

UNIT-2

NATURAL RESOURCES :-

Nature provides life support materials or resources for sustenance of life on earth for plants, animals and man. These resources are known as Natural resources.

Examples of natural resources are water, air, soil, forest, mineral, crops etc.

There are two categories of natural resources

① Renewable Resources.

These can be recycled and regenerated within a given span of time. eg Forest, wind energy, solar energy, biomass energy and hydro power etc.

② Non-Renewable Resources

These cannot be regenerated eg. Fossil fuel such as coal, petroleum, minerals etc. With increase in consumption, these will be exhausted in near future.

* It must be noted that even renewable resources are endangered and liable to extinction if there are exploited recklessly eg. Forests.

The major natural resources are :-

1) Forest Resources.

2) Water resources

- iii) Mineral resources.
- iv) Food resources.
- v) Energy resources
- vi) Land resources

Forest Resources

- Forests are one of the most important natural resources on earth, providing the earth with green cover.
- Forests also offer several environmental services which are essential for sustenance of life.
- About 33% of the world's land area is under forest cover.
- Plants constitute 99% of earth's living species and the rest 1% include animals and man who depends on the plant world for their food. If this ratio (99:1) is disturbed by elimination of plants (deforestation), then the natural balance will be lost and the entire living world will suffer most.
- There is a dynamic balance among plants (producers), bacteria and microorganisms (decomposers) who decompose mineral salts in soil elements which are cycled back into plants) and animal/human beings (consumers).
- Once this dynamic balance is upset, there would be ecological crisis and the entire

biosphere would be in danger.

- Forests are renewable resources. It plays a vital role in improving the quality of life environment by exerting beneficial effect on the life support system.
- Forests play a major role in economic development of the country by providing goods and services to people and industry.
- Forests are the treasure house of valuable plant and animals, their genes, medicinal plants etc. Hence the tropical forests are called as Bioreserves.
- It is well known that forests play a vital role in the life and economy of all forest dwelling tribes. For these tribes, forests supply food (tuber, roots, leaves, fruits and meat) from animals and birds, medicinal herbs and other forest products for commercial use which provides forest based subsistence.
- Deforestation:- The main cause for forest destruction are human population and livestock (cattle, buffalo, goat, sheep) population explosion. These enhance the demand for timber and fuel wood (for man) and grazing land (for livestock).

Forest Conservation:-

- According to the Forest policy of the Government of India (1952), $\frac{1}{3}$ rd (33%) of our land should be under forest cover. But this level has gone down to about 12%. We have almost reached a critical state which must be remedied now before it is too late for our own survival.

- The Remedial Measures are as follows.

① Conservation of Reserve Forests:-

• There are areas where our major water resources are located such as Himalayas, Western and Eastern Ghats and areas like Reservoirs, National Parks, Sanctuaries, Biosphere Reserves etc.

- These must be protected and no commercial exploitation be allowed in these areas.
- This is an important conservation strategy.

② Limited Production Forests:-

• These are less fertile areas at high altitudes (more than 1000 metres) with hilly environment.

- Here the health of the forests should not be damaged and only limited harvesting with utmost care be allowed.

③ Production Forests:-

These forests have high productivity and

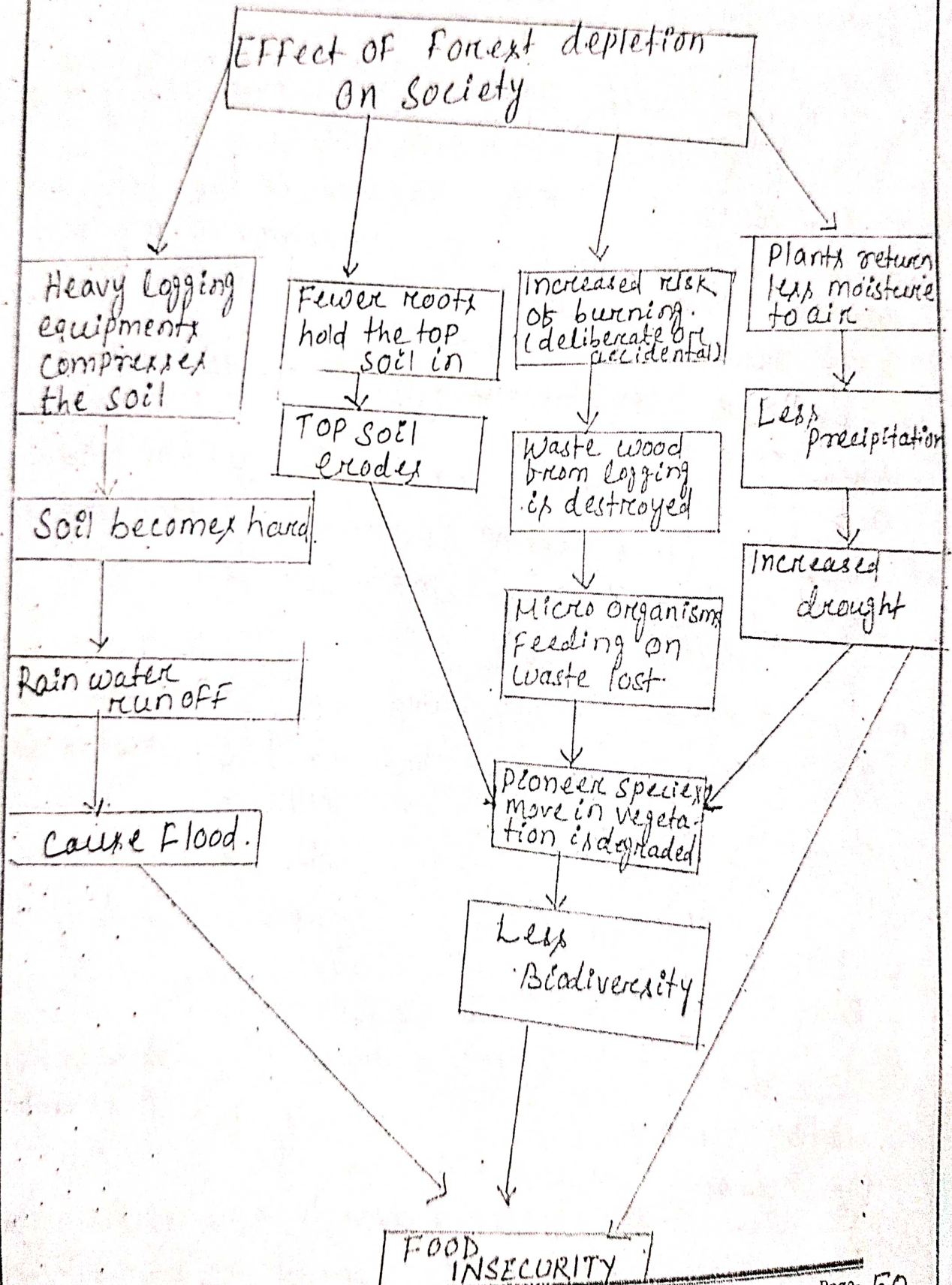
should be maintained to make up for the loss of Forest Cover.

④ Social and Commercial Forestry:-

- Social forestry is based on public and common land (privates) to produce firewood, fodder, fruit and small timber for rural people.
- Commercial forestry is meant to supply goods, timber, plywood and matchwood etc. for industrial purpose.
- The main idea for these forestry is to remove excess pressure on natural forests for these requirements.
- The programme should be conducted by a co-operative system including farmers, tribals, Panchayats and NGOs etc.
- Degraded lands should be utilized for social forestry for firewood, whereby the quality of land improves in course of time.
- Massive afforestation should be done involving multipurpose species of plants/shrubs so that every village/town/city is able to meet its requirements for firewood, fodder and small timber.
- Fallow lands (not used for agriculture), grazing lands can be used for raising

Such plantations.

→ Environmental impact of Forest depletion on Society.



WATER RESOURCES :-

- Water has no alternative. It is known as life. It is essential for the sustenance of all living organisms including plants, animals and man.
- All plants, insects, animals and human beings have 60-95% of water in their bodies.
- This water is partly released in the form of sweat, excreta, urine and vapour. So all these species require a lot of water daily for their body growth, nutrition etc.
- But our usable water resources like any other natural resource is finite (has some limit) and is likely to be exhausted within a century.
- Moreover, it is getting polluted by man-made activities and unfit for use sooner than expected.
- The United Nations Food and Agriculture Department estimates that if the present day practices of wasting and polluting water are not stopped, then within less than a century the world's biosphere including man will disappear.
- Availability of water:- About 97% of earth's water supply is in the ocean which is unfit for human consumption and other uses due to high salt content (dissolved salt). Of the remaining 3%, 2.3% is locked or present in

- Frozen form in ice caps (Polar) and Himalayas.
- The balance 0.7% is available as Fresh water but the bulk of it, 0.66% is ground water and the rest 0.03% is available to us as freshwater in rivers, lakes and streams.
- Form from this 0.03% of fresh water, lakes and ponds containing 0.01%, water vapour 0.001%, rivers 0.0003% and water combined in plants, animals and chemicals 0.0187%.
- Thus we have very limited stock of usable water i.e. 0.03% of surface water and 0.66% of ground water.
- The quantity of water vapour arising from evaporation of sea water, river water returning by the same volume to the earth's surface by rainfall and back to the water source by hydrological cycle (cloud formation and rainfall).
- From annual rainfall, 70% of water is lost by evaporation and transpiration by plants while remaining 30% goes into the stream flow.
- According to human consumption, 8% of the stream flow will be used for irrigation, 2% for domestic use, 4% for industries and 12% for electrical utilities.

- Irrigation for agriculture and electric power plants are the major consumers of water.

Water quality

- Clean water is essential for healthy environment to support life systems on this planet.

- Polluted water generates water borne diseases which kill millions of people every year all over the world. Particularly in developing countries.

- According to United States Public Health (USPH) prepared / assigned a Standard for water quality parameters (indicators) for drinking water.

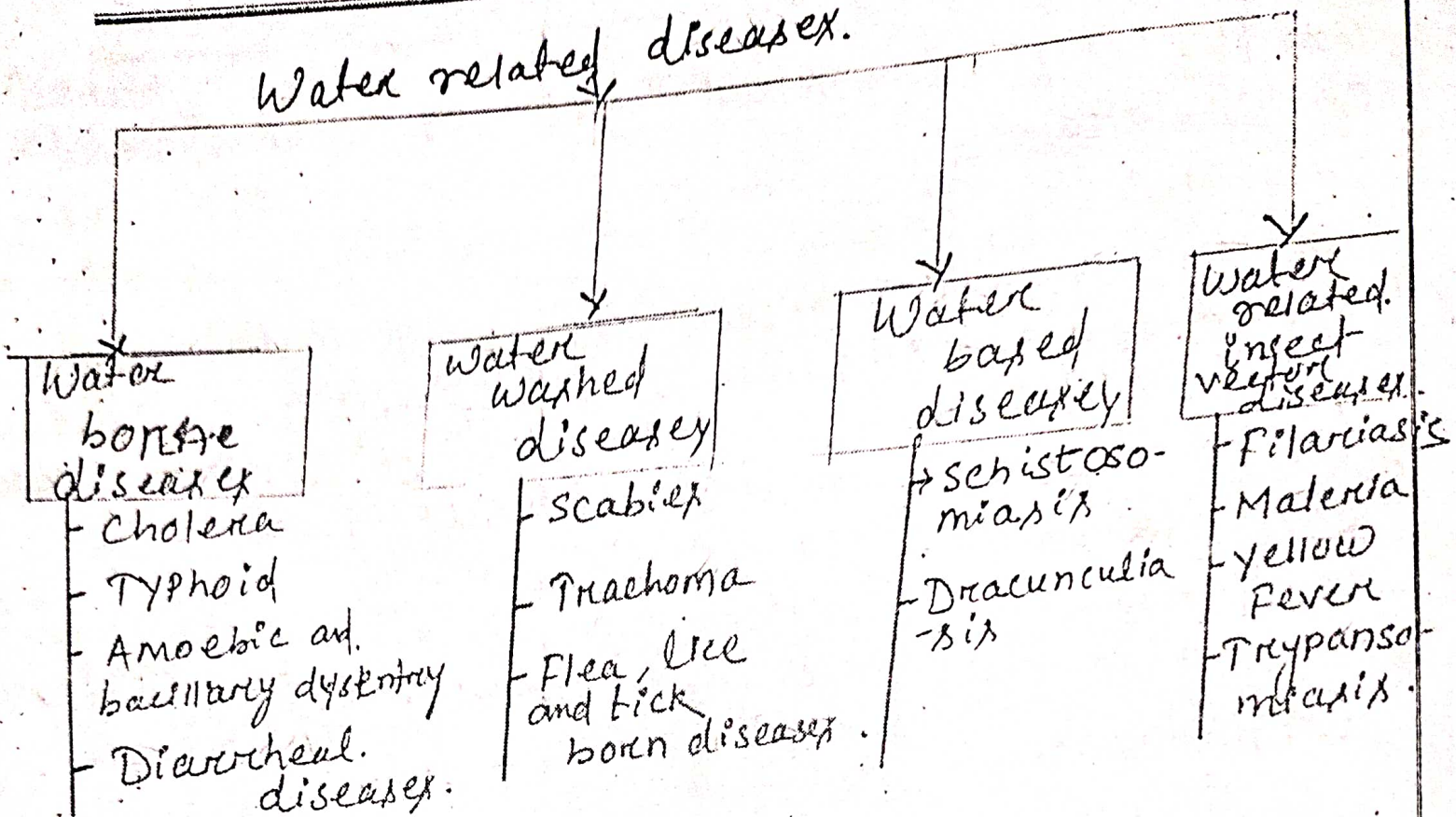
According to this Standard, the domestic water supply must contain dissolved O_2 (4-6 ppm), Chloride 250.0 ppm, Sulphate 250.0 ppm, Cyanide 0.05 ppm, lead 0.05 ppm, Mercury 0.002 ppm, Chemical O_2 demand 4.0 ppm, iron 0.3 ppm, Calcium 100 ppm, Zinc 5.5 ppm etc. along with PH 6.0-8.5.

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- Moreover, man made global and local climatic distortions due to global warming, deforestation, loss of topsoil etc. have adverse effect on the monsoon pattern as well as the quality of usable water.

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Water related diseases.



Water borne diseases

- Cholera is a highly contagious disease (water and food borne) caused by the bacteria Vibrio cholerae.
- Typical symptoms are ~~diarrhoea~~ diarrhoea with rice water stool, vomiting, rapid dehydration, muscular cramps and anuria. In severe case acute renal failure.
- Factors for spread of Cholera: Among environmental factors, water, food and flies play important role in spreading Cholera in the community.
- Social factors like big fairs such as Kumbha mela or Ardh Kumbha mela where

Lakhs of people assemble at the river ghats are the most important factors for the spread of Cholera.

Control of Cholera

- It can be achieved by early detection of the disease, isolation of the patients and their prompt treatment, improvement of sanitary facilities along with adequate supply of safe drinking water to the community.
- Active immunisation and health awareness are also the important measures for cholera control.

Amoebiasis

- This is a water borne disease caused by Entamoeba histolytica with or without clinical manifestations.
- The disease is characterised by liquid stools with mucus and blood.
- E. histolytica are found as cysts or motile trophozoites. These can cause ulcer in large intestine. Some may cause hepatitis also.
- Human being gets the infection through food chain (cut fruits, salads, vegetables, contaminated drinking water etc)
- The diagnosis is usually based on the detection of Entamoeba histolytica in the stools.

• The antibody of the parasite can be easily detected by immuno ~~fluorescence~~ Fluorescence Method.

• The disease can be prevented by:-

- i) Sanitary disposal of human excreta.
- ii) Water should be boiled and filtered before drinking. (Safe drinking water)
- iii) Hygienic kitchen practice
- iv) Protection of foods against flies.

• The drugs usually prescribed by physicians

- i) Metronidazole (400-800 mg)
- ii) Entozyme. (250 mg)
- iii) Triclidazole. (1-2 gm)
- iv) Furamide (500 mg)

⇒ Water related diseases.

• Water related diseases are caused by insect vectors especially Mosquitoes, that breed or feed near Contaminated water.

• These diseases are not directly related to the drinking water quality. However control of vector control can reduce the potential for water related disease transmission.

• The most common vector insects are mosquitoes and flies.

- Mosquito borne diseases
 - Malaria (Plasmodium - Parasite)
 - Yellow Fever (Virus)
 - Dengue Fever (Virus)
 - Filariasis (Worm)
- Fly borne diseases
 - Onchocerciasis (river-blindness) caused by bilateral worm Onchocerca volvulus
 - Trypanosomiasis caused by a parasite Trypano-
soma bruce
 - Leishmaniasis (Kala-azar)
 - Loiasis - caused by parasitic worm Loa loa
- ⇒ Fluoride problem in drinking water:-
 - Fluoride in diet or drinking water above 1.5 ppm causes fluorosis.
 - The maximum tolerance level in human body is 1.5 ppm.
 - The daily intake of F. from food and drinking water is usually less than 1 ppm.
 - Fluoride does not concentrate in any tissue but only in bones and teeth.
 - Fluorosis affects bones, teeth, tissues and other organs of the body, leading to death after prolonged illness.
 - It also causes dental decoloration and deformation.

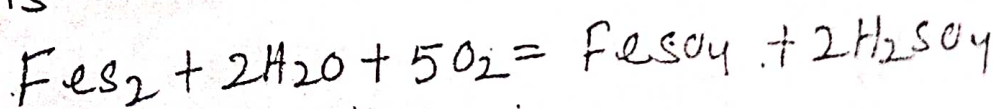
- Melting of bones causing knock knees, bow legs and stiffening of the joints, joint pains, back pain etc.

- Provision of safe drinking water (1 ppm fluoride) and creating awareness among people are essential measures for prevention of Fluorosis.

⇒ Arsenic problem in drinking water:-

- Arsenic is highly toxic in its inorganic form and present at high levels in the groundwater of a no. of countries.
- Excessive and prolonged exposure to inorganic Arsenic with drinking water is causing Arsenicism, a deteriorating and disabling disease characterized by skin lesions and pigmentation of the skin.

- Sources of Arsenic in ground water.
i) Oxidation of pyrite (FeS_2) and solubilisation of As



As liberated in aquifers

- ii) Reduction of Arsenic rich FeOOH in anoxic (depleted dissolved O_2) ground water (due to microbial oxidation of sedimentary organic matter, paddy cultivation etc)

- People are exposed to elevated levels of inorganic arsenic through drinking contaminated water, using contaminated water in food preparation and irrigation of food crops, industrial processes, eating contaminated food and smoking tobacco.
- Long term exposure to inorganic arsenic, mainly through drinking water and food, can lead to chronic arsenic poisoning (skin lesions and skin cancer etc).

MINERAL RESOURCES: —

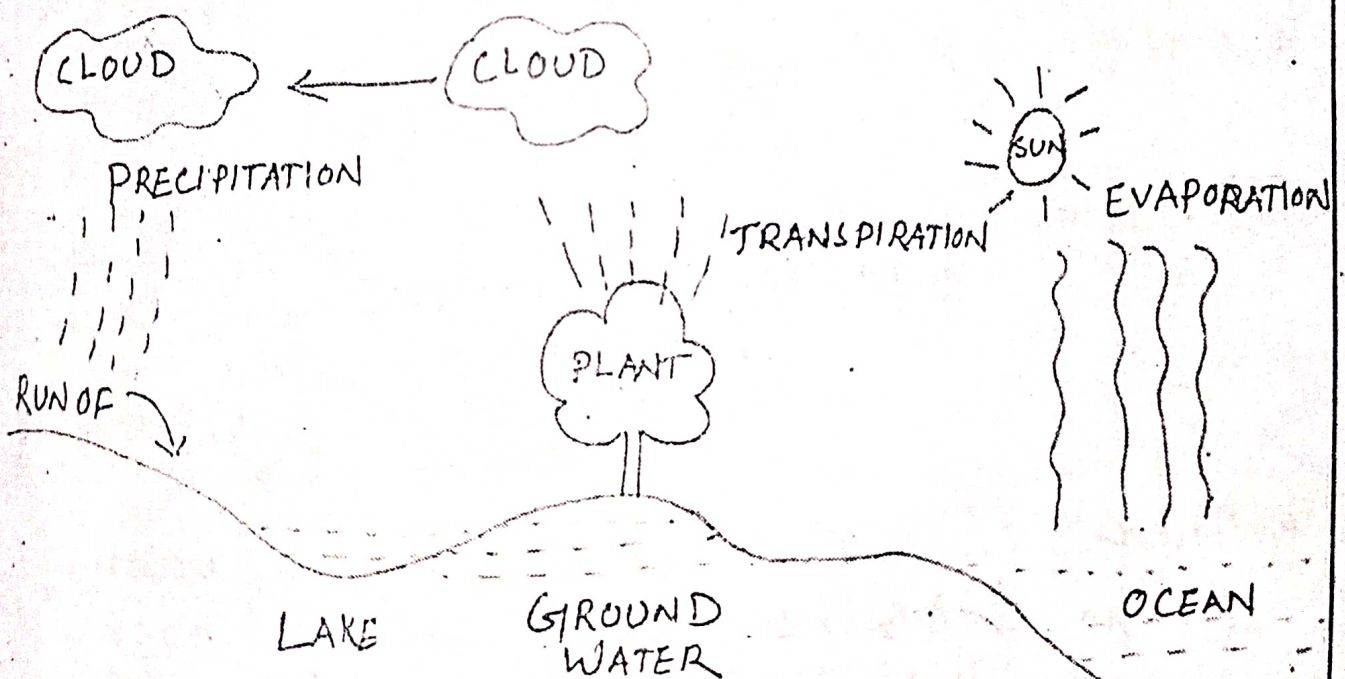
Material cycle: —

- Sometimes called nutrient cycle. It describes the flow of matter from the nonliving to the living world and back again.
- As a result, matter can be stored, transferred into different molecules, transferred from organism to organism and returned to its initial configuration.
- There are 5 material cycles.
 - a) The Hydrological cycle / water cycle.
 - b) Nitrogen cycle.
 - c) Carbon cycle.
 - d) Sulphur cycle.
 - e) Phosphate cycle.

a) Hydrological cycle.

- This cycle helps in exchange of water among air, land, sea, living plants and animals.
- About $\frac{1}{3}^{\text{rd}}$ of the solar energy absorbed by the earth is used to drive the hydrological cycle - Massive evaporation of water from the oceans, cloud formation and rainfall which supplies our reservoirs with fresh water.

At freezing temperature rainwater freezes into snow and forms hail in the presence of strong wind. Water as rain, snow, hail is precipitated on land and water surfaces. On land surface water seeps into the soil and is stored as groundwater. Ground water does not remain static but moves in various directions. It moves up and reaches soil surface where it is taken by the plant roots.



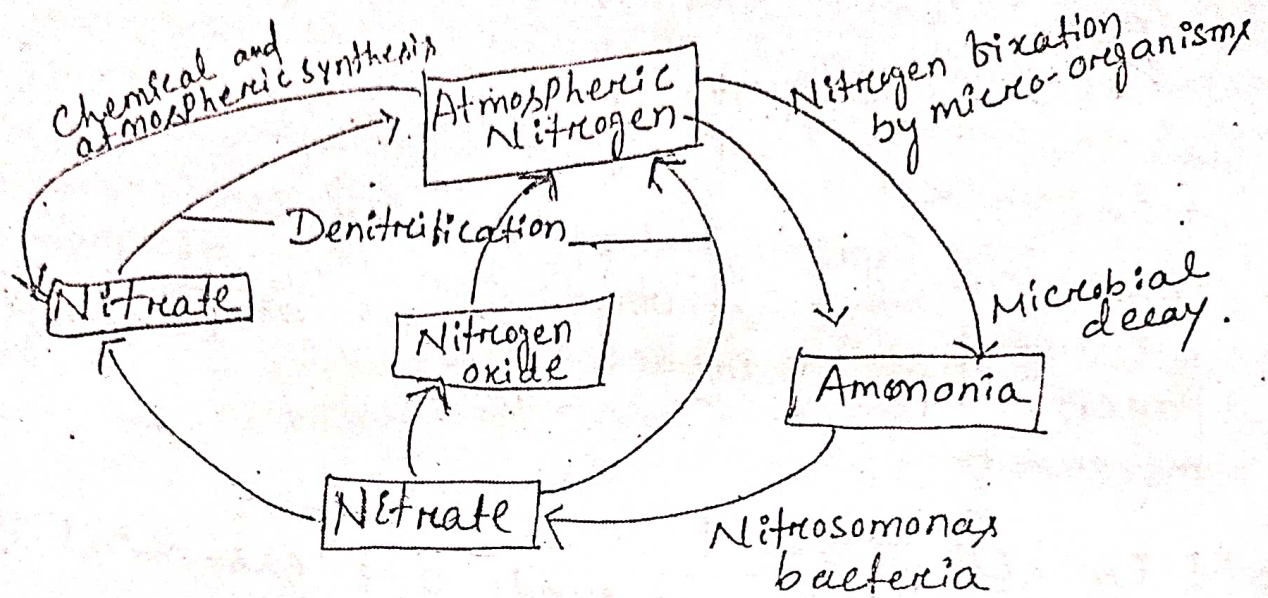
Surface water flows into streams, rivers, seas, lakes and reservoirs. Normal evaporation from oceans increases the precipitation by 10-1. This 10-1 moves as water vapour over the land surface and balances

the hydrological cycle.

- Plant absorbs ground water by root pressure and transpirational pull but give off excess water through leaves by the process of transpiration.
- Thus, the hydrological cycle consists of balanced continuous process of evaporation, transpiration, precipitation, surface runoff and ground water movements.

b) NITROGEN CYCLE

- Nitrogen and its compounds are essential for life processes in the biosphere.
- In nitrogen cycle, there is continuous exchange of nitrogen within the ecosystem.
- The major load of nitrogenous organic residue in soil originates from death and decay of plants and excreta of animals.
- These organic residues in soil are taken by various soil micro-organisms for their metabolism which give products such as ammonia, nitrate and nitrite.
- Plants absorb nitrate from soil which re-enter the nitrogen cycle. Some soil micro-organisms break down soil nitrate into nitrogen by denitrification process while others transform nitrogen into soluble nitrogen compounds.

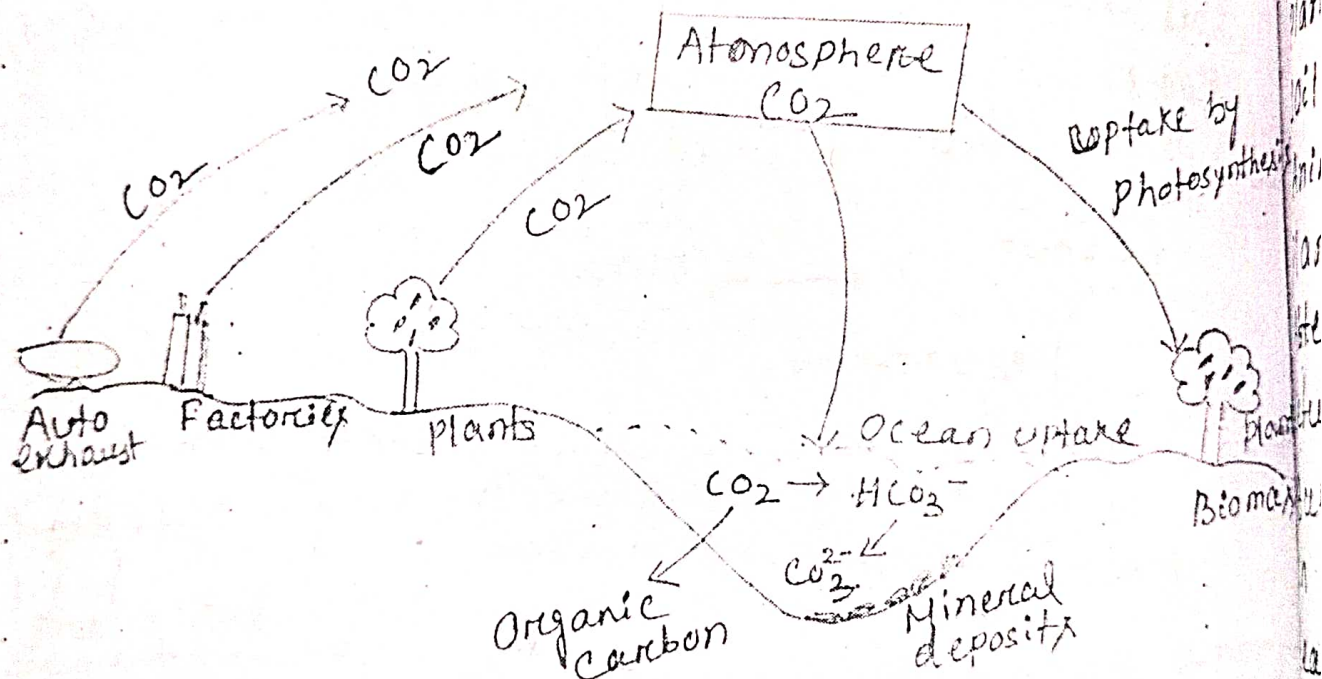


(The Nitrogen cycle)

⇒ c) CARBON cycle :-

- Carbon cycle is a very important chemical cycle.
- The atmosphere is a very minor reservoir of CO_2 while the ocean is the major reservoir containing as much as 50 times more as that of air where it is stored as bicarbonate mineral deposit on the ocean floor (which regulates the carbon dioxide level in the atmosphere).
- The cycle operates in the form of CO_2 exchanging among the atmosphere, biosphere and the oceans.

- Major sources of CO_2 emissions:-
 - Emissions by fossil fuel
 - Emissions by deforestation
 - Uptake in the oceans.
 - Uptake by CO_2 Fertilization.
- ~~Net~~ The Carbon cycle:-

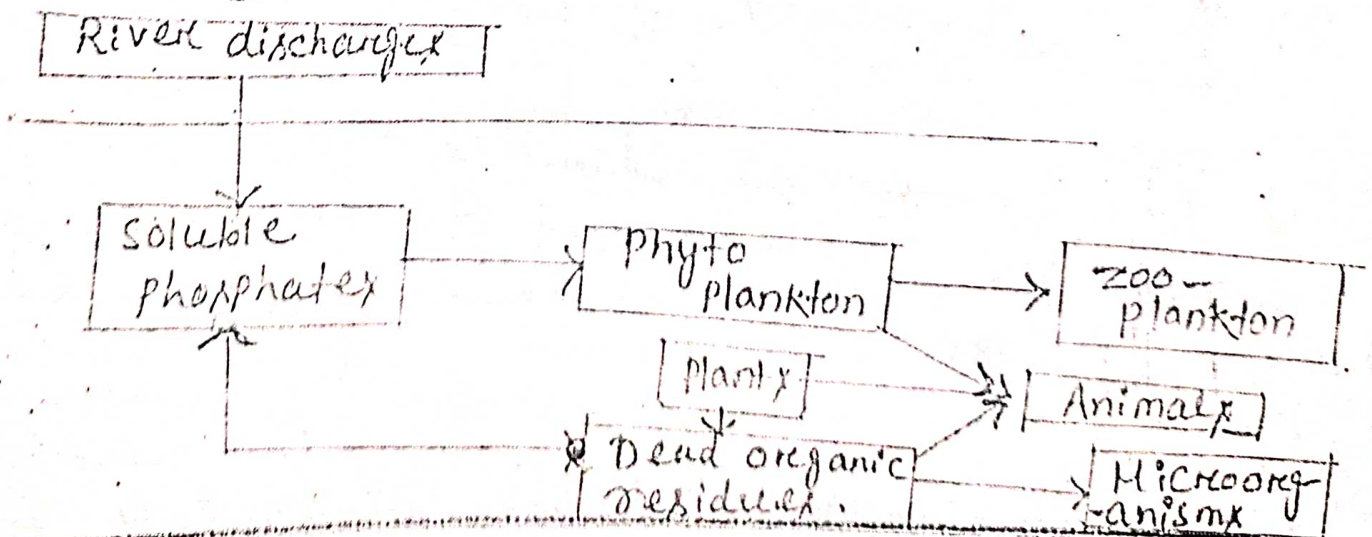


- There is a net increase of carbon dioxide in the atmosphere of 11 billion tonnes per year. This can be reduced by 50% if we can stop deforestation.

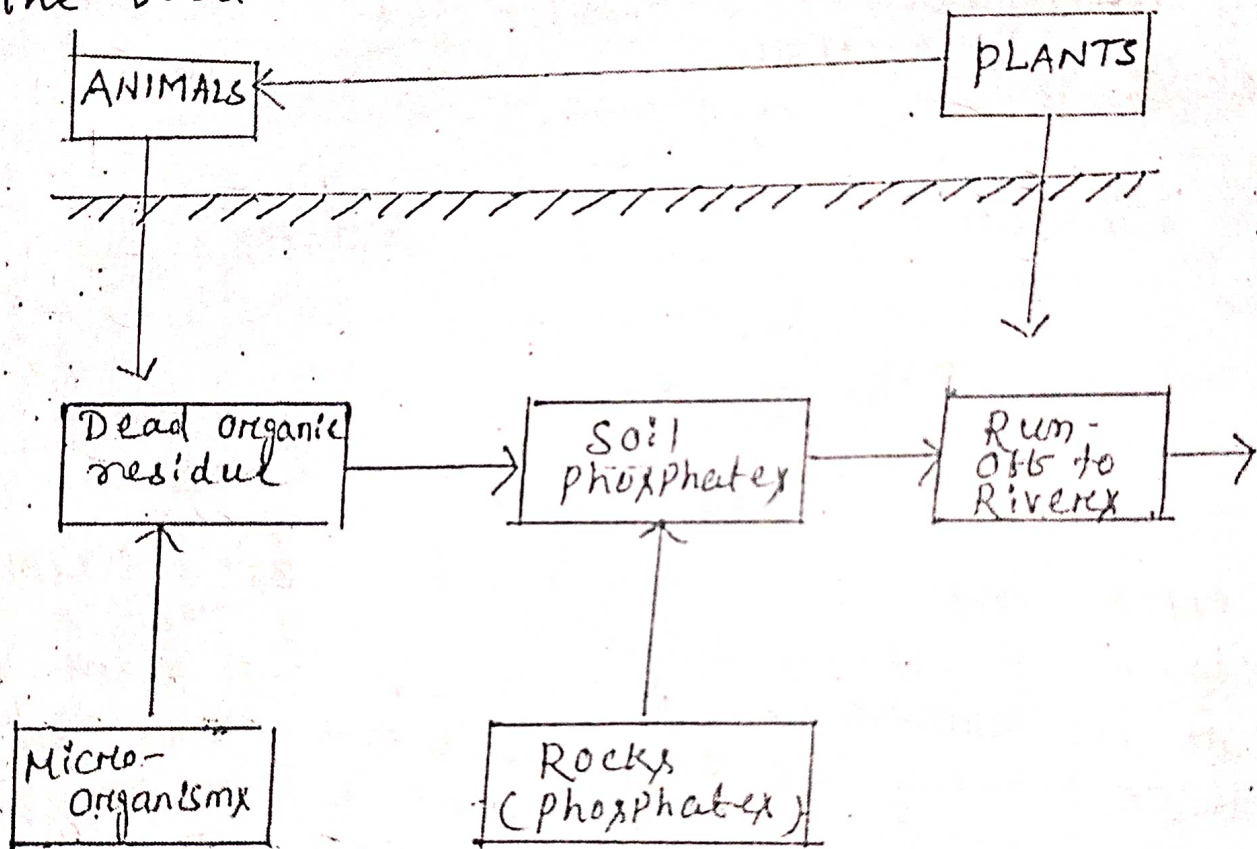
→ Phosphate Cycle :-

- phosphates are necessary for the growth and maintenance of animal and human bones and teeth while organophosphates are required for cell division involving production of nuclear DNA and RNA.
- Phosphate is the mineral exist in soluble and insoluble forms in rocks and soil.
- Plants absorb inorganic phosphate salts from soil and change them into organic phosphate.
- Animals obtain their phosphate by eating plants.
- After death and decay, plants and animals return phosphates to the soil.
- Bulk of phosphate in soil is fixed or absorbed on soil particles but some part of it is leached out into waterbodies.

The phosphate cycle in water



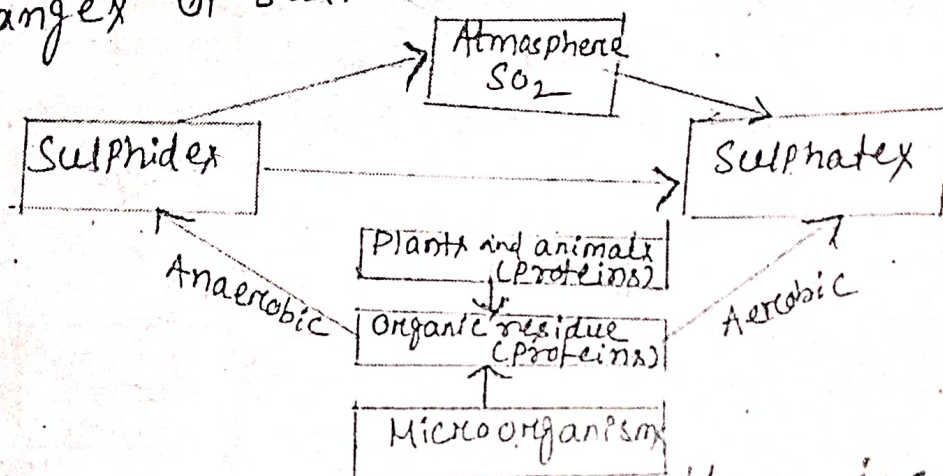
- The natural phosphate cycle is affected by pollution, mainly from agricultural containing superphosphate and also from domestic sewage.
- Phosphate pollution of rivers and lakes causing algal bloom (eutrophication) which reduces dissolved oxygen in water and disrupts the food chain.



The phosphate cycle on land

→ SULPHUR CYCLE : —

- Sulphur and its components are required by plants and animals for synthesis of some amino acids and proteins.
- Through Sulphur cycle the sulphur and its components circulate in the environment.
- Some Sulphur bacteria act as the media for exchange of Sulphur within the ecosystem.



- In upper half of the cycle, there is a sulphur oxidation process. Whereas the lower section shows the conversion of sulphate into plant and cellular proteins and decay of dead plant and animal material by bacterial action.
- In polluted waters under anaerobic conditions hydrogen sulphide is produced by bacteria giving deposits of iron sulphide.
- Whereas, in unpolluted waters under aerobic conditions the Sulphur bacteria transform sulphides into sulphates for further production of proteins.

Energy Resources:

- There are two types of energy resources:-

- ① Conventional energy resources / Non-renewable
- ② Nonconventional energy resources / Renewable

① Conventional energy resources

- The demands on energy are increasing with progress in human civilization. The quantum of life or standard of living is linked with the quantum of energy consumption.

- Electricity generation using heat of steam marked the beginning of thermal power production in the middle of 19th century.

- Maximum wastage of energy is observed in power plants and vehicles.

- The conventional energy resources are Fossil fuel (Coal, petroleum, and diesel), wood, natural gas, Hydroelectricity, Nuclear energy.

- The energy consumed by man, is 33% from petroleum and diesel, 27% from coal and 5 percent from nuclear fuels.

1.1 Coal

- Coal is substantially more abundant than oil.

gas. This is 1000 times more than the total global energy consumption from all fuels.

The main problem with coal is, it is a dirty fuel to burn. On combustion, it emits sulphur dioxide and forms sulphuric acid in air and causes acid rain. Thus it poses environmental hazards.

• Excavation of coal from mines causes soil depression of that area, which endangers the residential areas above the coal mines.

• Flyash arising from combustion of coal is also creates environmental problems.

Also being a solid, coal is less convenient to handle than petroleum or natural gas.

• In order to overcome these problems, the developed countries use less polluting forms of coal by transforming it into gaseous, liquid or low sulphur, low ash solid fuel.

For this suspending pulverized coal in a solvent and treated with 2% of its weight of hydrogen at a pressure of 1000 pounds per sq. inch and 450°C .

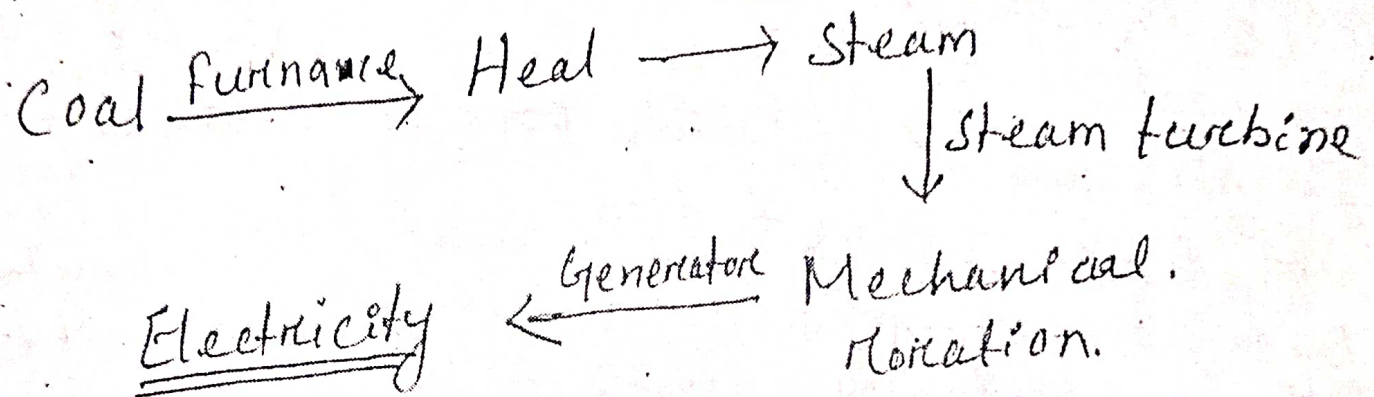
2. Thermal power :-

• Thermal power contributes about 65,000 Megawatts of electricity i.e. 70% of India's power supply.

• Thermal power stations (NTPC of India at Singrauli

and Rihand in UP, Talchar in Odisha and Farakka in West Bengal) are the major sources of severe air pollution.

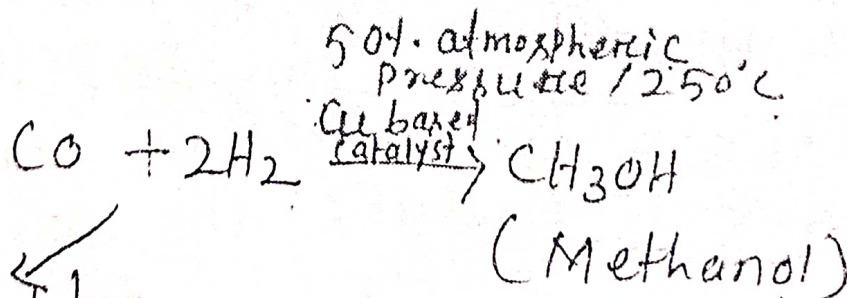
- Thermal power stations are operated on the above principle by combustion of coal in a furnace.



- Combustion of coal during electricity production is the major source of air pollution.

1.3 Methanol (CH₃OH) :-

- It is liquid fuel, which can be produced from coal.



Obtained from
coal, O₂ and
Steam.

- 15% Methanol makes an excellent additive to gasoline which improves fuel economy and also

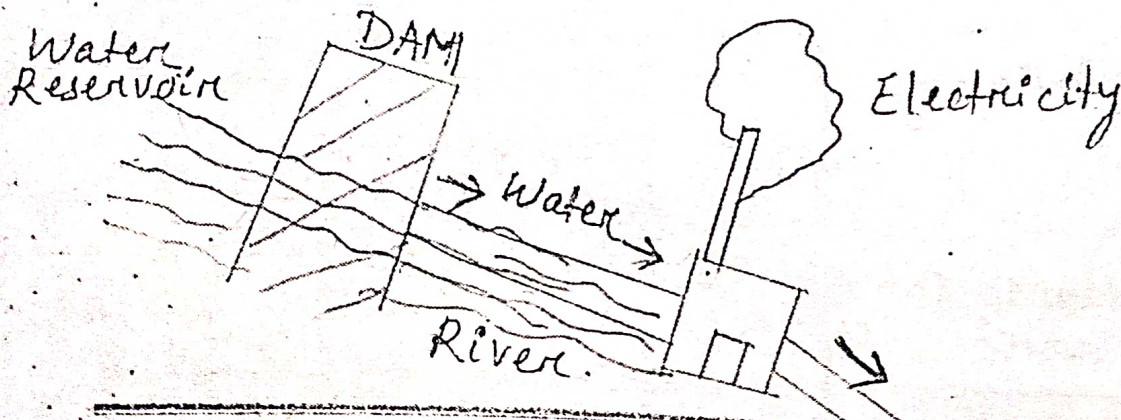
cut down the emission of practically all auto-mobile pollutants.

1.4) Petroleum are mineral oil :-

- The consumption of petroleum and natural gas is maximum in the developed countries.
- The industrial Revolution was initially fuelled by coal but later on preference was given to oil and gas, which provide cleaner fuel and easy transportation.
- Because of increased consumption of petroleum and mineral oil, these are likely to be exhausted within a century (sooner than expected)

1.5) Hydroelectricity

- Hydroelectricity means the electricity from water. In India, its water resources are properly utilized, it may be possible to generate more than 10,000 MW of electricity (at present only 16% or 6,500 MW).

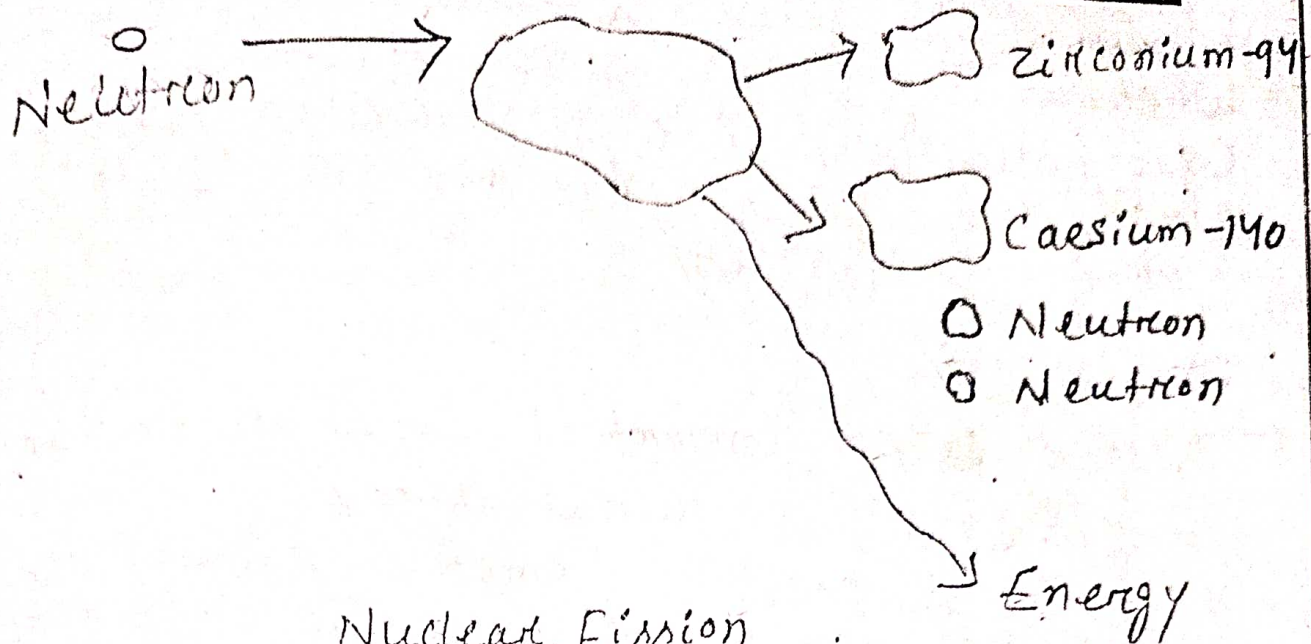


- The Merits of hydroelectricity are: Clean source of energy, no emission of greenhouse gases, no consumption of fuel, no need of high technology.

- But there are some environmental issues. Flora and fauna in the region are disturbed due to construction of dam, local people become refugees (migrated from their houses). The capacity of the reservoir gets reduced due to siltation, occurrence of floods in the area where surplus water has to be discharged in monsoon season.

1.6) Nuclear power: —

- It contributes only 5% of total electricity generation.
- Nuclear power plants do not emit polluting gases such as CO_2 , SO_2 like thermal power plants.
- But they have some major drawbacks like they are costly and release large quantities of radioactive fission products.
- These radioactive wastes remain lethal (deadly) for thousands of years and for this no disposal method has been devised. Thus it contributes only 5% of total electricity generations.



Nuclear Fission

- At present, nuclear fission is used to produce nuclear power. Heavy large atoms like Uranium and plutonium split up into smaller atoms when bombarded by neutrons.
- This fission/splitting liberates vast amounts of energy, through conventional techniques it is converted into electricity. Thus nuclear power is generated.

⑦ Wood

- Wood is a major renewable energy/natural resource. But due to increased population (domestic use), this renewable energy resource is in an endangered position.
- In India 76% of population lives in villages - almost all of them use wood as fuel for cooking. This is the main reason for extensive defor-

- Deforestation in rural areas.
- Each year we are losing about 1.3 million hectares forests. Deforestation increase greenhouse gas, Carbon dioxide concentration etc. (Burning of wood increase air pollution)
- The major products from wood are paper, cellophane, rayon, plywood, plastic, turpentine, Methanol and particle board etc.

1.8) Natural Gas

- It is a better fossil fuel than coal and petroleum. On burning it produces less CO_2 .
- For production of one unit of energy, mineral oil, coal and wood, on burning, produce respectively 35%, 75% and 80-90% more CO_2 than natural gas.
- Hence it is the choice of cleaner fuel.
- But it is a non-renewable energy resource ~~because~~ hence it can continue to be used only for the next 70-80 years.
- At present, in India the exploitable reserve of natural gas is about 700 billion cubic metres.

② Nonconventional Energy Resources : —

a. It is also called as Renewable energy resource

②.1 Solar energy

- This is an enormous and model energy resource which is clean, pollution free and inexpensive.
- It requires to be converted into other forms of energy by suitable techniques, which can meet our energy demand forever.
- The solar energy of one week is equivalent to the energy from the entire coal reserve of the world.
- The major problem is that sunlight is diffused in nature and difficult to be stored and utilized.
- But by using advanced technology, the sunlight may be directly converted into electricity through photovoltaic cell and this will cause conversion of light energy into electrical energy.
- The solar energy can be used in two ways.
 - i) Use of solar heat.
 - ii) Use of solar electricity.
- Solar heat is used in solar cooker, solar dryer, solar water heater, solar distillation.

- Whereas by using solar electricity, solar cell, sun rays are converted into electricity. Since the solar cells are made of silicon, called silicon cells.

(2.2) Biogas :-

- Biogas is an important solution to the present energy crisis in rural areas.
- It is an important domestic energy resource as it offers an environmentally clean technology. There is a vast reserve of biogas in Indian villages.
- The composition of the biogas is methane, CO_2 , hydrogen and nitrogen.

(2.3) Wind energy :-

- It is the cheap and clean energy resource.
- But there are some limitations for setting up wind power mill or wind mills. They require locations where the wind velocity is at least 6.5 m/sec .
- The technology for harvesting wind energy has become commercial in some developed countries but in India it is still in the preliminary stage.
- The department of nonconventional energy sources, Government of India has installed several wind pumps with pumping capacity of 20 litres.
- Wind energy can be used advantageously in remote

rural areas and would help in saving fossil fuels.

2.4) Ocean and Tidal energy:-

Ocean waves splash on ocean shores at tremendous speed, the mechanical energy in this process can be converted into electrical energy.

- It has been found that in the middle of North Atlantic ocean, each wave per 1 mt. height can generate 90 kW electricity whereas on the ocean shore, the wave can generate 25-70 kW.
- During storm, the generation level can rise up to 15 megawatts.

2.5) Tidal wave can also be trapped for generating electricity. During low tide seawater enters river - it is possible to store such seawater in a big tank and rotate turbines by the mechanical force in the process and generate electricity.

2.5) Geothermal energy

- The earth's core has a vast source of thermal energy, which has been tapped in many developed countries.
- In France and Hungary, hot water from hot springs has been utilized for heating houses and agricultural farms.

- Japan and New Zealand have been working on the exploration of geothermal energy as an energy resource.

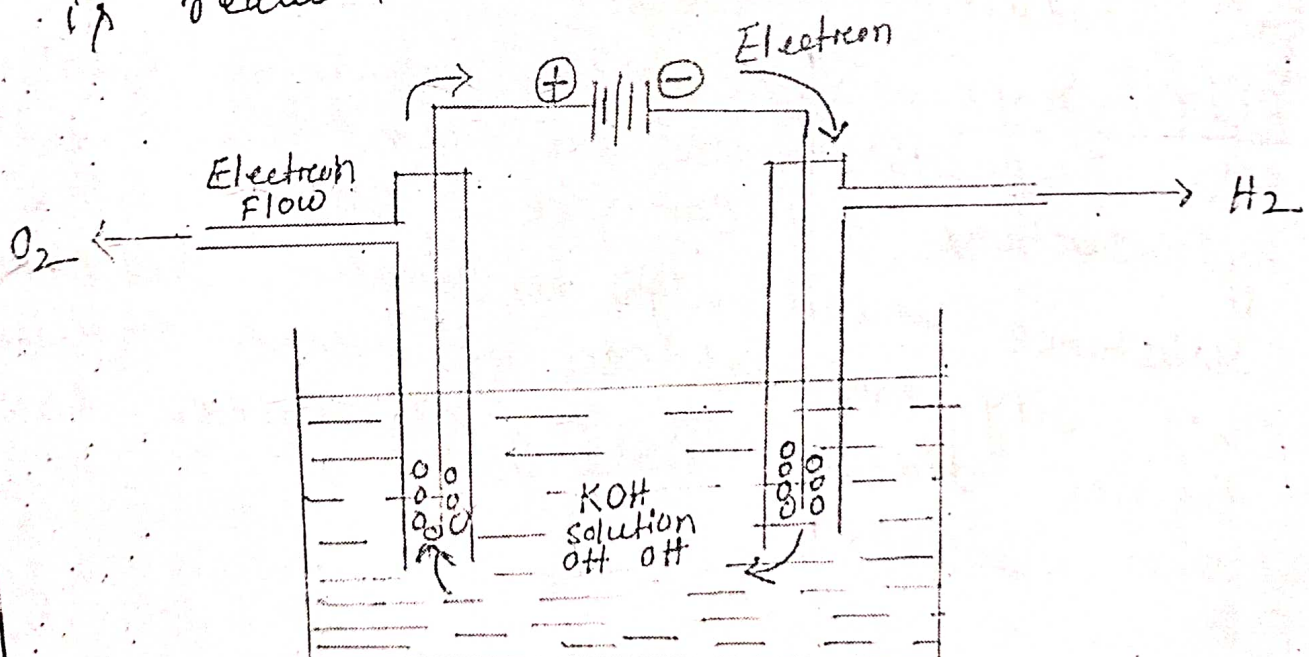
Q.6) Energy Plantation :-

Energy Production from waste.

- Energy can be produced from waste like agricultural, industrial and municipal waste.
- Agricultural waste are mainly crop residues. They are dried and used as fuel. Straw, Jute sticks and other crop residues are burnt by villagers for cooking and partial boiling of Paddy.
- In certain industries, the waste materials can be utilised as a source of energy. In Food processing, jute, sugar, paper and textile industries, the waste materials can be utilised for production of heat and electricity.
- Petro-crops:- Some latex containing plants like Euphorbia and oil palms are rich in hydrocarbons and can yield an oil like substance under high temperature and pressure. This oily material can be burnt in diesel engines directly or may be refined to form gasoline.

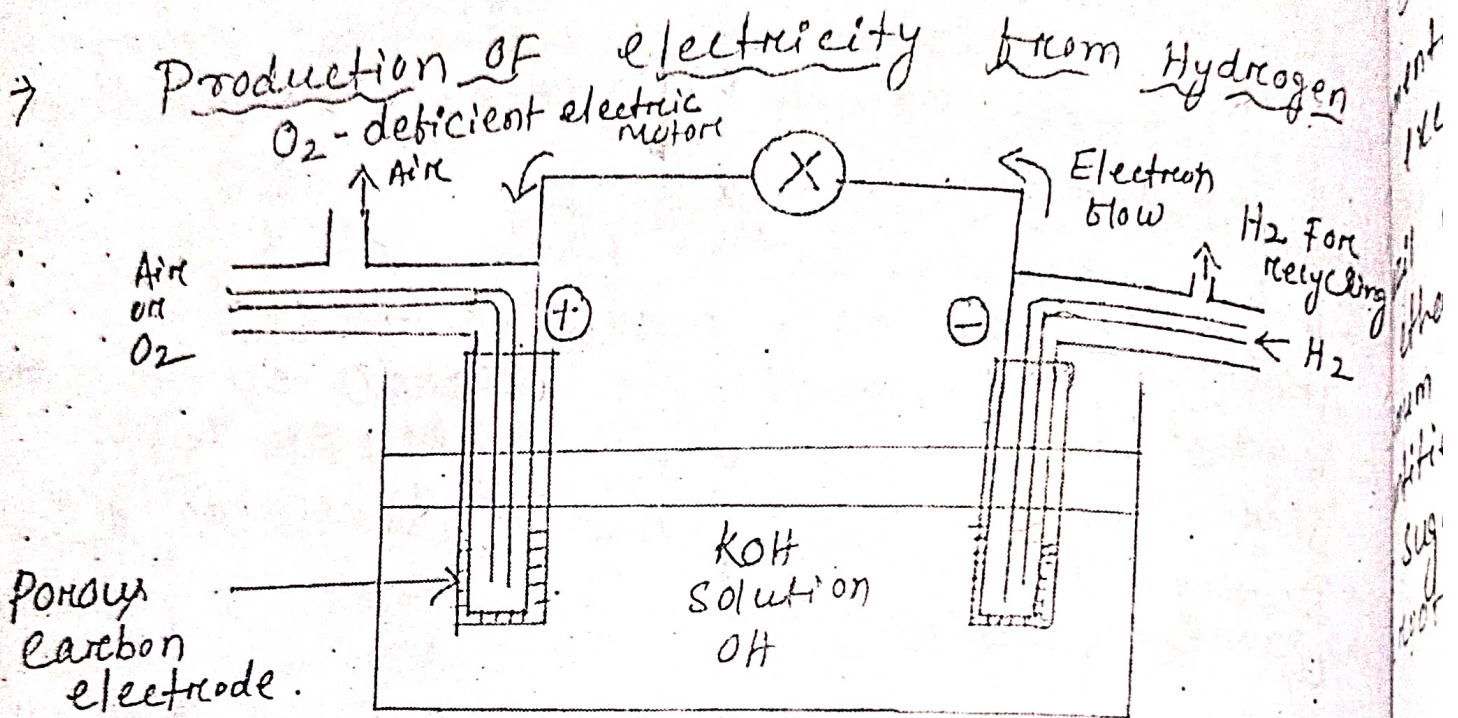
2.7 Hydrogen fuel :-

- It is an energy storage process where chemical stored in the form of H_2 .
- This gas is generated directly by electrolysis of water (H_2O)
- Electricity is passed between electrodes immersed in a conducting aqueous solution. H_2 is generated at the cathode and O_2 at the anode
- The energy stored in H_2 can then be converted into electricity using the reverse of the electrolytic cell called fuel cell.
- Here H_2 is oxidised at the cathode, where electrons are produced and passed through the circuit to the anode, where O_2 is reduced.



(production of Hydrogen electron)

Anode reaction: $2OH \rightarrow H_2O \rightarrow H_2O + \frac{1}{2}O_2 + 2e^-$
 Cathode reaction: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$



Anode reaction: $\frac{1}{2}O_2 + H_2O + 2e^- \rightarrow 2OH^-$

Cathode reaction: $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$

2.8 Gasohol

- Gasohol blended with up to 20% Methanol or ethanol is known as gasohol. This can be used as a fuel in existing internal combustion engine with little or no adjustment.
- Methanol or ethanol itself can be used as fuel (instead of gasoline) in a suitable designed internally combustion engine.
- Methanol is produced by the destructive distillation of wood or from synthesised gas manufactured from coal or natural gas.

- The manufacture of alcohol can be carried out by fermentation of sugar & resulting from the hydrolysis of cellulose in wood waste and crop wastes.
- Fermentation of these waste products provides an excellent opportunity for recycling.
- Brazil is the leading country in the manufacture of ethanol for fuel, this country provides optimum conditions for the growth of large quantities of biomass from the fermentation of sugarcane (recently cassava and manioc, a root crop).