UNIT-2

Natural Resources: *Introduction, Classification.*
Water Resources; *Availability, sources and Quality Aspects, Water Borne and Water Induced Diseases, Fluoride and arsenic Problems in Drinking Water.*
Mineral Resources; *Material Cycles; Carbon, Nitrogen and Sulfur cycles.*
Energy Resources; *Conventional and Non conventional Sources of Energy.*
Forest Resources; *Availability, Depletion of Forests, Environment impact of forest depletion on society.*

Natural Resources

Any natural substance that occurs in nature and is used by humans for survival can be considered a natural resource. Natural resources include oil, coal, natural gas, metals, stone, and sand. Other natural resources from nature are air, sunlight, soil, and water.

Types of Natural Resources

Natural resources are of two types:
1. Renewable Resources or Exhaustible Resources: Renewable resources are substances available in large amounts in nature. These resources are infinite and can be repeatedly used—for example, water, air, sunlight, etc.
2. Non-Renewable Resources or Inexhaustible Resources: These resources are also available in nature but are limited. They may end after continuous usage—for example, oil and natural gas, minerals, coal, etc.

Management of Natural Resources: Renewable and Non-Renewable

The difference between renewable and non-renewable resources are mentioned below:

Basis of Classification	**Renewable Resources**	**Non-Renewable Resources**
Definition	These resources are naturally available in large amounts and can be used again and again.	These resources are available in limited amounts so cannot be used again and again.
Depletion	These resources can never be exhausted.	These are energy resources and will be depleted
Environmental Impact	They have low carbon emissions, so they are environmentally friendly.	They have high carbon emissions and can harm t
Cost	These resources have a very low cost.	These resources have a high cost.
Area Requirements	A large area is required for the installation of its power plant.	A small area is required for the installation of its power plant.
Sources	Examples: Solar energy, Tidal energy, and Wind energy.	Examples: Coal, Oil and natural gas, and Minerals.

Water Resources: Quantity and Quality

Water pollution, together with loss of biodiversity, climate change, energy and socioeconomic issues, is one of the main threats and challenges humanity faces today. Human activities and human-related substances and wastes introduced into rivers, lakes, groundwater aquifers and the oceans modify the environmental water quality and make huge quantities of water unsuitable for various uses. This is the case not only for human-related uses such as drinking, bathing, agricultural irrigation and industrial production but also for terrestrial and aquatic ecosystems for which clean, fresh water is a prerequisite for life. Water pollution is a serious problem for human health and the environment.

Water Resources

The total volume of water on Earth is estimated at 1360 million cubic kilometers or

This number was derived from a long-term assessment of the average amount of water stored in the hydrosphere, that is, that part of the Earth covered by water and ice, the atmosphere and the biosphere (all living organisms on Earth). About 70% of the Earths surface is covered by oceans. The salt water in the seas and oceans represents97%of the total water on Earth, the remaining 3% being fresh water.

Freshwater is distributed in different components (glaciers, rivers, lakes, groundwater, atmosphere and biosphere) as shown in Table. From this table it can be seen that the greatest part (68.7%) of total freshwater is trapped in polar glaciers and ice sheets, and is therefore not directly accessible for use. Only 0.3% of the freshwater on

Table 1.1 Distribution of freshwater on Earth.

Source of freshwater (estimate)	Percentage of the total freshwater
Glaciers and permanent snow cover	68.7%
Groundwater	30.1%
Freshwater lakes	0.26%
Rivers	0.006%
Atmosphere	0.004%
Biosphere	0.003%

Earth is surface water, in the form of lakes (87%) and rivers (2%). Water exists in three states: liquid, solid (ice and snow) and gas (water vapour). Due to the energy supplied by the sun, water is permanently being transformed from one state to another, and is in constant motion between oceans, land, atmosphere and biosphere. water in motion constitutes the hydrologic cycle through the following hydrological processes, which take place in a permanent manner.

Over Exploitation of Fresh Water Resources

Due to population explosion the demand of water has been increased which resulted in over exploitation of fresh water resources.

Overexploitation of fresh water resources has resulted in many serious problems which directly affect the present and future need of the people. Some of the consequences are:

1. Lowering of water Table:

With the increasing population and demand for dry land area is also increased. There is large exploitation of underground water due to which water table is lowering down day after day. This problem can become major threat for future agriculture because of reduced water supply in future.

2. Water Logging:

One of the consequences of excessive irrigation in certain areas is that it can raise the water table. Salts which are found in rocks when come in contact with these water, it moves up when evaporation takes place in upper soil layer, so it results in salinity in the soil. Excessive irrigation also leads to water logging.

3. Sinking of ground water:

If more ground water is withdrawn then their recharging rate, the sediments in the aquifers get compacted, this phenomena is known as ground subsidence. This sinking could results in huge economic loses like structure damage in high building, fractures in pipes etc.

4. Saltwater intrusion

Saltwater intrusion is the movement of saline water into freshwater aquifers, which can lead to groundwater quality degradation, including drinking water sources, and other consequences. Saltwater intrusion can naturally occur in coastal aquifers, owing to the hydraulic connection between groundwater and seawater. Because saline water has a higher mineral content than freshwater, it is denser and has a higher water pressure. As a result, saltwater can push inland beneath the freshwater.

Water conservation methods

1. **Make effective use of soil water reserves**
   Planting deeper rooting crops, such as grasses or cereals that will leverage soil water reserves more effectively than shallower rooting crops such as vegetable crops and therefore can be grown in drier period.
2. **Take measures to avoid run off**

control water movement over the soil surface, dispose safely of the excess rainfall as runoff or concentrate inadequate rainfall runoff. Remedial measures such as incorporating plantings especially in areas where runoff collects protecting trees that help absorb and filter runoff, choosing permeable materials for pathways etc. can potentially contribute to reduce run off.

3. **Use rainwater effectively**
   Using rain water conservation methods like RAINWATER HARVESTING
4. **Rational Use of Groundwater**
5. **Protection of Water from Pollution**
6. **Traditional Water Conservation Methods**

a) Bamboo Drip Irrigation System

Bamboo is too expensive to use for a **low- cost building**, but is a boon for people of Meghalaya. Because, they have been leveraging it for water conservation methods in India. This system of water conservation is a brilliant drip irrigation system. It uses bamboo of various sizes and reduces the output to 20-80 drops per minute, which is excellent for betel leaf and black pepper crops.

b) Johads

Johad is a crescent shaped small check dam built from earth and rock to intercept and conserve rainwater in Rajasthan. This helps to improve percolation and increases groundwater recharge.

c) Kul

Kuls are diversion channels that carry water from a glacier to village. Often spanning long distances, with some over 10 km long, kuls have been around for centuries. They are the lifeline of people of Spiti valley of Himachal Pradesh and in Jammu too.

d) Eri

One of the oldest water conservation systems in India of Tamil Nadu is still widely used around the State. With over a third of irrigation in the State being made possible due to Eri, the traditional water harvesting system plays an important part in the agriculture. They also have other advantages such as prevention of soil erosion, recharge of groundwater, and flood control.

e) Zabo

This method of conservation of water in India is a unique combination with animal care, forests and agriculture. Mostly practised in Nagaland, Zabo is used to deal with a lack of drinking water supply. During monsoon, rainwater that falls on the hilltops is collected into the pond like structures that are carved out on the hillsides. The water is then passed onto cattle yards below from where the water enters the paddy fields rich in manure.

See, such still in use water conservation model that tells the beautiful story of water use and conservation doesn't have copyright and patent problems. It's open to the whole world. So why can't we be inspired by them and use suitable conservation method of water in our own lives?

8. Use of Modern Irrigation Methods

On average, 80 percent of the fresh water withdrawn from rivers and groundwater is used to produce food and other agricultural products. Therefore, we need to pay attention to improved methods of irrigation such as sprinkler and drip irrigation that save 50 per cent water.

In the drip irrigation method, the hole pipes are spread over the surface of the soil so that the crop receives water directly. There is no loss due to evaporation and approximately 95% water is used. This process therefore uses maximum water.

9. Increasing Forest Cover

According to recent reports, forests cover 31 percent of the world's land surface, just over 4 billion hectares which is down from the pre-industrial area of 5.9 billion hectare. This needs to be addressed since trees bear drought conditions for a long duration as compared to crops and they are helpful in reducing the demand for water along with recharging water sources.

10. Flood Management

11. Reuse of Urban Waste

Water Quality

Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks. This is particularly the case in health care facilities where both patients and staff are placed at additional risk of infection and disease when water, sanitation and hygiene services are lacking. Globally, 15% of patients develop an infection during a hospital stay, with the proportion much greater in low-income countries.

- Over 2 billion people live in water-stressed countries, which is expected to be exacerbated in some regions as result of climate change and population growth.
- Globally, at least 2 billion people use a drinking water source contaminated with faeces. Microbial contamination of drinking-water as a result of contamination with faeces poses the greatest risk to drinking-water safety.
- While the most important chemical risks in drinking water arise from arsenic, fluoride or nitrate, emerging contaminants such as pharmaceuticals, pesticides, per- and polyfluoroalkyl substances (PFASs) and microplastics generate public concern.
- Safe and sufficient water facilitates the practice of hygiene, which is a key measure to prevent not only diarrhoeal diseases, but acute respiratory infections and numerous neglected tropical diseases.

- Microbiologically contaminated drinking water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio and is estimated to cause 485 000 diarrhoeal deaths each year.
- In 2020, 74% of the global population (5.8 billion people) used a safely managed drinking-water service – that is, one located on premises, available when needed, and free from contamination.

Water borne Diseases:

Waterborne diseases are caused by pathogenic microorganisms which are directly transmitted when contaminated fresh water is consumed. Contaminated fresh water, used in the preparation of food, can be the source of food borne disease through consumption of the same microorganisms. Waterborne disease can be caused by protozoa, viruses, or bacteria, many of which are intestinal parasites.

Water induced or water related diseases

Water-related diseases occur due to the intake of dirty or contaminated water which can cause various diseases

Causes

Many of the water-related illnesses arise due to lack of adequate clean water for drinking and cooking purposes. Other diseases are caused due to inadequate sanitation facilities and poor personal hygiene practices that are directly connected to the lack of clean water.

- Water-washed diseases

Water-washed diseases are caused by poor personal hygiene that results from an inadequate supply of clean water. Typical water-washed diseases include shigella, which is a skin infection and scabies & trachoma, which are eye infections and highly contagious.

- Water-related insect vectors diseases

These diseases are spread by insects which form habitats on stagnant water sources. For this reason, the diseases they cause aren't as related to water as those more directly transmitted by water.

Some water-related insect vector diseases include malaria, filariasis, yellow fever, and river blindness. The most common of these, Malaria, is transmitted through the mosquitos which breed on fresh or brackish water.

Malaria is one of the greatest killers in all of human history.

- Diseases caused by defective sanitation

Some diseases caused by defective sanitation practices. Hookworm is contracted by contact with contaminated soil which has a huge mass of human feces. Hookworm larvae penetrate human skin to reach out to the small intestine, where it breeds and grows in number.

This disease causes itching, rashes, diarrhea, and cramps. However, for children, pregnant women and those who are malnourished, it can cause anemia, protein deficiency, and retarded growth.

Fluoride and arsenic Problems in Drinking Water

An estimated 300 million people worldwide use drinking water contaminated with arsenic or fluoride. These trace elements are natural (geogenic) contaminants, leached into groundwater from rocks and sediments. Depending on the geological conditions, they may occur in concentrations which pose a risk to human health. The guideline values specified by the World Health Organization are 10 micrograms per litre for arsenic and 1.5 micrograms per litre for fluoride.

In India, high Fluoride concentrations in groundwater (greater than 1 mg/l – milligrams per litre) are widespread in the arid to semi-arid western states of Rajasthan and Gujarat and in the southern states of Andhra Pradesh, Karnataka and Tamil Nadu.

However, continuing consumption of higher concentrations can cause dental fluorosis and in extreme cases even skeletal fluorosis.

Effect of arsenic

Non-cancer effects can include thickening and discoloration of the skin, stomach pain, nausea, vomiting; diarrhea; numbness in hands and feet; partial paralysis; and blindness. Arsenic has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate.

Common methods

The common methods used for the removal of fluoride from drinking water are divided in the following four categories:

- precipitation;
- adsorption and ion-exchange;
- membrane filtration processes;
- distillation.

Precipitation

Precipitation processes involve addition of chemicals and formation of fluoride precipitates. Among these are precipitations with calcium and aluminium salts. Precipitation chemicals must be added daily in batches and precipitation techniques produce a certain amount of sludge every day.

Adsorption and ion-exchange

Adsorption processes involve the passage of water through a contact bed where fluoride is removed by ion exchange or surface chemical reaction with the solid bed matrix. After a period of operation, a saturated column must be refilled or regenerated. The different adsorbents used for fluoride removal include activated alumina, carbon, bone charcoal and synthetic ion exchange resins.

Membrane filtration process

Reverse osmosis and electrodialysis are two membrane filtration processes which can be used for removal of fluoride.

Distillation

Distillation units can also be used for treating the drinking water.

Mineral Resource

Minerals are essential for the formation and functioning of organisms, plant animals and human beings. In the modern era, human life needs variety of minerals to sustain industry based civilization. Mineral resources are broadly defined as elements, chemical compounds, and mixtures which are extracted to manufacture sustainable commodity. India has rich mineral resource base to provide suitable base for industrial development in the country. Sufficient reserve of nuclear energy minerals is available in India.

India's reserves, as well as production are adequate in petroleum, ores of copper, lead, zinc, tin, graphite, mercury, tungsten, and in the minerals required for fertilizer industry such as sulphur, potassium and phosphorus.

Exploitation of Minerals

Depending on their use, mineral resources can be divided into several broad categories such as elements for metal production and technology, building materials, minerals for the chemical industry and minerals for agriculture. When usually we think about mineral resources we often think of metals but the predominant mineral resources are not metallic. The picture of annual world consumption of some elements is as under:

Sodium and iron are used at a rate of about 0.1 to 1.0 billion metric tons per year.

Nitrogen, sulphur, potassium and calcium are primarily used as fertilizers at a rate of about 10 to 100 million metric tons per year.

Zinc, copper, aluminium and lead are used at a rate of about 3 to 10 million metric tons per year;

Gold and silver are used at a rate of about 10 thousand metric tons per year.

Out of all the metallic minerals, iron consumption is 95% of the metals consumed

Thus, with the exception of iron, the non-metallic minerals are consumed at much greater rates than the elements used for their metallic properties.

Uses of Minerals

Due to increased population, there is increased demand of minerals by the industry, transport, agriculture and defence preparation. Depletion of almost all known and easily accessible deposits is

anticipated in near future. Moreover, there may be shortage of some crucial elements such as mercury, tin, copper, gold, silver and platinum. The limited resource of phosphorus, which is an essential component of chemical fertilizers, is another area of concern.

Environmental Impacts of Mineral Extraction

Extracting and use of mineral resources can affect the environment adversely. Environmental affect may depend on factors such as mining procedures, ore quality, climate, size of operation, topography, etc. Some of major environmental impacts of mining and processing operations are as under

1. Degradation of land.

2. Pollution of surfaces and ground water resources.

3. Effect on growth of vegetation due to leaching out effect of minerals.

4. Surface water pollution and groundwater contamination lead to occupational health hazards etc.

5. Air pollution due to emission of gases.

6. Deforestation affects flora and fauna.

7. Rehabilitation of affected population.

Conservation of Minerals

Conservation of minerals can be done in number of ways and these are as follows, Industries can reduce waste by using more efficient mining and processing methods. In some cases, industries can substitute plentiful materials for scarce ones. Some mineral products can be recycled. Aluminum cans are commonly recycled. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminum products does not require the large amounts of electric power needed to refine bauxite.

Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled.

Strict laws should be made and enforced to ensure efficient management of mining resources.

Case Study

Ara villi mountains which covers about 10% of geographical area is rich source of minerals wealth .This mountain range play important role in control of climate and act as mini water shed. On the request of environmentalist, Honourable Supreme Court has passed the order to stop these mines in Rajasthan

Marble mining near Rajsamant Lake has lead to drying up of lake. Marble mining was stopped on December 2002. Recently, mining in Goa has attained the attention of the press and media and ultimately government has to take the decision to stop this mining.

Nutrient Cycling

The nutrient cycle is a concept that describes how nutrients move from the physical environment to the living organisms, and subsequently recycled back to the physical environment. This movement of

nutrients from the environment into plants and animals and again back to the environment is essential for life and it is the vital function of the ecology of any region. In any particular environment, to maintain its organism in a sustained manner, the nutrient cycle must be kept balanced and stable.Nutrient cycling is typically studied in terms of specific nutrients, with each nutrient in an environment having its own particular pattern of cycling. Among the most important nutrient cycles are the carbon nutrient cycle and the nitrogen nutrient cycle. Both of these cycles make up an essential part of the overall soil nutrient cycle. There are many other nutrient cycles that are important in ecology, including a large number of trace mineral nutrient cycles.

Carbon Cycle

Carbon cycle is the process where carbon compounds are interchanged among the biosphere, geosphere, pedosphere, hydrosphere, and atmosphere of the earth.

Carbon Cycle Steps

Following are the major steps involved in the process of the carbon cycle:

1. Carbon present in the atmosphere is absorbed by plants for photosynthesis.
2. These plants are then consumed by animals and carbon gets bioaccumulated into their bodies.
3. These animals and plants eventually die, and upon decomposing, carbon is released back into the atmosphere.
4. Some of the carbon that is not released back into the atmosphere eventually become fossil fuels.
5. These fossil fuels are then used for man-made activities, which pump more carbon back into the atmosphere.

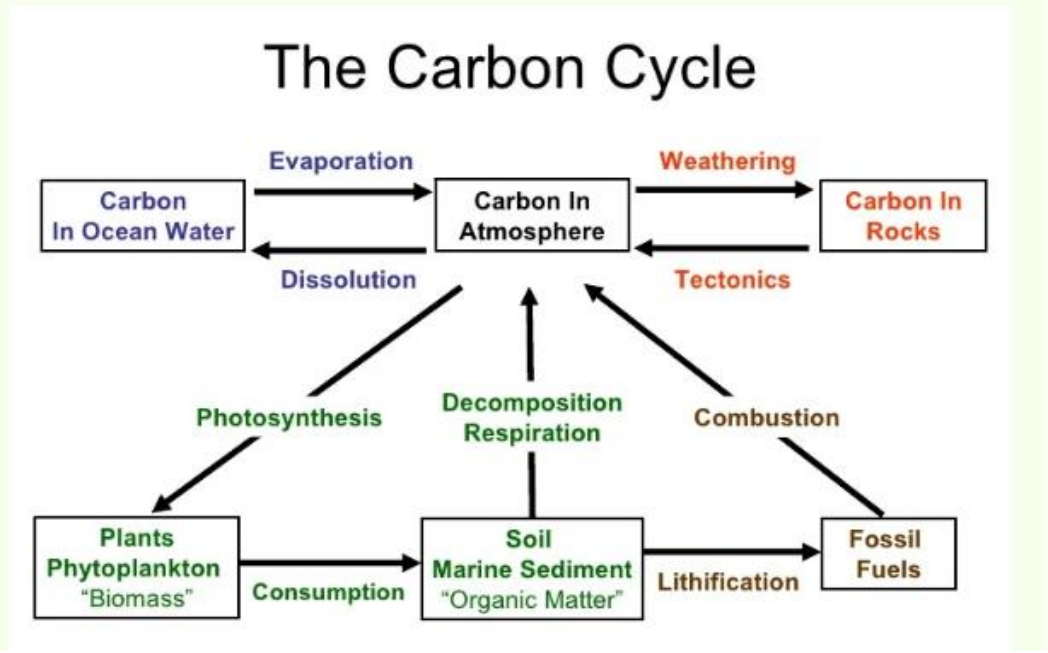
Carbon Cycle on Land

Carbon in the atmosphere is present in the form of carbon dioxide. Carbon enters the atmosphere through natural processes such as respiration and industrial applications such as burning fossil fuels. The process of photosynthesis involves the absorption of CO_2 by plants to produce carbohydrates. The equation is as follows:

$CO_2 + H_2O +$ energy $\rightarrow (CH_2O)n + O_2$

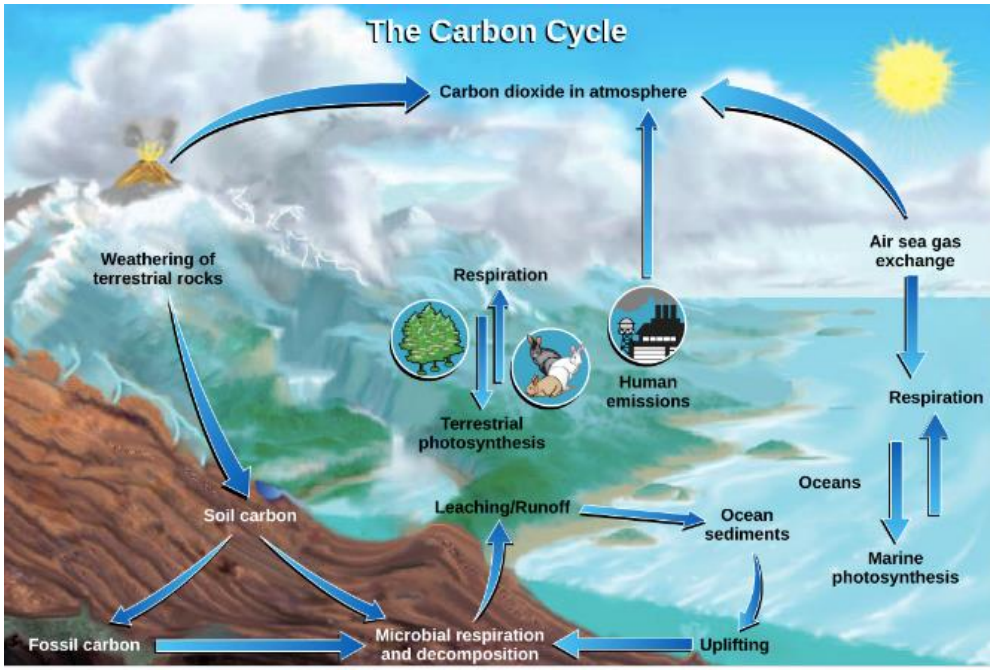
Carbon compounds are passed along the food chain from the producers to consumers. The majority of the carbon exists in the body in the form of carbon dioxide through respiration. The role of decomposers is to eat the dead organism and return the carbon from their body back into the atmosphere. The equation for this process is:

$(CH_2O)n + O_2 \rightarrow CO_2 + H_2O$



Oceanic Carbon Cycle

This is essentially a carbon cycle but in the sea. Ecologically, oceans take in more carbon than it gives out. Hence, it is called a "carbon sink." Marine animals convert carbon to calcium carbonate and this forms the raw building materials require to create hard shells, similar to the ones found in clams and oysters.



When organisms with calcium carbonate shells die, their body decomposes, leaving behind their hard shells. These accumulate on the seafloor and are eventually broken down by the waves and compacted under enormous pressure, forming limestone.

When these limestone rocks are exposed to air, they get weathered and the carbon is released back into the atmosphere as carbon dioxide.

Importance of Carbon Cycle

Even though carbon dioxide is found in small traces in the atmosphere, it plays a vital role in balancing the energy and traps the long-wave radiations from the sun. Therefore, it acts like a blanket over the planet. If the carbon cycle is disturbed it will result in serious consequences such as climatic changes and global warming.

Carbon is an integral component of every life form on earth. From proteins and lipids to even our DNA. Furthermore, all known life on earth is based on carbon. Hence, the carbon cycle, along with the nitrogen cycle and oxygen cycle, plays a vital role in the existence of life on earth.

NITROGEN CYCLE

Nitrogen Cycle: It is a complex cycle occurs in nature through various steps. About 79% of the atmospheric air is Nitrogen. It enters to the biotic world and got assimilate then again goes back to the atmosphere. Following steps are involved for the completion of Nitrogen cycle A. *Nitrogen enters to the living organisms*: Pure nitrogen gas cannot be used by the green plants. Only Nitrate & Ammonium forms of Nitrogen can be utilized by them. Thus, nitrogen gas first fixed into Nitrous Oxides, Nitric Oxides and Ammonium in the nature. The production of nitrates from nitrogen is called nitrification. Production of ammonia is called ammonification.

1**. Nitrification**: It can be done both by non-biological (physical) and biological way.

i) Non- Biological fixation of Nitrogen or Nitrification: During lightening, nitrogen gets combined with the oxygen in nature as this reaction needs a high amount of energy.

ii) Artificially nitrogenous compounds also get produced in industries. They are the chemical fertilizers. Farmers use these fertilizers to enhance the yield of the crops and soil fertility.

iii) Biological Nitrogen Fixation: As name indicates biological nitrogen fixation is carried out by the living organisms known as nitrogen fixing organisms.

Ex. Blue-green algae, Bacteria, Fungi etc.

Biological Nitrogen Fixation are of two types.

i) **Non-Symbiotic Nitrogen Fixation**: It is carried out by organisms, who live freely in the soil or water.

Ex. *Azobacter, Anabaena, Nostoc* etc.

ii) Symbiotic Nitrogen Fixation: Some microorganisms live inside the root nodules of different plants in a symbiotic association. They have the capacity to fix atmospheric nitrogen. This process is called symbiotic nitrogen fixation. In the roots of the higher plants, primarily in legumes (beans, peas, soybeans), the nitrogen fixing organisms form nodules, multiply inside these nodules and carry out the process of nitrogen fixation.

Ex. Bacteria, *Rhizobium* etc.

The nitrogen gas from the atmosphere gets converted into Ammonia (NH_3) which in then converted into amino acids. Amino acids are the building blocks of nucleic acids (DNA and RNA). Due to the symbiotic association legumes are regarded as a good biofertilizer for other crops which in turn reduces the

use of chemical fertilizer in the crop fields. Without root nodules also some symbiotic association are there for nitrogen fixation in the nature.

Example:(i) *Anabaena – Azolla* association

(ii) *Cycas* Coralloid roots etc.

B) **Ammonification:** Ammonification is an important step in the nitrogen cycle. It is the process of production of ammonia (NH_3) or ammonium (NH_4) compounds from the decomposition action of bacteria on organic matter. Thus, on the death and decay of the plants as well as animals the complex organic compounds are

released into the soil where they are again decomposed into simpler compounds by the microorganisms and release energy.

Examples of bacteria – *Nitrosomonas* bacteria, *Nitrosococcus* bacteria

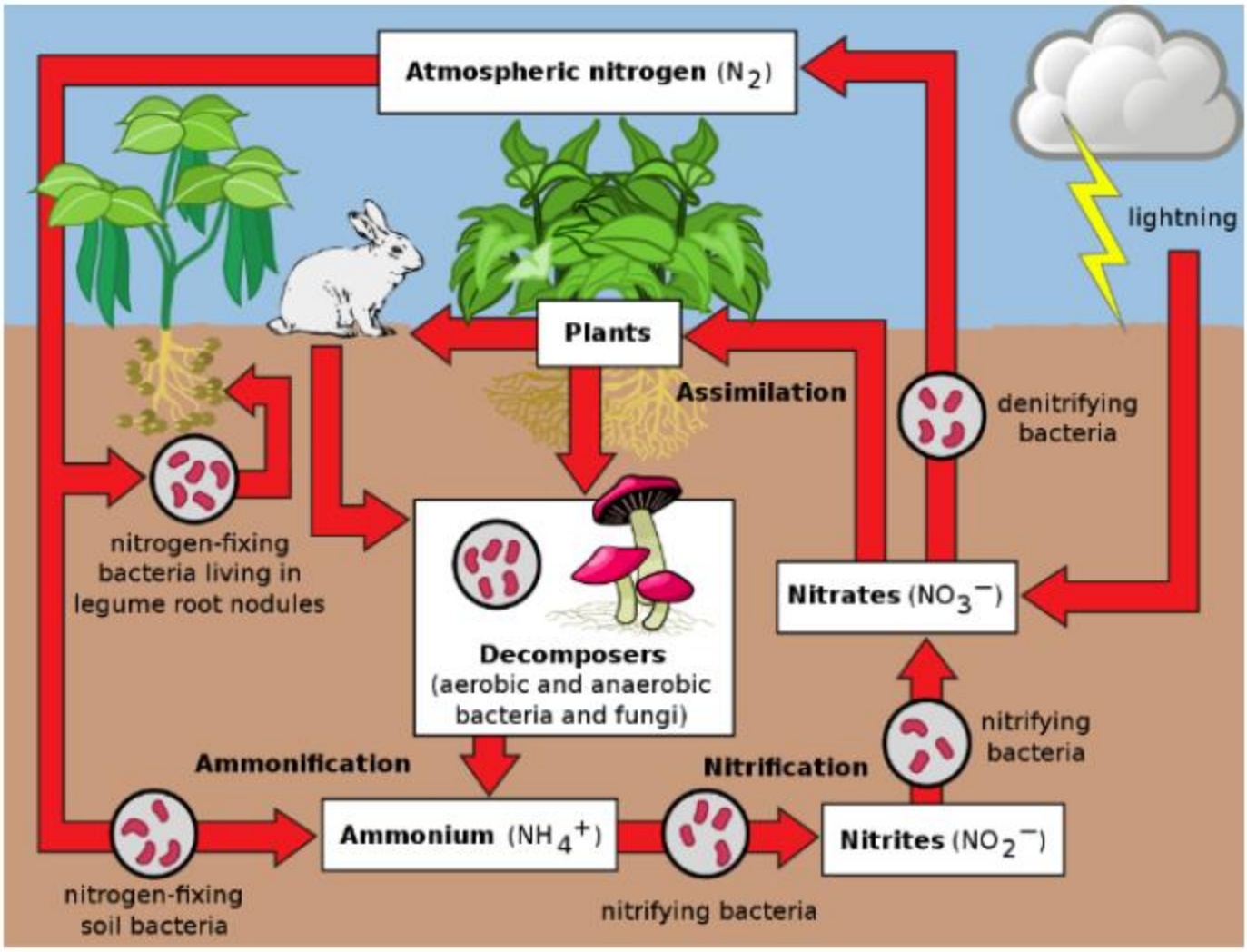


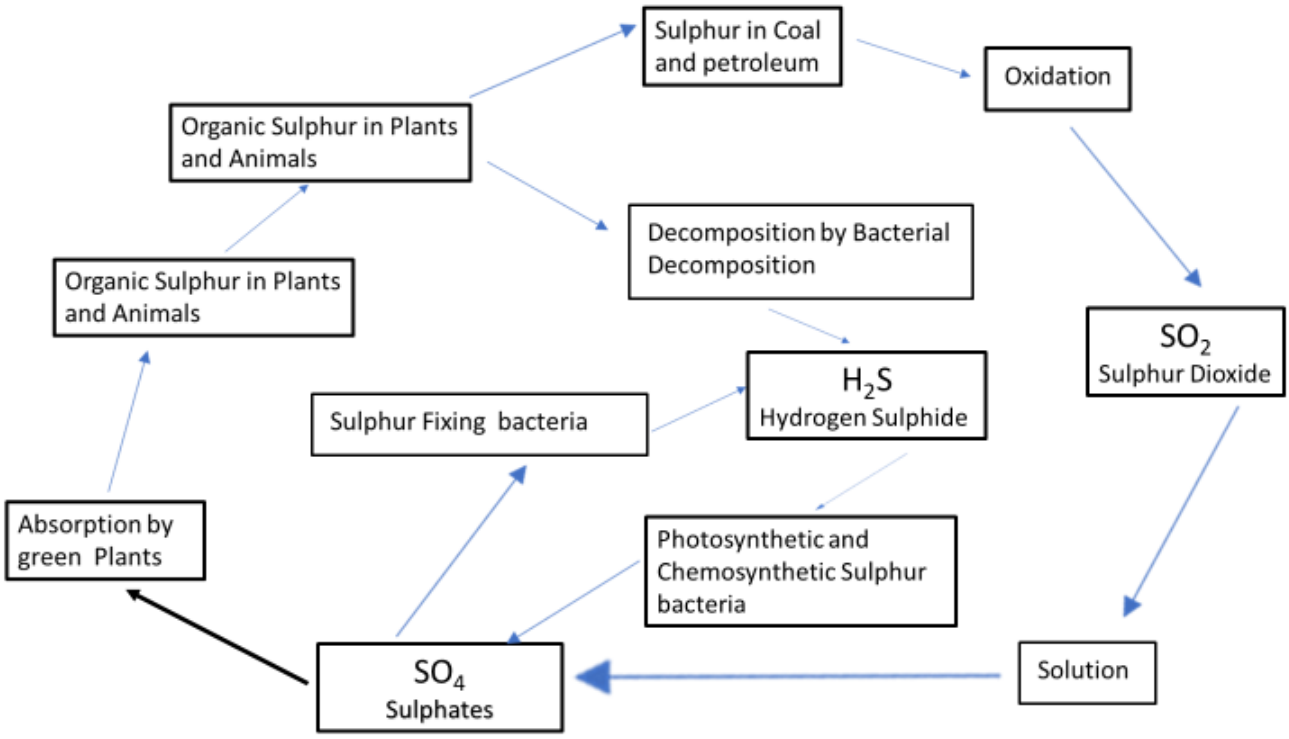
Fig.4.: Schematic Representation of Nitrogen Cycle

C) Nitrification: When ammonium gets converted into nitrates, it is called nitrification. Nitrates can be directly absorbed by the plants & incorporated into proteins, nucleic acids & other nitrogenous organic compounds. Some nitrates may be stored in the humus of the soil, immobilized by the bacteria & some may reach into the waterbodieswith the runoffs.

2) Nitrogen Gas back to the Atmosphere: Through the process of denitrification nitrogen gas goes back to the atmosphere. Some bacteria are there, who can convert Nitrates (NO_3) to Nitrites (NO_2).

They are called denitrifying bacteria. Ex. *Pseudomonas*Ultimately Nitrates, Nitrites & gaseous Nitrogen then released to the atmosphere.

Sulphur Cycle



Like other Nutrient Cycles, the movement of sulphur in the biosphere and the underground is called “Sulphur Cycle” (Fig.). Sulphur Cycle is a sedimentary type of nutrient cycle as the reserve pool is buried underground in rocks, minerals as well as sulphates (SO_4) in sea sediments.

Sulphur found in nature in following form.

i) Hydrogen sulphide (H_2S)

ii) Sulphur dioxide (SO_2)

iii) Sulphates (SO_4)

It enters to the living system as

i) Soluble form presents in the soil and pass on to the plants through the plants roots.

It is assimilated by the plant to synthesize protein, vitamins & same other important products.

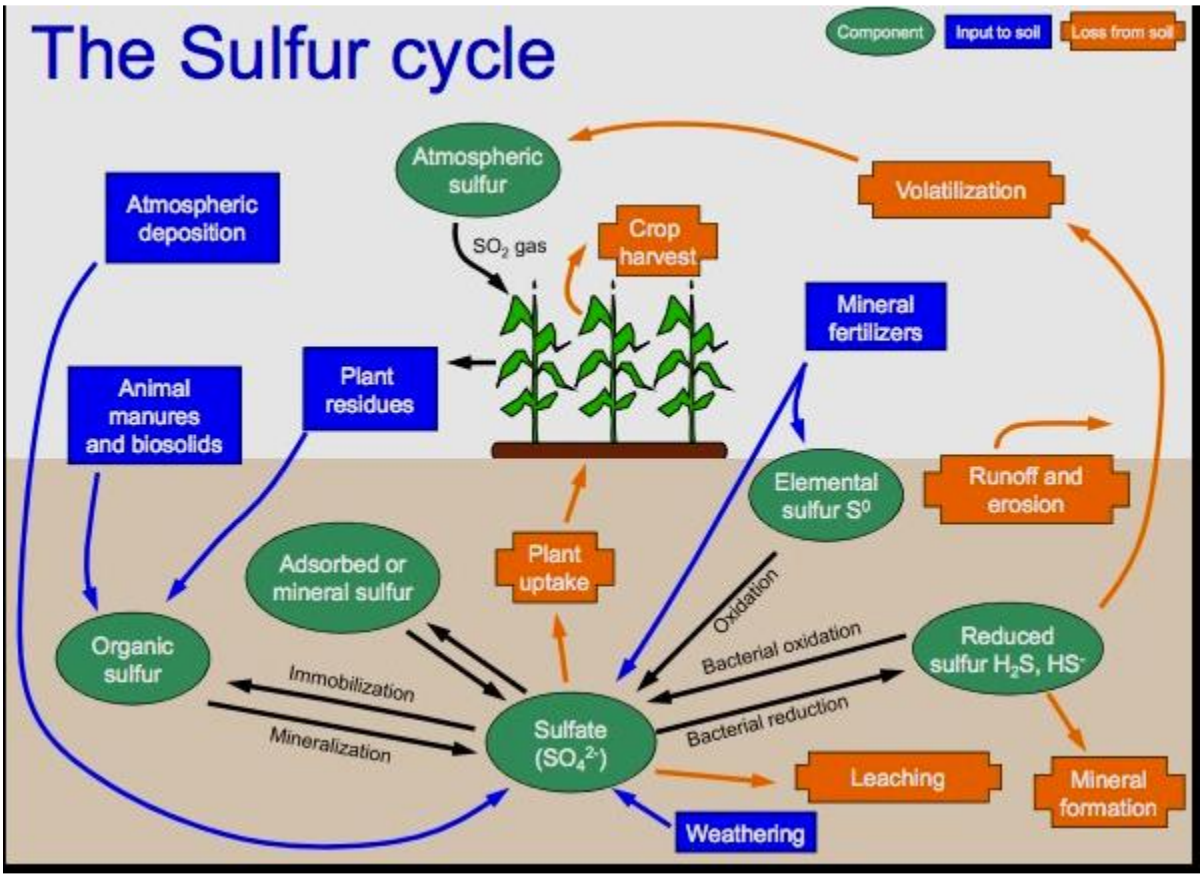


Fig. Schematic representation of Sulphur Cycle in detail

iii) Then the above compounds passed to the animal bodies through food chain. Within plants & animal bodies the organic sulphur decomposed by aerobic bacteria to sulphate (SO_4) or hydrogen sulphides (H_2S). Hydrogen Sulphides then get converted into elemental sulphur by anaerobic bacteria (these bacteria do not require oxygen). In this way sulphur gets back to the soil & sulphur cycle gets completed. Sulphur Dioxide (SO_2) is also released to the atmosphere by vehicular exhaustion i.e. the burning of fossil fuels (Fig.6).

Example: Petroleum, Coal etc.

ENERGY RESOURCES

The term energy means capacity to do work. Energy can neither be created nor destroyed but transformed from one form to other. Energy is closely related to force. When a force causes an object to move, energy is being transferred from the force to kinetic energy. Energy is present in a number

of forms such as mechanical, thermal, chemical, biological energy etc.. Energy production and utilization have become essential to carry out many activities in modern life. Energy is one of the important requirements that a country needs for its economic growth. At the same time, energy production has its impact on environment due to pollution and finally affects the quality of life of people. The energy is used for the following purposes:

a) Cooking, heating and lighting

b) Transporting people and goods by means of vehicles.

c) Manufacturing consumer goods and equipment

d) Conversion of fuels into other forms of energy for various use. For Example:

(1) Burning coal to produce electrical energy or mechanical energy (2) Chemical to electrical by dry cell batteries (3) Using water in dams to produce electricity through mechanical energy. The power generation capacity in the country has increased from 1400 MW at the end of 1947 to 92,894 MW at the end of 1999 from various sectors comprising as under:

Hydro sector	22,438 MW
Thermal sector	67,618 MW
Nuclear sector	1,870 MW
Wind sector	968 MW
From all sectors	92,894 MW

There are two types of energy sources namely: (1) Renewable energy sources and (2) Non – renewable energy sources. The important renewable energy resources are described below:

Solar energy: The energy which is derived from the sun is known as solar energy. It can be used for direct heating or sun‘s heat is converted into electricity. Photo voltaic cells convert direct solar energy into electricity. A number of solar equipments have been developed to utilize sun rays to heat water, to cook food, to pump water and to run certain machines and used for street lighting, railway signals etc. But the major problem with solar energy is that during cloudy weather it is available in less quantity than on sunny days.

Hydro-Power energy: Electrical power is generated by hydro-electric projects in which dams are constructed across the river. The kinetic energy of water is converted into mechanical energy by

means of turbines and in turn, the mechanical energy is transferred into electrical energy by generators. Hydro power projects lead to several environmental problems like destruction of animal habitats, deforestation, migration of people etc..

Geothermal energy: Geothermal energy found within rock formations. Inside the earth the temperature rises with depth .The temperature in earth‘s crust is around 4000oC. Geysers (a natural spring that emits hot water) and hot springs are examples for geothermal energy where the steam and hot water come to the surface, in areas where the steam is tapped by drilling. The obtained steam is then used to generate power. Air pollution results in case of geothermal energy where the gases like H_2S, NH_3, CO_2 present in the steam coming out of the geothermal sources. The overall efficiency for power production is low (15%) as compared to fossil fuels (40%).

Wind energy: Wind energy is the kinetic energy associated with the movement of atmospheric air. Wind mills convert the wind energy into electrical energy. On an average wind mills can convert 30 – 40 % of available wind energy into electrical energy at a steady wind speed of 8.5 mts / sec. The efficiency of wind mill is increased with the speed of wind and length of rotor blade. The total wind energy potential in India‘s estimate is 25,000 MW of this about 6000 MW is located in Tamil Nadu; 5000 MW in Gujarat and contribute the states of Andhra Pradesh, Maharashtra, Uttar Pradesh and Rajasthan for balance quantity.

Merits & demerits of wind energy:

1. It is a non – polluting and environment friendly source of energy.
2. It is a renewable energy available at free of cost
3. Power generation is cheaper with nil recurring expenses.

4.Wind mills are suitable to erect at on shore, remote and rural areas where wind blows with required intensity.

5. Favorable in geographic locations which are away from cities.

6. Wind turbine design, manufacturing, installation is complex due to varying atmospheric conditions.

7. Wind power doesn‘t suitable for large scale generation.

Ocean energy: Seas and oceans are large water bodies. Seas absorb solar radiation and a large amount of solar energy is stored in the tides and waves of the ocean. Ocean energy is non – polluting in nature and suitable at a few places only. Energy from seas or oceans is obtained from the following:

(1) ***Ocean Thermal Energy Conversion*:** The oceans collect and store huge quantities of solar on the surface of the water while the temperature of deep waters is very low. Using this temperature difference it is possible to convert heat into electricity.

(2) *Tidal energy*: Tidal waves of the sea can be used to turn turbine and generate electricity. Asia's first tidal power plant of 800 - 1000 MW capacity is proposed to be set up at Kandla in Gulf of Kutch.

(3) *Wave energy*: The wind blowing over water generates waves. A unique property of ocean waves is their ability to travel vast oceanic distances with negligible loss of energy and ultimately arrives the continental margin of that basin. India's first wave energy power plant of

150 KW capacity has been commissioned in Thiruvananthapuram, Tamil Nadu. 1 MW wave energy plant is being set up in Andaman and Nicobar islands.

(4) *Current energy*: Theoretically, the ocean water used to generate energy by allowing the water to pass through a series of turbines installed under water. The turbines are to be sealed and are kept at a depth of 10 to 20 mts. A propeller with a dia of 5 mts can generate about 150 MW of power.

Bio mass energy: Bio-mass is an organic material from living beings or its residues. It is a renewable source of energy derived from the waste of various human and natural activities. The bio-mass energy sources include Wood, animal manure, sugarcane waste, agriculture crops, house hold waste, roots of plants, garbage etc. The simplest way of using bio-mass energy sources is to allow them to dry out in the sun and burn them. **Bio-gas**: Bio-gas is a sustainable source of energy by virtue of its production from available natural organic wastes of cattle dung, human excreta, poultry waste, plant leaves, paddy husk etc…. Bio-gas is a mixture of methane (68%), CO_2 (31%) and N_2 (1%). Methane gas (CH_4) is produced by bio-gas plants and this gas is utilized as cooking gas whose calorific value varies from 4400 – 6200 Kilo Calories / cum. Heat value of bio gas can be improved by reducing its CO_2 content. Bio-gas production is carried out in an enclosed bio-gas plant made of bricks or steel. Slurry of waste organic matter is fed into the plant through an inlet and gas formed is tapped by an inverted drum. As gas is produced the drum rises and the gas may be drawn through an outlet. Bio-gas is commonly produced from cattle dung in a bio gas plant known as Gobar Gas plant. Bio-gas is a clean, cheap fuel that can be used for lighting purpose, lifting water through small pumps. **Non – renewable energy**

resources include (a) fossil fuels such as coal, crude oil, natural gas and (b) nuclear energy. **(a)Fossil fuels:** Fossil means the remains of an animal or a plant which have become hard and turned into rock. All these found in earth's crust which has been formed in the past by the geological processes. Fossil fuels are solid coal (lignite), liquid (crude oil / petroleum) and gases (natural gas). **Coal:** Huge quantity of plant materials buried under earth's crust and altered by geological process and converted into carbon rich fuel. It is a non – renewable source because it takes a very long period (million of years) for its formation. Coal is extracted by the process of mining and involves accidents due to mine collapse, ground water pollution, accumulation of poisonous material, explosive gases etc cause diseases. CO_2 pollution leads to green house effect (global warming).

Crude oil: It is obtained in the form of liquid. The crude oil is heated upto 600oC in the oil refinery and condense the vapours of hydro – carbons. Petrol and other petroleum products are refined fuels from crude oil. Petroleum products are used in large quantities in the manufacture of detergents, plastics, fertilizers, pharmaceuticals, synthetic rubber etc. The transport sector consumes about 40% of diesel; 25% industries and 19% household and rest 16% agriculture and other sectors. .

Natural Gas: Gas deposits are trapped from the sedimentary formations by means drilling holes into the rock formations. While burning of natural gas, the emission of CO_2 is less and thus reduces green house effect and global warming. A total of 734 billion cubic mts of gas is estimated as proven reserves.

(b) Nuclear Energy or Atomic power: It is the energy which is trapped inside the atom. It is non– renewable source of energy which is released during fission or fusion of certain radioactive elements. The most important advantage of atomic power is the production of an enormous amount of energy from a small quantity of radioactive element. For eg: 1 kg of Uranium liberates energy equivalent to 30000 kgs of coal. Energy released during nuclear reaction (mass – energy equation as per Albert Einstein's formula $E = mc^2$). Nuclear Energy is produced by two Processes namely (1) Nuclear Fission (2) Nuclear Fusion.

(1)Nuclear Fission: The nucleus in atoms is split by fast moving neutrons and in turn a tremendous amount of energy in the form of heat, light etc is released by a chain of reactions. Uranium is used as fuel. The energy released slowly in this process is utilized to generate electricity or else released suddenly all at once, results a tremendous explosion as in the case of Atom bomb.

(2)Nuclear Fusion: Nuclear energy can be generated by fusion process which involves two hydrogen atoms combine to produce one helium atom. Eg: hydrogen bomb. The disposal of nuclear wastes during mining, fuel production and reactor operation for a long time period resulting in adverse effects on environment. Disposable of nuclear waste is a national and global problem.

FOREST AS ARESOURCE

Forests are our treasures which provide us a wide variety of commodities such as timber, fuel wood, fodder, fiber, fruits, herbal drugs, cosmetics and many types of raw materials used by the industries. A great variety of mammals and birds which live in the forests, serve as useful living resources. Forests play a great role in soil formation, water conservation and regenerating of oxygen. Trees fix CO2 in their biomass and through transpiration (loss of moisture to atmosphere) they moderate the climate. Can you imagine what would happen if forest does not exist in the world .As mentioned above, it performs certain functions which can be directly observed. But there are certain functions which cannot be directly observed like purification of air, carbon sink etc. Broadly, all the above mentioned functions performed by the forest can be categorized under three major headings: economic, ecological and social.

i) Economic Significance

Forest is one of the largest available renewable resources on the planet earth. It provides a wide variety of goods and services which include food, fodder and fuel. Wood is used for making houses, furniture, matches, ploughs, bridges and boats. Forest products such as tannins, gums, spices, waxes, honey, musk, and hides are all provided by the flora and fauna of forests. Fruits, leaves, roots and tubers of plants form the food of forest tribes .Wood and bamboo pulp are used for manufacturing paper and rayon. The flora and fauna of the forest also holds the key to numerous life sustaining products such as pharmaceuticals, insecticides and pesticides. These substances should be harvested sustainably so that it could enhance the long term resource value of the forest.

ii) Ecological Significance:

As mentioned above forest performs certain function like moderation of global climate, supporting natural ecological systems and processes. Let us discuss them in detail:

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a) Moderation of global climate: Forests stabilize global climate in a significant manner by influencing natural cycles such as hydrological and carbon cycles. You might have read about these cycles when you were in school. As you know, spatial as well as temporal patterns of

rainfall are greatly influenced by forest. How much of water is retained in the soil, and how much flows away, sometime causing floods, also depends on tree cover. Similarly forest can also Influence the atmospheric carbon dioxide level. Tree biomass holds carbon dioxide in a fixed state. Therefore, forest acts as a major source of carbon sink i.e. ability to absorb carbon dioxide from the atmosphere. In other words, a carbon sink is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. When wood is burnt CO2 is released in the atmosphere. This has a direct impact on the extent of greenhouse effect and global warming. In other words, more forests lead to greater removal of atmospheric carbon dioxide during photosynthesis resulting reduction of the greenhouse gases in the atmosphere. Therefore, large-scale afforestation has been adopted as a measure to reduce greenhouse effect.

b) Protection of biodiversity: Forests are the greatest repository of biodiversity on the land as they provide ideal conditions for the survival and growth of living organisms. The number of species per unit area is much greater in a forest than in any other terrestrial ecosystem. For example, the tropical rainforest covers less than 7%of the earth's land Surface but accounts for more than 50% of all known species. About 62% of all known plants are found in these rainforests. That is why there has been a growing campaign for saving the rain forest in Amazon and Nile basin. The growing awareness about the importance and necessity to conserve biodiversity is helping human being to realize the significance of forest. Do you think this awareness or campaign is sufficient to protect rain forest? Think about it? We will discuss some of the conservation measures in the last section of this unit.

c) Supporting natural ecological systems and processes: As mentioned earlier forests perform certain activities which are crucial for supporting ecological systems and processes directly. Some of these functions and processes are as follows:

- Forests check the soil erosion by preventing the action of winds and water thereby preserves the fertile top soil.
- It prevents landslides and reduces the intensity of cyclones and floods.
- By preventing soil erosion, forests reduce silting of water bodies including reservoirs.
- Forest improves air quality by absorbing toxic gases and particulate matter.
- It protect watersheds and ensure perennial supplies of fresh water.

iii) Socio-cultural significance: As mentioned in the introduction, forests have been part of our social and cultural ethos since the inception of civilization. We find signs of such cultural bonds even in today's modern and materialistic life. This is largely because forests have significant aesthetic, recreational and spiritual value. I am sure, till now, you must have realised the importance of forest as a resource. You might be reading in the newspapers or might have watched in the television about clearing of forests for urbanization, mining, stablishing industries, construction of dams, railway lines, roads etc. Do you know rate of deforestation is so high the world over that it has started affecting our life. In the following section we will discuss about extent, causes and consequences of deforestation.

DEFORESTATION: CAUSES AND CONSEQUENCES

Deforestation refers to the permanent removal or destruction of indigenous forests. Today, it has been roughly estimated that the indigenous forest cover constitutes 21% of the earth's land surface. According to the World Resources Institute, deforestation is regarded as one of the world's most pressing landuse problems. Another major concern is the rate at which deforestation is occurring. Currently, 12 million hectares of forests are cleared annually. Almost all of this deforestation occurs in the moist forests and open woodlands of the tropics. It has been predicted that if deforestation continues at this rate then all the moist tropical forest could be lost by the year 2050, except for isolated areas in the Amazon and the Zaire basin, as well as a few protected areas within reserves and parks. In India, forests cover 24.39 percent of the total geographical area. However, it is assessed that the country needs 33% of its area under forests to meet the ecological and economic needs.

Causes of Deforestation

Let us discuss some of the major causes of deforestation all over the world in general and India In specific.

i. Population Explosion: Increasing human population is one of the major causes of deforestation. It poses a major threat to the environment. Vast areas of forest land are cleared (Fig. 5.2) to reclaim land for expansion of farming land, mining activities, creation of new and expansion of existing human settlements, and development of infrastructure like roads and railway tracks. Growth of population increases the demand for forest products like timber, firewood, paper and other valuable products of importance, all necessitating felling of trees. **ii.**

Forest Fires: This is also another major cause of deforestation. Forest fires occur either naturally or are human induced. Some of the major causes of forest fires are as follows:

 Dry humus and organic matter forming a thick cover over the forest floor provides ideal condition for ground or carelessly surface ires.Throwing burning cigarette stubs on dried foliage can light a fire.

 Crown fire takes place in densely populated forests where tree tops may catch fire by heat produced by the constant rubbing against each other. Fire destroys fully grown trees, results in killing and scorching of the seeds, humus, ground flora and animal life.

iii) Grazing of Animals: Trampling of the forest soil in the course of overgrazing by livestock has far reaching effects such as loss of porosity of soil, soil erosion and desertification reduced productivity of the previously fertile forest area.

iv) Pest Attacks: Pests destroy trees by eating up the leaves, boring into shoots and by spreading diseases.

Consequences of Deforestation

Forests are closely related with climate, biological diversity, wild animals, crops and medicinal plants. Large scale deforestation has far-reaching consequences:

i) Habitat destruction of wild animals. Tree-using animals are deprived of food and shelter.

ii) Increased soil erosion due to reduction of vegetation cover.

iii) Reduction in the oxygen liberated by plants through photosynthesis.

iv) Increase in pollution due to burning of wood and due to reduction in carbon dioxide fixation by plants.

v) Decrease in availability of forest products.

vi) Loss of plant, animal and microbial diversity.

vii) Scarcity of fuel wood and deterioration in economy and quality of life of people residing near forests.

viii) Lowering of the water table due to more run-off, and resultant increased use of the underground water.

ix) Rise in carbon dioxide level in the air due to burning of vegetation has caused global warming resulting in melting of ice caps and glaciers and consequent flooding of coastal areas.

CONSERVATION AND MANAGEMENT OF FOREST RESOURCES

As a result of increased exploitation of forests for timber, firewood and other forest products, without putting in adequate efforts to regenerate them, the forests are known to be fast disappearing. This has caused an environmental imbalance. For example, most of the rainwater is lost as runoff which flows over the mountain slopes unchecked often causing floods. The excessive washing away of top soil results in low fertility and reduces crop yields. It is because of these consequences of deforestation, a strong forest policy has been adopted by our Indian Government to protect forests and to plant more trees. Some of the conservation measures practiced in India and other parts of the world are as follows:

i) Increase in area of forest plantation: The Tree plantation can be raised in vacant or unused lands and waste, degraded and marginal lands, especially on road side, along railway tracts, on contours and on land not suited for agricultural production. Planting trees outside forest areas will reduce pressure on forests for timber, fodder and fuel wood. Apart from this, the deforested areas need to be reforested.

ii) Developing alternative sources and promoting the substitutes: It has become necessary to find alternative fuels as well as raw materials to manufacture paper, sports goods, packing cases, furniture and beams used in buildings. Research is going on to develop alternate sources; in some cases, plastics and composite materials have been successful in replacing the use of timber

.**iii) Increase the area of forest permanently reserved for timber**

Production: The most serious impediment to sustainable forest management is the lack of dedicated forests specifically set aside for timber production. If the forest does not have a dedicated long-term tenure for timber production then there is no incentive to care for the long-term interests of the forest. FAO (2001) found that 89 per cent of forests in industrialized countries were under some form of management but only about six per cent were in developing countries. If 20 per cent could be set aside, not only could timber demand be sustainably met but buffer zones could be established to consolidate the protected areas.

iv) Adoption and promotion of sustainable management of forest:

Achieving ecological sustainability means that the ecological values of the forest must not be degraded and if possible they should be improved. This means that **silviculture** and management should not reduce biodiversity, soil erosion should be controlled, soil fertility should not belost, water quality on and off site should be maintained and that forest health and vitality should be safeguarded. However, management for environmental services alone is not economically and

socially sustainable. It will not happen until or unless the developing nations have reached a stage of development and affluence so that they can accommodate the costs of doing so. There are vast areas of unused land some of which is degraded and of low fertility. Technological advances are being made to bring this land back into production. This should be a major priority since a significant proportion of cleared tropical forest will eventually end up as degraded land of low fertility.

v) Developing a reliable mechanism of information base and regular monitoring: Knowledge of how much forest, where it is and what it is comprised of seems to be straightforward. However, surprisingly, this most basic information is not always available. It is not possible to properly manage a forest ecosystem without first understanding it. Remote sensing technologies make it feasible and affordable to identify hotspots of deforestation. The international community could undertake monitoring efforts that would have immediate payoffs. A priority is to fund and coordinate basic monitoring on the rate, location and causes of global deforestation and forest poverty along with the impacts of project and policy interventions.

vi) Establishing an effective system of fighting forest fires:

vii) Strictly enforcing laws to deal with unauthorized cutting of trees.

viii) **Promoting agro-forestry and social forestry**: Rural people partly meet their needs for fire wood and small timber by growing fast growing trees planted within the limits of their village, along the footpaths, roadsides, alongside railway tracks, side roads or canals and streams, boundaries of fields and empty spaces. The aim of social forestry is to meet the needs of fuel, fodder, fruits, timber and other requirements of local people.

ix) **Participatory forest management and rights:** All stakeholders within interest in the fate of the forest should be involved in planning, management and benefit sharing. The balance of rights can be tilted strongly toward society in the form of publicly owned strictly protected areas. State ownership and management can be retained but with sustainable timber extraction allowed. As of now much of the world's tropical forest are state owned but community participation in forest ownership and management needs to be encouraged. Land reform is essential in order to address the problem of deforestation. However an enduring shift in favour of the peasants is also needed for such reforms to endure. Moreover the rights of indigenous forest dwellers and others who depend on intact forests must be upheld. Therefore, the recognition of traditional laws of the

indigenous peoples as indigenous rights will address the conflicts between customary and statutory laws and regulations related to forest ownership and natural resource use while ensuring conservation of forest resources. Keeping this in view various state Government in India has been implementation Joint Forest Management Programme after successful implementation in West Bengal and Haryana in 1970's.