by protecting the vegetation, plants, and natural environment found there. Afforestation should be carried out in barren areas. The roots of trees help prevent soil erosion, which can stop chemicals used in agricultural land from reaching the water source.

(ii) Conservation of Forests

To protect water resources, forests must be conserved. Forests help regulate climate, prevent soil erosion, control landslides, and protect water sources from drying up and pollution.

(iii) Conservation of Land

Land conservation significantly contributes to protecting soil quality and water resources. By conserving land and preventing erosion, soil and other

pollutants can be kept from entering water sources. Additionally, if the land has good quality soil, its capacity to absorb rainwater increases, which aids in the natural recharge of groundwater. Furthermore, the risk of floods and landslides is also reduced.

(iv) Proper Use of Water

For the proper use of water, its sources must be used wisely. Overuse leads to a decrease in the water level of water sources. Also, if water is wasted, future water scarcity problems can arise. Therefore, we must all adopt the habit of using water properly.

(v) Reuse of Water

Water that has been used once should be treated and reused. Doing this helps in the recycling of water resources and assists in the conservation of water and its sources. Water used for domestic purposes (such as water used in households, water from washing, etc.) can be reused.

(vi) Water Pollution Control

To conserve water resources, it is essential to prevent water pollution. To control water pollution, industrial and domestic wastewater, even if produced from any source, should not be discharged into water without treatment. Waste from mines and factories should also be treated in appropriate places. The use of chemical fertilizers and pesticides in agricultural areas also causes water pollution. Therefore, special emphasis should be placed on the use of organic fertilizers. Activities such as bathing, washing clothes, defecating, urinating, and discarding garbage into water sources can also cause water pollution, so such activities should be prevented. Afforestation around water sources can also help reduce water pollution.

(vii) Public Awareness

We have a special responsibility in the conservation of water resources. We must take initiatives in activities such as using water properly, preventing waste around water sources, protecting the plants there,



afforestation, and soil conservation. For this, public awareness programs on water resource conservation should be conducted.

(b) Soil

Soil is formed through the accumulation of rock fragments, minerals, organic matter, and decomposed plant and animal materials in the cracks and crevices of rocks over a long period of time. It forms the uppermost layer of the Earth's surface. Soil serves as the primary habitat for plants and many animals and is essential for the survival of all living organisms. Plants absorb essential nutrients from the soil to produce food. The life cycle of most living beings, including humans, is closely linked to soil. Therefore, soil is a vital natural resource, and its conservation is the responsibility of everyone.

Soil Formation Process

Soil contains both organic and inorganic substances. Inorganic substances are materials formed by the weathering of rocks, while organic substances are formed by the decomposition of dead animals and plants. The soil formation process can be studied by categorizing it in two stages.

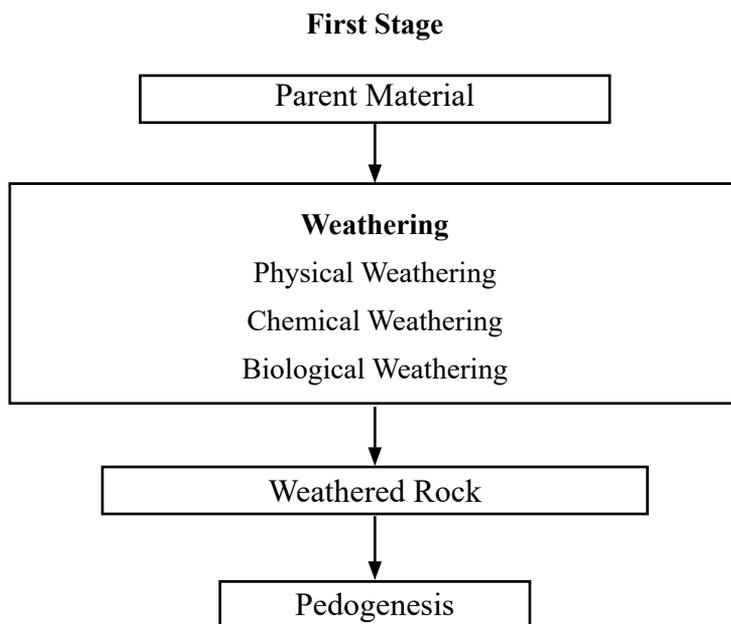


Figure : 3.5 Soil Formation Process

1. Weathering

In this process, rocks break down into smaller fragments (regolith) due to physical, chemical, or biological factors. Rock weathering occurs through two main processes: disintegration and decomposition. Weathering takes place through the following processes:

(a) Physical Weathering

This is the process where rocks break into smaller fragments due to climatic factors like sunlight, wind, frost, rain, etc. Rocks expand due to solar heat and contract when cooled, causing them to break. Sometimes, water entering cracks or pores in rocks freezes and expands, creating pressure that leads to rock fragmentation.

(b) Chemical Weathering

This type of weathering involves chemical changes in rocks. Chemical weathering also occurs through various processes such as hydration, hydrolysis, carbonation, oxidation, and dissolution. For instance, when water combines with rock, causing it to swell and break, it is called hydration. In hydrolysis, the interaction between water and mineral substances produces simpler types of minerals. When rock reacts with oxygen, it forms oxides that dissolve in water, weakening the rock structure and causing it to break down. In the dissolution process, the interaction between water and carbonic acid dissolves minerals like calcium carbonate and magnesium carbonate present in the rock through carbonation, forming bicarbonates.

(c) Biological Weathering

The process by which rocks are weathered due to the activities of various living beings, plants, animals, and humans is called biological weathering. Humans cause rock weathering during construction activities like building houses, roads, bridges, and tunnels. Similarly, animals and birds also contribute to rock fragmentation. Plants weather rocks through both physical and chemical processes. The roots of plants penetrate rock crevices, causing rocks to crack or split.

2. Pedogenesis

When rocks weather and break down, mineral fragments are formed, but these

fragments alone are not actual soil because vegetation cannot grow on them. The weathered soil must undergo many changes, a process known as Pedogenesis (soil development). While weathering is primarily a physical and chemical process, Pedogenesis is essentially a biological phenomenon. Through this process, dead plants and animals decompose to form humus. Humus is of two types: mor and mull. Mor humus is acidic and supports the growth of fungi and bacteria. It has a low calcium content. Mull humus is neutral and sometimes slightly alkaline. This type of humus has a higher calcium content, which promotes the activity of earthworms. As a result, the organic matter content in the soil increases.

Composition of Soil

Soil is formed by the accumulation of rock fragments and mineral substances. In addition, soil also contains water, air, and organic matter. The quality of soil varies depending on its type and composition. In a given area, different layers of soil can be observed from the surface downward. These distinct layers observed from the surface to the bedrock are collectively called the soil profile.

Activity 3.4: Practical Work to Identify Soil Types

Objective: To identify different soil types by examining them by hand

Materials: Different samples of soil collected from various places.

Method: Observation method

- Collect some soil samples from different places around the school.
- Put those soil samples into separate containers, add a little water, and mix it like mixing flour.
- Now, take the soil samples in your hand one by one and try to form them into a ball. Alternatively, place the soil between your two hands and try to roll it into a ribbon shape.
- While trying to roll the soil into a ribbon shape in this way, how did it feel? Did the soil samples form a long ribbon, a short ribbon, or just a ball? Or was it difficult to form a ball at all?
- Based on the observations you made, identify the type of soil you collected based on the characteristics of soil harshness, softness, and stickiness.

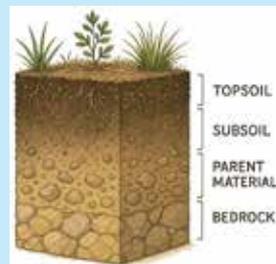


Figure 3.5: Layers of Soil

Types of Soil

Soil can be classified based on various criteria. Based on composition and properties, soil is classified as follows:

(a) Sandy Soil

Sandy soil is loose and granular. This soil is formed from sand and quartz. Such soil contains very few nutrients required by plants. It is not suitable for agricultural production.

(b) Clay Soil

In clay soil, the soil particles are very fine compared to sandy and loamy soil. Therefore, this soil does not have large pores (pores), because of which it has the ability to retain water, air, and nutrients in the soil for a long time. Since it can retain water and nutrients for a long time, such soil can be very beneficial for agriculture, but its structure slows down the drainage of water. Because of this, the roots of plants can rot due to excess water. Therefore, proper water drainage is necessary for the roots of plants to breathe.

(c) Loamy Soil

Loamy soil is a suitable mixture of clay and sandy soil. This type of soil retains more water and nutrients. Therefore, it is generally very suitable for agricultural work.

(d) Acidic Soil

When soil gives an acidic reaction (if the pH is less than 7), such soil is called acidic soil. As the pH decreases from 7, the availability of metallic nutrients like iron (Fe), zinc (Zn), and manganese (Mn) increases, which is harmful to many plants. In agricultural land where water collects excessively and rainfall is high, the nature of the soil there is acidic, and the productivity of such soil is low. Thus, in acidic soil, except for some special types of plants, ordinary plants cannot grow properly.

(e) Black Soil

Black soil can absorb and retain more solar heat than other types of soil. In this soil, organic matter is present in a relatively higher proportion, which also helps retain heat. Black soil is fertile due to the higher proportion of organic

matter. In this soil, nutrient elements are easily absorbed by plants, so plants grow well.

Soil Degradation

The loss of the basic physical, natural, or human-induced properties of soil is called soil degradation. Soil erosion plays a major role in soil degradation. A brief discussion on this is given below.

Soil Erosion

The process by which the topsoil of an area is carried away or displaced to another place by natural (water or wind) or human causes is called soil erosion. For example, the large amount of soil being carried from the hills to the plains by rivers is also erosion. Soil degradation occurs due to soil erosion.

Types of Soil Erosion

Various factors play a direct role in the occurrence of soil erosion in any particular place. Erosion is related to factors like vegetation cover, slope of the land, intensity of rainfall, heavy rain, etc. Soil erosion occurring due to different factors can be classified as follows:

(a) Water Erosion

Water erosion can be classified into the following types:

1. **Splash Erosion:** Raindrops scatter and displace the top layer of soil. This process is called erosion caused by rainwater.
2. **Sheet Erosion:** As rainwater collects and flows, it creates small streams. These streams erode the surface soil, which is called sheet erosion.
3. **Rill Erosion:** The flow and force of many small streams wash away the surface soil, creating small channels called rills. This is known as rill erosion.
4. **Gully Erosion:** Fast-flowing water creates deep channels in the soil. This type of erosion is called gully erosion.
5. **Riparian Erosion:** The strong flow of water in a river washes away the soil from the riverbanks. This is called riparian erosion.

(b) Wind Erosion

Generally, wind erosion is more common in areas with strong winds and desert regions. Strong winds lift and carry away the finer particles from the land's surface. In areas with strong winds and dry climates, soil particles and sand are lifted and carried away. In mountainous regions, winds blow from the south. In such areas, winds usually blow at high speeds from 10 AM to 5–6 PM. When such winds blow, it generally becomes difficult to keep the eyes open, and sometimes winds blow with dust storms.

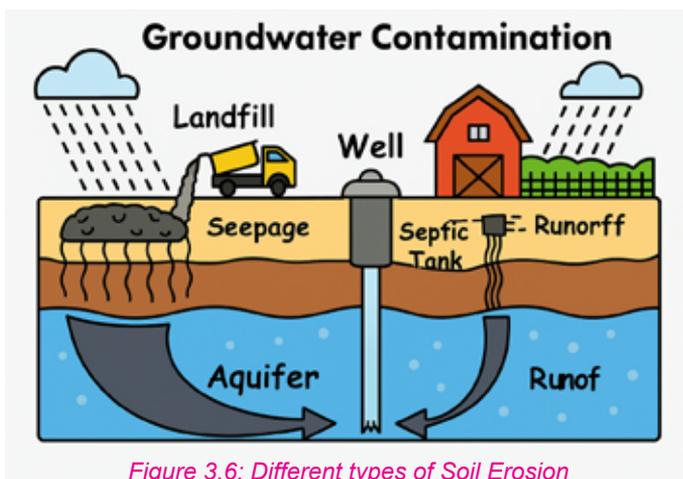


Figure 3.6: Different types of Soil Erosion

Evidence of erosion caused by dust storms can be seen in places like Mustang, Dolpa, and Manang. Due to cold deserts and wind erosion at an altitude of about 4,000 meters in the Himalayan region, desert-like conditions have emerged. For many countries in the world, wind erosion has created the major problem of desertification and sandy deserts. However, in Nepal, such sandy desert problems do not exist. Especially in agricultural land degradation, wind erosion is very harmful. This type of erosion is found in large quantities in desert regions, landlocked countries in Central Asia, and the northern parts of the Southern Hemisphere.

Activity 3.6

Study a nearby river area or a rocky terrain affected by soil erosion in your locality and investigate the causes of the erosion occurring there. Also, suggest possible measures that can be taken to control and prevent the erosion, and prepare a report.

Causes of Soil Erosion

A large part of Nepal's land is suffering from erosion. There are two main reasons for this:

- (a) Natural Causes
- (b) Man-made Causes

(a) Natural Causes

Erosion caused by natural processes occurs due to geographical conditions, topography, and climate. Natural causes of erosion can be classified as follows: Rainfall

1. Strong Winds
2. Landslides
3. Water Content in Soil
4. Soil Particle Structure



Figure 3.7: Wind-induced erosion

(b) Human-made Causes

Erosion caused by human activities occurs due to lack of proper management and overexploitation of natural resources. Human-made causes of erosion can be classified as follows:

1. Deforestation
2. Slashing vegetation
3. Overgrazing
4. Unsuitable Agricultural Practices
5. Unplanned Physical Construction (houses, bridges, etc.)
6. Fire

Effects of Soil Erosion on the Environment

Soil erosion is one of the most serious environmental problems in Nepal. Beyond agriculture and forestry, it also causes significant damage to other economic and environmental areas. Specifically, soil erosion has the following main effects on various aspects:

1. Loss of Vegetation
2. Loss of Animal Habitat
3. Decline in farming
4. Decrease in Productivity
5. Loss of Soil Fertility

Loss of Vegetation: When the problem of soil erosion becomes severe, the process of forest depletion begins. The issue of climate change intensifies. Additionally, deforestation leads to a shortage of basic food resources necessary for birds and other wild animals. Therefore, because soil erosion directly affects vegetation, it poses a threat to the survival of other organisms directly or indirectly dependent on that vegetation.

Loss of Animal Habitat: Since there is a close relationship between forests and wildlife, deforestation causes a shortage of necessary plant-based food resources for forest-dwelling animals. The lack of essential food and a suitable environment hampers the healthy growth and development of animals.

The risk of extinction for many species of climate-dependent animals increases.

Decrease in Soil Productivity: When erosion occurs, fertile elements like humus and organic matter in the soil are washed away. Plants cannot grow properly without these nutrients. Agricultural productivity decreases in areas lacking such nutrients. It takes hundreds to thousands of years to form just 1 cm of topsoil.



Figure 3.8: Flood affected area

Activity 3.7

Study the erosion-affected areas in the mountainous region near your locality. Investigate the causes of the erosion there and the significant damage caused to the local biodiversity and prepare a report based on your findings.

Control Measures of Soil Erosion

If we are to increase agricultural production, improve people's health and life expectancy, and raise living standards in Nepal, then it is absolutely necessary to find methods to control erosion originating from the hills and to enhance the land's productive capacity. Erosion control measures can be broadly studied by classifying them into engineering methods and biological methods. The following measures can be adopted:

Terrace Farming: Sloping land in the hills should be terraced and arrangements made for proper drainage of water. By constructing terraces and channels, forests can be planted along their edges to drain excess rainwater. This reduces the work of soil being washed away.

Construction of Embankments and Spurs: To prevent land on riverbanks from being damaged due to the river and to protect agricultural land from erosion, embankments and spurs should be constructed using locally available materials and traditional techniques.

Proper Drainage Management: Suitable drainage systems should be constructed to drain water for irrigation purposes in agricultural land and to properly drain water collected in agricultural fields. By constructing such drainage outlets in large fields and planting tall trees there, it helps prevent large amounts of soil and organic matter from being washed away by streams.

Landslide and flood Control: Trees and plants should be planted in landslide-affected areas. Similarly, controlling streams and gullies through check dams in agricultural and other productive lands also helps control landslides and prevents soil loss. Similarly, landslides can also be controlled by constructing check dams in riverbanks, cliffs, etc.



Figure 3.10: Land terraced for farming

Irrigation and River Flow Control: To control irrigation and river flow, it is necessary to construct small dams (check dams) at the edges of riverbanks, watershed areas, and channels carrying water from lakes, ponds, and wells. This type of control process not only helps control erosion but also prevents the soil of agricultural land from being washed away.

Control of Overgrazing: To control overgrazing, a rotational grazing system should be introduced, moving livestock from one pasture to another.

Forest Conservation: If forests are conserved, the environment of the area remains green. Conservation of plants in the forest prevents the topsoil of the land from being washed away. Introducing a multi-layered vegetation system on the land's surface prevents rainwater from directly washing away the soil. In this way, trees and various plants absorb the force of water coming from above, retain it in the soil themselves, and protect the soil by preventing erosion.

Proper Management of Water from Agricultural Land: For the proper management of agricultural land, by constructing terraces and drains and arranging for water drainage, the process of soil being washed away can be reduced. For this, it is absolutely necessary to develop conservation ponds. By constructing large pits and planting forests in agricultural land to drain excess water to suitable places, the risk of erosion can be reduced.

Afforestation: For the fallow, pasture, and various uses of agricultural land, proper use of land left fallow with the objective of afforestation, grass planting, and crop planting enhances the utility of the land and also helps in environmental conservation.



Figure 3.10: Plantation

Agroforestry System: Specifically, the roots of agricultural plants are established only in the upper layer of the soil. The roots of forest plants are spread up to about 1 to 2 meters deep in the soil. In this way, environmental conservation can be achieved through the integrated farming of agricultural and forest plants and proper land management.

Activity 3.8

If a particular place has been declared an erosion-affected area due to erosion, how will you, as an environmental science student, implement erosion control measures in such a situation? Based on the involvement of local people and the specific needs of the affected community, write and present the problem-solving measures.

Importance of Soil

- (a) Soil is the foundation and primary habitat for living beings. It provides plants with the means to produce food and grow. It offers shelter to living beings.
- (b) Soil serves as a source of food for all human and other living beings. Resources like wood and water are also found in the soil.
- (c) Soil is an important resource for maintaining the ecological balance. Green plants produce their own food from the soil. Animals obtain their food from plants. Dead plants and animals decompose within the soil. These are then absorbed by new plants. In this way, the ecological balance is maintained.
- (d) Soil is also a major storehouse of various mineral resources. It is a habitat for microorganisms and a reservoir of organic matter.

Soil Conservation

Soil is a key natural resource. Its proper conservation is necessary. Due to the sloping terrain of much of our country, a lot of soil is eroded by rainwater. Similarly, during modern farming and deforestation, soil is also washed away and carried off by water. For soil conservation, the following measures can be adopted:

1. Deforestation must be stopped.
2. Afforestation should be carried out in barren lands and barren hills.

3. Grasses and fruit trees should be planted in sloping areas.
4. Terraces should be built and farming done on sloping surfaces.
5. Deep-rooted plants like bamboo should be planted along riverbanks.
6. Overgrazing should be managed. Grazing should be controlled in slope areas.
7. Blasting should not be carried out during the construction of roads, bridges, and development works.
8. Gabion walls should be built in areas where riverbank erosion occurs.
9. The use of chemical fertilizers and pesticides should be minimized, and emphasis should be placed on the use of organic fertilizers and natural pesticides.
10. The activity of dumping garbage on soil should be prohibited.

Efforts on Conservation of Soil in Nepal

In Nepal, soil conservation is an important aspect of sustainable environmental management. Particularly due to the country's large area, fragile ecosystem, deforestation, and increasing land demand, soil conservation is challenging. Currently, sustainable agriculture and environmental management are emphasizing soil conservation. In Nepal, various government agencies, non-governmental organizations, and international partners have implemented targeted programs for soil erosion control, sustainable agriculture, and land rehabilitation. Soil conservation cannot be achieved by one agency alone; it requires the involvement, cooperation, and commitment of all sectors. The Forest and Soil Conservation Department, the Ministry of Agriculture, and the Water Resources Department of the Government of Nepal are actively working on soil conservation in Nepal.

Major ongoing campaigns and efforts in Nepal:

Watershed Management Programs: With the coordination of the Environment and Forest Department, various government agencies are conducting activities like pond construction, grass planting, and landslide control in prioritized watersheds. In addition, the central government and local governments are also carrying out environmental conservation activities.

Community Forestry Programs: The Community Forestry Division (Hario Ban) and the Forest Department, in collaboration with various governmental and non-governmental organizations, are providing training to forest user groups on forest conservation and promoting agroforestry to reduce soil erosion.

Activities related to agriculture: Government and non-governmental organizations, with the participation of locals, are conducting soil conservation activities to increase agricultural productivity, conserve topsoil, reduce surface runoff, and improve soil quality.

Bioengineering techniques: Using plants like bamboo and broom grass on roadsides and riverbanks for grass planting and erosion control, soil conservation efforts are also being carried out.

Awareness and training programs: With the support of various development partner organizations, training programs on the use of chemical fertilizers and their alternatives, and soil fertility improvement are being conducted for farmers through demonstrations, integrated farming, and group management. Soil conservation activities are also taking place.

(c) Minerals

Minerals are specific inorganic substances found in nature that can be extracted from ores for economic use. Many minerals exist in the form of compounds, while some are found in elemental form. For example, iron and copper exist as compounds, while gold, silver, and platinum are found in elemental form. A mineral is a naturally occurring, inorganic chemical substance with a definite chemical composition and physical properties. Minerals have specific composition, structure, and properties. Based on their color, density, crystalline shape and structure, diversity, ductility, malleability, electrical conductivity, and melting process, minerals have various physical properties.

Minerals can be classified into two groups: Metallic Minerals and Non-Metallic Minerals.

(i) **Metallic Minerals:** Minerals from which metals can be extracted are called metallic minerals. These minerals contain metals. Minerals from which metals can be extracted in usable form are called ores. For example, the ore of iron is hematite, and the ore of copper is chalcopyrite.

- (ii) **Non-Metallic Minerals:** Minerals that do not contain metals or do not have metallic properties are called non-metallic minerals. These minerals are used to make cement, chemical fertilizers, etc. Although these minerals contain elements like calcium, sulfur, and potassium, metals cannot be extracted from them in usable form. They are used to make glass, pottery, as fuel, and in the construction of houses, bridges, buildings, and in making chemical substances.

Current Status of Minerals

In Nepal, systematic geological surveys and mineral extraction work began from 2024 B.S. onwards. Only after this did industries like cement, agricultural lime, metal, and petroleum start to be established in Nepal. The availability of minerals in the country affects industrial development and progress. Some of the major minerals found in Nepal so far are as follows:

Iron (Fe): Iron is a major mineral resource of Nepal. In Nepal, iron has been used since ancient times for making agricultural tools and household utensils. There was a tradition of extracting and purifying iron from ore using traditional methods in Dang and Tanahun. Currently, iron ore is found in places like the mines of Phulchoki Mountain in Lalitpur, Those of Dang, Labdi of Tanahun, Zikhabang of Chitwan, Makawanpur, Nuwakot, Pyutha etc. The main ores of iron are hematite and magnetite.

Copper (Cu): Copper is also one of the major metals traditionally extracted in Nepal. Its main ore is chalcopyrite. From it, utensils, wires, tools, copper plates for roofing, etc., can be made. Copper is found in Kallitar of Makawanpur, Dhading, Solukhumbu, Tanahun, Baglung, Bhojpur, Dadeldhura etc.

Lead: Lead is an important metallic mineral. Its main ore is Galena. In Nepal, lead ore is found in Ganesh Himal, Phulchoki of Lalitpur, Khairabang of Makawanpur, and Solukhumbu.

Zinc: Although traditionally used less, its use has been increasing recently to coat iron and to make various alloys. Zinc ore is found in Ganesh Himal, Phulchowki, Makawanpur, Sankhuwasabha, etc.

Limestone: This is also a mineral that has been used since ancient times. Cement and lime can be made from it. The major industry related to minerals

in Nepal is cement and lime. Limestone deposits are found in the mines of Udaypur, Makawanpur, Surkhet, Arghakhanchi, Dhading, Kavrepalanchowk, Dang, Sindhuli and Chovar of Kathmandu.

Graphite: Graphite is found in Nepal's Ilam, Dhankuta, Sindhupalchowk, and Sankhuwasabha. Its main use is in making pencils and lubricants.

Talc (Soapstone): Talc is found in most of Nepal's hilly regions. It has been identified in some places in the mountains of Dolakha, Baglung and some places of Udaypur. It is used in construction and as a raw material.

Slate: Used for making roof tiles and flooring. Slate is found in Tanahun, Kaski, Bajhang and Dhading.

Nickel: Nickel is found in places like Sindhupalchowk, Ramechhap, Dhankuta, etc. Nickel is used to make high-quality steel and as a chemical substance.

Gold: Gold is found mixed with sand in various rivers of Nepal. Gold is known to exist in areas like Kaligandaki, Budhigandaki, Marsyangdi, Sunkoshi, etc.

Coal: Coal deposits have been identified in various parts of Nepal. Investigations show coal deposits exist in places of inner chure hills like Dang, Salyan, Kailali, Kanchanpur, Chitwan, Mustang, Baglung, etc.

Uses of Minerals:

1. Metals can be obtained from minerals.
2. Various chemical substances can be made.
3. Construction materials can be produced.
4. Used in the construction of houses, bridges, buildings, industries, and infrastructure.
5. Can also be used as fuel.
6. Mineral substances are also used for research and experimentation.

Conservation of Minerals

Humans use natural resources to improve their standard of living. If humans overexploit natural resources to fulfill their needs, the situation of resource depletion can arise. Therefore, natural resources must be used in a balanced manner.

When using mineral resources, measures such as minimal use, reuse, and recycling must be promoted. Since mineral resources are non-renewable natural resources, their conservation and sustainable use are extremely important. It is not acceptable to think about alternatives only after resources are depleted. Since most mineral resources are non-renewable, it is essential to prioritize sustainable use and the use of alternative resources.

Challenges and Sustainable Management Measures for Mineral Resource Conservation in Nepal

Although Nepal is rich in mineral resources, it faces various challenges in their extraction, conservation, and sustainable management. Factors such as unplanned extraction, weak legal enforcement, lack of technical efficiency, and insufficient involvement of local communities have made it difficult to derive optimal benefits from mineral resources. For sustainable mineral management, strict laws, technological application, and public participation are essential.

Major Challenges

Illegal Extraction: In many mining areas, minerals are being extracted haphazardly, leading to resource depletion and environmental degradation.

Technological Deficiencies: Due to the lack of modern technology and reliance on traditional methods, resource utilization remains inefficient.

Weak Policy Enforcement: Ineffective implementation of existing laws and regulations poses a significant problem.

Lack of Local Participation: Conservation efforts cannot be effective without the involvement of local communities.

Environmental Damage: Mineral extraction causes land degradation, soil erosion, water pollution, and deforestation.

Sustainable Management Measures for Mineral Resources

Reformation of Mineral Laws: Strict, comprehensive, and enforceable mineral laws should be formulated and implemented.

Technology and Monitoring: Environmentally friendly modern technology should be adopted, and systems for developing technical expertise should be strengthened.

Public Participation: The involvement of local levels and communities must be ensured, and the practice of social responsibility should be encouraged.

Reclamation Plan: Mining should be conducted with a prior plan for post-extraction land reuse, such as afforestation or agriculture.

Education and Awareness: Public awareness should be raised regarding the importance, sustainable management, and environmental impacts of mineral resources. This will help develop capable human resources.

Activity 3.9

Divide the students of the class into groups of 3 to 5. These groups should investigate what mineral resources (rocks, soil, and sand-based) are found in their locality or nearby areas. Then, discuss how those mineral resources are being used and prepare a report to present in class as a group.

(d) Forests

Forests and vegetation are crucial components of human life. According to the Forest Act, an area covered by trees, whether naturally or artificially, is called a forest. In technical terms, vegetation taller than 3 meters is called a tree. In reality, a forest is a collective group of vegetation, land, and wildlife present in a particular place. Humans' basic needs are met from forests. Forests are a vital natural resource for humans.

Nepal has diverse topography and climate. Consequently, the plants found in the country also vary according to its geography. Factors like land slope, soil fertility, water, air temperature, and sunlight cause differences in the growth and development of plants. Currently, about 44.74% of Nepal's land is covered by forests and shrublands. Recent studies estimate that there are about 10,633 species of plants in Nepal. Among these, about 3,991 species are flowering plants. Approximately 400 species of trees and 700 species of herbs are found in Nepal.

Importance of Forests

Among Nepal's natural resources, forests hold special importance. The oxygen gas that living beings use for respiration is also a resource provided by forests. The work of converting solar energy into other forms of energy on Earth is also done through forests. They provide habitat for living beings and help maintain ecological balance. The importance of forests can be summarized as follows:

- (i) **Foundation of Life:** Basic necessities like food, fuelwood, timber, shelter, materials for making tools, medicinal herbs for health, recreation, etc., are obtained from forests.
- (ii) **Source of Oxygen:** Forests are the reservoir of oxygen necessary for the respiration of living beings. Forests are the basis for obtaining clean air and pure oxygen (O_2). They absorb the carbon dioxide (CO_2) accumulated in the atmosphere, produce food, and provide the necessary oxygen to all living beings, including humans.
- (iii) **Basis for Climate Regulation:** Forests help regulate the hydrological cycle and maintain moisture in the atmosphere. In areas with dense forests, plants release more water vapor, keeping the humidity level there stable. Plants absorb CO_2 and produce O_2 , thus regulating the amount of CO_2 in the atmosphere. This prevents excessive greenhouse effects and helps control climate change. If the amount of CO_2 increases in the atmosphere, global warming increases, leading to the problem of climate change. Thus, forests regulate CO_2 and provide the basis for climate regulation.
- (iv) **Soil Erosion Control:** The roots of trees in forests hold the soil, preventing landslides. Rainwater from above is absorbed by trees, reducing its flow speed and minimizing the force that washes away soil on the ground. Plants also develop the capacity to absorb water in the soil and release it into the ground.
- (v) **Conservation of Biodiversity:** Forests provide habitat for various species of living beings and create a suitable environment, helping to conserve biodiversity.
- (vi) **Maintaining Ecological Balance:** Since forests contain various plants, animals, and organisms, these living beings are interconnected, forming a system. The living beings here play the roles of producers, consumers, and

decomposers, creating a food web. Thus, forests help maintain a balance among various living beings. This strengthens the relationship between animals, plants, and the environment, helping to maintain balance in the ecosystem.

- (vii) **Balance in Biogeochemical Cycles:** Forests help maintain balance in the hydrological cycle, oxygen cycle, carbon cycle, nitrogen cycle, etc.
- (viii) **Regulation of the Water Cycle:** Forests play an important role in regulating the water cycle, preventing problems like floods, droughts, and landslides. They produce water from the land and help regulate the water level in the atmosphere.
- (ix) **To Conserve Medicinal Herbs:** Since various medicinal herbs are found in forests and can be used to produce medicines to meet the needs of living beings, forests are very important for conserving medicinal herbs. This helps conserve medicinal herbs and also provides economic benefits.
- (x) **To Preserve Natural Beauty:** The diverse plants, animals, and birds found in forests help preserve natural beauty. This provides natural pleasure to humans. Forests can be used as recreational areas.
- (xi) **Basis for Economic Development:** The natural beauty obtained from forests attracts many people, providing opportunities for tourism-related economic development. Tourism and hospitality industries, along with other forest-based industries, provide the basis for economic development by utilizing forest products and natural beauty.

Causes of Forest Degradation

Deforestation is a major environmental problem. When humans overuse forest resources like necessary wood, fuelwood, and medicinal herbs to meet their needs, it leads to forest degradation. The main causes of deforestation in Nepal are as follows:

1. Rapid population growth and unplanned migration
2. Overexploitation of natural resources
3. Irregular and uncontrolled grazing

4. Weak government laws and poor regulatory enforcement
5. Deforestation for settlement and cultivation
6. Increasing urbanization and industrialization
7. Lack of adequate planning in project design and implementation
8. Lack of proper planning and implementation
9. Forest fires and encroachment
10. Due to erosion, landslides, and floods
11. Connection between migration and forest products
12. Weak forest protection system, management, and monitoring agencies
13. Low public awareness levels

Impacts of Forest Degradation:

Forests play a crucial role in environmental balance. Deforestation leads to environmental imbalance. The main impacts of deforestation are as follows:

1. Increase in the amount of carbon dioxide in the atmosphere
2. Climate change and problems like droughts and floods arise
3. Significant disruption in the water cycle, leading to rainfall problems and impacts on agricultural systems
4. Drying up of natural water sources
5. Loss of wildlife habitat
6. Loss of biodiversity
7. Imbalance in the ecosystem
8. Extinction of important medicinal herbs and wildlife
9. Loss of soil fertility
10. Promotion of desertification and desertification processes
11. Increase in natural disasters like landslides and erosion

Forest Conservation

To preserve biological diversity on Earth, forest protection is essential. For this, the following measures must be adopted:

(i) Afforestation and Deforestation Control

Afforestation should be carried out in barren and hilly lands to expand forest areas. In landslide-prone areas, suitable species of trees and grasses should be planted, and forest areas should be protected, expanding conservation efforts. Along with the management of forests, sustainable conservation programs should be implemented. The main objectives of afforestation are to increase forest productivity, enhance greenery, and meet local needs for forest products.

(ii) Grazing Control

In Nepal, alongside agriculture, animal husbandry is also an important industry. Especially in the hilly regions, there is a tradition of grazing sheep and goats. Overgrazing by animals causes excessive damage to vegetation. Therefore, for forest conservation, grazing must be managed through regulated processes. By controlling grazing areas, endangered and rare animals and plants can be conserved.

(iii) Prevention of Forest Fires and Poaching

The burning of bushes or forests is called a forest fire. Forest fires can cause great damage. If a forest fire occurs, many animals, birds, and plants can be damaged. It causes significant loss of biodiversity. Forest fires can occur for various reasons. They can also occur due to lightning. Humans causing fires for hunting can also lead to forest fires. Thus, forest fires can occur due to both natural and artificial reasons. They must be controlled immediately. To prevent forest fires, hunting by setting fires should be avoided, campfires should not be lit in forests, and fire lines should be created by clearing bushes in certain areas. For forest fire control, watchtowers should be arranged and kept in a state of readiness. Fire lines can be created by establishing open spaces at various points in the forest. This can help contain the fire to a specific area if a fire breaks out. Creating ponds near forest areas is another important measure.

Thus, for forest conservation, measures such as afforestation, controlling grazing areas, preventing forest fires, reducing dependence on forests, etc.,

must be implemented. This helps in forest resource conservation and also contributes to environmental protection. Forest conservation is the most important measure for environmental protection. It helps conserve biodiversity and, through the conservation of the natural environment, creates a suitable environment for living beings to survive.

Exercise

1. Write concise answers to the following questions:

- (a) What are natural resources?
- (b) How much land area does Nepal cover?
- (c) What percentage of the Earth's surface is covered by water?
- (d) What is acidic soil?
- (e) How many types of soil erosion are there? List them.
- (f) What are water resources?
- (g) What is soil erosion?
- (h) What are minerals?
- (i) What is deforestation?

2. Write short answers to the following questions:

- (a) Into how many categories can natural resources be classified? Explain.
- (b) Write about the current status of minerals in Nepal.
- (c) Into how many categories can minerals be classified? Write.
- (d) How many types of soil are there based on texture? List them.
- (e) Prepare a list of the causes of soil erosion.

3. Differentiate between the following:

- (a) Renewable and Non-renewable resources
- (b) Metallic and Non-metallic minerals
- (c) Soil erosion and Landslide
- (d) Clay soil and Loamy soil

4. Write long answers to the following questions:

- (a) Explain the importance of natural resources.
- (b) List the types of water sources and describe them.
- (c) Summarize the importance of water.
- (d) Describe the methods for conserving water resources.
- (e) Explain the soil formation process.
- (f) How can soil be conserved? Write in detail.
- (g) Describe the major minerals found in Nepal.
- (h) Explain the importance of forests.
- (i) List the impacts caused by deforestation.
- (j) Discuss how forests can be conserved.

Project Work

Identify the water sources present in your locality. For what purposes were those water sources used 25–30 years ago? Investigate the current condition of that source, its usage status, the management of the source's surroundings, and the conservation activities being carried out there by coordinating with local elders. Prepare a report and present it in class.

ENVIRONMENTAL POLLUTION



After studying the given picture, discuss in groups and present your conclusion:

1. What types of pollution are seen in the picture?
2. What are the major sources of air and water pollution seen in the picture?
3. What are the reasons for air and water pollution?
4. What could be the long-term effects of the pollution shown in the picture?
5. What role can local communities, governments, and industries play in cleaning and restoring the health of this river?

4.1 Introduction

Various living beings, including humans, use natural resources for their survival. Currently, due to the rapidly increasing population and industrial development in Nepal and worldwide, and the rise in energy demand, natural resources are being excessively exploited, leading to environmental degradation. To meet the needs of the growing population, industries and infrastructure have expanded excessively, and the use of vehicles has also increased. Along with population growth, socio-economic practices such as modern agricultural systems, urbanization, industrialization, and physical development have had significant negative impacts on the environment. As a result, our natural resources like air, water, and land have been severely affected. The environment itself purifies pollution within a certain limit. For example, plants purify the carbon dioxide emitted from industries and vehicles and maintain balance.

However, excessive exploitation of natural resources disrupts environmental balance and makes our surroundings polluted. For instance, respiratory diseases are increasing due to air pollution from industries, vehicles, and industrial areas. Similarly, our rivers and lakes are becoming seasonally dry. Additionally, the fertility of agricultural land is decreasing. Furthermore, industrial wastewater and untreated solid waste dumped into rivers are causing river pollution and contamination. Similarly, noise pollution is occurring alongside air pollution due to the operation of airplanes, buses, motorcycles, trains, and other transportation. Moreover, radioactive and chemical waste from laboratories treating hospital waste is polluting land and water resources. Similarly, the excessive use of chemical fertilizers and pesticides in agriculture is reducing land productivity.



Figure 4.1: Air Pollution



Figure 4.2: Water Pollution

Any undesirable change in the physical, chemical, or biological properties of our surrounding air, water, or soil caused by any agent is called pollution. Such changes disrupt the environmental balance and harm humans, living beings, and natural resources. The substances that cause pollution in the environment are called pollutants. Such pollutants can be physical (e.g., dust, suspended particles, radioactive substances, particulate matter), biological (e.g., bacteria, fungi, viruses, and microorganisms), or chemical/man-made (e.g., pesticides, chemical fertilizers, lead, mercury, industrial and household waste) (see Fig. 4.1 and 4.2).

4.2 Types of Environmental Pollution

Based on the component of the environment that is harmed, pollution can be broadly classified into the following four types:

- (a) Air Pollution
- (b) Water Pollution
- (c) Land/Soil Pollution
- (d) Noise Pollution

(a) Air Pollution

Various gases present in the atmosphere in specific proportions provide a suitable environment for humans and living beings. However, if pollutants mix and alter the composition of atmospheric gases, it can have adverse effects on humans and living beings. Thus, air pollution is the undesirable change in the state of the atmosphere caused by the introduction of harmful gases, smoke, or particles. Pollutants can be emitted from both point and non-point sources. If pollutants enter the environment from a single, identifiable source at a specific location, it is called a point source, e.g., smoke from a factory chimney, emissions from an industry, etc. Similarly, pollutants whose sources are scattered over a large area and are difficult to identify individually are called non-point sources, e.g., pollutants like pesticides carried into the atmosphere by wind from agricultural fields, construction sites, and vehicular areas.

Air pollution adversely affects the health of living beings, human well-being, and property, causing damage in economic and social areas as well.

Air pollution is further classified based on where it occurs into outdoor air pollution and indoor air pollution.

(i) Outdoor Air Pollution

This type of pollution includes smoke, soot, and dust emitted from transportation like airplanes, buses, motorcycles, trains, and from industries and infrastructure. Outdoor air pollution can be caused by both natural and human activities. Some examples of natural causes are:

1. Particulate matter carried by wind and storms
2. Gases and particles like Carbon Dioxide (CO₂), Hydrogen Sulfide (H₂S), Carbon Monoxide (CO), Hydrochloric Acid (HCl), Hydrofluoric Acid (HF) released during volcanic eruptions
3. Gases and particles like CO₂ and CO released during natural forest fires
4. Pollen from plants
5. Gases like methane and hydrogen sulfide released during the decomposition of organic matter
6. Non-native particles coming with sea air

Human-induced causes of outdoor air pollution include pollution from industries and infrastructure, vehicles, etc. In these areas, the excessive use of fossil fuels as an energy source leads to air pollution. Additionally, air pollution increases due to the rise in Carbon Dioxide (CO₂) and Carbon Monoxide (CO) levels in the atmosphere from human activities like deforestation. Similarly, various types of air pollutants are generated during open burning of waste. For example, burning tires releases harmful gases like Carbon Monoxide, Carbon Dioxide, Sulfur, and other toxic compounds. With the increase in population, the growing use of technology, and industrialization in the name of development, various chemicals are produced and used, causing significant harm to the atmosphere.

Human-induced air pollutants can be classified into two types. Pollutants that enter the atmosphere directly from the source are called primary pollutants, e.g., Carbon Monoxide, Nitrogen Oxides, Sulfur Oxides, particulate matter, etc. After primary pollutants enter the atmosphere, they react with each other and other environmental elements to form a new type of pollutant, which is called a secondary pollutant, e.g., sulfuric acid mist, nitric acid mist, etc.

(ii) Indoor Air Pollution

Pollution caused by smoke, soot, and dust generated from fuels like firewood, cow dung, and agricultural residues used for cooking inside homes, and from cigarettes and tobacco, is called indoor air pollution. Similarly, chemical substances like pesticides used indoors are also sources of indoor air pollution. The main sources of this type of pollution are:

1. Fuels burned indoors: firewood, cow dung, agricultural waste, coal, kerosene, gas stoves
2. Cigarettes and tobacco
3. Chemical-based cleaning agents, disinfectants, paints, and pesticides used indoors
4. Effects of outdoor air pollution.

Effect of Air Pollution

Air pollution has negative effects on human health, plants, animals, and the general environment. Such effects can be immediate in some cases, while in others, they can be long-term. The effects of air pollution can be categorized as follows:

(a) Effect on Human and Animal Health

Air pollution has a negative impact on the health of humans and all types of animals. For example, when humans and animals breathe polluted air (smoke), it gets deposited in the respiratory tract. Staying in a polluted environment for a long time can cause diseases in various organs. Pollutants can also enter the body through physiological processes, food and drink, and water. Due to air pollution, health problems such as allergies, cough, asthma, chest tightness, difficulty in breathing, and lung cancer can occur. The effect of air pollution on humans and animals is almost similar.

Some air pollutants and the effects they have on health are presented in Table 4.2 below:

Table 4.2: Effects caused by various pollutants on health

S.N.	Pollutant	Effect
1.	Sulphur Dioxide (SO ₂)	Coughing, wheezing, breathing difficulty, eye irritation
2.	Carbon Monoxide (CO)	Deficiency of Oxygen level in blood
3.	Nitrogen Oxide (NO)	Rupture of blood vessel
4.	Lead (Pb)	Affects brain and nervous system development in children and adolescents, causes high blood pressure, and damages kidneys
5.	Dust Particles	Causes coughing and damages lung tissues
6.	Radioactive element	Causes tumor diseases (Cancer)

(b) Effect on Plants

Air pollution affects the leaves, fruits, flowers, and all parts of plants. If the quantity of Sulphur Dioxide is high, the leaves of plants wither. If the quantity of Nitrogen Oxide is high, it affects the growth of plants. Pollutants like ozone found in the atmosphere also affect chlorophyll development and the photosynthesis process.

(c) Effect on Environment

Air pollution causes various negative effects on the environment. For example, smoke mixed with fog to form smog can reduce solar radiation and hinder the photosynthesis process, negatively affecting plant growth. It also reduces visibility, which adversely impacts the health of humans and plants. Similarly, specific pollutants like Sulphur Dioxide (SO₂) and Nitrogen Oxide (NO) react with other particles to lower the pH value of rainwater, causing harm to the environment.

Let's stay informed !

Under normal circumstances or in an unpolluted environment, the pH of rainwater is around 5.6. The reason rainwater becomes acidic like this is because the Carbon Dioxide (CO₂) present in the atmosphere reacts with the rainwater. However, the specific pollutants present in the atmosphere, such as Sulphur Dioxide (SO₂), Nitrogen Oxide (NO), and others, further increase the acidity of the water, forming rain with a pH value of 4 or lower. Such rain is called acid rain.

The following types of effects occur from this kind of acid rain:

1. It causes damage to the leaves of plants.
2. It harms historical monuments and structures built from marble and limestone.
3. Acid rain increases the acidity of water (lowering the pH below 6) and harms aquatic life in ponds, lakes, and other water resources.
4. Acid rain leaches essential nutrients for plants, such as Calcium and Potassium, present in the soil, creating deficiencies.

Control of Air Pollution

When air pollution is increasing, pollution concentrated in one place can spread to other areas. Therefore, it is necessary to adopt effective measures to control air pollution. For this, the following alternative measures should be adopted:

1. Encouraging the use of clean technology.
2. Reducing dependence on fossil fuels.
3. Promoting the efficient use of energy.
4. Making public transport, cycling, walking, and similar modes of travel attractive.
5. Managing industrial waste systematically.
6. Conducting environmental impact assessments for development projects.

7. Imposing pollution tax on polluting industries and areas and using it for pollution control.
8. Formulating appropriate legal frameworks for pollution control.

Activity 4.1: Dust Measurement

Objectives

1. To gain general skills in measuring pollution.
2. To determine the amount of pollution in your surrounding environment.

Required Materials

1. Two paper plates
2. Petroleum jelly or glycerin (as a dust-trapping substance)

Procedure

1. Write “High” on the back of one paper plate and “Low” on the back of the other plate.
2. Now place the plate marked “High” in the location near your school or home where you think pollution is the highest. Place the plate marked “Low” in the location where pollution is comparatively lower.
3. Apply petroleum jelly or glycerin evenly on the upper surface of both plates. Then place both plates in the selected locations for 24 hours.
4. After 24 hours, bring both plates back into the classroom and observe them carefully.
5. Compare which plate has more dust accumulated. Discuss the possible causes of pollution and the measures that can be adopted to reduce it.

(b) Water Pollution

Water is the basis of life for humans as well as other living organisms. Therefore, clean water is essential for all living beings. However, due to rapid population growth, industrialization, and intensive agriculture, water sources such as wells, springs, ponds, streams, and rivers are becoming increasingly polluted.

As a result, the quality of water is deteriorating. Any decline in the physical, biological, and chemical quality of water is known as water pollution. Thus, any undesirable change in the natural quality of water is called water pollution. Such changes in water quality have negative effects on living organisms and the environment.



Figure 4.3: Water Pollution

Similarly, due to the chemicals used in agriculture, medicine, and industry, and the fertilizers, pesticides, and detergents they contain, water has become polluted. Due to the disposal of domestic and petroleum waste, and the release of sewage, the water in settlements has become polluted. Water becomes dirty and polluted due to open defecation and littering. Similarly, with the modernization of urban areas and industries, the use of chemical fertilizers, industrial salt, and other industrial materials to increase production has polluted the water. On the other hand, such materials used to produce agricultural produce also have adverse effects on human health.

When polluted water is drunk and used for other purposes, there is a risk of various diseases to humans and other living beings. Diseases like diarrhea, cholera, and typhoid affecting humans are caused by water pollution. Similarly, due to water pollution, aquatic animals like fish, frogs, and insects can become extinct.

Water pollution can be classified into two types based on its source: point source and non-point source.

- (a) **Point Source:** A point source refers to a single, identifiable, and confined source from which pollutants are discharged. For example, pollutants released from a specific pipe constitute a point source. Pollutants coming from a pipe can be of both chemical and physical types, such as heated water and steam, smoke, waste materials, etc. Pipes



located near water sources are the main sources of water pollution. Waste, garbage, plastic, etc., flowing into water sources from pipes directly harm the health of living beings. The main sources of such waste include hospitals, factories producing pharmaceutical waste, and domestic waste disposal areas.

- (b) **Non-Point Source:** Non-point source pollution refers to sources that do not have a single, specific point of origin or location. Its pollutants come from a wide and scattered area. For example, waste materials and soil carried by rainwater from urban areas, agricultural fields, or construction sites into rivers, ponds, or groundwater are examples of non-point source pollution.

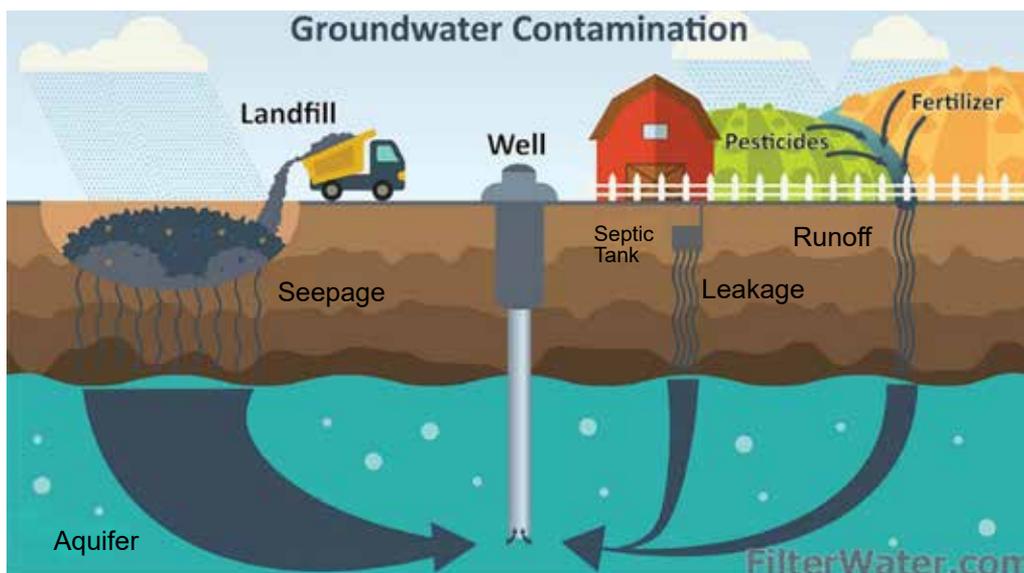


Figure 4.4: Sources of Ground Water Contamination

Ground Water Pollution

What do you think are the causes of groundwater pollution shown in the figure above ?

What kind of effects can arise from such pollution? Discuss in pairs and prepare a list, and present it in class.

The pollution caused by various types of pollutants being dissolved in groundwater is called groundwater pollution (Figure 4.4). For example, the various chemical, metallic, and toxic substances used in industry and in industrialized areas cause

groundwater pollution. The largest source of groundwater pollution is the existence of human settlements and sewage in soil and rock layers. Other sources include hospitals, urban areas, waste disposal, etc. If a groundwater source is polluted, it cannot be remedied immediately. The process of water replenishment in groundwater areas is slow, the number of purification organisms is low, and the lack of sunlight penetration also makes the process of pollutant decomposition/dilution slow. Therefore, it can take thousands of years for a once-polluted groundwater source to become free of pollution.

Effect of Water Pollution

The effects of water pollution depend on the type, quantity, and duration of the pollutants present in it. The main effects arising from water pollution are as follows:

Effect on Aquatic Life: Water pollution creates a shortage of habitat for aquatic organisms. Also, due to water pollution, the diversity of aquatic life decreases, harming organisms and even causing their extinction. For example, in the Bishnumati river in Kathmandu, fish have disappeared due to water pollution.

Effect in the Food Chain: Pollutants like lead, mercury, and arsenic present in water are absorbed by aquatic animals and algae, and when those animals are consumed by larger fish and humans, the food chain is affected. In this way, the concentration of these pollutants increases geometrically from one food level to another. This process is called biomagnification.

Effect on Human Health: In Nepal and other developing countries, diseases like diarrhea are widespread due to drinking polluted water. Similarly, drinking water contaminated with chemical and toxic substances can cause diseases like hepatitis and cancer. For example, due to water pollution, there was an epidemic in Minamata, Japan, because people consumed fish from the contaminated pond. This is also called the Minamata disease, and is famously known as Minamata disease.

Control Measures of Water Pollution: To control water pollution, the following measures can be implemented:

1. Pollutants must be controlled from being discharged into water sources, either directly or indirectly.
2. Polluted water must be treated before being released into water sources. Sewage, waste from offices, or other areas must be collected in a pit and treated

in a septic tank. Such wastewater must be collected from the pit through a pipe and treated through a treatment plant to improve its quality before releasing it into water sources. Similarly, waste produced during industrial production must also be properly treated before being released into water areas.

3. The use of chemical fertilizers must be controlled and organic farming methods promoted, for example: planting leguminous plants alternately among various crops. Leguminous plants perform nitrogen fixation from the atmosphere and increase soil fertility.
4. To control pollution entering water sources from urban areas, activities near water sources must be controlled. The use of chemical pesticides should be reduced.
5. Public awareness should be raised to control open defecation and littering in water source areas.
6. Legal provisions should be emphasized for the control of water pollution.

For the sustainable management of water pollution, its prevention is more important than the remediation process. For this, the following measures can be adopted:

- (a) **Reduce the use of industrial materials:** For example, using water-saving taps in place of traditional taps that waste water.
- (b) **Reuse wastewater:** For example, using treated wastewater for irrigation.
- (c) **Recycle pollutants:** Treating and reusing pollutants present in water in concentrated form.

Process of Water Purification

Water pollution present in any specific condition can also get purified by natural aquatic processes. Especially, pollution caused by physical pollutants gets purified naturally. Some other technical measures are as follows:

- (a) **Disinfection of Water:** In this process, harmful microorganisms present in water are killed to make the water potable. For this, chlorine gas can be used especially, which is called Chlorination.
- (b) **Sedimentation:** Substances suspended in water are removed through this process. For this, especially, cone-shaped or cylindrical containers are used and solid wastes are removed by letting them settle.

- (c) **Filtration:** The process of removing solid materials from wastewater in a physical way is called filtration. In the filtration process, first, polluted water is passed through layers of sand and gravel. In this process, mud, dirt, insects, and microorganisms present in water can be removed. For filtration, locally available sand filters and ceramic filters can be used.
- (d) **Softening of Water:** This method is used to remove the hardness caused by salts like calcium and magnesium present in water. For this, mainly two methods, boiling or using lime, are used to remove the hardness of water.

(e) **Land/Soil Pollution:**

The undesirable change in the natural state of soil due to the mixing of unwanted substances into it is called land/soil pollution. Solid wastes such as sewage, office waste, factory waste, etc., and industrial waste like heated water, ash, lead, smoke, chemical substances, construction materials, and other wastes cause land pollution due to improper disposal. Polluted water also pollutes the land. Similarly, salt and chemical fertilizers used in agricultural production and waste dumped in landfills also cause land pollution. Along with this, atmospheric pollutants like sulfur and nitrogen compounds also cause acid rain and pollute the soil. The pH of soil polluted by land pollution becomes very acidic or very alkaline, causing a deficiency in fertility, hindering production, and harming useful soil organisms.

Sources of Land/Soil Pollution:

- (a) **Agricultural Source:** Salt and chemical fertilizers used in agricultural production cause a deficiency in soil fertility, hindering production, and harming useful soil organisms. Similarly, it can adversely affect human and other organisms' health, causing problems in digestion, diseases like cancer, etc.
- (b) **Industrial Source:** This includes waste, smoke-related, and asbestos wastes. Such pollutants cause deficiency in soil fertility and also have direct adverse effects on human health.
- (c) **Domestic Source:** Waste materials from households such as smoke-related materials and utensils made from heated water cause land pollution because they do not decompose. Along with this, buried heated water and waste disposal on land can cause epidemics and harm human life when consumed.

Control of Land/Soil Pollution:

To control increasing land pollution due to human causes, the following measures can be adopted:

1. Physical waste from households, urban areas, or other places can be collected and used to produce useful compost.
2. The use of chemical materials in agricultural production can be controlled.
3. To treat industrial waste before disposal, appropriate methods like chemical treatment, incineration, etc., can be used to remove harmful substances.
4. Waste produced from vehicles can be disposed of in designated pits and destroyed.
5. The use of heated water should be minimized, and utensils made of glass or clay that can decompose should be used.

(f) Sound Pollution



Figure 4.5: No Horn

- (a) In the picture above (Figure 4.5) why has this sign been put up by the Metropolitan Traffic Police Division Kathmandu?
- (b) Why is the phone number displayed on the board as well?
- (c) What are the sources of sound pollution?

Normally, whether a certain sound is noise pollution or not depends on the individual's condition. For example, the same loud music might be pleasing to one person, but the same sound could be irritating noise to another person in a different situation. Therefore, any unwanted sound that causes physical and mental harm to a person is called noise pollution. The sound coming from vehicles, airplanes, machines, etc., sound from factories, the sound of bells ringing near schools, sound from loudspeakers and microphones, sound coming from industries—all can be noise pollution. Sound is measured in decibels (dB). The harmful effect of sound varies from person to person and their situation. The World Health Organization has set a standard of 45 dB during the day and 35 dB at night. Generally, a person can tolerate sound up to 80 dB. Sound above that has negative effects on a person's health. Loud, continuous noise can completely damage hearing. Similarly, short-term noise pollution can only cause temporary discomfort, but long-term exposure to noise pollution can cause permanent damage to a person's health. In addition, noise pollution also has adverse effects on birds and other living beings.

Source of Sound Pollution

Noise pollution has now emerged as a growing problem. Various human activities have increased noise pollution. Sources of noise pollution can be both indoor and outdoor. Table 4.3 shows some sources of noise pollution and their intensity.

Table 4.3: Sources of Noise Pollution and their Approximate Intensity

Source	Intensity	Source	Intensity
General conversation	20–30 dB	Radio music	50–60dB
Debate	60 dB	Motor vehicle	60–90 dB
Loaded Truck	90–100 dB	Motorcycle	105 dB
Aeroplane	90–120 dB	Jet engine	140 dB

- (a) **Indoor sound pollution:** This includes airplanes, trains, airports, public functions, household appliances powered by electricity. In urban areas, due to traffic congestion and industrial machines, noise pollution is higher than in rural areas.
- (b) **Outdoor sound pollution:** Public transport, road, construction sites near residential areas, markets, social and cultural activities, fairs, and various types of public gatherings are sources of outdoor noise pollution.

Effect of Sound Pollution

1. Noise pollution causes both physical and mental effects on humans. For example, irritation, headache, and high blood pressure in humans, as well as deafness and insomnia, etc., are direct effects caused by noise pollution.
2. Due to noise pollution, sleep is disturbed and daily life processes are disrupted.
3. Noise pollution reduces human work efficiency.

Prevention and Control of Sound Pollution

Noise pollution can be controlled at its source, the medium through which sound travels, and the place where sound is received. The following measures can be adopted to prevent and control noise pollution:

1. The use of environmentally friendly public transport and systematic traffic management must be done.
2. Proper traffic management during peak hours and construction of roads with less friction and noise-reducing walls on both sides of roads must be done.
3. Noise pollution from construction sites can be controlled by using appropriate sound absorbers.
4. In industrial areas where noise pollution occurs, the use of silencers must be done.
5. Loud sounds at night must be prohibited, and social activities should be scheduled during the day.
6. In sensitive areas like hospitals, schools, etc., silence zones must be designated.
7. Green belts can be constructed around noise-producing areas like vehicle stations, residential areas, etc., for noise reduction.

Activity 4.2: Noise Pollution Study

Objective: To provide students with information about the sources of noise pollution in the local area.

Required Materials: Notebook and pencil

Method:

1. All the students in the classroom should form groups of two or two pairs each and go around the school area.
2. Each group should list the sources of noise coming from their surroundings, categorizing them as having low or high intensity.
3. This activity should be conducted for up to 10 minutes.
4. What was the source of the noise? What measures can be taken to reduce such noise? Discuss in the classroom.

4.3 Waste Management

4.3.1 Concept of Waste

Any material or substance that becomes useless after production from nature and human activities is called waste. Due to such wastes, the vital components of our environment i.e. air, water, and land are becoming polluted. Because of this, not only is there harm to the environment, living beings, and human health, but there is also damage to air pollution and physical structures. Nature itself recycles waste to a limited extent through various organisms, keeping the environment in balance. However, due to increased human consumerism, the production of non-recyclable waste has increased more than nature's recycling capacity, while the production of wastes that take a long time to decompose, such as heated water, lead, and public waste, has reached an unmanageable level. If proper management is not done at the time of waste itself, it can threaten human life. Various statistics show that waste production is increasing globally. Among the produced waste, it is found that only about 25% is recyclable waste. Therefore, all of us need to reduce waste generation in the environment, adopt environmentally friendly methods, and also change our lifestyle.

4.3.2 Types of Waste

Based on the process of recycling in the environment, waste can be classified into two types: biodegradable waste and non-biodegradable waste.

(a) Biodegradable Waste

Waste that can be broken down into simpler components by living organisms is called biodegradable waste. Such wastes can be both solid and liquid. Glass, paper, wood, food items, dead animals, agricultural waste, etc., are included in biodegradable waste. Microorganisms decompose such waste through aerobic and anaerobic processes. Biodegradable wastes do not accumulate in the environment for a long time under suitable conditions and are not harmful either. However, if such waste is disposed of in the environment in quantities more than it can naturally decompose, it can also cause health problems.

(b) Non-biodegradable Waste

Normally, waste that cannot be broken down into simpler components by living organisms in nature is called non-biodegradable waste. Such waste does not decompose in nature for years. For example: heated water, lead, public waste, asbestos materials, chemicals, etc. Such waste is harmful and causes damage to the environment.

4.3.3 Sources of Waste

A large amount of waste in our surroundings is produced from human activities. During the production of any item, from the extraction of necessary raw materials to various stages of production, waste is also generated. In this way, materials become useless after use and are discarded as waste. Such materials are generated daily from our homes, schools, offices, commercial centers, factories, hospitals, construction sites, etc. There can be many sources of waste generation. The main sources of waste can be summarized as follows:

- (a) **Domestic Source:** Domestic sources include waste produced from daily human activities. In places like offices, hotels, schools, social venues, kitchens, residential areas, etc., waste is generated from activities related to daily human tasks. These places are considered domestic sources of waste production. From these areas, food, wood, household use items, plastic bags, diapers, glass, heated water, lead waste, etc., are generated as daily waste.

Along with solid waste, liquid waste is also generated from domestic sources, such as used water, water from bathrooms.

- (b) **Health and Pharmaceutical Source:** This includes various institutions related to health, such as health posts, hospitals, health clinics, medical camps, health fairs, etc. From such institutions, chemicals, syringes, bandages, cotton, used surgical woods, etc., are generated. Much of the waste generated from health and pharmaceutical sources is more hazardous than general waste.
- (c) **Agricultural Source:** Waste generated from materials used in activities related to agriculture, animal husbandry, horticulture, poultry farming, industry, etc., such as chemical fertilizer sacks, industrial salt residue, pesticide containers, rotten vegetables, etc., are sources of agricultural waste.
- (d) **Industrial Source:** Due to the increasing population's demand for consumer goods, industrialization is growing. In those factories, various wastes are also generated during the production of goods. Lead, heated water, ash, blood, bones, agricultural produce, fruits, chemicals, chemical fertilizers, glass, batteries and battery-related items, etc., are sources of industrial waste.
- (e) **Waste Generated from Construction or Demolition of Physical Structures:** From the time we build ordinary huts/houses/buildings to large buildings, industries, bridges, culverts, wells, dams, etc., during their construction, necessary materials are wasted or used, and leftover, broken, cracked materials pollute the environment as waste. This includes paper, marble, bones, bricks, mud, various types of pollutants like sand, gravel, etc. During natural disasters like earthquakes, various physical materials are also destroyed and become waste along with physical structures.
- (f) **Electronic of electric Equipment:** After use, electric items used by people become useless and are discarded as waste. Such materials include wires, cables, trains, ships, airplanes, vehicles, electronics, asbestos-containing essential public materials, etc. Some public materials, such as trains, ships, electronics, etc., contain harmful materials like lead (Pb), nitrogen compounds, etc., which cause serious pollution in the environment. The waste from battery materials is called e-waste. According to a report by the United Nations Institute for Training and Research (UNITAR), globally, an estimated 62 million tons of e-waste was produced in the year 2022.

4.3.4 Effects of Waste

If waste is not managed properly, it not only causes significant harm to the sustainability of the environment but also pollutes the environment. Along with the modernization of human lifestyles, the amount of waste has also increased, and consequently, the amount of harmful effects on the environment has also grown. The effects that can occur on the environment due to waste can be outlined as follows:



Figure 4.6: Waste deposited at Landfill site

1. Waste degrades the natural beauty.
2. Waste occupies unnecessary space and reduces land productivity.
3. Since items attracts rats, insects, mosquitoes, etc. creating a risk of epidemics.
4. Due to pollution, biological diversity is harmed.
5. Due to pollution, the beauty of religious, cultural and historical monuments decline.
6. Many biodegradable waste release foul odors. The water that leaches from them pollutes both land and water. If waste is not managed properly, gases like nitrous, oxide, methane, and ammonia are released from it, causing air pollution.
7. Non-biodegradable wastes, such as heated plastics, lead, aluminum, reduce soil fertility. Lead, mercury, etc. released from electronic waste pollutes air, water and land.
8. Due to pollution from waste, diseases like cough, diarrhea, cholera, typhoid, dysentery, malaria, jaundice, skin diseases, blood pressure, cancer, mental problems, chest tightness, difficulty in breathing, etc., can occur in humans.

4.3.5 Waste Management

Due to the increasing population and growing human consumerism, the amount of waste in the environment has also been increasing. Because of this, challenges have arisen in waste disposal management. In Nepal, due to increasing urbanization and the lack of proper management of liquid and solid waste generated from cities, many places have become polluted. If such waste is not managed properly, on one hand, public health is harmed. In addition, the resources that could be obtained from it and the economic benefits that could be derived from it have also not been achieved. Therefore, by adopting the following measures, waste management can be done and environmental and economic benefits can also be obtained.



(a) Liquid Waste Management

Liquid waste includes waste water, toxic waste, and waste from natural processes coming from our homes, restaurants, markets, offices, etc., as well as from factories and industries. Such waste may contain elements useful for agriculture and industry along with harmful substances. For example, sewage and toxic waste from households contain nutrients necessary for agriculture. Similarly, for the management of waste water generated from factories, hospitals, etc., specific methods must be developed and managed. For liquid waste management, the following measures can be adopted:

1. Use grey water (from bathrooms) for gardening. Also, construct a soak pit according to need and use it.
2. Using toilets and not defecating in open spaces.
3. Not disposing sewage directly into the rivers. Involve individuals,

communities, and local government bodies to manage waste disposal by treating it before dumping.

4. Dispose of liquid waste from factories and industries in the environment only after treatment.
5. The concept of 3R (Reduce, Reuse, Recycle) can be adopted for liquid waste management.

(b) Solid Waste Management

In the past, the human population was small, and at that time, waste generation was also less and its management was easier. Some wastes were managed naturally; at that time, there were mostly biodegradable wastes only, so burning, burying in pits for reuse or compost making, and destroying non-biodegradable wastes to some extent were done. However, with population growth and development in lifestyle, the amount of both biodegradable and non-biodegradable solid waste has increased daily. As the amount of waste increased like this, along with challenges in its management, various methods and techniques have also developed. For solid waste management, first of all, each citizen must be conscious and adopt management measures from a personal level. Also, involving the family, community, government, local bodies, etc., can accelerate waste management work. Some wastes can also be eliminated by scientific methods, but doing so requires care to avoid polluting the environment. For waste management, mainly the following measures can be adopted. There are mainly three measures (3R principle) for solid waste management, whose brief concept is given below:

- (i) **Reduce:** Among the most effective methods of waste management is to reduce its production itself. Various products available in the market are over-packaged. Many of these packages are non-reusable. When we buy any product, we must consider goods with less packaging. By not producing and purchasing unnecessary goods, we can also reduce waste.
- (ii) **Reuse:** We can also reduce waste by reusing any item. For example, after using a sack, other materials can be stored and used in its bag. Used items like plastic bags, wooden boxes, cans, and containers can be used for other purposes.

- (iii) **Recycle:** The process of collecting, processing, and reusing any item after its use as a new product is called recycling. For example, after processing used paper, it can be used to make paper bags, cartons, or containers. Lead and pesticide containers can be processed and made into new containers. Used cooking oil can be recycled as biofuel, and hot water bags can be recycled as water heating elements.

Besides the above 3R, any item should be used only after considering whether it is necessary for oneself or not. By using any product only after thinking about how much waste will be generated after its use, how and where it can be managed, can help in waste management. Finally, the waste generated from our daily activities must be disposed of in landfills only.

Activity 4.3: Waste Journey

Required Materials:

1. Cloth or Jute sack/bags: 5–7 pieces
2. One big Tarpaulin, weighing machine (to spread out and sort items)
3. Gloves and mask (1 pair each per student)

Method:

1. Form groups with all the students present in the classroom. The number of students in a group should be appropriate, from 5 to 10. All students should wear gloves on their hands and a mask on their face, and each group should take one bag.
2. Now, each group should go to different places in their school's surrounding area, collect waste in their bag, and bring it back. Each group can do waste collection within a specified time limit.
3. Note down which group collected the most waste within that time limit and weigh it using weighing machine.
4. Each group should separately spread out the waste they collected on the tarpaulin and place it. Now, each group should examine what kind of waste they have collected in a group-wise manner.
5. Each group should separate and make a list of biodegradable and non-biodegradable waste from the waste they collected.

6. Discuss with your group members about how much time it takes for biodegradable and non-biodegradable waste to be recycled in the environment.
7. Finally, discuss and include in your report about: what types of waste production can be reduced, what should be done to protect the environment, and how waste can be managed.

(c) E-waste Management

Electronic waste or e-waste is defined as obsolete electrical and electronic equipment. It can generally be classified into three categories, such as: large household appliances (refrigerators and washing machines), IT and telecommunications equipment (computers and mobile phones), and consumer electronics (televisions, electronic toys, and sound equipment). Components of this waste, such as circuit boards, batteries, and other encapsulated heated water cells, capacitors, resistors, and plastic cables, and lead solder are also considered e-waste. Unlike general household or industrial waste, the nature of public waste is different. It contains toxic and hazardous materials. To minimize environmental impact, special technology and reuse methods are required for e-waste disposal. E-waste trading can also occur. From it, along with toxic gases, other reusable materials can be obtained.



Furthermore, due to a lack of environmental laws, policies, and effective technology, globally only about 10% to 15% of e-waste is formally recycled. The e-waste that is not reused is dumped in landfills or burned. Similarly, it is found that such waste from developed countries is dumped in developing countries, and these countries provide less priority to its management.

For e-waste management, the following measures can be adopted:

1. Preparing list of e-waste in major cities.
2. Coordinate with major local governments and develop e-waste management strategies.
3. Establish effective collection systems for discarded electronic waste.
4. Increase the capacity and efficiency of e-waste collection centers.
5. Develop environmental management systems for waste sites.
6. Establish e-waste mechanism for updating inventory of e-waste.

Exercise

1. Write very short answers to the following questions:

- (a) What is a pollutant? Give examples.
- (b) What is the secondary pollutant in air pollution?
- (c) What is nitrogen fixation?
- (d) In what unit is noise pollution measured?
- (e) According to the report of the Asian Development Bank, what percentage of biological waste is generated in Nepal?
- (f) What are the three main concepts of waste management?

2. Write short answers to the following questions:

- (a) Classify the types of pollution.
- (b) Explain point and non-point sources of pollution with examples.
- (c) Differentiate between primary and secondary air pollutants of outdoor air pollution.
- (d) How is smog formed? Write its effects.
- (e) How is acid rain formed? Write its effects.
- (f) List the measures for controlling air pollution.
- (g) Write the measures to be adopted at the individual level to avoid air pollution.

- (h) What should be done to control groundwater pollution? List the measures.
- (i) List the methods for water purification.
- (j) List the sources of land pollution.
- (k) Classify the sources of noise pollution in short.
- (l) How can noise pollution be prevented and controlled?
- (m) Prepare a chart about the classification of waste.
- (n) Write in short about the effects caused by waste.

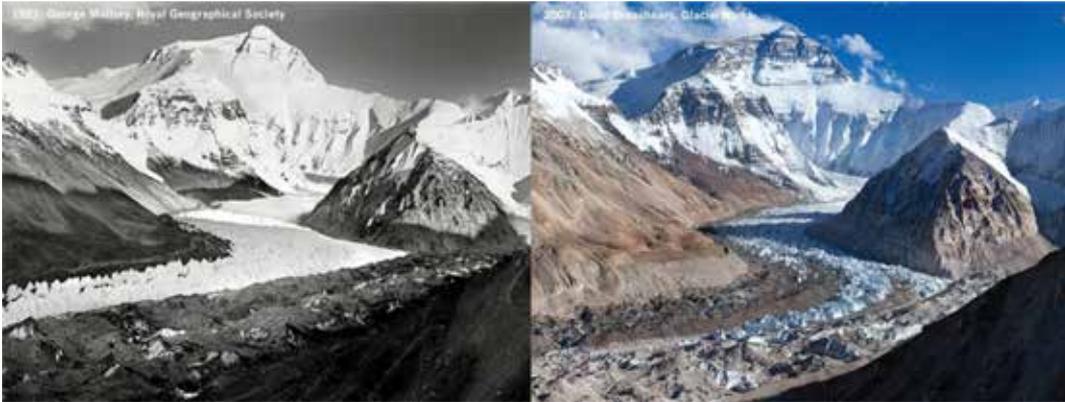
3. Write detailed answers to the following questions:

- (a) "The main cause of pollution generation and control is humans." Justify this statement.
- (b) Identify the sources and effects of water pollution, air pollution, land pollution, and noise pollution and suggest effective measures for their control.
- (c) The lack of integrated waste management has become a major problem in Nepal. Present possible roles to be played by the family, local community, and government to address this problem.

Project Work

1. Conduct a study based on daily records of domestic air pollution from various sources such as kitchen stoves, incense, television, etc., and prepare a report on the pattern of pollution.
2. Survey a water source located near your school. Assess its condition and prepare a classification chart of natural and man-made sources of pollution. Present it in the classroom.
3. Identify what sources of noise pollution exist around your school. Investigate how these noise pollution sources can be controlled and prepare a report.
4. For your school, estimate the amount of solid waste generated per day over one week, list what types of waste are present, and, based on this list, prepare a group report on what activities are being done for its management and what else can be done.

CLIMATE CHANGE AND ITS MITIGATION



As usual, Pasang wakes up early in the morning and looks out of his room window at the nearby mountains, feeling amazed for a moment. A few years ago, the mountains were covered in white snow and glaciers, appearing truly mesmerizing. Today, however, the white glacial rivers have turned into streaks of black rock. The mountains no longer look the way they used to. Why has this happened? Many questions arise in Pasang's mind. What do you think? Why do the mountains appear like this? Discuss this among yourselves.

5.1 Weather and Climate

Every moment, changes keep occurring in the Earth's atmosphere, such as: temperature, rainfall, humidity, hailstone, snowfall, storms, wind speed, and others. This kind of frequent and short-term change in atmospheric conditions is called weather. The long-term change in average rainfall and temperature caused by natural or human activities over an extended period is climate change. Therefore, weather and climate are different things. Weather refers to the condition of the atmosphere for a short period, while climate represents the overall long-term pattern of the atmosphere. Weather can generally be predicted based on daily levels

of temperature, precipitation, and wind flow. It originates from the natural state of the atmosphere. Even normal atmospheric variations can bring changes to our daily weather. Climate is a scientific concept, usually defined as the average form of overall weather conditions over a long period of time.

Activity 5.1: Measure the components of weather and prepare a weather chart.

Objective: To learn the method of measuring weather components in the local area and to record the daily weather details of that place.

a. Measuring Temperature: Compare the difference in temperature inside the house and in the crop/field area.

Required Materials: Laboratory thermometer, notebook, and pen.

Method/Procedure

Weather		Date																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Temperature	Minimum																															
	Maximum																															
Sunshine Hours																																
Cloud/fog																																
Rainfall																																
Windstorm																																
Snowfall/Hail																																

Take one thermometer, and while using the thermometer, keep it placed in the shade. Measure the temperature at different times. Record the temperature daily in the morning, afternoon, and evening also. If a thermometer is not available, use a smartphone and find the temperature through weather-related apps, and present the results in class by filling the table as shown below.

b. Measuring humidity

We can use materials available in our own surroundings to measure the humidity of any place. For example, take a pine cone and keep it placed outside for a whole day. Then, in the evening, observe the condition of the cone and note it down.



Again, keep the same pine cone outside overnight as well, observe its condition in the morning, record the details, and compare the two observations.

By doing this, if the humidity level is high in that condition, the doors remain closed, but if the humidity is low, the doors open automatically. In this way, when the doors open, the air inside also circulates. If no device is available to measure the humidity, take a glass tumbler filled halfway with water. Place a few ice cubes into the tumbler and leave it in the room for about five minutes. If large droplets of water appear on the outer surface of the glass tumbler, it means the humidity in the room is high. If only very small droplets appear on the outer surface of the tumbler, it means the humidity of that room is low. In this way, the humidity of the location can also be estimated using locally available materials.



c. Measuring rainfall

we can make our own rain gauge and measure the amount of water that has fallen in forests and farmlands. First of all, take a plastic or glass bottle available at home or school. Using a ruler, fill water in the lower part of the bottle up to a certain height, level it properly, and mark it as zero. According to that, continue marking other numbers gradually upward on the upper part as well. Now place the bottle outside in the open rainfall area at any suitable place. For some days, observe the water collected in the bottle and note the level up to which the water layer has reached. In this way, the water layer seen in the bottle itself indicates the measurement of rainfall that occurred at that time and place.

5.2 Concept of Climate Change

Earth is estimated to have originated about four hundred sixty crore years ago, and it is believed that during that time, Earth was extremely hot. But as time passed, scientific evidence shows that around one hundred crore years after its formation, Earth's surface was completely covered with snow, resulting in a very cold climate. After that, along with the gradual natural formation of various gases, changes started occurring in the weather and climate of Earth, and it is accepted that the environment of Earth gradually became favorable for plants and animals.

Similarly, due to major fluctuations and changes in climate at different times, the evolution of living beings as well as their gradual extinction has also been found. Therefore, climate change is also a continuous natural process. Besides, different

natural processes, the unplanned and excessive use of natural resources by humans has also started affecting Earth's climate. Because of this, a negative impact is being observed on the entire environmental system of Earth, such as: sometimes extreme heat occurring, sometimes extreme cold occurring, sometimes excessive snowfall happening, sometimes not happening, sometimes drought and famine occurring due to no rainfall, sometimes flood, landslide, and inundation problems occurring due to unnecessary heavy rainfall, and other such effects. All these impacts are indicators of rapid climate change in the present time. Climate affects natural, cultural, and economic activities in every place. That is why climate change in the present time has become a very important global issue for the entire world.

Some special gases present in the Earth's atmosphere, such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbon (CFC), water vapor (H₂O), and others, work like the glass walls of a greenhouse. These types of gases do not allow the heat and light energy coming from the sun and reflected from the Earth's surface to escape back out of the atmosphere. Because of this, such gases are called Greenhouse Gases. Due to the effect of these gases, our Earth is becoming warm, and this process is called the Greenhouse Effect. If the greenhouse effect did not exist, the average temperature of the Earth would be lower than 18 degrees Celsius, making it unfavorable for humans and other living beings to survive. Therefore, this process is a very essential process for life on Earth. That is why this process is an extremely important natural phenomenon necessary for the existence of life on Earth.

Various activities performed by us, such as factories, increasing use of chemical fertilizers and pesticides in agriculture, deforestation, large livestock farming operations, increasing use of fossil fuels, forest fires, and other similar causes, have been increasing the amount and effect of greenhouse gases in the atmosphere. Due to this, the average temperature of the Earth is rising, and this process is called Global Warming. Because of global warming, the problem of climate change has been increasing widely in the last 50 years. Since the greenhouse gases increased by our activities are continuing to show more impact, climate change has now become a major challenge for this Earth, and it has remained as the main threat and key concern for the entire world.

Greenhouse

A house built to protect plants from cold temperatures is called a greenhouse. Its walls and roof are made of transparent glass or plastic, through which sunlight can easily pass. Because of this, the heat that enters inside the house is absorbed by the

soil and the plants, and later they start releasing that same heat through various processes, which also begins to warm the air inside the greenhouse. The walls and roof of the house do not allow the heat to escape outside and maintain the warmth inside. If the natural greenhouse effect did not exist, Earth's temperature would become unbearably cold, and animals would not be able to survive.



Figure 5.3: Greenhouse Model

Activity 5.2: Greenhouse in a Bottle

Purpose of the Activity: To observe the operation process of greenhouse and know how our earth gets warmer.

Materials Required:

1. A transparent bottle - 1
2. Pieces of cardboard - 2
3. Small thermometer - 2
4. Rubber Band



Method/Procedure

- (a) Using rubber bands, tie both thermometers onto two cardboard stands. While tying, make sure the scale of the thermometer is visible.
- (b) Place one thermometer inside the glass container and close the lid.
- (c) Now, place the glass container with the thermometer in sunlight or near a bright lamp, and place the other thermometer outside the container nearby. However, make sure that direct light does not fall on either thermometer.
- (d) For one hour, record the temperature of each thermometer every 10 minutes.
- (e) In addition, by continuing this experiment, the temperature of both thermometers can be recorded at the same time every day for a week. Plot the daily recorded temperatures on a graph and discuss the changes in temperature.

discussion

- (a) Why would the thermometer inside a glass container show a higher temperature?
- (b) Will a greenhouse made of glass have the same effect throughout the day?
- (c) How is a glass container functioning like the atmosphere, and in what ways is a glass container different from the atmosphere?

5.3 Causes of Climate Change

Greenhouse gases in the atmosphere are emitted from both natural and human-made sources. Natural sources include forest fires, volcanic eruptions, and the decomposition of plants and leaves. Human-made sources include extensive use of fossil fuels in transportation, industries, and factories, deforestation and changes in land use, livestock farming, and improper management of waste.

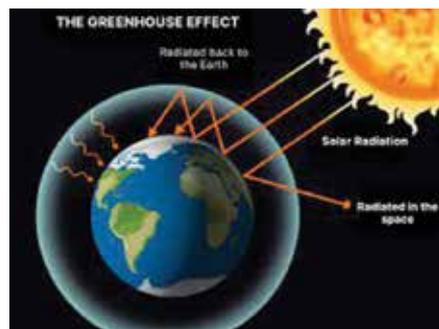


Figure 5.4: Greenhouse Effect

The greenhouse effect unnaturally increases the temperature of the Earth's surface, which leads to changes in climate. Greenhouse gases in the atmosphere are emitted from various natural and human-made sources. Excessive emission of greenhouse gases increases the intensity of the greenhouse effect and contributes to global warming. This, in the long term, facilitates climate change. The human causes of greenhouse gas emissions are described in the following points:

a. Urbanization and Industrialization

Due to industrial activities and the rapid increase in vehicles, the levels of gases like carbon dioxide and nitrous oxide in the atmosphere are rising. Similarly, industrialization has intensified the emission of greenhouse gases such as carbon dioxide, chlorofluorocarbons (CFCs), and nitrous oxide. These gases released into the environment by industries, factories, and vehicles contribute to enhancing the greenhouse effect. As a result, this also accelerates global warming. According to United Nations data, urban populations are expected to increase significantly over the next 20 years, with the greatest impact occurring in developing countries. If the growing urbanization is not controlled, the level of pollution in urban environments will rise, leading to an increase in the greenhouse effect and causing unnatural changes in climate.

b. Environmental Pollution

The increasing population in urban areas is also contributing to a rise in environmental pollution. The rapid growth of population has, on one hand, increased the pressure of vehicles, and on the other hand, increased the amount of solid waste. As a result, major cities around the world are experiencing problems such as air pollution, water pollution, and land pollution.

c. **Agriculture**

Agriculture is also one of the causes of climate change. Greenhouse gases are emitted from the farming systems we use and the various chemicals applied in agriculture. For example, leaving rice seedlings in the field for a long-time release methane gas. Similarly, manure from livestock also emits methane gas. Excessive use of chemical fertilizers and modern agricultural machinery leads to the emission of gases such as carbon dioxide and nitrous oxide.

d. **Deforestation**

Large-scale deforestation is also a major cause of climate change. Trees and other vegetation in forests help maintain the balance of carbon dioxide in the atmosphere through the process of photosynthesis. When extensive deforestation occurs, the absorption of carbon dioxide from the atmosphere decreases, which further enhances the greenhouse effect. As the greenhouse effect intensifies, global temperatures rise, leading to changes in climate.

Activity 5.3

Collect news articles about events caused by climate change and make a poster. For this, gather news and articles related to the effects of climate change published in local, national, and international newspapers and magazines. Paste them on chart paper and present the poster in the classroom.

5.4 Impacts of Climate Change

Changes in climate have led to an increase in unexpected events such as floods, landslides, droughts, and hailstorms. This has adversely affected agriculture and food production, water resources, forests and biodiversity, health, tourism, and infrastructure. Some of the impacts of climate change on different regions of the Earth are as follows:

a. **Agriculture and Food Security**

The agricultural sector is entirely dependent on water. To meet its water needs, it relies on seasonal rainfall, rivers, and other water sources. However, in terms of climate change, agriculture falls into a very vulnerable category. Increases in temperature, irregular rainfall, and the intensity of other climate-related events negatively affect global agricultural production and businesses. In Nepal, the majority of the population depends on agriculture. However,

due to a lack of necessary resources and limited irrigation facilities, much of Nepal's agriculture relies on rainwater. Changes in the timing and amount of rainfall caused by climate change have severely affected Nepal's agricultural system. Fluctuating temperatures, loss of soil moisture, strong winds, hailstorms, increasing floods, droughts, and the spread of new diseases and pests have badly impacted traditional farming practices. As a result, arable land is gradually turning barren, and food shortages are increasing day by day. On the other hand, importing food from other countries to meet shortages affects the country economically.

b. Forest and Biodiversity

Climate change has had a negative impact on biodiversity. Every plant and animal in the world have a close relationship with its environment and climate. Plants and animals require suitable temperature, air, water, food, nutrition, and a favorable environment. Therefore, in changing climatic conditions, they are often unable to adapt, which threatens their very existence. Recently, climate change has been observed to negatively affect bird migration patterns, nesting times, and the distances they travel in search of food. Similarly, climate change has also impacted ecosystems, resulting in grasslands gradually turning into deserts and ponds and large lakes drying up due to water shortages, transforming into dry plains.

c. Human Health

Climate change has emerged as a new and serious problem for human health. Humidity, temperature, and rainfall are directly related to human health. Therefore, even normal changes in climate negatively affect the food we eat, the water we drink, and the air we breathe. Rising temperatures have led to an increase in diseases such as diarrhea and vector-borne illnesses like malaria, kala-azar, and Japanese encephalitis, transmitted by mosquitoes, resulting in higher mortality rates. The Terai region of Nepal is most affected by these problems, but the issue is also evident in the hill and mountain areas. During floods and landslides, the lack of clean drinking water exposes many people to waterborne diseases. Due to increasing temperatures, hundreds of deaths occur every year in the Terai region of Nepal.

d. Water Resource

Climate change has the greatest impact on water resources. Snow and ice are considered the primary sources of water. Similarly, during the dry season, the

flow of our rivers depends largely on the snow in the mountains. However, due to global warming, the sources of water are rapidly drying up, and melting snow indicates a potential water shortage in the future. In Nepal, the rainy season begins around Jestha–Asar (May–June), and in other parts of the world, rainfall also follows specific months and periods. However, climate change has altered rainfall patterns, causing irregularities such as droughts, excessive rainfall, scanty rainfall, and intermittent rainfall. This leads to water shortages when it is needed and unexpected water when it is not required, affecting various sectors dependent on water resources.

e. **Extreme Weather Events**

Every year, Nepalese people suffer from natural disasters. Due to climate change, the frequency and intensity of extreme weather events are increasing. In the high Himalayan region, glacier retreat, the increase in the number and size of glacial lakes, glacial lake outburst floods, floods, landslides, and other extreme weather events are occurring. Climate change has led to an increase in unexpected events such as floods, landslides, droughts, and hailstorms. As a result, in the mid-hill regions, disasters like debris flows, riverbank flooding, soil erosion, and abnormal droughts are on the rise. Similarly, farmland and settlements are affected by inundation, river course changes causing floods, riverbank erosion, and droughts, making the Terai region prone to displacement. According to the Ministry of Home Affairs, over the past fifteen years (since 2065 B.S.), more than 4,000 Nepalese have died due to climate-induced disasters, and property damage is estimated at around NPR 5.3 Arab. Additionally, every year, over 10 lakhs people are affected by climate-related disasters such as floods, landslides, glacial lake outburst floods, and droughts.

f. **Glacier Lake Outburst**

Nepal has approximately 3,252 glaciers and 2,323 glacial lakes, which serve as sources of clean water for more than 130 million people in South Asia. Therefore, the Himalayan region is often called the “water tower of Asia”. However, rapid



Figure 5.4: Imja Glacier Lake, which is at risk of bursting

warming is threatening the very existence of the Himalayas. Due to global warming, some glaciers in Nepal's mountainous regions are melting. Floods generated by glacial lake outburst events are called glacial floods (see Figure 5.4). These floods damage schools, health posts, and other physical structures in lower areas, and also affect sources of clean water. In some cases, they may even force the relocation of settlements.

g. Socio-economic Effects

Due to global warming, as water sources are drying up, people in rural areas have to walk for hours just to fetch a pot of water. Similarly, as snow melts from the Himalayan regions, the natural beauty has diminished, affecting tourism as well. As a result, the nation has suffered economic losses amounting to millions. Due to global warming, agricultural lands are becoming barren, causing unemployment among those involved in farming, forcing many to go abroad in search of work. Likewise, floods and landslides cause significant loss of life and property every year, creating an uncomfortable and difficult social environment.

h. Physical Infrastructure

Physical infrastructure is a strong foundation for social development. Physical infrastructure includes transportation, sanitation systems, energy systems, information and communication, cultural heritage, buildings, hospitals, and educational facilities. With climate change, the increase in temperature and changes in rainfall patterns (excessive rainfall and drought) can be observed to have direct impacts on such physical infrastructure and urban settlements. Various events caused by climate change, such as acid rain and heavy rainfall, reduce the durability of infrastructure and the construction materials used in them. As a result, infrastructure deteriorates, collapses, or becomes non-functional more quickly. Various natural disasters caused by climate change, such as floods, landslides, storms, and inundation, tend to cause greater loss of life and property in densely populated areas.

i. Decrease in Soil-quality

Climate change has a significant impact on soil quality. Increasing drought has led to soil erosion, desertification, and higher soil acidity. Similarly, due to climate change, heavy rainfall can cause soil pores to become blocked,

increasing the likelihood of waterlogging in agricultural fields for extended periods. This reduces soil fertility and, consequently, agricultural productivity.

j. Ocean Acidification

Since the Industrial Revolution began over the past 200 years, the extensive use of fossil fuels has increased the amount of carbon dioxide in the atmosphere. According to a study, carbon dioxide levels are rising at a rate of 2 million tons annually on the ocean's surface, which is also affecting seawater. As a result, the concentration of carbonic acid in seawater is increasing, leading to higher ocean acidity. This can have negative impacts on marine life.

5.5 Effects of Climate Change in Nepal

Although Nepal's contribution to greenhouse gas emissions, a major cause of climate change, is very small, its impacts are already being felt in the country. Climate change has affected sectors such as agriculture, water resources, biodiversity, and human health in Nepal.

a. Glacier Lake Outburst

Due to the greenhouse effect, the impacts of climate change have begun to appear in Nepal's Himalayan regions. Rising temperatures cause snow in the mountains to melt, forming glacial lakes. If the snow in these lakes continues to melt and the volume increases, there is a significant possibility that these lakes could burst. Floods caused by the bursting of glacial lakes are known as Glacial Lake Outburst Floods (GLOFs).

Many of Nepal's mountains and the settlements located below these Himalayan areas face serious problems from GLOFs. Sometimes, floods from bursting glacial lakes are accompanied by landslides, which can wash away entire settlements in the lower regions. Similarly, floods with higher river flows, combined with landslides, are increasing the problem of inundation even in flat areas.

b. Desertification

With rising temperatures, reduced rainfall (drought), irregular rainfall, and increasing deforestation, the drying of water sources and streams is accelerating. As a result, along with the risk of drought, some areas may even turn into desert-like conditions.

In Nepal, low rainfall during the monsoon and excessive rainfall after the monsoon have been serious problems for more than a decade. Globally, temperatures are increasing by approximately 0.03°C per year, while in Nepal, temperatures are rising by 0.056°C annually, which is not a good sign. Rising temperatures make already dry areas drier and humid areas even more humid. Therefore, in dry regions, higher temperatures cause faster evaporation of water, increasing the risk of drought and ultimately leading to desertification.\

c. **Impact of Health**

Changes in weather due to climate change have also begun to negatively affect the health of the Nepali population. Areas that did not have mosquitoes 10–15 years ago are now experiencing an increase in mosquitoes, midges, and other disease-carrying insects. As a result, various mosquito-borne diseases such as malaria and dengue, as well as waterborne diseases like diarrhea, cholera, and typhoid, have become more prevalent. Similarly, in recent years, dengue transmission has increased in Kathmandu. Due to climate change, infectious diseases are now widespread in 65 districts of the country, with 13 districts among the 52 affected showing high prevalence. In Nepal, the first case of dengue was reported in 2004 from Chitwan district, and the first outbreak occurred in 2006 in Banke district.

d. **Impact on Biodiversity and Agriculture**

Due to climate change, a suitable environment may not be maintained for many plants and animals. Some plants and animals may even become extinct from their original habitats, while the number of invasive plant species may increase, causing local species to disappear, which affects overall biodiversity. Continuously rising temperatures, drying rivers and streams, irregular rainfall, excessive rainfall, and drought prevent timely farming, promote the spread of various pests and diseases, and reduce agricultural productivity. As a result, climate change is having a negative impact not only on crop yields but on the entire agricultural system.

Discussion Question:

Due to the increasing impacts of climate change, what kind of effects might it have on Nepal's hydropower projects in the future? Discuss.

5.6 Measures to Reduce the Impact of Climate Change

1. Stay informed about climate change and teach others what you know.
2. Use renewable energy sources such as improved stoves, biogas, and solar energy.
3. Use electric vehicles where possible and advocate for their use.
4. Walk or cycle for short distances and develop the necessary infrastructure to support this.
5. Conserve forests and manage them sustainably.
6. Do not indiscriminately dispose of household waste; convert organic waste into compost, and promote and preserve traditional knowledge and skills within local communities.
7. Document traditional skills, knowledge, technologies, and practices that address climate change, and develop and implement them as needed.
8. Strengthen community capacity to deal with floods, landslides, and other natural disasters, and ensure preparedness.

5.7 Adaptation

Adaptation refers to carrying out activities that are suitable to the changing environment caused by climate change in order to increase one's capacity to survive. Adaptation methods include enhancing the ability of humans and animals to cope with environmental changes and carrying out activities that can be implemented locally. The following activities can be undertaken:

a) **Construction of Physical Structures and Use of Technology:**

1. Build embankments along rivers and streams, plant trees on barren lands, and implement soil erosion control measures.
2. Promote habits of efficient water use and conservation, such as rainwater harvesting, constructing artificial ponds in different locations, and using technologies like drip irrigation that allow maximum irrigation with minimal water.

3. Install technologies for early warning of natural disasters in various locations.

b) Changes in Agricultural Systems:

1. Adjust cropping patterns according to changing weather, change seed types when necessary, and, where possible, arrange crop insurance to compensate for losses.
2. Adopt multi-cropping systems – growing two or more types of crops simultaneously in the same field.
3. Implement crop rotation systems, e.g., changing crops each year in the same location.
4. With technical support and advice, establish seed banks in certain areas to supply seeds locally.

c) Public Awareness and Cooperation:

1. Understand climate change and educate others about it.
2. Discuss potential disasters caused by climate change and prepare necessary methods and materials in advance.
3. Collaborate with various government and non-government organizations, experts, civil society, and local communities to conduct collective discussions, raise awareness, and implement joint actions regarding climate change, its impacts, emissions, and adaptation measures.



Exercise

1. Write very short answers to the following questions:

- (a) Define climate.
- (b) Mention any two major human activities that cause climate change.
- (c) Define global warming.
- (d) What is a greenhouse?
- (e) Write one impact of global warming in Nepal.
- (f) What is the greenhouse effect?
- (g) Write the names of any two greenhouse gases.

2. Write short answers to the following questions:

- (a) Briefly explain the relationship between climate change and the greenhouse effect.
- (b) Describe how the greenhouse effect increase global warming.
- (c) Briefly explain how the greenhouse layer is formed in the atmosphere.
- (d) Differentiate between:
 - i. Climate and Weather
 - ii. Greenhouse effect and global warming
 - iii. Excessive rainfall and drought
- (e) Write a short note on:
 - i. Rise in sea level
 - ii. Greenhouse effect
 - iii. Greenhouse gas
 - iv. Ocean acidity

3. Write long answers to the following questions:

- (a) Identify the causes and impacts of climate change and explain the measures to reduce its effects.
- (b) Explain the causes and impacts of global warming. Identify the impacts observed in Nepal due to global warming and suggest measures to mitigate them.
- (c) What measures can be adopted in your area for climate change adaptation? Present them in bullet points.

Project Work

Investigate the changes in the climate of your residential area over the past 25 years by talking to the elderly in your community. Compare the past climate conditions with the current ones (e.g., rainfall patterns, winters, summers, storms, etc.).

1. Identify what problems these changes have caused.
2. Explore what measures could be adopted to prevent or reduce these problems.

Prepare a report based on your findings and present it in class. With the help of your teacher, conduct a group discussion and create a list of local measures as a collective conclusion, then display it in the classroom.

SUSTAINABLE DEVELOPMENT AND ECO-FRIENDLY LIFESTYLE



Figure 6.1

Concept

Have you ever thought that your lifestyle affects the environment? The daily activities we do are connected to the environment. Have you ever thought what will happen if we do not care about it? What is an environmentally friendly lifestyle? Why should we follow it? Think about this and write a short group article in your notebook mentioning its importance, benefits, and ways to adopt it.

To protect our environment and keep it clean, we all must follow an environmentally friendly lifestyle. For this, we should make small changes in our daily habits and adopt a healthy lifestyle that does not harm the environment. We should plan our activities properly and use resources wisely.

Living an environmentally friendly life helps reduce negative impacts on nature. We can save water, manage waste properly, reduce air pollution, use less fuel, save energy, and protect plants and animals. If we all follow this lifestyle, it will help control pollution and support climate change solutions.

6.1 Introduction

As science and technology have progressed, human needs have also increased. To fulfil these growing needs, people are using more natural resources than ever before. Because of this overuse, the environment is being damaged day by day. If we keep harming nature like this, future generations may not get the necessary things they need to live a good life. Today, we are facing many environmental problems such as air, water, and land pollution, deforestation, climate change, soil erosion, shortage of water, and the destruction of wildlife habitats. These problems are affecting our health and daily life directly. If such environmental issues continue to increase, the survival of all living beings on Earth will become more difficult. Therefore, it is very important to protect the environment to maintain balance in nature. A clean and healthy environment is essential for keeping all living beings safe and healthy.

6.2 Concept of Sustainable Development

Sustainable development means development that meets our present needs without harming the ability of future generations to meet their needs. In simple words, it means developing the country while protecting nature for the future. Sustainable development includes three main aspects: economic growth, social development, and environmental protection. These three aspects must be developed equally for real progress. It helps improve education, health services, employment, transportation, agriculture, industries, and living standards while making sure the environment stays clean and safe.

Sustainable development teaches us to use natural resources wisely and not to waste them. When we do development work, we should think about the safety of nature and ensure that development benefits all people equally. It encourages us to protect



Figure 6.2

forests, water, soil, and wildlife, and reduce pollution. By practicing sustainable development, we can improve our current life while also keeping resources safe for future generations.

According to the concept of sustainable development, the following principles should be followed:

- (a) We should not do any work that lowers or harms the quality of the environment.
- (b) We should not use renewable resources more than their ability to regenerate or recover.
- (c) We should make sure that resources and materials are available for future generations as well.
- (d) While fulfilling our present needs, we should not reduce the ability of other living beings and future generations to meet their needs.

Although sustainable development has been defined differently, a frequently used definition comes from the Brundtland Commission, which stated the following in its report "Our Common Future" in 1987 AD.

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Although the term sustainable development itself is new, the practice of its principles has been in use for a long time. Some development works done in the past and present are also in accordance with sustainable development. The challenge of sustainable development is to transfer to future generations while living in a way that does not degrade the environment. While discussing the concept of sustainable development, attention should be paid to the interrelationship of three main aspects: environmental, economic, and social. If these three aspects are taken into consideration while carrying out any development works, then environmental degradation can be prevented by protecting natural resources, the economic situation becomes stronger, and there is also improvement in the living standards of people.

Aspects of Sustainable Development Goals



Environmental	Economic	Social
1. Conservation of forests	6. Opportunities for economic growth	10. Participation and inclusion
2. Improvement in air, water and land quality	7. Economic stability and security	11. Elimination of poverty
3. Proper waste management	8. Environment-friendly employment and elimination of unemployment	12. Food security
4. Conservation of species	9. Proper utilization of resources	13. Fair distribution of resources
5. Implementation of resource conservation measures		14. Better livelihood options and opportunities

Figure 6.3 Sustainable Development Goals

The long-term sustainable development relating to the three pillars can be understood from the figures given above 6.2 and 6.3. The first figure summarises that long-term sustainable development goals can only be achieved if all three pillars are properly addressed in our development policy formulation and implementation, while the second figure presents the benefits and opportunities that can be obtained from long-term sustainable development.

6.3 Need of Sustainable Development

The Earth's population is ever increasing. According to the census of 2025, the Earth's population is more than 8.2 billion, which was only 3 billion in 1960. With this kind of population growth, the Earth's natural resources are being unsustainably exploited and depleted. Modern technologies have accelerated this depletion process. This has threatened the existence of environmental systems and natural resources that provide relief to human and all living beings.

The increasing population, depletion of natural resources, climate change and global warming have negatively impacted human life. The impact of environmental degradation will not be limited to any national boundary, the global warming produced by industrial nations has affected everyone. Over the last few decades, people have started to become aware of the environmental crisis created by development. Now, the concept of sustainable development is coming forward to solve the serious crisis that has appeared.

6.4 Sustainable Development Goals

The Sustainable Development Goals (SDGs) encompass environmental sustainability, poverty alleviation, peace establishment, and partnership building. Discussions regarding the Sustainable Development Goals were formally conducted for the first time at the United Nations Sustainable Development World Conference "Rio+20" in Rio de Janeiro in 2012 and at the United Nations General Assembly in 2014 AD. In 2015 AD, the United Nations, aligning with the collaborative development goals timeline, determined 17 Sustainable Development Goals and 169 target indicators from the end of 2015 AD to 2030 AD. To achieve the Sustainable



Figure 6.4: Themes of Sustainable Development

Development Goals and target indicators, five important areas have been identified, and action plans will be focused on them. These areas are as follows:

a. **People**

Focuses on ending poverty and hunger in all forms and dimensions. It is committed to ensuring that all human beings can fulfil their potential with dignity and equality and in a healthy environment.

b. **Planet**

Aims to protect the planet from degradation through sustainable consumption and production, sustainably managing its natural resources, and taking urgent action on climate change. This is essential to support the needs of the present and future generations.

c. **Prosperity**

Determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social, and technological progress occurs in harmony with nature.

d. Peace

Committed to fostering peaceful, just, and inclusive societies which are free from fear and violence. There can be no sustainable development without peace, and peace cannot be achieved without sustainable development.

e. Partnership

Seeks to strengthen the spirit of global solidarity to support the achievement of the Sustainable Development Goals. It focuses on the needs of the poorest and most vulnerable communities, with the participation of all countries, stakeholders, and people.

The 17 Sustainable Development Goals (SDGs), which were established based on the success of the Millennium Development Goals (MDGs), encompass the world's current major challenges. These issues include: climate change, economic inequality, innovation, sustainable consumption, peace and justice. The targets set by the Sustainable Development Goals are interconnected, making the achievement of any one goal simpler by achieving success in another.

The 17 Sustainable Development Goals:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-Being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace, Justice and Strong Institutions
17. Partnerships for the Goals



Figure 6.5: Sustainable Development Goals

6.5 Carrying Capacity of The Earth

The Earth supports the lives of thousands of living organisms. The ability of the Earth to support the maximum number of people, animals, or organisms that can live in a particular environment sustainably is called carrying capacity. This capacity is determined by factors such as the availability of resources (food, water, energy), and the environment's ability to absorb waste.

Human activities are currently growing at a faster rate than the Earth's carrying capacity, leading to problems like resource scarcity, pollution, climate change, soil degradation, and loss of biological diversity.

Today, we are generating waste that the Earth cannot assimilate, and we are depleting its

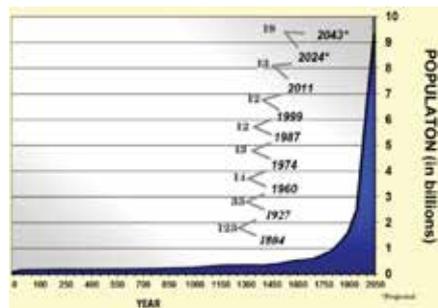


Figure 6.6

resources faster than they can be renewed, which is leading to environmental imbalance.

For examples:

1. Deforestation and loss of biological diversity
2. Climate change due to greenhouse gas emissions
3. Excessive use of non-renewable resources
4. Soil and water pollution
5. Increase in solid waste and plastic pollution

According to the Global Footprint Network, we have reached a point where the world's population is currently exceeding the Earth's carrying capacity. Humanity currently requires approximately 1.7 Earths to meet its current resource demands sustainably.

If this trend continues, where resource consumption grows at the current rate, the Earth will only be able to support a population of 1.5 to 2 Arab people.

Sustainable Development Goals (SDGs) Connection, these goals are particularly relevant for ensuring a sustainable future:

1. SDG 12 Responsible Consumption and Production
2. SDG 13 Climate Action
3. SDG 14 Life Below Water and Life on Land

We need to promote the use of renewable energy and eco-friendly human behaviours to sustain the Earth's carrying capacity, protect human health, and build a prosperous, sustainable future for the coming generations.

6.6 Factors Affecting Earth's Carrying Capacity

The limit of the Earth's carrying capacity depends on the situation used to measure it. This limit is generally considered to be between half billion to fourteen billion people.

Carrying capacity refers to the maximum number of individuals or species that a particular environment can sustain indefinitely without depleting its resources. The

projected limit of Earth's carrying capacity depends on how new inventions and technologies are developed. Various factors influence the Earth's carrying capacity, with the major ones listed below:

- a. Availability of Natural Resources
- b. Environmental Conditions
- c. Human Activities
- d. Technological Progress
- e. Socio-economic and Political Factors
- f. Climate Change and Natural Disasters

a. Availability of Natural Resources

Natural Resources Constraints: The basis of life and the continuity of the ecosystem is determined by the sustainable use of the Earth's resources. Developing countries often face the impact of resource scarcity to a greater extent.

Water Resources: Clean water scarcity has affected the health of the population and the ecosystem. In terms of water use, irrigation accounts for 70%, industrial use accounts for 20%, and domestic use accounts for 10% of the world's water consumption. The negative impact of water use in production and consumption also affects the Earth's carrying capacity. Due to limited water availability and increasing population, the amount of potable water available on Earth is decreasing. According to the United Nations, more than two billion people face a scarcity of clean drinking water, and over three billion people worldwide are facing water scarcity for at least one month of the year. The excessive extraction of groundwater for agriculture and irrigation also affects the Earth's carrying capacity.

Land and Geography: The impact of human settlement and biological life is increasing on the land. According to a world bank report, only 10.9 percent of the total land area on Earth is cultivable. Therefore, population growth requires an increase in food production and cultivable land. If cultivable land is not increased due to population growth, the demand and supply for food and land will become unbalanced.

b. Environmental Conditions

Climate and Seasonal Changes: Changes in temperature, rainfall, and extreme weather events can cause damage to ecosystems.

Soil Quality: Soil erosion, loss of fertility, or desertification can reduce agricultural production.

Loss of Biological Diversity: The loss of biological diversity and the introduction of invasive species can affect the balance and structure of the ecosystem, thereby impacting the Earth's carrying capacity.

c. Human Activities Constraints

Deforestation and Land Use Change: Deforestation, urbanization, and land encroachment lead to the loss of biodiversity and changes in the ecosystem structure, which reduces the Earth's carrying capacity.

Pollution: Air, water, and soil pollution affect the ecosystem and reduce the Earth's carrying capacity.

Over-extraction of Resources: The increasing extraction of non-renewable natural resources reduces their availability, thereby impacting the Earth's carrying capacity.

Urbanization and Industrialization: Excessive urbanization and industrialization increase the demand for natural resources, which affects the earth's carrying capacity due to higher consumption and production.

d. Technological Progress

In 1960, the world population was around 3 billion, and today it has surpassed 8 billion. This rapid population growth has resulted in the excessive use of fossil fuels, forests, soil, water, and other natural resources for daily needs and development activities. More than 80% of the world's energy is still produced from fossil fuels and other non-renewable sources, which has significantly increased pressure on the Earth's carrying capacity.

Therefore, the adoption of renewable energy solutions such as electric vehicles, solar power, and other clean energy technologies is strongly encouraged.

e. **Socio-economic and Political Factors**

High Demand for Resources: A rapidly increasing population puts high demand pressure on environmental resources. Developed countries also put pressure on these resources due to their high consumption patterns.

Policies and Laws: Environmental protection, resource conservation, and effective sustainable development strategies are essential for maintaining carrying capacity.

f. **Climate Change and Natural Disasters**

The increase in Earth's temperature and changes in rainfall also affect the availability of food and water. Extreme natural events, such as floods, droughts, hail, storms, and epidemics, affect the livelihood system and human society. While the world's population is facing diverse challenges to meet their needs, environmental degradation is a complex problem. Temperature rise, melting of ice caps, and changes in the normal cycle of the seasons are some changes that impact the Earth's carrying capacity.

6.7 Sustainable Development and Economy

Sustainable development is essential for a peaceful and prosperous future. The economy and economic activities should be organized in a way that provides the benefits of sustainable development (e.g., controlling the type and quantity of waste generated).

SDG 12: Responsible Consumption and Production: The objective of SDG 12 is to ensure the efficient use of resources and reduce waste and environmental pollution resulting from our production and consumption processes. This involves managing waste from the beginning of a product's life cycle to its final disposal. Responsible consumption and production are a concept that promotes natural resource protection, pollution reduction, and a future where resources can be used for a long-time including reuse, recycling, repair, and new innovative products. This goal contributes to reducing waste, saving natural resources, and fostering environmentally responsible living.



Linear and Circular Economy Concepts

Feature	Linear Economy	Circular Economy
Main Concept	Production-Consumption-Disposal	Production–Consumption–Reuse/Repair/Recycle
Resource Use	Used once and then disposed of	Reused, repaired, and recycled repeatedly
Management of Produced Goods	Used as a final product	Used as new materials
Environmental Impact	Pollution, resource scarcity, loss of biological diversity	Pollution minimization, resource sustainability, ecological protection
Economic Benefit	Short-term gain, long-term impact	Long-term cost savings, creation of new employment
Examples	Electronic waste, the practice of using chemical fertilizers in agriculture and buying new goods.	Recycling plastic to produce new goods, repairing and recycling electronic goods, organic farming, and using compost fertilizer

Activity 6.1

Prepare a list of 10 items found in your home (e.g., utensils, clothes, electronic goods, toys). Think about the purpose for which each item can be used again and write it down.

Item/Material	Use	Justification
1.		
2.		
3.		
4.		
5.		

Analyse the listed items: Did any item break down due to a flaw or defect in its design/manufacturing? How can the lifespan of that item be extended? Present ideas such as reuse, repair, recycling, repurposing, or improving the design.

In this activity, students are expected to present their ideas related to SDG 12 and the concept of a Circular Economy such as reducing waste, reusing materials, responsible consumption, minimizing environmental impact, and redesigning products.

6.8 Principles of Eco-Friendly Lifestyle

An eco-friendly lifestyle helps maintain environmental balance. It reduces the negative impacts caused by the excessive use of natural resources in daily life and promotes sustainable development. By adopting eco-friendly habits in our daily activities such as using resources wisely, minimizing waste, and conserving energy we can reduce pollution and protect the environment. Developing an eco-friendly habit involves making small but meaningful changes in our lifestyle. Some important principles are explained below:

(a) Reduce, Reuse, and Recycle (3R's)

The 3R principle helps promote an environmentally friendly lifestyle. It encourages reducing unnecessary consumption of natural resources, reusing materials whenever possible, and recycling used or damaged items to make new products. By applying the 3R principles, we can reduce the overall pressure on natural resources and protect the environment.

(b) Energy Conservation:

It is important to conserve energy to reduce greenhouse gas emissions and mitigate climate change. This includes stopping the use of devices when not in use, reusing possible equipment, and adopting practices that reduce electricity consumption, such as utilizing natural light.

(c) Appropriate Use of Water:

This is necessary for the conservation of clean and fresh water sources and for ensuring water availability for future generations.

Activity 6.2: Commitment to the 3R Program

Activity Objective

To emphasize the importance of Reduce, Reuse, and Recycle and to develop environmentally friendly behaviour regarding the use of energy, water, and daily consumables among students.

Time: 30-40 Minutes

Required Materials:

1. Colored paper, chart paper
2. Markers, pictures or illustrations of used items, and
3. Trash bins (that can be used as temporary waste collection containers)
4. Pre-written sheets (e.g., plastic bottles, empty wrappers, old clothes, paper, waste, water, etc.)

Activity Phases

Phase 1: Materials Classification (10 minutes):

1. Divide students into groups of 3–4 people.
2. Distribute 5-7 various used items to each group.
3. Now, students should be asked to classify these items into Reduce, Reuse, or Recycle categories and then separately write a report. It is suggested that groups include a specific reason for their decision.

Example: "Plastic bottles are highly reusable and can be repurposed for various functions, such as storing water or creating vertical gardens by hanging them near windows".

Phase 2: Energy and Water Saving Tips Poster

1. Provide a chart paper to each group.
2. Students should create a descriptive poster by writing 3–5 suggestions regarding "Energy Saving" and "Water Saving," and then display the poster.
3. The posters should be evaluated based on creativity, correctness, and practical applicability.

Phase 3: Responsible Consumption Pledge (10 minutes):

1. Engage students in an activity to make a one-minute pledge to reflect on their environmentally friendly behavior in the future.

Example:

Instead of buying plastic bags after paying money, I will use a cloth bag.

I will clean and reuse the wrappers of the goods that I consume at home.

Concluding Activity provide a small prize (organic fruits, vegetables, books, etc.) to students who produce the best poster or show commitment. Display the students' commitment pledges in an exhibition.

6.9 Practical Strategies for Eco-Friendly Living

- a. Promote Eco-Friendly Transportation:** Opting for and using eco-friendly modes of transport such as walking, cycling, or utilizing public transportation contributes to environmental improvement by reducing carbon emissions. To minimize environmental impact, prioritize public transport options instead of single-occupancy vehicle use.
- b. Reduce Waste Generation:** Develop a habit of minimizing the use of plastic. Waste production should be reduced by composting organic waste and adopting careful consumption habits. Cultivate the habit of purchasing durable, long-lasting products.
- c. Choose Sustainable Food Options:** To lessen the environmental impact of food production, select plant-based foods and locally produced seasonal goods. Sustainable farming practices that prioritize soil quality improvement, biodiversity, and animal welfare should be encouraged and promoted.

- d. **Be a Conscious Consumer:** Decisions to purchase various materials should only be made after considering their environmental and social impact. Before purchasing any item, prioritize its durability, local production (daily use), and support companies and brands that adhere to ethical labor practices. Before purchasing goods, one should read the labels concerning the packaging materials. One should advocate for transparent supply chains by choosing eco-friendly alternatives.

Activity 6.3

The Interrelation between Nature Worship in Local Communities and Sustainable Development.

Discuss in a group the traditional practices related to nature worship in your community and fill out the table provided. Conclude on the relationship between our indigenous knowledge, skills, and practices, and sustainable development.

S.N.	Name of Worship	Name of Community	Activity	Relation to Sustainable Development
1.	Tulsi Worship	Hindu Community	Sowing seeds, planting, caring	(As it has medicinal utility, various health issues can be resolved, promotion of greenery)
2.	Sithi Nakha	Newar Community	Cleaning water sources	(As water is the basis of life, regular conservation of water sources and maintenance of quality is ensured)
3.	Chhatha			
4.	Lhosar			
5.	Nwagi Festival			
6.				
7.				
8.				
9.				
10.				

6.10 Benefits of an Eco-Friendly Lifestyle

- a) **Environmental Conservation:** Adopting eco-friendly practices helps protect ecological systems, safeguard biodiversity, and conserve natural resources. It also contributes to minimizing the impacts of climate change on the Earth.
- b) **Health and Healthy Living:** An eco-friendly lifestyle reduces exposure to pollutants, toxic substances, and harmful materials, which supports and enhances healthy living. Staying connected with nature, engaging in outdoor physical activities, and consuming healthy and nutritious food promote overall well-being.
- c) **Economic Savings:** Eco-friendly practices, such as energy conservation, use of locally produced goods, efficient use of resources, and reduction of unnecessary consumption, help save economic costs. Proper utilization of resources as per requirement and avoiding social and cultural extravagance support the reduction of economic burden.

Activity 6.4: Eco-friendly Living

Objectives

This activity aims to help students explore and practice the principles of an eco-friendly lifestyle, including Reduce, Reuse, Recycle, Energy and Water Conservation, and the use of Sustainable Products, in their daily lives.

Required Time: 45 minutes

Required Materials:

- Reusable or old materials (paper, plastic bottles, containers, old clothes, etc.)
- Round or rectangular paper
- Posters/chart papers, stationery items such as markers, adhesives, and other necessary supplies

Activities

1. First and foremost, a discussion should be initiated regarding lifestyles that reduce the burden on the environment (reducing, reusing, recycling, composting, and water conservation, among other practices). Following this, students should be requested to bring materials from home that they can upcycle.

2. The class should be divided into groups of 4-5 students.
3. Provide a fixed time to the groups, allowing them to utilize the materials they brought from home.
4. Encourage the students to reuse and decorate those materials, determining what useful items can be created, such as making a pen holder from plastic bottles, a basket from old cloth, or decorative flowers from newspapers.
5. Instruct each student to bring one item made from the materials they worked on. Display these materials in the class to promote their reuse.

After the presentation, each group prepares a chart titled “Declaration of Green Living” and displays the eco-friendly lifestyle commitments they intend to follow in their daily life.

"How will we bring about change in our own lifestyles?"

- Example:**
- We will refrain from using plastic bags.
 - We will adopt 5 ways to save water every week.
 - We will set up compost pits at home.

Moral: The teacher explains that even small changes in our habits can bring significant results. Students are encouraged to continue eco-friendly practices at home and in their surroundings.

6.11 Ecological Footprint

The ecological footprint measures how much pressure human activities place on nature. It helps determine the extent of natural resources required to sustain human lifestyles. The ecological footprint compares the rate at which natural resources are being consumed with the rate at which the Earth can regenerate those resources. Overuse of natural resources increases environmental problems.

The ecological footprint also measures the amount of land and water area required to produce the resources humans consume and to absorb the waste they generate. These include food, clothing, housing, transportation, water, and energy. It is a tool used to assess whether human consumption is within the Earth’s capacity or exceeding it. Natural resources take time to regenerate. If humans use resources faster than their regeneration rate, the ecological footprint increases. As a result, humans face a shortage of necessary resources. Pollution and climate change also continue to rise.

Therefore, analysing the ecological footprint helps understand how sustainable our lifestyle is and what changes are required to protect the environment. Understanding this concept supports responsible consumption and long-term sustainability.

A. Components of the Ecological Footprint

- 1. Carbon Footprint:** This measures the consumption of fossil fuels by living organisms during activities like transportation, electricity generation, heating, cooling, and industrial processes, calculated by the amount of carbon dioxide (CO₂) emissions generated.
- 2. Water Footprint:** This measures the amount of fresh water consumed directly or indirectly by an individual, business, or nation for purposes like agriculture, domestic use, and industrial production.
- 3. Land Footprint:** This measures the biologically productive land required to produce the resources and absorb the waste (like food, fiber, and wood production, urban development, and infrastructure) generated by human activities.
- 4. Energy Footprint:** This involves assessing the total energy consumed by an individual or a community. This includes both direct consumption (like electricity use) and indirect consumption (like the energy consumed in the production of goods).

B. Calculating the Ecological Footprint

We can estimate our ecological footprint by evaluating the consumption patterns of various goods made from natural resources found in different places and the corresponding land and resource requirements.

Measuring the footprint helps individuals and communities identify areas for improvement and implement responsible practices.

Strategies for Reducing the Ecological Footprint:

It is necessary to adopt certain practices to reduce our ecological footprint. Here we discuss some key strategies for reducing the footprint:

C. Energy Conservation:

We must strive to save energy by reducing unnecessary consumption and using renewable energy sources like solar and wind power. We should also use energy-efficient appliances.

D. Water Conservation:

We need to stop wastage for sustainable use of water. Install water-saving devices in toilets and faucets. Use methods like sprinkling grey water (water drained after washing clothes, cleaning utensils, bathing, etc.) for irrigation in gardens and fields.

E. Waste Reduction:

Avoid sending garbage to landfills. Materials that can be reused or recycled must be re-entered into the consumption cycle. We should use organic composting for maintaining soil nutrients and reduce the use of plastic items.

By taking these steps in our daily lives, we can reduce our biological demand on the Earth and contribute to the conservation of natural resources and ecosystems.

Activities 6.5: Calculating Your Environmental Footprint

Objective: Through this activity, you will become aware of the environmental impact of various activities in your daily life, be able to discuss and report on how you can contribute to reducing this impact, and be able to implement this in your daily life.

Required Materials: Set of questionnaires, pencil, pen, etc.

Procedure: Divide all participants into groups and distribute the questionnaire, and then circle the answer that matches your condition.

Questionnaire:

- 1. How did you come to school today?**
 - Walking or cycling
 - By bus
 - By private vehicle
- b. How much water do you use when washing your hands?**
 - I use one bucket of water
 - I use a small amount
 - I do not use a full bucket
- c. How many saplings have you planted?**
 - One or two
 - A few
 - Never planted
- d. Do you have leftover food after finishing your meal?**
 - I always finish my plate
 - I often leave food
 - I never finish my plate
- e. Do you buy things in plastic at school?**
 - Yes, always
 - Sometimes
 - No, never

- f. When you go out, do you turn off unnecessary lights and electrical appliances?**
- Always - Sometimes - Never
- g. Do you use recycled materials at your home or school?**
- Always - Sometimes - No, never
- h. When you go shopping alone or with your family, do you take the goods in plastic bags?**
- Never - Sometimes - Always
- i. Your school books from last year were.....**
- Given to someone else for reuse - Given to paper merchants
- Thrown away
- j. How many bags of trash does your family produce every week...**
- 1 - 2 - 3 or more

Know the Answer!!!

Give 1 mark for each answer 'a', 2 marks for each answer 'b', and 3 marks for each answer 'c'. Now, check your score by comparing it with your predicted score.

Score 10–15: Your footprint is increasing. You are clearly helping to conserve Earth's resources and reduce waste.

Score 16–20: You have a medium footprint. Although you are trying to reduce your environmental impact, you can make some changes, which will help you reduce it further.

Score 21–30: Your footprint is low.

Review the steps again and ask yourself how you can make changes to reduce the size of your footprint.

Small Change Also Has an Impact! What are you waiting for?

By recognizing the environmental impact of human activities and developing opportunities for sustainable living, we can reduce our ecological footprint through energy conservation, proper use of materials, waste minimization, and responsible consumption, thereby working to achieve a sustainable and equitable future for all of us.

6.12 Use of Environment Friendly Technology in Sustainable Development

Environmentally Friendly Technology refers to maximizing the utilization of naturally renewable resources through technology without causing harm to the environment. Its primary objective is to gain maximum productivity and benefits from minimal consumption of natural resources. This type of technology facilitates

the use of stored energy found in the sun, water, wind, and the sea. Since this technology promotes energy-efficient use and minimizes waste generation, it aids in environmental conservation, with examples including electric vehicles and LED lights.

This technology plays a significant role in addressing environmental challenges and promoting sustainable development. In this section, we will study the application of environmentally friendly technology and its impact on creating a sustainable future for our Earth. The utility of some environment-friendly technologies for sustainable development is discussed below:

1. **Renewable Energy Sources:** Encourage the use of renewable energy sources such as solar energy, wind energy, and hydroelectricity as clean and sustainable alternatives to fossil fuels. The use of solar panels helps generate electricity using sunlight, reducing dependence on non-renewable sources and minimizing greenhouse gas emissions.

Wind energy can be utilized to generate electricity using wind turbines. Energy derived from wind is a reliable and sustainable energy source.

Hydroelectric systems are also an important source of renewable energy. The use of hydroelectricity helps reduce reliance on non-renewable sources and minimizes greenhouse gas emissions.

2. **Energy-Efficient Equipment:** Energy-efficient equipment helps reduce energy consumption and greenhouse gas emissions. Using high-efficiency equipment saves energy, which results in lower electricity bills for the user and reduces the overall environmental impact.
3. **Green Building Materials and Practices:** Our focus should be on using materials and methods that are environmentally friendly, based on the principle of reducing the environmental impact of various materials used in our daily lives. For example, the use of recycled steel, bamboo, and reusable materials helps conserve natural resources and manage waste for long-term sustainability.
4. **Eco-Friendly Transportation:** This focuses solely on reducing emissions through the use of electric vehicles and fuel-efficient vehicles. This helps reduce air pollution and minimize the impact on climate change.

6.13 Role of Environment Friendly Technology in Sustainable Development

In the present era, the use of environment-friendly technology is increasingly necessary to address growing environmental challenges and promote sustainable development. This technology contributes to achieving development goals through minimizing greenhouse gas emissions, waste management, employment generation, and circular economy practices. The utility of some environment-friendly technologies for sustainable development is discussed below:

- 1. Mitigating Climate Change and Reducing Greenhouse Gas Emissions:** Environment-friendly technologies play a significant role in reducing climate change and minimizing greenhouse gas emissions from energy production, transportation, and industrial processes. These technologies focus on utilizing natural resources efficiently, reducing environmental pollution, and conserving ecological systems for future generations.
- 2. Conservation and Promotion:** The use of environment-friendly technology contributes to minimizing waste generation, conserving natural resources, and ensuring the preservation of limited resources through practices like recycling and renewable energy.
- 3. Creation of Green Jobs and Promotion of Economic Growth:** The adoption of environment-friendly technology, such as renewable energy, clean transportation, and green building, creates opportunities for green jobs. Green construction and infrastructure contribute to economic growth and promote social equity. This helps developing countries move forward.

Achieving sustainable development goals and ensuring a prosperous and healthy future for humanity requires the use of environment-friendly technology. By adopting technologies such as renewable energy, energy-efficient equipment, green construction materials, and eco-friendly transportation, we can ensure the utilization of resources for future generations and build a sustainable future.

Activities 6.6

Organize a classroom speech program on the theme 'Environment-Friendly Technology and Eco-Friendly Behaviour for Sustainable Development'. (This activity may also be conducted in the form of a competition.)

Exercise

1. Write very short answers to the following questions:

- a. Describe the concept of sustainable development as explained by the “Brundtland Commission.”
- b. What are the interconnected aspects (pillars) of Sustainable Development?
- c. Until when is the goal of Sustainable Development set? How many total targets does it have?
- d. Explain the concept of the Earth’s carrying capacity.
- e. Who first brought the concept of the Ecological Footprint into use and when?
- f. In what unit is the Ecological Footprint measured?
- g. What does an eco-friendly lifestyle mean?
- h. Which five significant areas (P's) have been determined for achieving the goal of Sustainable Development?
- i. Write about any three strategies or practices we must adopt for an environment-friendly lifestyle.

2. Write short answers to the following questions:

- a. Provide a brief introduction to the Earth's carrying capacity and describe the main elements that affect it.
- b. State the basic assumptions of Sustainable Development and describe them briefly.
- c. Write a short note on:
 1. Ecological Footprint
 2. Sustainable Development Goals (SDGs)
 3. Environment-friendly Lifestyle
 4. Green Economy for Sustainable Development
- d. Briefly describe the historical development of the concept of Sustainable Development.

- e. What kind of programs should be conducted to achieve the Sustainable Development Goals? Write in bullet points.
- f. Mention what environment-friendly technologies can be used for Sustainable Development.

3. Write very long answer to the following questions:

- a. Give an introduction to Sustainable Development and explain its interconnected aspects (pillars).
- b. Mention the Sustainable Development Goals and identify the challenges encountered while fulfilling these goals. Also, provide suggestions on how to face these challenges.
- c. Explain the elements that affect the Earth's carrying capacity and how they impact the Earth's carrying capacity.
- d. Provide suggestions on what individual and institutional work should be done to adopt an environment-friendly lifestyle.
- e. Present your suggestions on which sectors and how environment-friendly technologies can be used for Sustainable Development in the context of Nepal.

4. Write a paragraph, including concrete examples, about where and how the following environment-friendly technologies and materials can be used at the local level:

- (a) Recycling of waste
- (b) Solar panel
- (c) Use of green materials
- (d) Electric vehicles

Project Work

- 1. Find your ecological footprint and prepare a report on the actions you can take for environmental conservation, and present it in class.
- 2. Visit the office of a local Rural Municipality, Municipality, Sub-Metropolitan and Metropolitan. After meeting with the office head or deputy head, prepare a short report on the progress made in achieving the Sustainable Development Goals in the local area and what future plans they have.

ENVIRONMENTAL HEALTH



Study the pictures given above and write the message that the pictures are trying to convey in four points.

- a.
- b.
- c.
- d.

7.1 INTRODUCTION

There is a close relationship between the environment and human health. Environmental factors, such as changes in air, water, soil, and noise, directly or indirectly affect human health. For example, air pollution leads to various types

of respiratory diseases. Similarly, consuming fish from polluted lakes and rivers introduces toxic elements that negatively impact human health. Therefore, a clean and balanced environment is essential for a healthy life. According to one statistic, approximately 3,500 children in Nepal die annually from waterborne diseases. Maintaining a clean environment not only ensures a healthier life but also helps prevent the loss of lives and resources.

Environmental health refers to the work of keeping the surrounding air, water, soil, food, and living spaces clean and safe to maintain the good health of humans and other living things. It helps to protect people from diseases and enables them to live a healthy life. The main goal of environmental health is to diagnose diseases arising from unhealthy environments and to assist in creating a healthier environment. Knowledge about environmental health also aids in the development and use of environment-friendly methods and technologies. It informs people about the benefits of healthy environment and the drawbacks of unhealthy ones on human health. For this, it is necessary to understand the interrelationship between the environment and health. Environmental health includes those aspects of human health where the quality of life is determined by physical, chemical, biological, social, and physiological factors present in the environment. It also refers to the principles and practices of assessing, correcting, controlling, and preventing environmental factors that could potentially cause adverse effect on the health of current and future generations.

7.2 INTERRELATIONSHIP BETWEEN HUMAN HEALTH AND ENVIRONMENT

Changes in environmental elements such as air, water, and soil directly or indirectly affect humans and their daily activities. If there are positive changes in these environmental elements, it positively impacts human health; conversely, negative changes have a negative impact. The relationship between health and the environment can be presented as follows:

A. Air

There is an interdependent relationship between human health and air. The existence of human life is not possible without air. The oxygen present in the air is the vital life force essential for respiration. A person cannot survive even for a moment without oxygen. Oxygen works to purify the impure blood in the human body and reaches every cell to assist in metabolism. If negative

changes occur in this oxygen-rich air, it negatively impacts on the health of humans and other living beings. Similarly, air pollution also negatively affects plants. For example, particulate-polluted air can cause the pores (Stomata) on plant leaves to close, leading to a reduction in their productive capacity.

B. Water

Water makes up about 75% of the human body. Water constitutes a large part of the composition of microscopic cellular components like protoplasm and nucleoplasm, as well as blood, muscles, and various bodily fluids. Water is essential for the functioning of all bodily systems. For example, water plays crucial role in controlling body temperature, expelling unnecessary substances from the body and it supports physical growth. Similarly, water plays a vital role in balancing the body's blood pressure and in the proper functioning of the circulatory system. Additionally, plants require water for photosynthesis (or food production). When water sources become polluted, it negatively affects the health of humans and all living beings. For example, when water is polluted with substances like Lead, Mercury, and Arsenic, these toxic substances can enter the human body through aquatic life like fish, causing negative effects. The effects of such toxic substance can even lead to death.

Minamata Disease: Spread by Polluted Water

Minamata disease was first detected in the city of Minamata, Japan, in 1956. This disease originated because the industrial waste, Methylmercury, from a chemical factory owned by the Chisso Corporation was mixed into the water, a practice that continued



from 1932 to 1968. During that period, a portion of the mercury sulfate in the wastewater was metabolized into methylmercury by bacteria. This highly toxic chemical biomagnified in the shellfish and fish of Minamata Bay and the Shiranui Sea. When the local pollution consumed this contaminated fish, they suffered from Mercury poisoning. The poisoning resulted in deaths among both humans and animals for 36 years, while the Chisso Company and the Minamata government failed to stop the epidemic. Symptoms of this disease include, Shaking and cramping of the hands, appearance of the palms resembling a cat's paw, diminishing eyesight, high fever.

C. Soil

Diet plays a crucial role in sustaining the human life process. For humans, food is mainly derived from soil. Therefore, if the soil is polluted, the pollutants enter human health via crops, causing negative effects. For example, consuming crops, vegetables, and fruits that have been treated with excessive chemicals pesticides has resulted in various types of diseases in humans. If adverse environmental changes occur, leading to a decline in soil productivity, it directly impacts food production. To increase production, people often overuse various types of chemical fertilizer and pesticides. This practice harms the organisms living in the soil, reducing their fertility. It also increases the soil acidity, leading to negative consequences. Therefore, agricultural production should be done either by using organic manure or by using chemical fertilizers only in a careful managed manner.

D. Forest

There is a close relationship between forests and human health. The vital life-giving oxygen required for the respiration of humans and other living beings is continuously supplied by forests. The conservation of forests helps in the creation and preservation of watershed areas, which also supports agricultural works. The green environment inherits in forests positively impacts human health. Greenery makes breathing easier and protects against chronic respiratory diseases like asthma and coughing. Additionally, consuming fruit-based food items obtained from forest helps the human health sound. Forest plays a crucial role in absorbing the increasing carbon dioxide gas in the atmosphere and keeping it balanced. This prevents the greenhouse effect and protects human health from negative impacts. Forest hold special importance for wild animals. Forests are the habitat of wild animals, where they find everything necessary for survival, from food to their entire basis of life.

Activity 7.1

Study of the Interrelationship Between Environment and Human Health

Divide the class students into four groups. Each group should collect information through research, observation, and experiences regarding the interrelationship between human health and the aspects listed below. Then, prepare a chart or poster that reflects this interrelationship and present it in class.

a. Group One: Interrelationships between Air and Human Health

- b. Group Two:** Interrelationship between Water and Human Health
- c. Group Three:** Interrelationship between Soil and Human Health
- d. Group 4:** Interrelationship between Forest and Human Health

7.3 Importance of Environmental Health

Humans are in constant contact with the environment every moment. Interactions with environmental elements directly affect a person's standard of living, lifestyle, and activity level. Therefore, environmental health plays a crucial role in improving people's health. The concept of environmental health includes both the creation of a healthy environment and the diagnosis of diseases resulting from an unhealthy environment. In such a situation, knowledge of environmental health is extremely essential. The importance of environmental health can be discussed under the following headings:

A. Availability of Healthy Habitat

Knowledge of environmental health makes it easier for people to build and live in a healthy habitat. When the habitat is healthy, it positively impacts human health. A place is considered a healthy habitat if the surrounding is physical. Biological, chemical, and social aspects are strong. If every person maintains personal hygiene and keeps their living space clean and tidy, a healthy environment is automatically created. As a result, we can avoid various types of illnesses caused by poor environments. Many factors must be included in creating a healthy environment. An environment can be considered healthy if the following aspects are properly managed:

1. Systematic settlement planning
2. Access to drinking water facilities
3. Provision of renewable energy
4. Organized sewage disposal planning
5. Access to communication facilities
6. Green Environment
7. Guarantee security

Activity 7.2

Clean your Classroom, Water Sources, and School Premises

Divide your classmates into five groups.

- Group One and Two should collect waste materials scattered in the classroom (paper and plastic waste, metallic items, etc.) and place them in separate bins for biodegradable and non-biodegradable waste.
- Group Three and Four should uproot unnecessary grass growing in the school premises, collect waste materials like paper, plastic, and metallic items, and place them in separate bins for biodegradable and non-biodegradable waste.
- Group Five should clean and tidy the area around the school's drinking water sources.

B. Availability of Clean Water

Clean air is a major aspect of environmental health. Clean air is air that is free from dust, smoke, and chemical toxins. Clean air is essential for humans to remain healthy. If the air is clean, people can avoid various communicable and non-communicable respiratory diseases that might otherwise be transmitted through polluted air. When the air is clean, the environment automatically becomes healthier. Polluted air causes various types of diseases, such as the common cold, tuberculosis, and various allergies. Therefore, environmental health plays a vital role in maintaining healthy air in the environment. Since a healthy life can only be imagined with the availability of clean air, environmental health can be directly linked to human and biological health.

C. Availability of Potable Water

Safe water is another crucial aspect of environmental health. Safe water plays an important role in keeping human health balanced. Even though water may look clean to the naked eye, it may not necessarily be safe. To make water completely safe, one must boil it or adopt other purification methods. Boiling



Figure 7.1

water is the best method for making it germ-free. Most diseases that affect human health enter the body through polluted water. Diseases like diarrhea, dysentery, and typhoid are the results of contaminated water. Therefore, pure water is essential for maintaining human health.

D. Disease Control

The main objective of environmental health is to resolve the negative impacts on human health by preventing environmental pollution. If various aspects of environmental health, such as air, water, and soil, are negatively affected, human health is also negatively impacted. Polluted water spreads diseases like cholera, dysentery, parasitic worms (like hookworm), diarrhea, and typhoid. Similarly, polluted air spreads tuberculosis, polio and diphtheria. Furthermore, an unhealthy habitat leads to an increase in flies, rats, cockroaches, and disease-causing germs, which contaminate the environment and cause various types of diseases. Environmental health teaches us how to keep the air, water, and soil pollution-free. Therefore, the study of environmental health is necessary for disease control.

Activity 7.3

With the teacher's help, divide the class students into four groups. All four groups should visit a health post, hospital, or other health institution in their respective areas. Inquire about the communicable diseases that have appeared in that facility during the current month. If necessary, conduct interviews with the health workers. Finally, prepare a short report on the communicable diseases observed in your area.

7.4 ENVIRONMENTAL RISKS

Adverse effects occur in the environment due to natural and human activities, which leads to environmental risk. Environmental risk refers to elements, conditions, or events that have the potential to negatively affect the environment. Environmental risks include various forms of pollution and natural disasters. Environmental risks adversely impact human health and can be both natural and human made. Such risks can also stem from physical, chemical, and biological factors. For example, pollution of air, water, and soil from sources like transportation, agriculture, industry, and other areas falls under environmental risks. Environmental risks also cause various negative effects in the workplace and on the people working

there. Environmental risks can be classified into four types: Chemical, Physical, Biological, and Occupational (or Professional).

a. Physical Risks

Physical risks are events that adversely affect human health. Physical risks can occur naturally, such as natural disasters (earthquakes, wildfires, landslides, etc.) or extreme weather events. Additionally, physical risks can arise from human structures or activities, such as traffic accidents, explosions, building collapses, radiation, injuries from mechanical equipment, or stress on the body from repetitive movements. Radiation is energy emitted by a substance in the form of rays or high-speed particles, and certain types of radiation present a physical risk. Some forms of radiation include infrared radiation (heat), light, ultraviolet (U-V) rays, radio waves, and microwaves. We encounter radiation every day from natural sources. For example, we are regularly exposed to the sun's ultraviolet radiation. We are also exposed to radiation from human-made sources, such as medical X-rays.

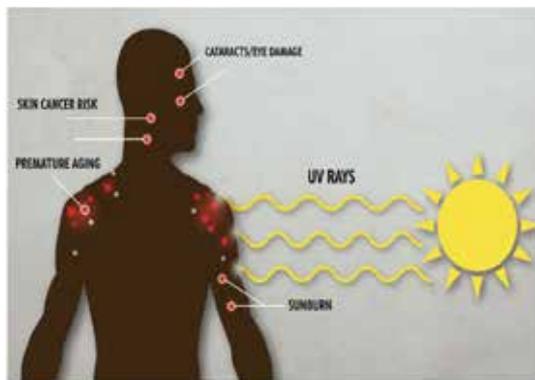


Fig.7.2 Effect of Radiation on Humans

Measures for Mitigating Physical Risks

Follow the necessary policies, laws, and programs to mitigate and regulate physical risks.

- Use and store radioactive materials in a safe manner.
- Help control various types of pollution (air, water, soil, etc.) originating from homes, schools, and communities.
- Use appropriate technology for managing pollution generated by hospitals and industries.
- Conduct awareness programs related to physical risk mitigation from the school level to the community level.

b. Chemical Risks

Chemical risks are considered elements that adversely affect human health, the environment, and the ecosystem. Sources from which these risks arise include industrial activities, agricultural practices, household products, waste disposal, and more. Chemical risks are caused by toxic substances that damage living organisms. Examples of chemical risks can be presented as follows:



Fig. 7.3 Radioactive Chemicals

- i. **Industrial Pollution:** Heavy metals, organic pollutants, etc.
- ii. **Pesticides and Herbicides:** Chemical substances used in agriculture to control pests and weeds, etc.
- iii. **Household Chemicals:** Chemicals used in cleaning, pesticides, various types of rods (possibly referring to chemical sticks or products), solvents, etc.
- iv. **Hazardous and Toxic Wastes:** Improper disposal of toxic wastes, which includes electronic waste (e-waste), hospital waste, and industrial waste.
- v. **Air Pollutants:** Smoke released from vehicles, smoke emitted from industries, nitrogen oxides, sulfur dioxide, ozone, etc.

Measures for Mitigating Chemical Risks

1. Follow the necessary policies, laws, and programs to mitigate and regulate chemical risks.
2. Use and store chemicals in a safe manner.
3. Help control various types of pollution (air, water, soil, etc.) originating from homes, schools, and communities.
4. Use appropriate technology for managing pollution generated by hospitals and industries.

5. Implement proper management of chemicals released from homes and schools.
6. Use organic chemicals as an alternative to chemical pesticides and herbicides.
7. Conduct awareness programs related to chemical risk mitigation from the school level to the community level.

c. **Biological Risks**

Biological risks include micro-organisms like bacteria, viruses, fungi, toxins, and protozoa. All of these can be harmful to human health. Although rarely visible, biological risks are not always easy to identify. Exposure can lead to sudden and long-term health problems, and sometimes even life-threatening diseases. Biological risks are widely found in the natural environment and, as a result, are present in many workplaces and industries.



Fig. 7.4 Sources of Biological Risks

Although most biological risks are harmless, they still pose a hazard and a risk in all workplaces due to the potential health problems and effects they can cause. Health problems can result from direct contact with germs or be a consequence of allergies and toxins.

Measures for Mitigating Biological Risks

1. 40. Follow the necessary policies, laws, and programs to mitigate and control biological risks.
2. 41. Safely dispose of biological waste and toxins in designated locations.
3. 42. Properly manage various types of waste originating from homes, schools, and communities.
4. 43. Use appropriate technology for managing toxic waste produced by hospitals and industries.

5. 44. Properly clean and manage water sources located in homes and schools.
6. 45. Conduct awareness programs related to biological risk mitigation from the school level to the community level.

D. Occupational Risks

Occupational risk is a hazard experienced in the workplace. It includes many types of risks, including chemical risks, biological risks, psychosocial risks, and physical risks. Occupational risk literally refers to both long-term and short-term risks associated with the workplace environment. This is an area of study within occupational safety and health, as well as public health. Short-term risks include physical injuries (such as injuries to the eyes, back, or head), while long-term risks include complex diseases like cancer or heart disease. Generally, the adverse health effects caused by short-term risks are manageable, whereas the effects caused by long-term risks are irreversible.

Measures for Mitigating Occupational Risks

1. Formulate the necessary policies and laws to mitigate and control occupational risks.
2. Maintain a healthy and safe working environment in the workplace.
3. Properly dispose of various types of waste generated from the workplace.
4. Utilize appropriate technology for managing toxic waste generated in the workplace.
5. Keep the tools used in the workplace in the correct manner and at the appropriate location.



Fig. 7.5 Source of Biological Risks

6. Conduct awareness programs at the community level regarding the mitigation of occupational risks.
7. Maintain the correct temperature in the workplace and ensure proper ventilation.

Overall, an analysis shows that environmental health is important for mitigating every type of environmental risk.

Activity 7.4

With the assistance of the teacher, the students in the class should be divided into four groups. Divide the workload using a draw (lottery) or another suitable method so that each group is assigned one of the four study areas (Physical, Biological, Chemical, and Occupational). Each group should conduct a site study visit within the school or community based on the subject area they are responsible for. Each group must prepare a report that includes: The current state of the assigned risk, the sources of the risk, the potential future hazards and the measures for mitigation. Finally, all four groups should present their reports for discussion in the class.

Exercise

1. Write very short answers to the following questions:

- a. What is environmental health?
- b. What is safe water?
- c. What is a healthy habitat?
- d. Write about any two diseases transmitted due to unhealthy air.
- e. Write any two effects on agriculture due to non-fertile soil.
- f. Write any two effects on health due to unsafe water.

2. Write short answers to the following questions:

- a. Clarify the importance of healthy environment.
- b. Mention the importance of environmental health.
- c. Mention what things should be considered when building a healthy habitat.
- d. Explain the importance of forests in environmental health in points.

3. Differentiate Between:

- a. Healthy habitat and Unhealthy habitat
- b. Disease control and environmental health
- c. Chemical risk and biological risk

4. Write a short note on:

- a. Healthy air
- b. Healthy soil

- c. Importance of Forests
- d. Physical Risk
- e. Occupational Risk

5. Write long answers to the following questions:

- a. Explain the relationship between the environment and human health, using examples.
- b. A healthy body requires a healthy habitat. Clarify this statement. Give suggestions on what should be done to create a healthy habitat.
- c. Explain the measures for mitigating environmental risks, using examples.

Project Work

Observe a location in your surroundings (e.g., your neighborhood, a nearby park, or a public area) and prepare a report based on the following points:

- 1. The status of the location from a healthy perspective (Suitable/ Unsuitable)
- 2. Reasons why the location is suitable or unsuitable from a healthy perspective.
- 3. Measures for improvement if the location is found to be unsuitable.
- 4. The role of individuals and the community in making the location healthy.

HAZARD AND DISASTER MANAGEMENT



*Figure 8.1:
Debris created by the earthquake*

The flood that occurred in the Melamci River in Sindupalchowk in 2078 BS (2021 AD) and the earthquake that struck Jajarkot and surrounding areas of Nepal in 2080 BS (2023 AD) caused extensive loss of life and property. These are just a few representative examples of natural disasters. Share experiences related to various calamities and disasters that have occurred in the past within your settlement, village, city, or municipality, similar to these examples.

8.1 Concept

Various types of events occur on Earth at different times. Some of these cause significant loss of life and property and also create an imbalance in the environment. Every year, natural and non-natural calamities such as floods, landslides, lightning, fires, road accidents, and epidemics cause substantial damage and loss of life and property.



Figure 8.2 Condition of a Calamity and Disaster

What is happening in the given picture? What might be the cause of such events? How do they affect our lives? What can we do to mitigate the impact of such events? Discuss this in a group.

Due to Nepal's geographical structure, fragile geological foundation, climatic variability, and climate change, natural calamities such as earthquakes, floods, landslides and soil erosion, inundation, lightning, drought, snowfall, hailstorms, avalanches, glacial lake outbursts, excessive rainfall, insufficient rainfall, windstorms, cold waves, heat waves (Loo), and forest fires are constantly occurring.

The Great Earthquake of 1990 BS (1934 AD), the earthquake that struck Barpak in Gorkha District in Baisakh 2072 BS (April 2015 AD), and the extensive loss of life and property resulting from it, are recent examples of these calamities. In this unit, we will study the introduction, types, causes, and effects of natural calamities, as well as measures for the prevention of calamities and disasters.

8.2 Introduction to Hazard, Disaster, and Risk



Figure 8.3: Damage caused by flood

What might have happened in the given picture? Where in Nepal might this event have occurred? What do we call such events? Discuss in a group, draw conclusions, and write down in bullet points the actions we can take to minimize the damage that can result from this type of event, and then display the list in the classroom.

Study the given case and reach a conclusion after discussing it in class.

It appears that the impact of natural calamities caused by rainfall can be reduced if human development activities prioritize the environment as a core foundation. If developmental work is carried out by embracing the concept of sustainable development, the damage caused by rain induced flood calamities will be close to zero. For instance, had the river and stream areas and their banks within the Kathmandu Valley been developed into well organized residential areas by adhering to established standards, the tragedy of a nine-month pregnant women being swept away by the floodwaters after sitting on a corrugated iron sheet for hours awaiting rescue would not have occurred. Loss of life and property will continue as long as the state mechanism pursues development without conducting feasibility studies, environmental studies (Simplified Environmental Study, Initial Environmental Examination, and Environmental Impact Assessment), and Strategic Environmental Analysis. For this to change, the state must consider study and research as the backbone of development. For example, if a concrete bridge is constructed after taking into account the water level flowing through

the relevant watershed and the results of its various dimensions, the concrete bridge would never be swept away. *Gorkhapatra (October 3, 2024, Thursday)*

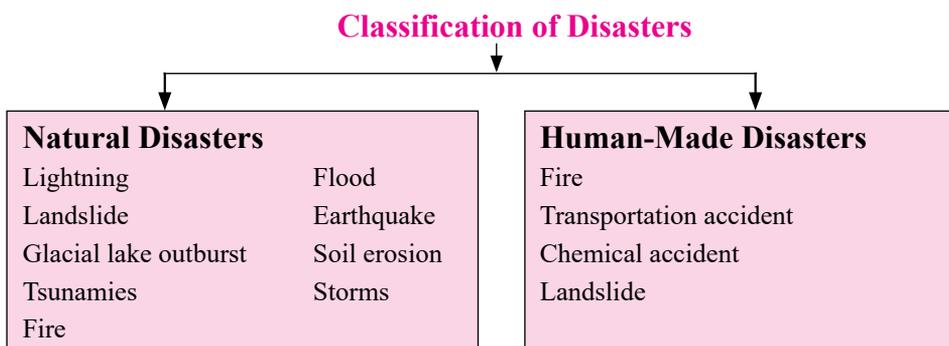
1. What seems to be the main cause of the incident presented above?
2. What are the necessary initiatives that should be adopted to mitigate the damage caused by such incidents?
3. What kind of preparedness is required for calamities like the one mentioned above?

Various types of events occur on Earth, such as floods, landslides, earthquakes, soil erosion, glacial lake outburst, tsunamis, lightning, volcanoes, fires, etc. Any natural or human-made event or process that can negatively affect life, property, and the environment is called a hazard. Some of these events can cause damage and loss to life and property, as well as to the social, economic, and environmental sectors.

8.2.1 Types of Hazards

Hazards can be broadly divided into two main types based on their origin:

- Natural Hazard:** Hazards that originate as natural phenomena are called natural hazards. These natural hazards include geological hazards, such as landslides, soil erosion, and earthquakes; Hydro-meteorological hazards, such as lightning, hailstorms, snowfalls, floods, windstorms, drought (Loo) and cold waves; and biological hazards, such as contagious diseases affecting plants or animals.
- Human-induced Hazard:** Hazards that arise from various types of environmental degradation and pollution caused by human activities, as well as various technical failures that occur during work, fall under human induced hazards. Examples include deforestation and its consequences, drought, industrial accidents, pollution, fires, transportation accidents, and factory explosions.



The examples mentioned above are only a few. Other hazards may also appear over time, such as the Coronavirus, plague, and so on. Some natural hazards are related to the Earth's surface, while others are related to its interior. Earthquakes and volcanoes are also destructive hazards. Events like floods, landslides, drought, and cyclones completely disrupt human life. Many nations around the world have fallen into poverty after being affected by such hazards. When human actions adversely affect nature, a state of calamity begins to emerge. Natural hazards are created by pressure on nature; for instance, deforestation leads to hazards such as floods, landslides, and climate change. As the human population increases, human needs grow, leading to increased pressure on nature. Therefore, as population density rises, the impact and frequency of natural hazards also appear to be increasing. Damage can result from hazards originating from either natural or human causes. Thus, it is the responsibility of everyone to devise and implement measures to reduce these hazards.

Activity 8.1: Observation Visit

From groups with your classmates and investigate a hazardous incident that occurred near the school, or within your ward or municipality, and conduct a field observation visit to that area. Based on the observations visit, perform the following tasks and present them in class:

- a. Draw a map of the area and include a key.
- b. Specify whether the hazard was a natural or human-induced type.
- c. Discuss with the local community when the incident occurred and the impact it had on the area and provide the conclusions in bullet points.

8.2.2 Disaster



Figure 8.4: Disaster caused by an Earthquake

What might have happened in the given picture? What could have caused such a disaster? What are the people doing there? What kind of precautions should we take during such a disaster? Discuss this and provide a conclusion.

A disaster refers to an emergency and damaging situation created when communities and the environment suffer harm due to various types of sudden hazardous conditions on Earth, such as earthquakes, floods, landslides, and windstorms. The ecosystem is sustained by maintaining a balance between the biotic and abiotic elements in nature. If any of these elements are affected, an imbalance occurs, leading to negative consequences. Environmental imbalance not only devastates the lifestyle of living organisms but also destroys their habitats. Nepal is one of the countries at extreme risk of disasters arising from such various hazardous events. Hazards can appear suddenly or gradually; for example, a large flood in an area can immediately trigger a landslide.

Activity 9.2: Let's Act

Work together in groups to prepare for and perform a rescue operation following a disaster caused by a hazard. Present this acting performance at the school or in the community.

8.2.3 Risk



Figure 8.5: Landslide-prone area

What risk is the settlement in the given picture facing? Is it considered safe or unsafe to build settlements in such places? Facilitate interaction among the students regarding high-risk areas and potential disasters.

Disaster risk refers to the potential harmful events arising from a hazardous situation and the estimated damage that can result from them. It can also be interpreted as a potential disaster. Measuring risk is particularly difficult because it is partially based on human perception and, to some extent, on individual knowledge and information. Nepal is a country at extreme risk of disaster caused by the continuous recurrence of multi-hazard events. Nepal is also considered a disaster-risk zone due to its fragile geological conditions and climate change, among other factors.

The disasters caused by hazards in high-risk areas can lead to the loss of life and property, as well as disturb the environmental balance. Therefore, we all must understand the causes of hazards and disasters and work together to prevent them.

Activity 8.3

Divide yourselves into appropriate groups based on the student population. Each group should obtain a map of your municipality. Now, each group should identify the ward where they live, with each group taking one ward. Next, divide that ward into different places, settlements, and areas, and discuss as a group the potential natural hazard risks that could occur in those specific locations- what the risk is, how severe it is, and what type of risk it might be. Write the bullet points of your discussion's conclusion on Meta cards, identify the types of hazards/risks in the local area, present them in the class in turns, and collectively reach a conclusion.

8.3 Difference between Hazard and disaster

Hazard and disaster are things that occur together. Although they are interrelated, they can be differentiated based on various aspects.

Basic Aspects of Differences	Disaster	Calamities
Based on Definition	A disaster is a state or event that carries the potential for harm, damage, or loss.	A calamity is a sudden, devastating event that causes widespread destruction, loss of life, or significant disruption.
Based on Nature or Quality	Disasters can be natural (such as earthquakes, storms, floods) or they can be human made (such as accidents, chemical spills, or nuclear incidents).	A calamity can be a consequence arising from natural or human made disasters, and it often causes severe damage to a large area or population.
Based on Area/ Scope	A disaster can result if previous events or conditions are not adequately managed or mitigated.	A calamity represents the actual impacts and consequences of a disaster, including its effects on the public, infrastructure, and the environment.

Based on Impacts/ Effect	A disaster may or may not cause damage, which is dependent on factors such as risk and preparedness.	A calamity generally results in consequences such as widespread damage, loss of life, displacement of people, economic disruption, and long term social and environmental impacts.
Based on Management	Disaster management includes things like identification, evaluation, and mitigation of risks to reduce the probability and severity of potential disasters.	Calamity management focuses on preparedness, response, recovery, and impact mitigation activities to reduce the effects of a disaster and enhance the capacity of affected communities to cope with the calamity.

8.4 Causes of hazard and disaster

What could be the cause of disasters and hazards? Let's discuss among ourselves the potential reasons behind the hazardous events that have occurred in our own settlement or surrounding areas. Hazards occur due to various reasons. Some hazards are caused by natural factors, while others are the result of impacts from human activities, which bring about hazards that subsequently lead to disasters. Some major causes of hazards are presented below in bullet points:

- Population growth and the exploitation of natural resources.
- Deforestation, floods, landslides, and soil erosion.
- Weak and sloping geological structure.
- Excessive rainfall (heavy rains) and insufficient rainfall (drought).
- Unscientific agricultural practices.
- Unplanned urbanization and industrialization.
- Unscientific methods of mineral extraction.

- Unscientific development and construction work, such as road construction, canal, and dam construction.
- Climate change.
- Lack of public awareness.

8.5 Impacts of hazard and disaster

When a hazard occurs in any place, it leads to a disaster. The disaster caused by the hazard affects various multi-faceted aspects of society, including natural, cultural, physical, and economic spheres. Some of the various impacts caused by hazards are listed in bullet points below:

- Loss of life and property.
- Damage to development and construction infrastructure.
- Destruction of archaeological heritage.
- Disruption in the provision of essential services.
- Destruction of water sources.
- Creation of uncomfortable social conditions.
- Destruction of natural resources and means.
- Loss of biodiversity.
- Imbalance in the ecological system.

8.6 Prevention of hazard and disaster

We cannot stop or prevent natural hazards, but we can reduce or minimize the hazards resulting from human or other artificial activities. Prevention means not allowing the circumstances that generate a hazard to arise as much as possible, and if a hazard does occur, taking measures to lessen its impact. This is what is meant by the prevention of hazards and disasters, which fall under disaster risk reduction measures. Minimizing the impact of hazards is also a function of disaster management.

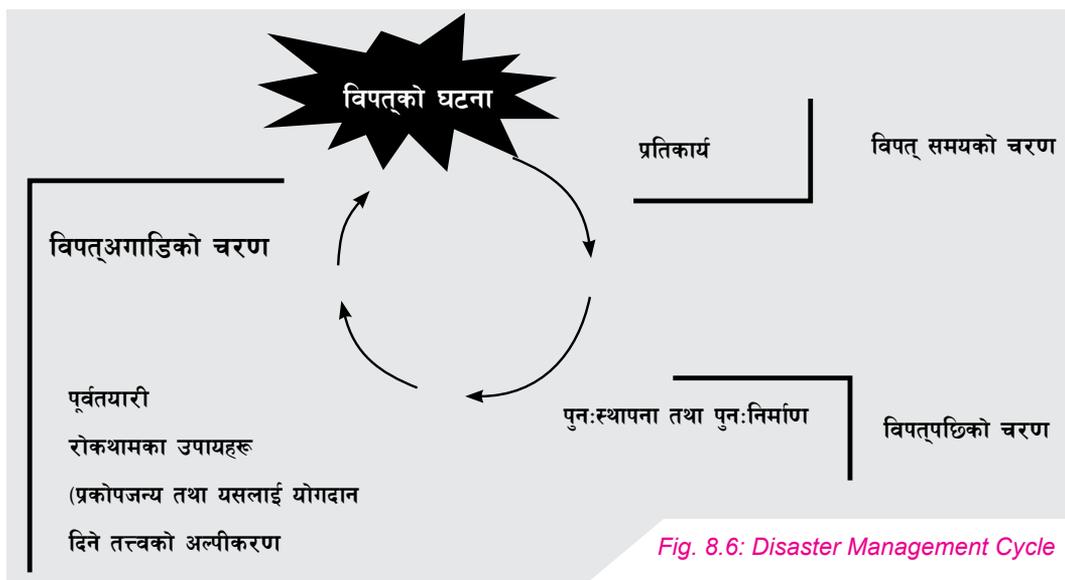


Fig. 8.6: Disaster Management Cycle

Source: UK aid, 2010 (Citation: Practical Action, 2010. Disaster Management: Concepts and Practices in the Context of Nepal. Kathmandu, Nepal: Practical Action)

To prevent hazards and disasters, a disaster management plan must be created and implemented accordingly. The measures for the management and mitigation of hazards and the resulting disasters also differ according to the nature of the hazard and the ensuing disaster situation.

To prevent hazards and disasters, we can take the following actions:

1. Employ biological methods for the conservation of rivers, streams, and steep slopes, such as planting trees, planting grass, and using soil conservation techniques.
2. Stop indiscriminating against deforestation, excavation, plotting of land, and unplanned settlement construction.
3. Arrange for proper management of drainage and sewage systems.
4. Prevent riverbank erosion and landslides through gabion walls, bio-engineering, and other measures.
5. Protect or relocate human settlements located in high-risk zones.
6. Conduct disaster assessment and forecasting.

7. Prepare a preparedness plan and manage the storage of relief materials.
8. Manage the information system.
9. Conduct training, capacity building, and public awareness programs.



Fig. 8.7: Working for Hazard Prevention

The causes, impacts, and prevention measures for different disasters can vary. A brief discussion is presented below regarding some of the hazards frequently observed in Nepal and many parts of the world, the disasters they cause, their reasons, impacts, and prevention measures.

Activity 8.4

Divide yourselves into two student groups. Both groups should take materials such as meta cards and markers. One group should list the hazardous events that have occurred in the municipality where the school is located, along with their causes. The other group should list the resulting disasters. Now, separate and list the hazards, the causes of the hazards, and the related disasters one by one, and present your findings.

8.7 Earthquake



Fig. 8.8: Debris created by the earthquake

Let's look at the given picture. What might have happened here? [Image related to an earthquake, such as damaged buildings] Have you ever felt the tremor of an earthquake? If yes, when and where did you feel it? How did you feel at that time? What kind of impact did it have on that area? Discuss with your teacher and friends. (If you have not felt one, discuss the experience of the 2072 BS (2015 AD) earthquake with your parents/guardians.)

Earthquake refers to the movement of the Earth's surface. An earthquake is the tremor that occurs on the surface when rocks within the Earth's interior stretch and

compress due to a disturbance in the balance of the internal structure of the Earth. Earthquakes also occur during volcanic eruptions. The Earth's surface sometimes shakes horizontally and sometimes vertically; this is what is called an earthquake or (bhuinchaalo). Nepal generally falls within a high-risk zone for frequently recurring earthquakes. Based on Nepal's seismic risk map, the country is divided into three zones. According to this map, these zones spread from the north towards the west-south and southeast directions, and the central part of Nepal appears to be at a higher risk of earthquakes than the northern and southern parts. Although the historical background of earthquake impact in Nepal goes back a long time, the effect of the 1990 BS earthquake has been significant in the current century. This earthquake caused the death of more than 8,000 people and destroyed approximately 300,000 buildings. Similarly, the 2072 BS earthquake also caused extensive loss of life and property.

8.7.1 Causes of Earthquake

There are many reasons why earthquakes occur. Some of the important causes are as follows:

1. Earthquakes occur when the rock formations within the Earth's interior stretch and compress.
2. Earthquakes are generated when the tectonic plates (large plates) situated beneath the Earth's surface rub against or collide with each other.
3. Earthquakes occur during volcanic eruptions.
4. Large-scale explosions can generate earthquakes.
5. A large amount of water pressure on the rocks at the bottom of the hydrosphere can cause an earthquake.
6. Earthquakes are generated when water seeps through pores in the ground surface, turns into steam due to internal heat, and exerts pressure on the rocks as it tries to escape.

8.7.2 Impacts of Earthquake

- Loss of life, property, livestock, and other animals may occur.
- Water sources may dry up, and new water sources may emerge elsewhere.

- Drinking water pipes, electric lights, telephone wires, etc., may be broken.
- Sewage lines may burst and be scattered.
- Monasteries, temples, and palaces of archaeological importance may be destroyed.
- Structures such as houses, factories, bridges, and roads may be ruined.
- Landslides may occur on steep slopes.
- The topography of the land may change. High hills may become plains, and flat areas may turn into hills.

8.7.3 Earthquake Impact Mitigation Preparedness

Since earthquakes have widespread impacts, the following measures can be adopted to minimize their effects:

- Adopt safe technology when constructing structures.
- Pay attention to the arrangement of goods inside the house.
- Identify and select safe places.
- Arrange for emergency supplies.
- Remain prepared by pre-planning actions to be taken before, during, and after an earthquake.
- Conduct public awareness enhancement programs.



Fig. 8.9 Model of a Quick Exit/Escape Route

8.7.4 Measures for Earthquake Impact Mitigation

For earthquake management, one should remain constantly prepared by pre-planning actions that need to be taken before an earthquake, while it is occurring, and after it has passed.

What should we do for Earthquake Preparedness?

1. Engage in mutual discussions among family and community members for public awareness.
2. Keep first aid supplies at home.
3. Secure heavy and tall items and furniture in rooms so they cannot fall or tumble.
4. Arrange to keep heavy items on the ground floor.
5. Adopt earthquake safety measures when constructing new houses.
6. Keep a flashlight and radio (with batteries) in a ready state.
7. Keep a record of the individuals and agencies to be contacted during an emergency.
8. Arrange for quick exits/escape routes.



Figure 8.10

By remaining restrained and performing these actions before, during, and after an earthquake, it helps to mitigate the damage caused by the earthquake.

What should we do when an Earthquake occurs?

1. Do not panic and remain calm.
2. If inside a house or building and unable to immediately move to a safe outdoor area, stand under a doorway or take shelter under a table or desk, covering your head.
3. Do not stay near windows that may shatter or objects that may fall.
4. If you are in a location convenient for exiting, do not panic, immediately go outside and stay in a safe, open area.
5. Since stairs become weak during an earthquake, do not use them and do not jump out of windows.
6. Do not go near power lines, riverbanks, tall trees, or buildings.
7. If you are driving a vehicle, pull off the road and stop in a safe location.
8. Prioritize helping children, the elderly, pregnant women, and people with disabilities.

Activity 8.5: Let's Search on the Internet

Search the internet for information about earthquakes. In groups, investigate aspects such as the causes, impacts, and preparedness measures for earthquakes specifically in the context of Nepal. Present your findings in the classroom as a group.

8.8 Flood

A flood is defined as the excessive flow of water in streams and rivers beyond their normal capacity. When rainwater overflows rivers and streams, it spreads into the surrounding areas and causes inundation there. Thus, a flood is defined as the excessive flow of water not only from rivers and streams but also from other land areas. Because floods can destroy and submerge physical structures on the land surface, cause loss of life and property, and harm livestock, flooding is considered a natural hazard. The southern plains (Terai) of Nepal, the mid-hills, and the high Himalayan regions are all areas at risk of flooding.



Fig. 8.11: Flooding in progress

Floods are observed to occur due to the destruction of natural dams that control the glacial meltwater, and the bursting of glacial lakes. These lakes are formed by piles of rock and soil carried by inner ice blocks and glaciers, where the water pressure on the upper part of the natural dam, caused by melting ice, leads to the outburst of the glacial lake. Similarly, changes in weather cause the snout of the glacier to melt rapidly, and the glacial lakes, unable to remain under the control of the natural dam, burst more frequently, leading to an increasing number of flood incidents.

The problem of flooding appears to be increasing every year due to the accumulation of large amounts of rock and soil at the bottom of rivers, and the construction of embankments near the flow of rivers, especially near the border with India.

8.8.1 Causes of Flooding

Floods are found to occur due to both natural and human-induced causes. Here is the translation of the section on the natural causes of flooding:

a. Natural Causes

- i. **Rainfall or Excessive Precipitation:** Rainfall is the primary natural cause of floods. Floods occur when there is continuous or heavy rainfall in the river basin area.
- ii. **Soil Erosion and Landslides:** In the hilly and Himalayan regions of Nepal, floods occur when temporary dams created by landslides that block the river burst. When a landslide occurs, a large volume of sloping soil and rocks from the hilly area slide downwards. This debris blocks the river, creating a large lake in the upstream area. When these temporary dams burst, a sudden, large volume of water flows down the river, causing massive flooding in the downstream areas.
- iii. **Glacial Lake Outburst Flood (GLOF):** There are many glacial lakes in Nepal's Himalayan region. Floods occur when a large volume of water, rapidly melted and accumulated in these glacial lakes, suddenly bursts out. The massive quantity of water surging at high velocity due to a glacial lake outburst, mixed with stones and soil, causes extensive damage to infrastructure like roads, bridges, and hydropower projects, as well as to agriculture and life and property in the downstream areas.

According to a report prepared by ICIMOD, the 3,252 glaciers in Nepal cover a total area of 5,323 square kilometers. Similarly, out of the 2,315 glacial lakes here, 21 are at risk of bursting. Numerous incidents of floods caused by glacial lake outbursts have been recurring in Nepal over the past few decades. The flood that resulted from the outburst of the Zhangzangbo Glacial Lake in Tibet on July 11, 1981, not only washed away the Nepal-China border bridge but also caused damage up to 50 kilometers downstream. Similarly, the flood caused by the outburst of the Dig Tsho Glacial Lake on August 4, 1985, washed away the structures of the Namche Hydropower Project, causing damage estimated at approximately 1.5 million US dollars.

b. Human-induced Causes

- i. **Deforestation:** Continuous deforestation in hilly areas leads to increased soil erosion and a reduction in the soil's capacity to absorb water, consequently increasing the frequency and intensity of floods. The increased population



Fig. 8.12: Area where deforestation has occurred

density, particularly in Nepal's Mahabharat and Chure mountain ranges, has exacerbated deforestation. This has led to an increase in flooding in lower areas even with minimal rainfall in the hilly regions.

- ii. **Unplanned Land Use:** Traditional land-use patterns, unscientific farming systems, and excessive grazing by livestock also contribute to soil erosion, which heightens the risk of floods.
- iii. **Encroachment on Rivers:** The construction of development structures and human settlements within the river channels and on the riverbanks obstructs the flow of water, significantly increasing the risk of floods.



Fig. 8.13 Impacts of Flooding

8.8.2 Impacts of Flooding

1. Loss of life and property
2. Damage to agricultural land
3. Damage to houses, industries, and factories
4. Loss to development infrastructure such as roads, bridges, powerhouses, canals, and irrigation channels.
5. Destruction of forests, vegetation, and wildlife
6. Reduction in biodiversity
7. Increase in diseases, poverty, and social crimes
8. Environmental imbalance

8.8.3 Flood Prevention Measures

1. Construct embankments along riverbanks.
2. Remove human settlements from riverbanks.
3. Plant deep-rooted plants like bamboo along riverbanks.
4. Practice terraced farming (making Garas) on sloping land.
5. Arrange for proper water drainage near settlement areas.
6. Control excessive grazing.

7. Plant trees.
8. Stop indiscriminate extraction of stones and sand from rivers.
9. Prevent encroachment on rivers and streams.

8.8.4 Flood Management and Impact Mitigation

To minimize the impact of floods, special attention must be paid during and immediately after the flood hazard. During a flood, we should not go to dangerous areas; instead, we should move to the safest possible location and follow the instructions provided by rescue workers. Children, the elderly, people with disabilities, and pregnant women should be given prompt treatment and immediately taken to a hospital based on their condition.

After a flood, one should avoid walking, swimming, or driving through the water. Since there is a risk of various diseases spreading as an epidemic after a flood, special attention must be paid to sanitation and drinking water. Besides this, we should carry out the following tasks:

- Community houses should be built in safe places for shelter during a flood.
- Structures such as houses, cowsheds, wells, tube wells, and toilets should be constructed higher than the level where floodwater might accumulate, and proper drainage for wastewater should be arranged.
- Sandbags, bamboo, and other barriers should be installed along riverbanks, and tree planting should be done. However, the river's flow path should not be obstructed, nor should the river be encroached upon.
- For large-scale protection, embankments should be constructed by filling wire mesh (gabions) with stones.
- Items such as boats, tire tubes, and ropes should be arranged for rescue operations.
- Light food items, first-aid medicine, and clothing should be kept in an emergency kit, which can be easily carried during a flood.

Activity 8.6

Discuss with the elderly members of your household, family members, or neighbors to investigate the time of flooding, its impacts, prevention measures, and the extent of damage that occurred in the past 20 years versus the current situation. Prepare a report based on this comparative study and present it for discussion in the classroom.

8.9 Landslide

A landslide is defined as the process where a part of a hill or sloping land, or a mass of rock, separates and slides downwards due to the force of gravity. Due to geological processes, soil and other materials also flow from high ground towards lower ground. Similarly, excessive rainfall weakens the soil on a sloping surface, causing it to slide downwards. Thus, the process by which soil and various other materials flow from a high place towards a lower place through various processes is called a landslide.

Among the natural disaster events occurring in Nepal, landslides are a major disaster. Nepal's mountainous land surface is extremely fragile. Landslides occur frequently in the hilly regions of Nepal due to rapid deforestation, extremely steep hills and mountains, slash-and-burn farming, unscientific cultivation practices, torrential rainfall during the monsoon season, and the subsequent high temperatures. Additionally, landslides are frequently observed in the hilly regions because infrastructure such as roads, large buildings, and irrigation canals are often constructed improperly without adopting safety measures.



Fig. 8.14 a: Landslide-affected area

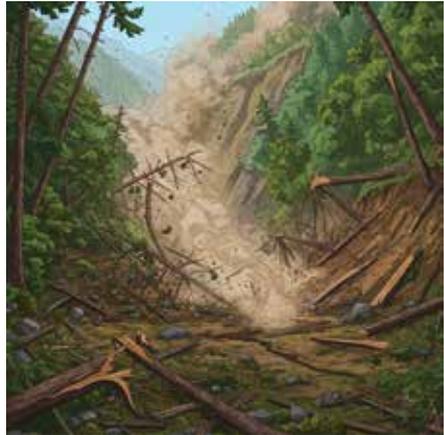


Fig.8.14 b: Landslide-affected area

8.9.1 Causes of Landslides

1. Landslides originate due to geological activity and the force of gravity.
2. The ground surface weakens due to excessive rainfall and slides downwards.
3. Landslides can occur due to an increase in the underground water table.
4. River erosion causes landslides.
5. Landslides are caused by explosions used to excavate land during development and construction work, such as building roads and bridges.
6. Excessive grazing causes the land to become bare, leading to landslides.
7. Unscientific farming practices in sloping areas also cause landslides.
8. Deforestation also leads to landslides.

8.9.2 Impacts of Landslides

1. Loss of life and property
2. Destruction of agricultural land
3. Destruction of houses, bridges, roads, and development infrastructure
4. Destruction of forests
5. Reduction in wildlife and biodiversity
6. Increased risk of flooding

8.9.3 Landslide Prevention Measures

1. Do not build settlements in high-risk sloping areas.
2. Construct embankments along riverbanks.
3. Avoid indiscriminate blasting when constructing roads.
4. Implement organized grazing practices (controlled grazing).
5. Practice terraced farming (garas) on sloping areas.
6. Advance the work of afforestation and conservation simultaneously.
7. Identify landslide-prone areas and take precautions.
8. Carry out physical construction work only after a technical study, including an Environmental Impact Assessment (EIA).
9. Conduct public awareness enhancement programs.



Fig. 8.15: Landslide Prevention Measures

8.9.4 Landslide Management and Impact Mitigation

Since landslides cause loss of life, property, and physical infrastructure, it is essential for us to exercise extreme caution to minimize their impact while a landslide is occurring. We should stay in a safe place at a higher elevation than the area where landslides are occurring. People buried by the landslide should be rescued as quickly as possible, and the injured should be taken to the hospital.



Fig. 8.16: Landslide Prevention using Wire Mesh in the Affected Area

People in landslide-prone areas must always remain vigilant. We should listen to news and information on local radio. If any danger signals are heard, such as heavy rainfall or the sound of falling rocks, we should move far away from the landslide site.

Even after the landslide has stopped, one should not go back to the affected area because the landslide might occur again. Surviving individuals should check on their neighbors to ascertain their condition. The decision to return to the landslide-affected area or not should only be made after consulting experts. In areas prone to frequent soil erosion, landslide control measures should be adopted using local technology and resources. For this purpose, the probability of a landslide occurring must be identified by analyzing the geographical structure, land use patterns and technology, farming systems, natural resource-based or mineral industries, and the pattern of human settlements. The following measures can be adopted for landslide control:

- Conserve forests, plant trees, and control deforestation.
- Divert water flowing from submerged or cracked ground by creating drainage channels (kuleso).
- Construct retaining walls in the area where a landslide is about to occur to prevent rocks and soil from falling.
- Prevent people and domestic animals from entering the area prone to landslides.

Activity 8.7

Observe a landslide-affected area and prepare a report mentioning the cause of the landslide, its impact, and measures for impact mitigation.

8.10 Erosion

Soil erosion is defined as the process where soil from one location is transported to another, or the quality of the soil deteriorates. Some land is hard, and some are soft. The soil in some places is loose, while in others it is compacted. The extent of soil erosion can be estimated based on



Fig. 8.15: Landslide Prevention Measures

the geological structure of the land. Soil erosion is more prevalent on sloping land and along riverbanks and streams.

Soil erosion can primarily be divided into four types:

1. Water Erosion- Caused by Water
2. Wind Erosion- Caused by wind
3. Glacial Erosion- Occurring on snow/ice
4. Marine Erosion- Occurring in the sea

8.10.1 Causes of Soil Erosion

- a. Deforestation:** Soil erosion is more prevalent in areas lacking vegetation.
- b. Sloping Land:** Soil is washed away more readily on sloping land.
- c. Overgrazing:** When livestock graze indiscriminately, the grass-covered area becomes bare, leading to soil erosion.
- d. Unscientific Farming Practices:** Indiscriminate farming on sloping land also leads to soil erosion.
- e. Unplanned Development and Construction:** Unplanned development and construction work cause soil erosion.
- f. Uneven Distribution of Rainfall:** Both excessive rainfall and low rainfall contribute to soil erosion.
- g. Change in River Course:** When a river changes its course, it washes away the soil of fertile land, causing soil erosion.



*Irq *!=!**

- h. Obstruction to Water Flow:** Obstruction in the flow of water due to various reasons causes soil erosion.
- i. Natural Causes:** Natural factors like wind, storms, floods, and landslides cause soil erosion.

8.10.2 Impacts of Soil Erosion

1. Reduction in land productivity occurs.
2. Deforestation may take place.
3. It leads to a reduction in biodiversity.
4. It causes disruption in the ecological system.
5. Environmental imbalance may ensue.
6. Lakes and ponds may become silted up (filled with sediment).
7. Cultivable land along riverbanks begins to be destroyed.
8. Soil begins to accumulate on the seabed.
9. When soil on sloping land is washed away, it becomes difficult for plants to grow on the remaining rock.

8.10.3 Measures for Soil Erosion Prevention

1. Tree planting (Afforestation) should be done.
2. Overgrazing must be controlled.
3. Terraced farming (gaha) should be practiced on sloping land.
4. Embankments should be constructed along riverbanks to control flooding.
5. Drainage channels (for water outflow) must be prepared.

8.11 Fire

The problem of fire incidents is prevalent across most settlements in Nepal. Due to the careless use of fire for domestic purposes and negligence in its management, fire outbreaks are common in rural areas. This issue is particularly severe in the Terai region, where summer temperature can soar up to 45 degrees Celsius, making fire a major hazard in both rural and urban settlements there. Additionally, the recent increase in forest fires(wildfires) has also emerged as a significant problem.



Figure 8.19: Fire Affected Area

8.11.1 Cause of Fire Incidents

The causes of fire incidents can be primarily classified into two types:

A. Natural Causes:

Fire incidents can occur due to natural processes and reactions, even without the use of tools developed by humans for controlling fire. Fire resulting from such events are referred to as naturally caused fires. The natural reasons leading to fire incidents can be presented as follows:

- When dry trees or trees with peeling bark rub against each other, generating friction that produces fire.
- When fire is produced due to lightning strikes.
- When sunlight is continuously reflected by a shiny object, a bright stone, or water, concentrating the rays onto dry, easily combustible materials (tinder), thereby generating fire.

B. Human Induced Causes

Fire disasters occur due to the careless use of fire to fulfill needs and the negligence involved in its subsequent management. The potential human causes of fire incidents are as follows:

- Careless use of fire.
- Old and faulty electrical wiring.
- Fire coming into contact with sensitive areas during political protests, such as when carrying or using torch rallies (Raanke Juloos), and the spread of indiscriminately discarded fire (e.g., cigarette butts, leftover embers)
- Fire spreading due to fireworks, exploding crackers, or the detonation of explosives.

- Fire spreading from airplane crashes, or when fire reaches flammable and highly combustible materials (such as fuels or chemicals).
- Fire being generated and spreading due to excessive heat and light produced during the use or explosion of such flammable materials.
- Fire being generated and spreading due to the clashing of large electrical wires or accidental fire resulting from electrical motors.
- Deliberately setting forest fires (wildfires) to produce green grass (a common practice in some areas).
- Fire being generated and spreading in residences, industries, factories, or other location due to various causes.

8.11.2 Effects of Fire Incidents

Loss of life: Fire causes various forms of harm to life, including human lives, domestic animals, birds, plants, and other living creatures.

Property Damage: Fire causes loss of public and private wealth (Jandhan), which includes houses, industrial materials, vehicles, and other physical assets.

Environmental Impact: Fire affects the environment, leading to increased risk of windstorms, air pollution, and climate change.

Social Consequences: Fire incidents have significant social impacts, disrupting the standard of living and potentially leading to social conflict in daily life.

Economical loss: Fire renders businesses, production, and service providers inactive, causing disruptions to the economy and employment.

8.11.3 Fire Prevention

Preventing Fires: Awareness and education must be increased for this purpose. Fire should not be lit just anywhere, and matches and lighters should not be used or discarded carelessly. Children should not be allowed to play with flammable objects.

Fire Control Equipment: Fire control equipment, such as fire alarms, fire extinguishers, etc., must be arranged and kept ready.

Adopting Safety Policies: Fire safety policies must be implemented and followed in public places, industries, and other locations.

Drills and Training: Various drills and fire safety training should be conducted for fire control.

Safe Housing Design: To reduce the impact of fire, adequate priority must be given to safety in house design.

Caution in Electrical Construction: Safety must be a priority in public electrical construction, and fire control devices should be stored in safe locations.

8.11.4 Measures for Escaping and Managing a Fire Incident

1. **Mobilizing Community Participation:** Ensure the news of the fire reaches the entire village and community by shouting or blowing a whistle, thereby gathering public participation.
2. **Immediate Control:** Immediately work to control the fire before it has a chance to spread.
3. **Optimal Use of Resources:** Control the fire by correctly utilizing available resources and means.
4. **Organizing Manpower:** Line up the available workforce to pass items like water, green plants (leaves/branches), sand, and soil to the site of the fire.
5. **Assisting Victims:** Help people caught in the fire by having them exit using the safest possible method available (such as running, rolling, or otherwise), depending on the situation.
6. **Assisting Trapped Victims:** Provide victims who cannot escape the circle of fire with clothes soaked in water and help them exit by wrapping such clothes around their bodies.

Activity 9.9: Let's Do Drill Practice.

Gather in the school yard or any open space to conduct a fire drill with the help of an expert or teacher. Practice the measures needed to escape the fire and prevent loss of life and property. After the drill, discuss the ways to prevent fire incidents in the classroom.

8.12 Pandemic

A pandemic refers to the outbreak of an infectious disease in any geographical area. The outbreak of the disease can spread across a single country or even globally.

Infectious diseases, especially those caused by viruses and bacteria, are often found to take the form of a worldwide pandemic. Pandemics affect humans, animals, birds, and even plants. Examples include the Plague, COVID-19, and Swine Flu. When the impact of a global pandemic extends beyond the health sector, it affects society as well as the economy. In Nepal and worldwide, millions of people lost their lives due to COVID-19, and the economic condition of even the world's wealthiest nations was weakened.



Fig. 8.20 Problems Caused by COVID

8.12.1 Causes of Pandemics

Emergence of Global Pathogens: A pandemic can spread due to the emergence of new strains of various viruses or bacteria against which humans and animals have not developed immunity. These viruses or bacteria are often found to originate in animals and subsequently infect humans when they come into contact with them.

Global Travel and Trade: Increasing international travel and trade, facilitated by growing globalization and open economies worldwide, makes the spread of infectious diseases across borders easier. In such situations, infected pathogens or organisms can easily move from one region to another.

Urbanization and Population Density: In urban areas with high population density, if one person is infected, the proximity between individuals helps the disease spread quickly. The rate of infection spread is lower in sparsely populated areas with less crowding compared to densely populated, crowded areas.

Environmental Factors: Various changes in the environment, such as deforestation, climate change, and habitat destruction, can disrupt the ecological system. Disturbances in the ecosystem can lead to the emergence of new infectious agents like bacteria and viruses. When these agents come into contact with animals, they increase the risk of disease transmission.

Inadequate Public Health Infrastructure: A weak public health system, lack of access to healthcare services, and insufficient disease surveillance and response mechanisms can hinder early detection and prevention efforts, thereby contributing to the spread of a pandemic.

8.12.2 Impact of Pandemics

- a. **Health Consequences:** A pandemic cause causes widespread illness and high death rates. It can lead to severe respiratory problems, organ failure, and even death, particularly among the elderly, those with pre-existing conditions, and children.
- b. **Social and Economic Disruption:** A pandemic disrupts daily life, resulting in school closures, travel restrictions, and breakdowns in business and the economy. Issues like mandatory quarantine, social distancing, and facing isolation can arise. Furthermore, it often leads to financial hardship and unemployment.
- c. **Strain on the Healthcare System:** The surge in demand for medical services during a pandemic can put immense pressure on the healthcare system, leading to shortages of hospital beds, medical supplies, and healthcare workers. This, in turn, impacts on the capacity to provide adequate care, even for patients who require specific, focused treatment outside of the pandemic context.
- d. **Psychological Effects:** The uncertainty surrounding the illness, social isolation, and grief over losing loved ones can cause fear, anxiety, and mental health issues in individuals. Additionally, people in affected communities who contract the virus often face social stigma during a pandemic. As a result, people continue to be affected long after the direct impact of the pandemic has passed.

8.12.3 Pandemic Prevention and Impact Mitigation

A multi-faceted plan is required to prevent and reduce the effects of a pandemic, which must include public health measures, medical preparedness, community engagement, and international cooperation. The following are some strategies to prevent the impact of a pandemic:

- (a) **Early Detection and Surveillance:** Robust systems must be established for monitoring infectious diseases to detect potential pandemics in their initial stages. This involves tracking outbreaks globally and domestically, analyzing data, and using Artificial Intelligence (AI) to identify patterns that signal potential outbreaks.
- (b) **Rapid Response and Control:** Response capabilities must be developed to control outbreaks quickly before they escalate into pandemics. This includes swift problem identification, contact tracing, implementing isolation/quarantine measures, and deploying targeted programs in affected areas.

- (c) **Vaccine Development and Utilization:** Governments and relevant stakeholders should invest in the research and development of vaccines against known diseases and ensure equitable access to vaccination programs. Vaccination not only protects individuals but also contributes to herd immunity, helping to reduce the spread of infectious diseases throughout communities.
- (d) **Public Health Education and Communication:** Comprehensive public health education campaigns should be implemented to raise awareness about pandemics, modes of transmission, prevention measures, and the importance of vaccines. Clear and accurate communication from health officials is crucial for gaining public trust and cooperation.
- (e) **Strengthening Healthcare Infrastructure:** Healthcare infrastructure must be strengthened and capacity increased to accommodate the growing demands during a pandemic. This involves focusing on increasing hospital beds, medical supplies, and the number of healthcare workers, as well as improving coordination between different health services.
- (f) **Personal Protective Measures:** Personal protective measures like hand hygiene, physical cleanliness, wearing masks, and using sanitizers should be adopted to reduce the spread of infectious diseases. These practices should be encouraged in various settings, including schools, workplaces, and public spaces, and others should be encouraged to adopt them as well.
- (g) **International Cooperation:** Mechanisms for collaboration, coordination, and cooperation must be put in place among national and international organizations and NGOs to share information, resources, and best practices for pandemic preparedness and response. This facilitates providing aid and support to countries in need during a pandemic.

By implementing the strategies in a coordinated and sustained manner, it is essential for governments and communities to work together to prevent pandemics and minimize their impact on public health and society.

Activity 8.9

Divide yourselves into appropriate groups based on the number of students in the class. Write about the problems you and your family members faced during the COVID-19 period and the measures you adopted to solve them. Then, present your findings as a group to the class.

8.13 Cold Wave

A cold wave refers to a weather phenomenon characterized by a prolonged period of unusually cold temperatures compared to the seasonal average. These persistently cold conditions can lead to dangerous situations, particularly when temperatures fall below the normal range for an extended duration. Cold waves can negatively impact our daily lives by affecting health, infrastructure, agriculture, society, and the environment. In our country, the effects of cold waves are typically felt during the winter season, especially in the Terai region.



Fig. 8.21: Terai region affected by Cold Waves

8.13.1 Cause of Cold Wave

- (a) **Cold Air Pressure from Polar Regions:** Cold waves are often caused by the pressure of cold air masses originating from the polar regions, which move from north to south. This air pressure brings cold temperatures and covers large areas, leading to widespread cold conditions.
- (b) **Seasonal Variability:** Cold air waves are more prevalent during the winter months, when temperatures naturally decrease. However, due to changes in weather patterns and climate change, cold waves can also occur during other times of the year.
- (c) **Geographical Factors:** Geographical features such as being near mountains, valleys, and water sources tend to intensify the severity and duration of cold waves. For example, cold air can become trapped in valleys surrounded by hills, which increases the chill factor.

8.13.2 Impact of Cold Waves

- (a) **Health Risks:** Cold waves pose significant health risks. Exposure to cold temperatures can lead to hypothermia, frostbite, respiratory problems, and heart attacks, particularly among the elderly, young children, and those with existing medical conditions who have weaker immune systems.
- (b) **Impact on Infrastructure:** Cold waves can disrupt critical infrastructure, including transportation, energy, and water distribution systems. Freezing

temperatures can turn roads icy, leading to accidents. Water freezing inside pipes can severely affect distribution systems.

- (c) **Impact on Agriculture:** Cold waves can damage crops, especially sensitive fruits, vegetables, and flowering plants. Frost and low temperatures can harm agricultural production, resulting in crop losses and creating economic impacts for farmers and along with the food supply chain.
- (d) **Social and Economic Disruption:** Cold waves can disrupt daily life and economic activities, leading to school closures, business interruptions, and an increased demand for energy for heating. Cold-related respiratory illnesses and injuries also negatively affect public health.
- (e) **Environmental Impact:** Cold waves can affect wildlife and ecosystems. A sudden drop in temperature followed by several days of unnatural cold can lead to food shortages. Species sensitive to the cold may struggle to find food and shelter, which can result in population decline and ecological imbalance.

8.13.3 Measures to Prevent and Mitigate the Effect of Cold Waves

- (a) **Development of Early Warning Systems:** Robust weather forecasting systems should be implemented to provide advance notice about an approaching cold wave, allowing communities to prepare and adopt preventive measures.
- (b) **Public Awareness Campaigns:** The public should be educated about the dangers of cold waves, and preventive actions should be promoted, such as staying indoors during extreme cold, wearing appropriate clothing, and safely using heating devices.
- (c) **Infrastructure Development and Improvement:** To protect against cold waves, measures must be taken, including insulating buildings, maintaining water heating systems, and ensuring the reliability of electricity and water supplies.
- (d) **Development of Community Preparedness Plans:** Plans should be developed and maintained in a constant state of readiness, including the construction of community shelters for use in emergencies, establishing information networks, and arranging transportation, medicine, and medical services.
- (e) **Provision of Aid Supplies:** An advance plan, complete with a budget and implementation unit, should be set up to arrange warm clothes, blankets, and access to transportation for shelter or medical services for vulnerable individuals, including the sick, the elderly, and children.

- (f) **Emergency Coordination and Collaboration:** Emergency efforts must be coordinated between government agencies, non-profit organizations, and community groups. Search and rescue operations and the distribution of emergency supplies should be arranged to ensure a timely and effective response to the effects of a cold wave.

8.14 Glacial Lake Outburst

Water is found in all three states: solid, liquid, and gas. The solid state of water is snow and ice. Generally, water becomes solid at a temperature of 0°C. Due to extreme coldness in the sky, water falls to the ground as snow, causing snowfall in the mountains. This snow melts to form glaciers.

Lakes formed in the Himalayan region where snow accumulates, surrounded by rocks, are called glacial lakes. As the temperature rises, the rate at which the ice in the glacial lake melts increases, thereby increasing the volume of water in the lake. As the water volume gradually increases, the dam can break, leading to a massive flood, which is known as a Glacial Lake Outburst Flood (GLOF).

8.14.1 Causes of Glacial Lake Outburst Flood (GLOF)

The major causes of Glacial Lake Outburst Floods (GLOFs) are as follows:

- (a) **Global Warming:** Currently, the world's temperature is increasing day by day. This accelerates the melting of ice and snow, leading to an excessive accumulation of water in glacial lakes, thus increasing the risk of an outburst.



Fig. 8.22: Glacial Lake Outburst Flood (GLOF)

- (b) **Avalanches:** Avalanches cause the water level in the lake to rise, leading to a glacial lake outburst.
- (c) **Dam Failure:** The moraine dam of a glacial lake can weaken due to various reasons and collapse on its own, causing a glacial lake outburst.
- (d) **Earthquakes:** Earthquakes can also cause a glacial lake outburst. When the ground shakes, the resulting water waves can overtop the dam. As this water erodes the dam material, it can lead to a glacial lake outburst.

Thus, a combination of factors such as the accumulation of a large amount of snow on steep slopes, the erosion and weakening of hard rock, the continuous process of freezing and thawing of water that seeps into rock fissures, heavy snowfall, and ground shaking due to earthquakes, all contribute to the occurrence of glacial lake outbursts.

8.14.2 Impacts of Glacial Lake Outburst Floods (GLOFs)

- (a) **Sudden Massive Flash Floods:** It can cause sudden and massive flash floods.
- (b) **Destruction of Forests and Arable Land:** It destroys forests and cultivable agricultural land.
- (c) **Destruction of Livestock and Wildlife:** It destroys domestic animals and wildlife.
- (d) **Destruction of Development Structures:** Structures such as roads, bridges, and hydropower stations are destroyed.
- (e) **Loss of Life and Property along with the Creation of Fear:** It causes loss of life and property and generates panic.
- (f) **Negative Impact on the Ecosystem:** It negatively affects the ecological system.
- (g) **Displacement of Human Settlements:** It causes the displacement of human settlements.



Fig. 8.23: Area affected by landslides

8.14.3 Measures to Mitigate the Impacts of Glacial Lake Outburst Floods (GLOFs)

Most of the major rivers in Nepal originate in the Himalayas and flow downwards. Human settlements are often found located along riverbanks. Agriculture and animal husbandry are also concentrated in the areas along the rivers. The following measures should be adopted to mitigate the impacts arising from the Glacial Lake Outburst Flood (GLOF).

- (a) **Technical Measures:** By using appropriate technology, skills, and knowledge, it is possible to prevent a glacial lake outburst, and if an outburst does occur, the resulting damage can still be minimized.

- (b) **Establishment of Early Warning Systems (EWS):** By establishing a Glacial Lake Outburst Flood Early Warning System, residents living along the riverbanks can be informed prior to the outburst of the glacial lake.
- (c) **Awareness Activities:** Awareness-raising education about glacial lake outbursts should be regularly provided to communities residing near the banks of glacial rivers.

When constructing development structures like roads, bridges, and hydropower plants in areas that could be affected by a glacial lake outburst, appropriate technology and site selection should be used to minimize potential damage.

Activity 8.10: Let's Draw a Picture

Create and present a picture that depicts the potential impacts (consequences) in the downstream area caused by a Glacial Lake Outburst Flood (GLOF), as well as the actions that residents in the downstream area should adopt to protect themselves from it.

Exercise

1. Give Very Short Answers to the following questions:

- (a) What is a natural disaster? Write the names of its types.
- (b) What is a flood?
- (c) What is a landslide?
- (d) Write the meaning of soil erosion.
- (e) What is an earthquake?
- (f) What is a pandemic? Also, write two examples.
- (g) Why does a glacial lake outburst occur?

2. Give Short Answers to the following questions:

- (a) Briefly describe the types of natural disasters.
- (b) Mention the causes of natural disasters.
- (c) What kind of effects do natural disasters have? Write the measures to mitigate those effects.

- (d) Explain the stepwise activities required for natural disaster management.
- (e) Mention the causes of floods and write the resulting impacts in point form.
- (f) What can be the preventive measures for floods? Mention them.
- (g) What kind of preparations should be made in advance to be protected from the impacts of floods and landslides? Write them.
- (h) Mention the causes and preventive measures for landslides.
- (i) Mention the causes of earthquakes.
- (j) Mention the impacts of earthquakes and explain the preparedness required for their mitigation.
- (k) Mention the stepwise actions that should be taken after an earthquake to mitigate its impacts.
- (l) Mention the impacts seen from soil erosion and write the preventive measures.
- (m) Mention the causes of Glacial Lake Outbursts (GLOFs) and write the measures to mitigate their impacts.
- (n) How does a fire occur and make a list of the actions we should take for its prevention.
- (o) Write the reasons for the spread of a pandemic and make a list of the actions that can be taken to mitigate its impact.
- (p) Write in point form which region is likely to be affected most by a cold wave and why.

3. Give Long Answers to the following questions:

- (a) What are the impacts of natural disasters? Identify practical measures to mitigate the impacts of natural disasters in Nepal.
- (b) 'Humans have a special role in natural disaster management.' Explain with reasoning.
- (c) Explain what kind of preparations should be made in advance to be protected from the impacts of floods and landslides.

- (d) Mention the impacts of an earthquake and prepare an outline of the preparedness required for its mitigation.
- (e) Suppose an epidemic of severe diarrhea (cholera/dysentery) starts spreading in your settlement. What measures will you adopt to protect yourself from this epidemic? Additionally, prepare a list of ways you can help the community from your side.

Project Work

1. Prepare a list of the potential disasters that can occur in your area. Observe the effects these disasters have on the social, economic, and environmental aspects of that area. Then, research and identify management measures and prepare a report.
2. The problem of epidemics like severe diarrhea (cholera/dysentery), dysentery, and cholera is still prevalent in Nepal's remote Himalayan and hilly regions. Discuss with local guardians and knowledgeable individuals about what the local community should do to reduce this situation and minimize the loss of life and property. Write the findings in point form and present them in class. Additionally, interact with local representatives (elected officials) to find out what plans the local government (municipality or ward) has made for epidemic control, and present a list of those actions in class.
3. Prepare a drama, with the help of your teacher, that includes the actions local government and the community should take to reduce the problems of the heat wave ('Loo') seen in the Terai region during the summer and the cold wave during the winter. Present this drama in the school and the community.
4. Prepare a sample of an emergency kit (Go-Bag) that is used during a disaster and present it in the classroom.

ENVIRONMENT MANAGEMENT



Study the picture above and answer the following questions with group discussion:

- What activity is taking place in the pictures.
- How does the above activity benefit the environment?
- What is the practice of waste management like in your school?

9.1 INTRODUCTION

Environmental management includes aspects such as nature conservation, biodiversity protection, development of sustainable social structures, population management, and preservation of cultural heritage. Environmental management is a system through which adverse environmental effects are continuously minimized through a procedural approach, thereby maintaining environmental quality. Environmental management embraces the concept of ‘green development’. This field aims to make human activities and development work environmentally friendly, thereby reducing and adapting to the adverse effect of pollution and climate change. This unit discusses the introduction to environmental management, its necessity and importance, the role of different levels of government in environmental management, and environmental-friendly livelihoods. Environmental management

is a management system that makes the relationship between humans and the environment sustainable by the judicious use of available environmental resources. Growing urbanization and industrialization, pollution, over-exploitation of natural resources, and natural disasters are directly or indirectly affecting the environment. Environmental management is about mitigating these effects and adopting a greater amount of environmentally friendly technology or lifestyle.

9.2 Importance of environmental management

Adopting a healthy lifestyle necessitates a healthy environment. Therefore, the proper management of the environment is an essential prerequisite for maintaining that healthy state. The necessity and significance of environmental management can be presented as follows:

1. **Sustainability in the Ecosystem:** Environmental management helps in the conservation of biodiversity and ecological systems, and in maintaining the balance of natural resources. It aids in preventing the destruction of habitats, species, and various ecological systems such as forests, wetlands and oceans.
2. **Mitigation of Climate change impacts:** Environmental management plays a crucial role in reducing greenhouse gas emissions, promoting renewable energy sources, and implementing strategies for climate adaptation. Proper forest management, land use practices, and energy consumption contribute to minimizing the effects of global warming and mitigating climate change.
3. **Clean Environment:** A clean environment is fundamental to human health. Managing environmental factors such as air and water quality, waste disposal, and toxic substances help prevent pollution-related illnesses, respiratory diseases, waterborne infections, and other health risks.
4. **Conservation of Natural Resources:** Environment management is concerned with the sustainable use of natural resources such as water, soil, minerals, and energy. Efficient resource management practices help conserve these finite resources for future generations, minimize degradation, and foster long term economic stewardship.
5. **Economic Stability:** Environmental degradation can adversely affect the economy, leading to reduced agricultural productivity, increased health costs, biodiversity loss, and infrastructure damage from extreme weather events. Environmental management initiatives promote sustainable development,

innovation, and job creation in green enterprises.

6. **Enhanced Quality of Life:** A clean and healthy environment enhances the overall quality of life for individuals and communities. Access to green spaces, clean air, safe drinking water, and a pollution-free environment contribute significantly to human physical and mental well-being, thereby fostering the development of a healthy, happy, and prosperous society.
7. **Global Partnership:** Issues like climate change and pollution arising from the overexploitation of natural resources and human activities, are no longer confined to a single community or nation borders, making them a global challenge. Therefore, international and transnational cooperation plays a vital role in addressing these challenges. Collaboration among governmental bodies, NGOs, and local communities is essential to comprehensively tackle global environmental problems.
8. **Protection of Ecosystem Services:** Healthy ecosystems provide indispensable services-including air and water purification, soil fertility, and climate regulation. A core objective of environmental management is to safeguard these services, ensuring food security, clean water, and overall environmental stability for humans and other life forms.
9. **Sustainable Development:** Environmental management is vital for meeting Sustainable Development Goals (SDGs), balancing economic growth with environmental conservation and social equality. It promotes responsible consumerism, supports eco-friendly production patterns, and aims to reduce humanity's ecological footprint, ensuring harmony between human activities and nature.
10. **Conservation of Cultural Heritage:** Diverse cultural practices and traditions are profoundly linked to the natural environment. Environmental management efforts help protect cultural heritage, traditional knowledge, and indigenous practices, thereby preserving cultural diversity and enriching the overall human experiences.

9.3 Role of different levels in environment management

The responsibility for managing the environment falls directly and indirectly upon individuals, communities, nations, and the international community. The roles of some of these key levels are discussed below:

A. Individual or Family

The individual is the fundamental unit for the formation of society. Society is built on individuals. If a radical change is to be brought about in society, change must be first introduced at the individual level. Therefore, the role that an individual can play in environmental management are present as follows:

1. Focus on personal hygiene.
2. Ensure the provision of potable (drinkable) water.
3. Properly manage biodegradable waste at home.
4. Collect and reuse rainwater at home.
5. Support the proportion of greenery around residential areas.
6. Practice thriftiness in energy use (energy conservation)
7. Give priority to the use of renewable sources of energy.



Fig. 9.1 Personal Hygiene

B. Community of Locality

A community is a group of individuals or families. If the actions adopted by a community are not exemplary, the consequences can affect the entire nation. It is therefore essential for the community to give proper attention to environmental management and to conduct and implement activities related to it. The role that a community can play in environmental management are as follows:

- Forming environment improvement committees within the community and neighborhoods.
- Organizing neighborhood cleaning campaigns.
- Running programs for the promotion of greenery and aesthetics (beautification)



Fig.9.2 Neighborhood Cleanup Campaign

- Controlling neighborhood-level pollution.
- Managing waste materials (garbage and refuse).
- Protecting drinking water sources.
- Regulating good environmental governance (ensuring accountability and effective practices)
- Making proper arrangements for sewage drainage.
- Minimizing the use of pesticides and chemicals in agriculture.

C. Local or Municipal level

The local level is understood as a larger collective structure formed by combining smaller communities, neighborhoods, and wards. Under the current administrative system, the term “local level” includes Village councils (Gaupalikas), Municipalities (Nagarpalikas), Sub-Metropolitan cities (Upamahanagarpalikas), Metropolitan cities (Mahanagarpalikas). The local level is a distinct organ of the state. The policies and action implemented by the local level have an impact across the entire state. Therefore, it is crucial for the local level to dedicate proper attention and run programs toward environmental management. The role that the local level can play in environmental management are as follows:

- Establishing and implementing drinking water schemes.
- Constructing sanitary landfill sites.
- Forming disaster management committees.
- Arranging for the provision of public toilets.
- Imposing restrictions on the use of plastic materials.
- Creating and enforcing building construction codes (or bylaws).
- Establishing and managing public parks and gardens.
- Setting up an environmental protection unit (or cell).
- Coordinating with organizations and institutions working on environmental issues.

9.4 Environment Friendly Indicators

As outlined in the Environment-Friendly Local Governance Framework, 2070 (2013/2014 A.D.), environment-friendly local indicators are categorized into two types:

a. Fundamental Indicators (Basic Indicators)

The indicators that are mandatory for any household, settlement, or neighborhood to fulfil, form the household level up to the district level, to be declared environmentally friendly, are the Basic Indicators. Once all basic indicators of the respective level are fulfilled, there is a provision for granting that level environmentally friendly recognition or honor.

b. Developed Indicator

Indicators that are at a higher level than the basic indicators are categorized as Development Indicators. Although fulfilling these indicators is not mandatory for environmentally friendly declaration, developed indicators are measured for further standardization. The scope of development indicators is broader than that of basic indicators. Development indicators have been established with the aim of encouraging additional environmentally friendly activities.

Local Governance Indicators for Municipal level

The following Environment-Friendly Local Governance Indicators are in place for various levels within a municipal area:

Level	Basic Indicators	Developed Indicators
	A. Sanitation and Health	A. Sanitation and Health
	Latrine with a pan	Paved latrine with a septic tank
	Proper management of waste within the house compound	Cleanliness status of the street outside the house compound
	Personal Hygiene	Regulation of plastic bags
	B. Renewable Energy	B. Use of Clean Energy
	Energy utilization	Utilization of clean energy
Household	C. Greenery/ Urban Aesthetics	C. Greenery and Urban Aesthetics
	Promotion of greenery and urban aesthetics	Management of open spaces within the house premises
	D. Drinking Water	Urban aesthetics
	Rainwater harvesting	D. Adherence to Building Codes

	Pure drinking water	Safe building construction
	A. Institutional Arrangement, Sanitation, and Aesthetics	Public area sanitation
	Formation of Neighborhood Development Organization/ Neighborhood Improvement Committee	Promotion of greenery in the neighborhood
Neighborhood	Neighborhood sanitation campaign	Noise pollution control
	Good environmental governance of the institution	
	Promotion of urban aesthetics	
	Noise pollution control	
	A. Drinking Water and Sanitation	A. Road and Drainage Management
	Protection of drinking water sources	Management of roads and drainage channels
	Waste management	B. Agriculture
Wada	Pond construction and management	Encouragement of organic farming
	B. Disaster Management	Adoption of organic farming system
	Emergency safe zone	Encouragement of beekeeping
	C. Forest and Land Conservation	C. Disaster Management
	One Ward, One Nursery	Formation and capacity development of the local disaster management committee
	Management of barren/fallow land and promotion of greenery	D. Forest and Land Conservation
		Tree planting and garden management on barren and fallow land
		E. Noise Pollution Control
		Penalizing those who cause noise pollution
		A. Drinking Water and Sanitation
	A. Sanitation	
	Preparation of a strategic plan for drinking water	Scientific management of the sanitary landfill site
Municipality/ Rural Municipality Level	Operation of a sanitary landfill site	Arrangement for sewage treatment
	Provision of public toilets	Monitoring of hotels and restaurants
	Ban on the use of plastic	B. Agriculture
	B. Disaster Management	Integrated Pest Management (IPM) in agriculture production
	Provision of fire trucks	C. Renewable Energy
		Solar energy for roads and settlements

	A. Disaster Management Committee Activation and Fund Management	A. Sanitation
	Adherence to the National Building Code	Biogas production from public toilets
	C. Forest and Land Conservation, Biodiversity, and Greenery	Establishment of a special fund related to environmental protection
	Operation of parks/gardens	B. Disaster Management
		Disaster risk mapping
		C. Plastic Management
		Plastic collection and management
		D. Education
		Environmental education in schools
		E. Forest, Land Conservation, Biodiversity, and Greenery
		Promotion of greenery
		F. Physical Infrastructure Development
Municipality/ Rural Municipality		Land use planning
		Parking area management
		Management of animal slaughterhouses
		Determination and implementation of road standards
		A. Related to Industrial Pollution Control
		Regulation of industrial pollution
		B. Noise and Air Pollution Control
		Noise pollution control
		Air pollution reduction
		C. Provision of Service Center
	Arrangement related to the service center	

9.5 Environmental Audit

The environmental audit falls under the method used to assess the impact on the environment caused by the activities and practice carried out at the organizational or community level. This method involves systematically examining various aspects, such as natural resources consumption, waste generation, pollution levels, and compliance with environmental regulation. The primary objective of an environmental audit is to identify areas for improvement that can help mitigate negative environmental impacts and enhance sustainability.

Activity 9.1: Waste Journey

Concept: Students will be able to discover what kinds of waste they generate over the course of a week. Furthermore, they will understand that their small efforts can play a significant role in reducing the overall volume of waste.

Required Materials

- 5-7 cloth or jute sacks/bag (as needed)
- One large tarpaulin and rubber gloves (one pair for each student)
- Weighing machine (scale) and tape (adhesive/cello tape)

Method and Process

- Give each student one pair of gloves and one bag/sack. Then, instruct them to collect the dry waste items they usually throw away and place them in the bag. Students should collect items like paper and plastic, but they should not include food waste or moist (wet) biodegradable items, as these can decompose on their own. It is mandatory for them to wear gloves and a mask while collecting waste items.
- For safety, younger students should not be instructed to collect sharp objects or broken glass pieces.
- Students should be told to pile the collected waste daily in a designated area for the accumulated waste. Students may also use a needle and thread to sew the bags shut.
- Students should be instructed to estimate the average weight of the waste items they collect each day.
- A prize should be arranged for the student whose estimate is the closest to the actual weight.
- The collected waste should be spread out on a large plastic sheet, and students should be instructed to sort it into different types and place them in separate containers, such as plastic, bottles, glass, aluminum, etc.
- They should keep a record (log) of the waste sorted into different categories. Finally, a discussion should be held about which types of waste we can reduce to help keep the environment clean.

Source: Green School Resource Book

Activity 9.2: Let's Conduct an Environmental Audit of Our School's Waste, Water, and Energy.

Objective: To conduct an environmental audit of the school's waste, water, and energy.

Required Materials: Waste baskets or containers, a torch, and other materials as needed.

Mehod: Based on the example presented earlier, divide yourselves into three groups. One group will conduct the environmental audit for waste management, the second group for water, and the third group for energy. Seek assistance from the teacher as necessary. Analyze the results obtained from the audit and submit a report to the school with recommendations for improvement.

9.6 Environmentally Friendly Livelihoods

Environmentally Friendly Livelihoods refers to the means of subsistence adopted by people without causing any kind of harm to the environment or its components, or by preventing environmental damage as much as possible. The following are important Green Businesses and practices that fall under environmentally friendly livelihoods:

a. Eco-tourism

Ecotourism is a type of tourism based on scenic beauty, biological and cultural richness, and biodiversity. It encourages the prohibition of methods and materials that negatively affect the environment. It adopts measures that ensure the sustainability of the environment by promoting environmentally friendly activities.



Figure 9.3

Ecotourism prohibits activities in tourist areas such as smoke, dust, pollution, destruction of biodiversity, exploitation of natural resources, and deforestation. Looking at the history of ecotourism, it is found to have started in 1983 by tourism professional in Costa Rica. In the words of ecotourism expert Edward Inskip, ecotourism is defined as a controlled journey by a limited number of travelers, guided by the local residents own interpretation and narration, to natural areas, villages, and agricultural fields.

Ecotourism in the Context of Nepal

In the context of Nepal, the potential for ecotourism is vast and beneficial. Ecotourism can play a crucial role in enriching the Nepali economy. Nepal's Chitwan National Park and the Annapurna Conservation Area are renowned worldwide as major ecotourism destinations for tourists.

Similarly, homestay programs (Gharbas Karyakram) are begin operating in various parts of the country to contribute to ecotourism. This program has played a significant role in fostering self-employment opportunities at the local level, conserving biological and cultural diversity, and supporting economic prosperity.

Homestay Programs as Good Practice in Ecotourism

The Amaltari Buffer Zone Community Homestay (Gharbas) is located in Baghkor, Ward No .15 of Kawasoti Municipality, in the Nawalparasi (Bardaghat East) District of Gandaki Province. The settlement is 7 kilometers from Danda on the East-West Highway. One of 212 households in this settlement, which includes Tharu, Musahar, and Bote communities, homestay tourism operates in 24 hours-3 houses belong to the Bote community and 21 to the Tharu community. The Amaltari Buffer Zone Community Homestay was initiated in 2070 BS (2013/2014 A.D) under the 'Hamar Digo Gaun' (Our Sustainable Village) program of the Amaltari Buffer Zone Users Committee. Homestay tourism, which started with 18 houses, has now expanded to 24 houses and has the capacity to welcome 35,040 tourists annually.

The Kalabad Community Homestay (Gharbas) was started in Chatitra 2071 BS (March/April 2015 AD) in Kalabad Gharedi, Ward No. 22 of Pokhara Metropolitan City, Kaski District. To get there, one must travel 9 kilometers from Prithvi Chowk towards Syangja on the Siddhartha Highway to Tilhar. From Tilhar, after leaving the highway and travelling distance of 2.5 kilometers, one can reach Kalabad Gharedi. In the location, which has 156 households belonging to the Brahim, Dalit, and Gurung communities, homestay tourism is operated in 18 houses. These includes 11 homestays run by the Gurung community, 6 by the Brahmin community, and 1 by the Dalit community. It has the capacity to accommodate 68 tourists daily and 24,820 tourists annually. In both locations, the management committees are actively operational.

b. Non-Timber Forest Products or NTFPs

The collection and cultivation of Non-Timber Forest Products serve as an important source of livelihood for Nepal's rural communities. NTFPs include medicinal herbs fodder, various types of mushrooms, and fruits, among others. Non-Timber Forest Products are useful items available in forests

that do not require trees to be cut down to obtain them. Forest products such as Yarsagumba (caterpillar fungus), Chiraito (Green Chiretta), Panchaule (Himalayan marsh orchid), and pine resin have been traditionally collected and used for generations as a means of livelihood. Besides this, people are now generating income by commercially cultivating certain NTFPs, such as floriculture, fruit farming, and mushroom farming. The cultivating of NTFPs is an excellent method for forest conservation because it does not require deforestation. Moreover, this type of cultivation helps support the preservation of forest resources. The cultivation and use of medicinal herbs among NTFPs have also had a positive impact on public health.

In the context of Nepal, there are numerous possibilities for the cultivation of Non-Timber Forest Products. Given the dense forest, grasslands, and pasture lands found here, Nepal is suitable country for NTFP farming. Currently, many pharmaceuticals are operating in Nepal based on the cultivation of medicinal herbs, and besides that, various types of food products are being cultivated as a means of income generation.

Activity 9.3

Find the names of Non-Timber Forest Products (NTFPs) used in your surrounding area and fill in the table given below.

Non-Timber Forest Products Name	Part Used	Usage/Application
1.		
2.		
3.		
4.		
5.		

c. Agroforestry

The agroforestry system refers to the process of cultivating useful plants or trees found in forest areas alongside agricultural crops. When only single crops are farmed repeatedly, the soil gradually loses the mineral elements necessary for plant life, and it becomes difficult to replenish them. There are certain wild plant species that, when planted with food crops, help to

renew the mineral elements in the soil. Similarly, some types of vegetation help protect food crops from strong winds, pests, and insects. In Nepal, plants such as Bakaino (Indian Lilac), Kabro (Ficus lacor), Ipil Ipil (Leucaena leucocephala), Saal (Shorea robusta), and Harro (Terminalia chebula) are currently being cultivated widely within the agroforestry system.



Fig. 9.4 Agroforestry System practiced in Kavre

d. Community Forest

A Community Forest refers to a small forest established on public land with community investment for the purpose of forest conservation and the benefits and welfare of the community. The full executive authority of the community forest is vested entirely within the community itself.



Figure 9.5 Forest products obtained from the Community Forest

Community forestry is also a type of environmentally friendly livelihood option. Specifically, the concept of community forestry was put forward by the Government of Nepal for the development, maintenance, and promotion of forest areas. Its strong points include providing legal recognition to forest user groups, enabling rural and community development, participatory programs, freedom in forest development and product utilization, sustainable forest management, and biodiversity conservation. Through this system, users have benefited from aspects like public participation, shared ownership, community development, poverty alleviation, environmental conservation, improvement in children's health, and the creation of sustainable resources.

d. Organic Farming

Organic farming is an inexpensive agriculture method that produces crops without the use of chemical fertilizers or chemical pesticides. It focuses on maintaining soil fertility, implementing crop rotation, and utilizing green manure and compost. Since organic farming maintains the soil's fertility, there is no reduction in agricultural productivity; rather, the productivity of the crops increases.

In addition, because no chemical pesticides are used in this type of farming system, there are no negative effects on the health of humans and other living organisms or on the environment. Consuming food produced this way even helps to boost people's immune systems. In contrast, the overuse of chemical pesticides in inorganic farming systems has put human health at risk and it also negatively impacted the environment. The benefits of organic farming are as follows:



Fig. 9.6 Organic Farming in Terai of Nepal

- A. Soil Fertility Improves.
- B. Production costs decrease as there is no reliance on chemical fertilizers.
- C. Pollution caused by chemical fertilizers and pesticides is reduced.
- D. The underground water level of the land increases.
- E. The water retention capacity of the soil improves.
- F. Evaporation of water from the soil is controlled.
- G. The negative health impacts on humans caused by the use of pesticides are reduced.

Exercise

1. Write Very Short Answers to the Following Questions:

- a. What is environmental management?
- b. Write any two significances (importance) of environmental management.
- c. How many environment-friendly local indicators are there?
- d. What is a basic indicator?
- e. Define a developed indicator.
- f. What is a local level (local government unit)?
- g. What is agroforestry?
- h. Define community forest.
- i. What is ecotourism?
- j. What is a Non-Timber Forest Product (NTFP)?

2. Write Short Answers to the Following Questions:

- a. Briefly explain the role of an individual or household in environmental management.
- b. Mention any five activities that can be adopted for environmental management at the community level.
- c. Mention any five roles that can be played by the local level (local governmental unit) in environmental management.
- d. Mention the measures for environmentally friendly livelihoods and briefly describe any one of them.
- e. List the basic and developed environmental indicators in your surrounding area and society, and differentiate between them.

3. Differentiate Between the Following:

- a. Environmental Conservation and Environmental Management
- b. Agroforestry and Community Forest
- c. Tourism and Ecotourism

4. Write Short Notes on the Following:

- a. Non-Timber Forest Products (NTFPs)
- b. Organic Farming

5. Write Long Answers to the Following Questions:

- a. Argue the point that ‘the role of various levels (of governance/society) is indispensable in environmental management’
- b. Analyze the reasons why farmers practicing inorganic farming experience various health problems compared to those practicing organic farming.
- c. Present an argument on how Non-Timber Forest Products (NTFPs) help people with their livelihoods.
- d. Identify the measures adopted for environmentally friendly livelihoods and discuss them with examples.

Project Work

Inquire with the officials of the Community Forest User Committee and prepare a collective report to be presented in class on how the community forest has contributed to the livelihoods of the people.

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