Unit 1

Introduction:

- Components of Environment and their interactions
- Ecology, Ecosystem and types

Natural Resources:

- Forest Resources-Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions
- Water resources, World's water reserves, Hydrological cycle
- Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types
- Mineral resources of India, Mining & its adverse effects

Numerical problems on rainfall & runoff

Introduction: The word environment is derived from French world **"Environ**" means encircle or surround. The environment can be defined as;

1. Physical and biotic habitat that surrounds us.
2. The conditions or circumstances that surround an organism or groups of organism,
3. The complex of social or cultural conditions that affect an individual or community.

In general **'Environment'** is the natural world in which people, animals and plant live. The subject of environment is inherently inter disciplinary. Environmental issues are affected by all our activities to varying degrees. It is the study of complex relationships that exists in our surrounding among human, plants, animals, water, air, soil and other organisms. The physical and biotic component of environment that integrates knowledge from a wide range of disciplines, including physics, chemistry, biology, geography, geology, soil science, technology, economics, sociology, ethics, oceanography, anthropology, politics, psychology and so on. It is the study of how all the components of nature and human interact. It is also the study of interaction of the **biotic (plants, animals and micro-organisms)** components among themselves and with the **abiotic** (**temperature, rainfall soil air, water atmosphere etc).** Ecology is the science that studies the relationships between living things and their environment. It is often considered as the discipline of biology.

Components of Environment and their interactions: By considering the relationship between man and nature, a broader interpretation of the term **'environment'** has been provided by the National Environment Policy Act **(NEPA)** of USA. According to this the term **'environment'** includes physical, social, cultural, economic and aesthetic dimension. Traditionally, when people thought about the environment, they have considered water (in its various forms and locations), air, the solid earth and various living organism. In other words, conventional consideration of the environment has involved the **hydrosphere, the atmosphere, the geosphere and the biosphere.**

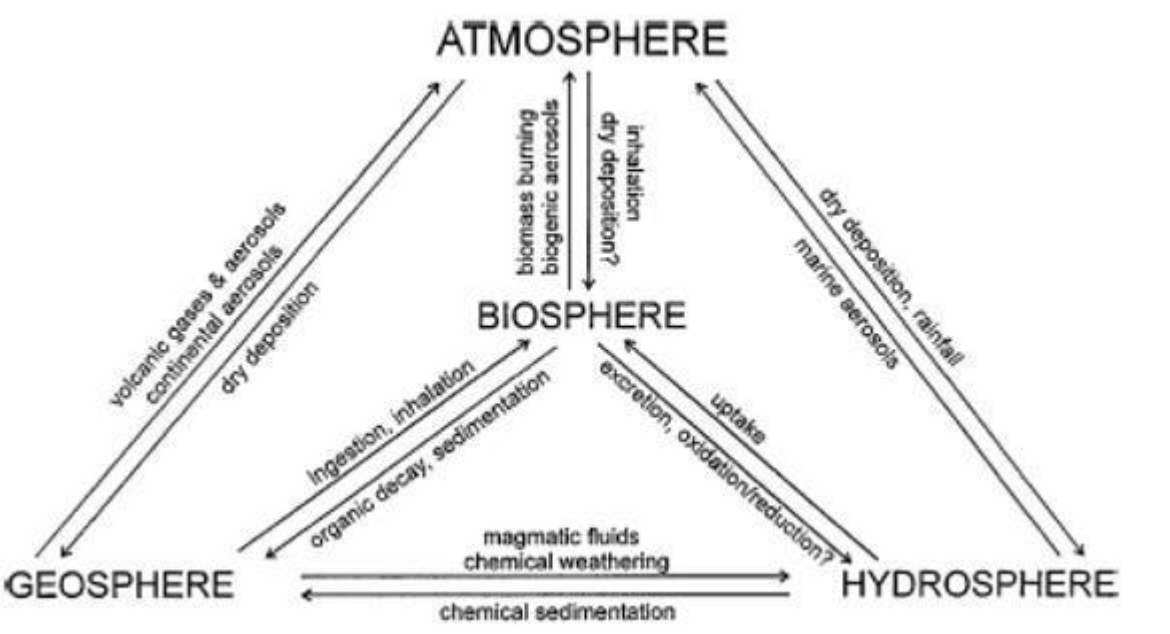

Figure: 1.1 Components of Environment

The classification of nature into different spheres helps to understand the distribution and flow of chemicals in the environment. A schematic representation of the four environmental components and their inter relationships is shown in figure 1.1. In this figure the inter connection emphasize the close dynamic, inseperable, coupling among the environmental components. In this conceptual model, if there is change in one component, immediately all other components respond. **The two-way linkage** in the diagram signifies that matter may flow from one component to another in both directions.

Matter can neither be created nor destroyed; hence in this conceptual model the major objective is to find the location and chemical form of the substances at any given time.

1. Atmosphere

The cover of air that surrounds the earth surface is known as the **atmosphere.** Atmosphere is the protective thick gaseous layer, surrounding the earth, which sustains the biological life and saves it from the adverse effect of our space. Without atmosphere there will be no **Wind, Cloud, Rain, Snow, Lightening etc.**

The atmosphere extends up to **1600 km** from the earth's surface. There are five different layers with in the atmosphere. Each layer can be differentiated on the basis of temperature and each layer has its own characteristics. The different layers are;

- **Troposphere**
- **Stratosphere**
- **Mesosphere**
- **Ionosphere or Thermosphere**
- **Exosphere**

The different layers are shown in figure 1.2.

Troposphere: The densest layer lies closest to the earth's surface and extends to an altitude of **0 to 12 km. In this layer man lives along with other organisms**. It is the region of all changes we experience in our daily life and circulation of air takes place. This layer contains **N_2, O_2, CO_2,** water vapour and other trace gases. The temperature decreases with the height (altitude) and varies between **17^oC to -56^oC.** The top layer of troposphere is tropopause.

Stratosphere: Layer above troposphere that extends upto **50 km** is known as stratosphere. Air is extended upto stratosphere. The temperature rises from **-56^o to -2^oC**. Because of the very low temperature, there are virtually no clouds, dust or water vapour. Here, ozone forms a well-marked **ozone layer**.

Mesosphere: Next to stratosphere is mesosphere that is characterized by low atmospheric pressure and temperature of **-2^o C to -90^o** C. The mesosphere extends roughly **80-90 km**. This layer is characterized by low temperature due to low absorption of ultraviolet radiations by ozone.

Ionosphere or Thermosphere: The thermosphere starts just above the mesosphere and extends upto **700 km**. The temperatures in this region can increases as high as **1727^oC.** This layer is known as upper atmosphere.

Exosphere: The upper most layers of atmosphere above the thermosphere is called exosphere or outer space. It extends upto **1600 km** and gives way for interplanetary space. All the layer of atmosphere are important to the ecological balance of life because together they form the blanket of air in the biosphere, which is a part of lithosphere, hydrosphere and atmosphere in which living organisms live together and interact with each other.

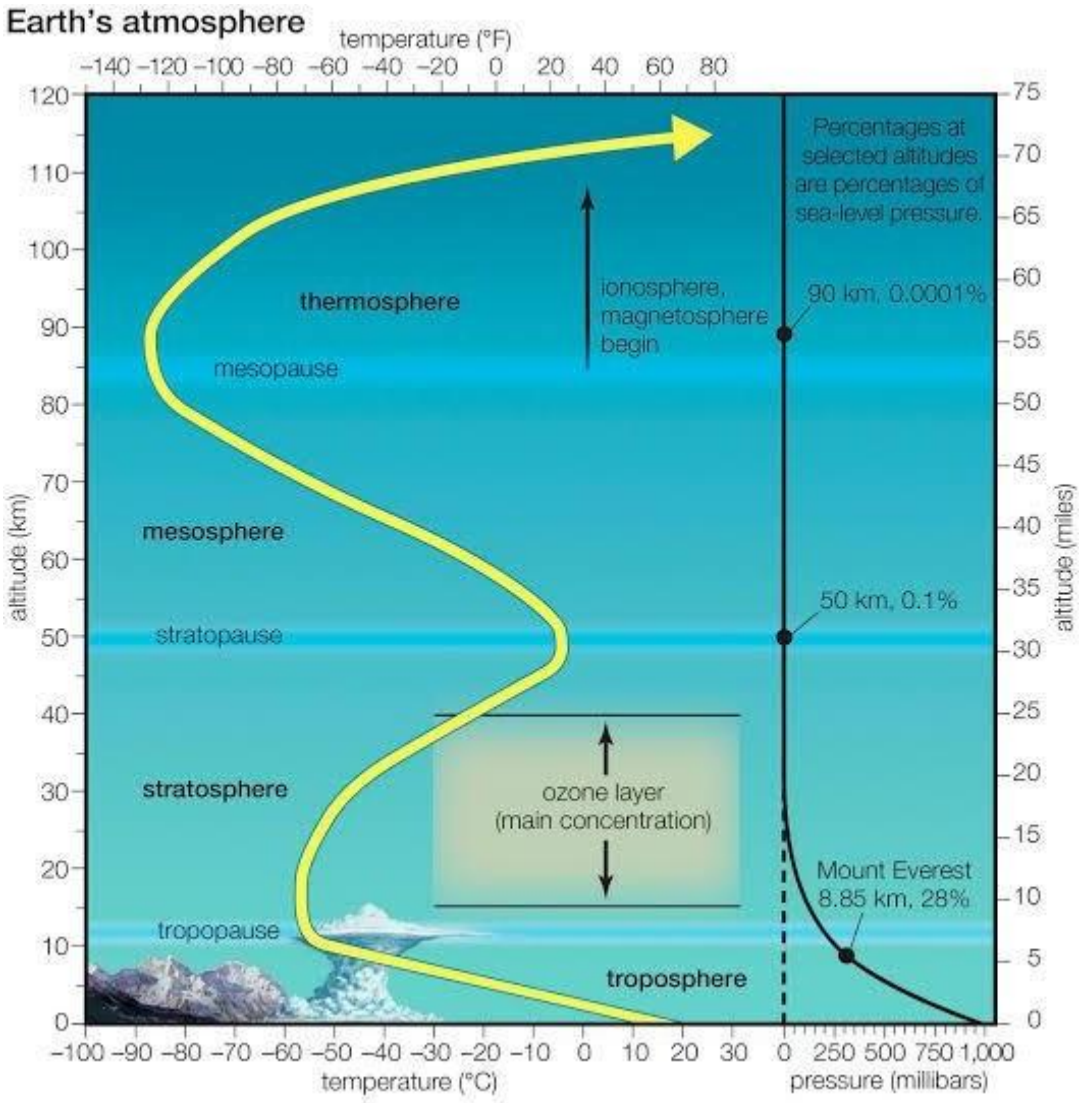

Figure: 1.2 Layers of Earth's Atmosphere

2. Hydrosphere

It covers more than **75 percent of the earth's surface** as oceans (salt water), rivers, sea, lakes, ponds, streams etc. Fresh water is also available in the form of rain, snow, dew etc. Evaporation of water from oceans and other water bodies forms cloud and precipitation,

are responsible for worldwide water supply through hydrological cycles. The life on the earth was first originated in water and water is essential for all living things.

3. Lithosphere

It is the mantle of rocks (inorganic material) that forms the **earth's crust** It consists of soil and the underlying rocks down up to the depth of **50 km**. The soil is most significant part of the lithosphere. Soil consists of minerals, water (ground water) and it supports crops, wild life and livestock. The soil supplies nutrients to plants and is one of the most important ecological factors called "**edaphic factor."**

4. Biosphere:

It is the domain of living organisms and their interaction with environment i.e. atmosphere, lithosphere and hydrosphere. It occupies the least volume of all spheres but it is responsible for flow of **matter and energy**. **Biosphere or ecosphere** is known as biochemical system capable of capturing, converting, storing and utilizing the sun's energy.

ECOLOGY

Ecology is a field of study concerned with the relationship between the **environment and living organisms**. It involves a reciprocal relationship between an organism and its environment. Today environmental science is recognized as indispensable tool for creating and maintaining the quality of human life. Consequently, ecology is becoming the branch of science that is most relevant to everyday life in nature. A proper understanding of the true nature of human's interactions with his surroundings would help plan and design a sustainable framework for resource mobilization, utilization and protection.

Definition of ecology: The word ecology is derived from two Greek words, **Oikos,** meaning 'house or home' and **logos** means 'study of'. Generally ecology is defined as the study of the relation of organism or group of organisms to their environment or surrounding. Ecology had emerged as distinct field of study during 19^{th} century. From then, number of definitions has been proposed for ecology from different authors.

- Ecology is the study of structure and function of the ecosystem **(Odum, 1969).**
- Ecology (Ockologie) is the study of organism in relations to their environment **(Warming, 1895).**
- Ecology is the science of community **(Clements, 1916).**

- Ecology is the science of all the relations to all organisms to all their environment **(Taylor, 1936).**
- Ecology is the scientific study of the interactions that determine the distributions and abundance of organisms **(Krebs, 1985).**

ECOSYSTEMS

Ecosystem is the basic functional unit in ecology. It includes both biotic (plants, animals & microbes) and non biotic (physico-chemical) environment. A.G.Tansley (1935) proposed the term **ecosystem.** He defined it as the system resulting from the integration of all the living and non-living factors of the environment. An ecosystem can be defined as the self-sustained community of plants and animals existing in its own environment.

The size and scale of an ecosystem can vary widely. The ecosystem may be a whole forest, a community of bacteria and algae in a drop of water, or even the geobiosphere itself. Different types of ecosystems are often separated by geographical barrier, like **lake or river, mountains, deserts, oceans** etc. As these separations are almost never rigid, ecosystem tend to blend into each other. As a result the entire earth can be seen as a single ecosystem, or a lake can be divided into several ecosystem depending on the scale used. All ecosystems therefore are contained with in the largest of all ecosystem called the **ecosphere**, which contains the whole physical earth, called the **geosphere** and all living components called the **biosphere.**

Types of Ecosystems

Ecosystem can be classified into major types Natural ecosystem and Artificial ecosystem.

1. **Natural ecosystems**: These are self-regulatory in nature and derive their energy from sun without any major interference by man. Natural ecosystems are of two types:
   - Terrestrial ecosystems like forest, grassland, desert, Mountain etc.
   - Aquatic ecosystems like river, stream, spring, lake, pond, sea, ocean, estuary etc.
2. **Artificial ecosystem**: These are not self regulated and depend on human intervention to meet their energy requirements.eg paddy fields, croplands etc.

Structure and function of an ecosystem

The two major aspects of ecosystem are structure and functions of ecosystem.

Structure of an ecosystem includes;

- The composition of biological community including species (plants, animals and microbes), numbers, biomass, life history, life cycle and distribution in space, etc
- The quantity, distribution and cycling of abiotic (non-living) materials, such as macro and micro nutrients, water, trace elements, etc.
- The range or gradient of conditions existing such as temperature, rainfall, light, wind, relative humidity etc.

Function of an ecosystem includes

- The rate of biological flow of energy i.e. production and respiration rates of the community.
- Rate of material or nutrient cycles, and
- Biological or ecological regulation, which includes both regulation of organism by environment and regulation of environment by organism.

Natural resources

Forest resources:

A forest is a highly complex, constantly changing environment made up of a variety of living (wild life, trees, shrubs, wildflowers, lichens, fungi, microscopic soil organisms) and non-living (water, nutrients, rocks, sunlight, air etc) things. Trees are the dominant components of this complex community.

Forests cover much of the planets land area. They are extremely important to humans and the natural world. For humans, they have many aesthetic, recreational, economic, historical, cultural and religious values. Timber and other products of forests are important economically both locally and as exports. Forests provide employment for those who harvest the wood or products of the living forest. Other non-wood forest products come in the form of medicinal compounds, dyes and fabrics. There are many people who are dependent on forests for their livelihoods. The forest environment provides a perfect opportunity for ecotourism which includes hiking, camping, bird watching and other outdoor adventures or nature study activities.

Benefits of forests:

1. Provides clean water: Trees intercept rain water and slows it down by aiding soil absorption for gradual release into streams at a slow and even rate. This effectively

prevents flooding, filters toxins and impurities and facilitates water availability in summer when it is most needed. Trees cleanse ground water as it filters through their root systems.

2. Provides home to unique plants and animals: Both urban and rural forests are home to a wealth of wildlife which depends on trees for survival. As forests are the natural home of diverse species of plants and animals, it becomes essential to protect our forests for the sake of them. There are possibilities that many herbs of potential medical treatments, cures and vaccines may lie undiscovered within the forests.
3. Source of economic growth: Timber production and other wood based industries still comprise an important part of economy of many countries. Paper production and other industries such as furniture making are also important to a nation's economy. Recreation based tourism provides enormous employment potential. Trees provide fruits, nuts, flowers and many other products of economic value.
4. Provides clean air: Trees help to cool and refresh the air we breathe. Not only do they moderate the air temperatures, but through photo synthesis, their leaves take in carbon dioxide and release oxygen for us to breath. Mature trees reflect our natural heritage. Each acre of forest absorbs 31.45 tons of carbon per year; it also filters out harmful pollutants and provides us with oxygen.
5. Provides recreational opportunities: The most important forest based recreational activities are hunting, camping, hiking, fishing, watching wildlife, horseback riding and plant collecting.

Ecological benefits:

1. Forests provide the clean air we breathe, help to maintain the clean water we depend upon and provide habitat for numerous species of life forms. Also forests are taking carbon dioxide out of the earth's atmosphere to produce wood and leaf matter. This is known as carbon sequestration. This is important because carbon dioxide is a leading greenhouse gas that can contribute to global climate change.
2. Mature trees improve our aesthetic environment, absorb noise, reduce stress and create a peaceful place to relax or socialize.
3. Trees provide positive mental benefits and healing qualities. Mature trees provide a sense of "Home" to a neighborhood.
4. Trees protect the soil against erosion and reduce the risk of landslides and avalanches.

5. Water from roots is drawn up to the leaves where it evaporates. The conversion from water to gas absorbs huge amounts of heat there by cooling hot air.

Deforestation: Deforestation refers to the loss of forest cover, land that is permanently converted from forest to agricultural land, golf courses, cattle pastures, homes, lakes or desert. The FAO (Food and Agriculture Organization) defines tropical deforestation as "change of forest with depletion of tree crown cover more than 90 percent." Depletion of forest tree crown cover less than 90 percent is considered forest degradation. Logging most often falls under the category of forest degradation and thus is not included in deforestation statistics Therefore forest degradation rates are considerably higher than deforestation rates.

The United Nations Conference on Environment and Development (UNCED) in 1992 defines deforestation as "land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities."

The clearing of forests across the Earth has been occurring on a large scale for many centuries. This process, generally known as deforestation, involves the cutting down, burning and damaging of forests. The loss of forest is more profound than merely destruction of beautiful areas. If the current rate of deforestation continues, the world's forests will vanish within the next 100 years causing unknown effects on global climate and eliminating the majority of plant and animal species on the planet.

Causes of deforestation: The causes of deforestation are very complex. A competitive global economy drives the need for money in economically weak developing countries. At the national level, governments sell timber to raise money for projects, to pay international debt or to develop industries. Many development institutions and politicians consider population explosion as another major factor causing forest destruction. Nobody can deny the serious global problem of population growth. However, the belief that this is the main cause of deforestation is used by many governments and business to imply that there is little or nothing they can do about the problem of forest destruction. The economic exploitation of poorer countries by world's industrialized nations causes much of the over exploitation of forest resources by populations without land or employment. The following are the major causes of deforestation around the world.

1. **Agriculture:** Deforestation occurs in many ways. Most of the clearing of forest around the world is done for agricultural purposes (grazing cattle, planting crops etc.). Poor

formers cut down small areas (typically a few acres) and burn the trees and proceed with agriculture. Intensive or modern agriculture destroys forest on a much larger scale, sometimes destroying several square kilometers at a time. Large cattle pastures often replace rain forest to grow cattle for the world market.

2. **Commercial logging:** Commercial logging, another common form of deforestation is cutting trees for sale as timber. Logging can occur selectively (only the economically valuable species are cut) or by clear cutting (all the trees are cut). Commercial logging employs heavy machinery, such as bulldozers to remove cut trees and build roads. These roads enable landless people to access to the interiors of the forest, which in turn results in further deforestation.
3. **The cash crop economy:** The cash crop economy is an integral part of Third World "development" and a major cause of deforestation. The best land is taken to earn export income, which is very often used to pay the foreign debt. Farmers are forced onto marginal lands, resulting in deforestation, land degradation and poverty.
4. **Mining and dams:** Mining, industrial development and hydroelectric schemes are also significant causes of deforestation, both in term of the land they occupy and their displacement of forest people. Dams also open previously inaccessible forest and damage downstream ecosystem.

Effects of deforestation: Since many people are dependent on the world's forests, deforestation will have many social, economic and ecological effects. Deforestation results in many negative consequences and the following are a list of social and economic effects of deforestation.

1. Fewer trees results an insecure future for forest workers.
2. Heavy rainfall and high sunlight quickly damage the topsoil in clearing of the tropical rainforests. In such circumstances, the forest will take much longer to regenerate and the land will not be suitable for agriculture use for quite some time.
3. Where forests are replanted, their replacement can mean a loss of quality.
4. Loss of future markets for ecotourism. The value of a forest is often higher when it is left standing than it could be when it is harvested.
5. Some indigenous peoples' way of life and survival are threatened by the loss of forests.

6. Often, the stakeholders associated with forest areas are not always consulted before clearcutting occurs. This has sometimes led violent confrontation and fueled bitter rivalries between area residents, the forest sectors and environmentalists.
7. Deforestation can cause the climate to become extreme in nature. The occurrence and strength of floods and droughts affecting the economy.
8. Forests store large amount of carbon. Deforestation leads to release of carbon when trees are cut or burnt which results in greenhouse effect.
9. The stress of environmental change may make some species more susceptible to the effects of insects, pollution, disease and fire.
10. Rising sea levels caused by global warming have the potential to threaten the locations of many major cities, much fertile agricultural land, purity of fresh water supplies.
11. The clearing of forest land results in increased erosion and land slides.
12. Soils from areas of reduced forest cover can fill reservoirs created by dams. Thus a dams' ability and future capacity to generate hydroelectricity and provide irrigation would be significantly reduced.
13. Forest plays a crucial role in the management of fisheries. Logging has directly and indirectly damaged grounds, blocked river channels, raised water temperatures and caused water levels in streams to fluctuate dangerously. Therefore, the removal of trees can reduce the viability of fish stocks in their watershed and downstream environments.

Environmental effects of deforestation:

The major environmental effects of deforestation are

1. **Destruction of biodiversity:** The World Wildlife Fund (WWF) defines biodiversity as "the wealth of life on earth, the millions of plants, animals and microorganisms, the genes they contain and the intricate ecosystems they build into the living environment." Forests are one of the most biologically diverse regions of the world. Over a million species of plants and animals are known to live in the forests and millions more are not classified. The unique environment of the forest allows for such biodiversity existing. The process of deforestation in various geographical regions is destroying this unique environment. Consequently, many animals and plants that live in forest face the prospect of extinction. The extinction of the plants and animals leads to diminished gene pool. The lack of biodiversity and a reduced planetary gene pool could have many unforeseen effects some of which could be fatal to the future of humanity. In addition

there are ethical, aesthetic and philosophical questions regarding mankind's responsibility for other life forms. This issue concerns more industrialized countries than it concerns lesser developed countries.

2. **Desiccation of previously moist forest soil:** The soil gets baked due to the exposure to the sun and the lack of sunshade by trees causes the moisture quickly evaporates into the atmosphere. Thus, previously moist soil becomes dry and cracked.
3. **Moist humid region changes to desert:** This is related to the desiccation of previously moist forest soil. Primarily because of the lack of moisture and the inability to keep moisture, soil that is exposed to the sun will dry and turn into desert sand. Even before that happens, when the soil becomes dry, dust storms become more frequent. At that point, the soil becomes useless.
4. **No recycling of water:** Moisture from the oceans fall as rain and the moisture is soon sent up to the atmosphere through the transpiration to fall again on forest areas. This cycle repeats several times to rain on all forest regions. With the disappearance of forest this process will stop.
5. **Less carbon dioxide and nitrogen exchange:** The forests are important in the carbon dioxide exchange process. They are second only to oceans as the most important "sink" for atmospheric carbon dioxide. Deforestation leads to nearly 10 percent of greenhouse gas emission. Green house gases are gases in the atmosphere that trap heat. Thus there is a global warming in which the average global temperature becomes progressively higher.
6. **Soil erosion:** Deforestation is known to contribute to increased run-off of rainfall and intensified soil erosion.

Solutions to the problems of deforestation: Deforestation is a serious problem, but humans can make a difference. The following actions could serve as effective solutions to the problem of deforestation.

1. Reduce the consumption of forest and related products.
2. Avoid harmful products by consumer boycotts, such as tropical rainforest wood, old-growth wood from the tropical rainforest.
3. Boycott products of companies involved in deforestation.
4. Compel government and industry to make changes in the forest policies.

5. Individuals may communicate their uncertainty about the future of the world's forests to politicians, corporate executives and non-governmental organizations through personal communication or in groups using petitions and rallies.
6. Environmental conservation may be given importance in school curricula.

Water resources:

The world's supply of fresh water is running out. The amount of water in the world is limited. Even though water covers about two-thirds of the Earth's surface, most of it is too salty for use. The United Nations Environmental programme (UNEP) reported water shortage as one of the two most worrying problems (the other one was global problem). The major factors worsening the present water crisis are

1. Growing population
2. Inefficient irrigation
3. Pollution

Agriculture sector is the major user of fresh water. Nearly 80% of the fresh water is used for the agricultural purposes. The remaining 20% is used for power generation, domestic and industrial uses. The major factors that affect the water crisis are inefficient irrigation, pollution of surface and ground water sources and the growing world population. Water on the earth is in cycling through the hydrological cycle. The utilization of water on the earth mainly depends on the movement of water. On the earth surface, in some places water may be available in excess than the normal. Some places may experience shortage or drought or flood, however, the total available quantity remain the same.

World's water resources: Water on the earth occurs in three forms viz., liquid, solid and vapour (gaseous). The world's total quantity of water is estimated to be about **1.36×10^8 million hectare meters (M ha-m).**

- About **97.2%** of this water is contained in the oceans as salt water.
- About **2.8%** is available as fresh water on the earth.
- Out of the **2.8%** of fresh water, around **2.2 %** is available as surface water and the rest (i.e. **0.6%**) is available as ground water.
- Out of the **2.2%** of available fresh water, around **2.15%** is in glaciers and icecaps.
- Out of the remaining **0.05%** of fresh water, **0.01%** is available in lakes and streams and the remaining **0.04%** is in other forms.

- In the 0.6% of stored ground water, only about **0.25%** can be extracted economically with the available drilling technology and the remaining is at greater depth of the earth's crust.
- Whatever the smallest quantity (0.01%) is precious and it has to be preserved for the present use and for the future generation.

Hydrological cycle:

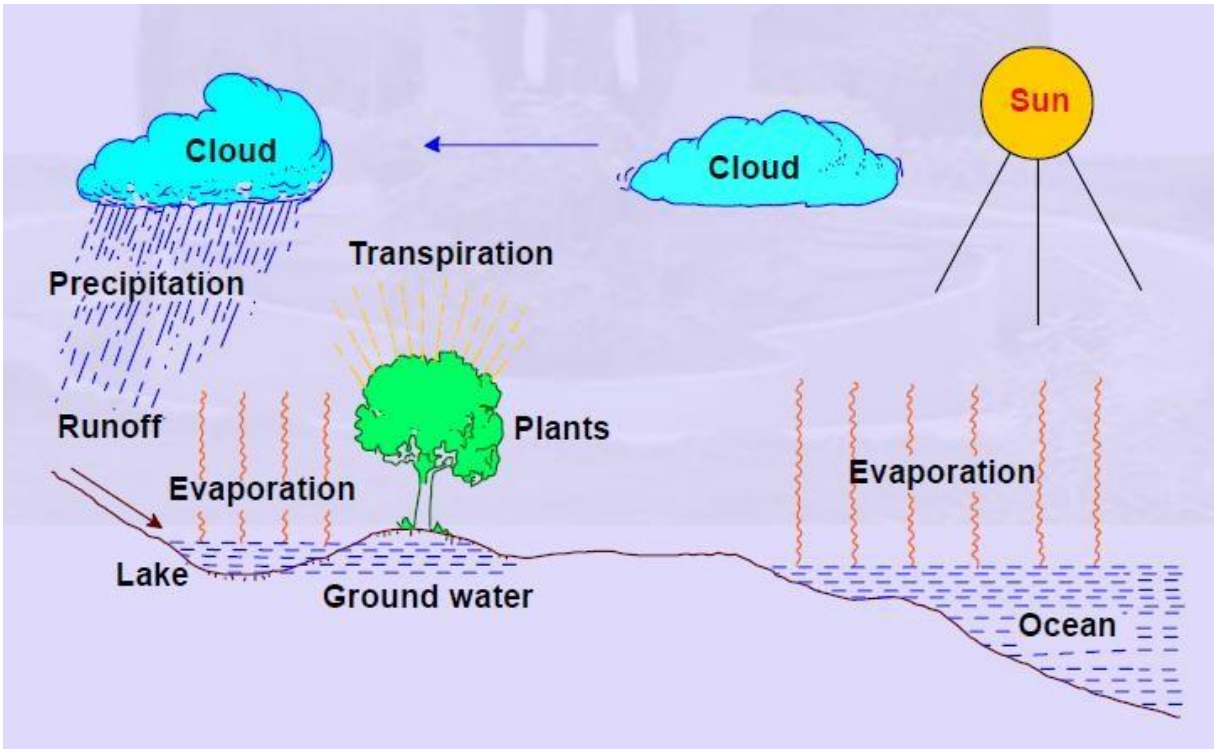

Figure: 1.3 A schematic representation of the hydrological cycle

The Hydrological cycle shown in figure 1.3 involves the movement of water in our environment. Water is the most important resource of our earth, which has made life possible on this planet. Water is made up of two basic elements, i.e. hydrogen and oxygen, H_2O being the chemical formula for water, representing that each molecule of this compound contains two hydrogen atoms and one oxygen atom. Billions of H_2O molecules combine loosely together, to form liquid water. This liquid water may freeze to form snow and ice. It may evaporate to an invisible vapour (gas) in which form, it circulates between the biotic and abiotic world, as well as between different segments of the abiotic component.

Hydrological cycle is the continuous transfer of water in the nature. The three important phases of the hydrological cycle are:

1. **Evaporation and evapotranspiration**
2. **Precipitation**
3. **Runoff.**

The planet Earth has one-third land and two-thirds water. Evaporation from the surface of oceans, lakes, ponds, reservoirs etc., and evapotranspiration from the surface vegetations (plants) take place. The water vapour moves upwards and forms clouds. Clouds condense and fall back to oceans and earth in the form of precipitation of different forms like rain, snow, mist, hail, sleet etc. A part of this precipitation may evaporate back to atmosphere during precipitation itself. A part of this precipitation flows over the ground surface called runoff and a part infiltrates in the soil and joins the ground water table. The surface runoff and a part of the ground water flow to the ocean. Again the evaporation starts from the lakes, ocean, ponds etc. and the cycle continues.

Among the three phases of hydrological cycle, the runoff phase is important because it is directly available as fresh water for the purposes of water supply, irrigation, power generation etc. This surface run off can be stored in dams and reservoirs for the non-rainy seasons.

Water requirement for human activities:

Water is required for the following

- **Domestic purposes**
- **Recreation (swimming, boating)**
- **Irrigating crops.**
- **Industrial processes**
- **Aquaculture**
- **Protection of aquatic ecosystems**
- **Wildlife habitats**
- **Scientific study and education**

Land resources:

Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated ground water reserve, the plants and animal populations, the human settlement pattern and physical results of past and present activity.

The quality of a soil is controlled by its properties like the structure of soil, type and size of soil particles, extent of voids (controlling its water holding capacity) which ultimately decides as to what kind of vegetation can grow effectively on the given soil under the given climatic conditions. In view of this reason, the quality of soil and maintaining it in good condition becomes extremely important since the fertility of the soil will decide the quantum of production of crops and other vegetations.

As a matter of fact, along with sunlight, air and water, a soil supports all living beings on Earth. All higher terrestrial plants and vegetations have their roots in the soil from which they absorb life sustaining water and nutrients. All animals including humans, in turn, depend on these plants for food either directly or indirectly. Foods, vegetable oils and fats, fiber, wood and various other indispensable agricultural products come from soils. To produce more, we not only need fertile soil but more of it. A nation's economic prosperity is thus closely related to the fertility and abundance of its soil resources. Hence the soil can be considered as one of the most precious resources of a country.

Land degradation: Land degradation can be considered as loss of actual or potential or utility as a result of natural or anthropogenic factors. It is the decline in land quality or reduction in its productivity. Mechanisms that initiate land degradation include physical, chemical and biological processes.

- Physical processes initiate decline in soil structure leading to crusting, compaction, erosion, and desertification.
- Chemical processes initiate acidification, leaching, decrease in cat-ion exchange capacity and fertility depletion.
- Biological processes initiate reduction in total and biomass carbon and decline in land biodiversity.

Soil erosion: Soil erosion is the washing or blowing away (by wind or water) of the top layer of soil. This is a serious problem for people who want to grow crops. Crops are the foods that farmers grow. If the soil has eroded, the crops will not grow very well. Soil erosion is a natural process. It becomes a problem when human activity causes it to occur much faster than under natural conditions.

Causes of soil erosion: Wind and water are the main agents of soil erosion. The amount of soil they can carry away is influenced by two related factors:

- Speed - the faster either moves, the more soil it can erode.
- Plant cover - plants protect the soil and in their absence wind and water can do much more damage.

Preventing soil erosion:

1. Use of contour ploughing and wind breaks.
2. Leaving grass strips between ploughed lands.
3. Making sure that there are always plants growing on the soil and that the soil is rich in humus (decaying plants and animals). This organic matter is the “glue” that binds the soil particles together and plays an important part in the prevention of erosion.
4. Avoiding overgrazing and over use of crop lands.
5. Allowing indigenous plants to grow along the river banks instead of ploughing and planting crops right up to the water edge.
6. Encouraging biological diversity by planting several different types of plants together.
7. Conservation of wetlands.

Soil conservation and its type: Soil conservation is a set of management strategies for prevention of soil being eroded from the Earth’s surface or becoming chemically altered by overuse, acidification, salinization or other chemical soil contamination. The various soil conservation practices are

1. **Planting Vegetation:** This is one of the most effective and cost saving strategies. This measure is among soil conservation technique used by farmers. By planting trees, grass, and plants, soil erosion can be greatly prevented. Plants help to stabilize the properties of soil, and trees act as a wind barrier and prevent soil from being blown away. This is also among strategies used for soil conservation in urban areas, one can plant trees and plants in the landscape areas of the residential places. The best choices for vegetation

are herbs, small trees, plants with wild flowers, and creepers which provide a ground cover.

2. **Contour Ploughing:** Contour farming or ploughing is used by farmers, wherein they plough across a slope and follow the elevation contour lines. This method prevents water run-off, and thus prevents soil erosion by allowing water to slowly penetrate the soil.
3. **Maintaining the Soil pH:** The measurement of soil's acidity or alkalinity is done by measuring the soil pH levels. Soil gets polluted due to the addition of basic or acidic pollutants which can be countered by maintaining the desirable pH of soil.
4. **Soil Organisms:** Without the activities performed by soil organisms, the organic material required by plants will litter and won't be available for plant growth. Using beneficial soil organisms like earthworms, helps in aeration of soil and makes the macro-nutrients available for the plants. Thus, the soil becomes more fertile and porous.
5. **Crop Rotation Practice:** Crop rotation is the soil conservation method where a series of different crops are planted one after the other in the same soil area. This method is used greatly in organic farming. It is done to prevent the accumulation of pathogens, which occur if the same plants are grown in the soil, and also depletion of nutrients.
6. **Watering the Soil:** We water plants and trees, but it is equally important to water soil to maintain its health. Soil erosion occurs if the soil is blown away by wind. By watering and settling the soil, one can prevent soil erosion from the blowing away of soil by wind. One of the effective soil conservation ways in India is the drip irrigation system which provides water to the soil without the water running-off.
7. **Salinity Management:** Excessive collection of salts in the soil has harmful effects on the metabolism of plants. Salinity can lead to death of the vegetation and thus cause soil erosion, which is why salinity management is important.
8. **Terracing:** Terracing is among one of the best soil conservation method, where cultivation is done on a terrace leveled section of land. In terracing, farming is done on a unique step like structure and the possibility of water running off is slowed down.
9. **Bordering from Indigenous Crops:** It is preferable to native plants, but when native plants are not planted then bordering the crops with indigenous crops is necessary. This helps to prevent soil erosion, and this measure is greatly opted in poor rural areas.

10. **No-tilling Farming Method:** The process of soil being plowed for farming is called tilling, wherein the fertilizer is mixed and the rows for plantation are created. However, this method leads to death of beneficial soil organisms, loss of organic matter and compaction of soil. Due to these side effects, the no-tilling strategy is used to conserve soil health.

Mineral resources in India

India is quite rich in minerals. Substances which are found in the rocks or are lying hidden under the ground are called minerals. These substances are mined out or pumped out of the earth. Mines are big holes dug out in the earth's surface to take out minerals. Sometimes these holes are quite big and long. Some /of the minerals like iron, copper, zinc, aluminium, gold and silver are metals while some others like coal, petroleum, lime stone and salt are non-metals. The metals are found in their crude form known as ores. The metals have to be obtained from their ores by melting or by other process.

Iron: Iron is the most important of all the minerals. It is used for making heavy machinery, railways, motor-cars, buses, bridges', buildings, agricultural impli-ments and many other articles of house-hold use. In fact all the progress made by man could not be possible with-out the use of iron and steel. Iron is found in the earth's surface in its crude form known as iron-ore. India has huge deposits of iron-ore in Bihar, Orissa, Madhya Pradesh, Karnataka and Maharashtra. We have one-fourth of the world's finest iron-ore deposits in India. Iron-ore is found in the mines at Singhbhum in Bihar and Mayurbhanj in Orissa. Steel is obtained by alloying iron with manganese. We have big steel plants at Jamshedpur, Bhilai, Bokaro, Durgapur, Rourkela and Bhadravati.

Coal: Coal is an equally important mineral. It is used for extracting iron and other metals from the ores. It is used as fuel and for generating thermal power. It is known as 'black diamond'. Products like nylon, chemicals, dyes, drugs and perfumes are obtained from the distillation of coal. Coal is found in Bihar, West Bengal, Damodar Valley, Orissa, Andhra Pradesh and Madhya Pradesh. Jharia in Bihar and Raniganj in West Bengal are the largest coal mines in India. Other coal mines are located at Suhagpur (Madhya Pradesh) Dhanbad (Bihar) Neyveli (Tamil Nadu) and Singarani (Andhra Pradesh).

Petroleum: It is also called mineral oil or crude oil. It is dark, thick liquid found at a great depth under the rocks or the sea bed. Sometimes gas is also found where petroleum is found. This gas is used as household fuel. A deep hole is made in the ground to take out petroleum. It is called drilling. Pipes are fitted in these holes to pump out petroleum. Then it is piped to the refineries for purification. We get petrol, diesel, kerosene oil, heavy oil, mobile oil, wax, vaseline, neptha and tar when petroleum is refined. Many other products as dyes, paints, drugs and chemicals are the bye-products of petroleum. Petroleum is known as 'black gold'. Petroleum is found at Digboi in Assam, Combo/, Ankaieshwar and Kalol in Gujarat and Bombay High off the shore of Bombay. The petroleum produced in India is not sufficient to meet our requirements. Petroleum refineries have been set up at many places in India.

Manganese: Manganese is used in the manufacture of steel. It is also used in chemicals and glass industries. India is one of the largest producers of manganese in the world. Some manganese is exported \o other countries. It is found in Orissa, Karnataka, Madhya Pradesh and Maharashtra.

Mica: It is a bad conductor of electricity. It is used as insulator in making electrical goods like radio sets and wireless sets. India is the largest producer of mica in the world. Its huge deposits are found in Gaya, Monghyr and Hazaribagh districts of Bihar. Mica is also found in large quantities in Andhra Pradesh and Rajasthan. A large quantity of mica is exported to other countries.

Aluminium: It is a light but hard metal. It is used for making household utensils, airplanes, ships, automobile bodies, electric wires and many other things. The ore from which aluminium is produced is known as bauxite. Huge deposits of bauxite are found in Bihar, Orissa, Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra.

Copper: It is a valuable metal. Being a good conductor of electricity, it is used for making electric wires and electrical appliances. It alloys with zinc to form brass and with tin to form bronze. It is also used for making household utensils. It occurs in small quantities in India. It is found at Khetri in Rajasthan. Some copper has been found in Andhra Pradesh, Uttar Pradesh and Tamil Nadu.

Gold: It is a very precious metal. It is used for making ornaments. It is the basis of international trade. Some gold is produced from the mines at Kolar and Hutti in Karnataka and Anantapuram in Andhra Pradesh.

Diamond: It is a precious stone. Diamonds are found in the mines at Panno in Madhya Pradesh. Mineral deposits in the earth are limited. We should use them carefully. We should not exhaust all of our resources un-thoughtfully. We should find some alternative to minerals.

Mining: Mining is the extraction of valuable minerals or other geological materials from the earth .Ores recovered by mining include metals, coal, oil shale, gemstones, limestone etc.

Adverse effects of mining: Mining on an industrial scale can produce environmental damages resulting from exploration and development, even long after the mine is closed. The exploratory phase generally causes the least impact, although drilling holes to determine the existence of deposits may involve transporting heavy equipments and building roads. Such activities can disturb the local habitat and increase access to otherwise remote areas of forests. The most significant impact occurs during the operational phases or after active operations have ceased. Following is the list of adverse impacts of mining.

1. Mining, especially open-pit mining, generates enormous quantities of waste. Water interacts with these wastes to generate contaminated fluids that can pollute soils, rivers and ground water. These fluids can be highly acidic and metal laden or highly alkaline and they often contain various forms of cyanide depending on the waste source. Acid mine drainage can occur when water and air come into contact with geologic material containing iron sulphide, as in abandoned waste piles. Such drainage can contaminate nearby streams and ground water for centuries after a mine is closed. The tendency to form acid mine drainage can be aggravated by high rainfall and high temperatures.
2. Erosion and sedimentation present another environmental issue for mine sites. When material is disturbed in significant quantities, as it is mining process, large quantities of sediment are transported by after erosion. The sediment eventually settles at some point downstream from the erosive source.
3. Damage to forest cover is smaller in scale and more localized for mining locations than for logging locations. However, both increase access to otherwise remote forest areas and provide an opportunity for further activities, especially in places where population pressure already exist.

4. Dust generated from mining activities can cause a serious cause of illness, generally in the form respiratory troubles. Dust can also deposit in surface water causing sedimentation and turbidity problems.
5. Mining activities consume enormous quantities of timber for their construction in the case of underground mines and as source of energy for mines with charcoal-fuelled casting ovens.
6. Noise is another major problem from mining operations. The deafening sound of the machinery used in mining and the blasting crate conditions that may become unbearable for the local population and the forest wildlife.
7. The large disturbances caused by mining can disrupt environments, adversely affecting aquatic habitats and terrestrial habitats.

Social damages of mining: As large scale mining creates new infrastructure and provides additional employment, permanents settlements can arise around these operations in areas that otherwise would have remained more sparsely inhabited. Mining comes along with its promise of wealth and jobs, but millions of people thought the whole world testify to the high social costs that it brings with it. The following is a list of the negative social impacts of mining.

1. Appropriation of the land belonging to the local communities.
2. Impacts of health.
3. Alteration of social relationships.
4. Destruction of forms of community subsistence and life.
5. Social disintegration.
6. Radical and abrupt changes in regional cultures.
7. Displacement of other present and/or future local economic activities.

Problems on Computation of average or mean rainfall over a basin:

1. Arithmetic average method:

$$P_{ave} = \frac{P_1 + P_2 \ldots + P_n}{n} = \frac{\sum P}{n}$$

Where P_1, P_2, P_3 … P_n etc., are the precipitation or rainfall values measured at n rain gauge stations.

2. Thiessen polygon method:

$$Pave = \frac{A_1P_1 + A_2P_2 \ldots + A_n}{P_n A_1 + A_2 \ldots + A_n} = \frac{\sum(AxP)}{\sum A}$$

Where A1, A_2, A_3 ….A_n are the area of Thiessen polygon.

3. Isohyetal method:

$$Pave = \frac{\left[\frac{P_1 + P_2}{2}\right]Ax + \left[\frac{P_{n-1} + P_n}{2}\right]A_{n-1} + \ldots\ldots}{A_1 + A_2 + \ldots + A_n}$$

Problem - 1: The rainfall values for the four sub-basins constituting a large river basin are 289, 334, 442 and 397 mm. The areas are 360, 275, 420 and 650 Km^2 respectively. Compute the depth of average rainfall for the basin as a whole by Arithmetic average method and Thiessen polygon method.

Solution: P_1 = 289mm, P_2 = 334mm, P_3 = 442mm and P_4 = 397mm.

$A_1 = 360Km^2$, $A_2 = 275Km^2$, $A_3 = 420Km^2$, $A_4 = 650Km^2$.

Arithmetic average method:

$$Pave = \frac{P_1 + P_2 + P_3 + P_4}{4} = \frac{289 + 334 + 442 + 397}{4} = \textbf{365.5 mm (Ans)}$$

Thiessen polygon method:

$$\underline{P}ave \quad \frac{A_1P_1 + A_2P_2 + A_3P_4 + A_4}{A_1 + A_2 + A_3 + A_4} = \frac{360x289 + 275x334 + 420x442 + 650x397}{360 + 275 + 420 + 650}$$

= **375.12mm (Ans)**

Problem - 2: Following table indicates the area in Km^2 between isohyets. Calculate the mean precipitation over the area.

Values of isohyets bounding the strip in cms	Area in Sq. Km
30 - 40	42.0
40 - 50	148.0
50 - 60	87.0
60 - 70	92.0
70 - 80	228.0
80 - 90	120.0
90 - 100	45.0

Solution:

$$P_{ave} = \frac{\left(\frac{P_1+P_2}{2}\right)A_1 + \left(\frac{P_2+P_3}{2}\right)A_2 + \left(\frac{P_3+P_4}{2}\right)A_3 + \left(\frac{P_4+P_5}{2}\right)A_4 + \left(\frac{P_5+P_6}{2}\right)A_5 + \left(\frac{P_6+P_7}{2}\right)A_6 + \left(\frac{P_7+P_8}{2}\right)A_7}{A_1+A_2+A_3+A_4+A_5+A_6+A_7}$$

$$= \frac{\left(\frac{30+40}{2}\right)42 + \left(\frac{40+50}{2}\right)148 + \left(\frac{50+60}{2}\right)87 + \left(\frac{60+70}{2}\right)92 + \left(\frac{70+80}{2}\right)228 + \left(\frac{80+90}{2}\right)120 + \left(\frac{90+100}{2}\right)45}{42+148+87+92+228+120+45}$$

P_{ave} = **66.23cms (Ans)**

Problem - 3: A watershed has five rain gauges installed in the area the annual rainfall recorded for one year is as follows. Determine optimum number of rain gauges assuming 10% error in estimation of mean rainfall.

Rain gauge station	1	2	3	4	5
Annual rainfall in cm	125	95	175	110	90

Solution:

1) Calculate the mean average annual rainfall i.e.

$\bar{P} = \frac{\sum P}{n}$ where n = existing number of rain guage stations.

$\bar{P} = \frac{\quad}{\quad} = \quad$

P = = = 119 cm

2) Calculate the mean of squares i.e.

$$\overline{P}^2 = \frac{\sum(P^2)}{n} = \frac{\text{———————————}}{\text{———}} = 15095\ cm^2$$

3) Calculate the standard deviation i.e.

$$\sigma = \sqrt{\frac{n}{n-1}\left[\overline{P^2} - \left(\overline{P}\right)^2\right]} = \sqrt{\frac{5}{5-1}(15095 - 119^2)} = 34.16$$

4) Calculate the coefficient of variation i.e.

$$Cv = \frac{100\sigma}{\overline{P}} = (100 \times 34.16)/\ 119 = 28.71$$

5) Optimum number of rain gauges (N) is given by

$$N = \left(\frac{Cv}{E}\right)^2 = \left(\frac{28.71}{10}\right)^2 = 8.24 = 8 \textbf{ Nos. Ans}$$

6) Additional rain gauges required to be installed = N – n = 8 - 5 = **3 Nos. Ans**

Problem - 4: basin (catchment area) consisting of different type of surfaces measures 500 hectares. An average rainfall of 5 cm was received in 24 hours. Calculate the resulting total runoff from the basin for the following data.

Sl. No.	Type of area	% of area	Co-efficient of runoff (I)
1	Wooded area	20	0.2
2	Road surface	25	0.8
3	Grass/Garden	15	0.5
4	Roof top	40	0.9

Note: Co-efficient of runoff 0.7 means 0.7 times the volume of rainwater generated over an area will be produced as runoff and remaining 0.3 times the volume will be lost in the form of infiltration, evaporation and other losses.

Solution:

Basin consists of different types of surfaces and the coefficient of runoff (I) varies with the type of area.

To find the weighted co-efficient runoff

$I_{Average} = (A_1I_1+A_2I_2+.....+A_nI_n)/A$

$\sum A_i I_i$

$$= \frac{\qquad}{A}$$

To calculate the area of different surfaces

Wooded area	——	= 100 ha
Road surfaces	——	= 125 ha
Grass area	——	= 75 ha
Roof top	——	= 200 ha

Volume of runoff = Area x Rainfall x I_{Avg}

= 500 x 10^4 x (5/100) x 0.675

= 1,68,750 m^3/day

= 1,68,758 x 10^3 L/day

= (168758 x 10^3)/10^6 ML/day

Question Bank:

1. With the help of a neat sketch, explain the flow of matter among the various components of the environment.
2. List the major urban environmental issues in India
3. Explain the components of environment and their major interactions
4. Explain the impact of urbanization on the environment.
5. Explain the causes, effects and management options for the various urban environmental issues.
6. List the effects of deforestation.
7. List the possible social impacts of mining on local communities
8. Write a short note on the mineral resources of India.
9. Differentiate between renewable, non-renewable and sustainable sources of energy with examples.
10. Enumerate the methods of prevention of soil erosion.
11. What are the key benefits of intact forests?
12. What are the ecological benefits of forests?
13. Explain the common causes of deforestation around the world.
14. Explain the environmental impacts of deforestation.
15. “Environmental damages caused by mining last long after the mine has closed.” Explain.
16. List the major arguments cited against the construction of dams.
17. Hydroelectric power is generally considered as clean energy. However, what are the problems related with dams make you doubtful about it?