7. It should be cheaper.
8. Their transport and storage should be easier.

Types of Energy Resources

On the basis of pattern of their use, energy resources are of two types -conventional and non-conventional sources of energy. Resources are of two types-conventional sources and non-conventional sources.

(A). CONVENTIONAL SOURCES OF ENERGY

Energy resources that are being used by man since long back are called **conventional sources of energy**. E.g. Fossil fuels (eg. Coal, petroleum and natural gas) and firewood. These sources of energy are also called as **non-renewable** sources of energy as they are available in limited quantities.

1. Fossil fuels

Fossils fuels are the remains of plants and animals that were buried in the earth millions of years ago. Actually it was the radiant energy of the sun that caused the growth of these plants, which were then later on converted into fossil fuels. Without sunlight, there could have no coal, petroleum, natural gas, wood or any other fuel in this world. Today we burn fossil fuels, we are actually making use of the sunlight energy that was stored by plants millions of year ago.Fossil fuels like coal, petroleum and natural gas are non-renewable sources of energy, which, if exhausted, cannot be replenished in short time. This is because of the fact that fuel, which we use today took millions of years to be formed and if they are exhausted today they will again take millions of years to be formed. This is why fossil fuels are very precious and should be used with care and caution and not wasted so that the existing resources of fossil fuels can be used over long period.

(I). Coal : Coal is a fossil fuel. It is a conventional source of energy, which is a complex mixture of carbon, hydrogen and oxygen. It contain small amount of sulphur and nitrogen also. The coal deposits are the remains of those plants, which were found in large marshy place before 300 million years ago. These plants were buried in the earth and converted in to coal. The process of coal formation is called carbonization, is very slow process, which takes millions of years. To day coal is extracted from coal mines to fulfill our energy need. In India coal deposits are found mainly in Bihar, Jharkhand, Orrisa, Madhya Pradesh, Chattisgarh and Bengal. Coal is mainly found in three forms, lignite (brown coal), bituminous and anthracite coal. The amount of combustible substances and moisture contents vary in different forms. Foe e.g. Lignite coal contains 38% carbon, 19% combustible substances and 13% moisture contents. Bituminous coal contains 96% carbon, 1% combustible substances and 3% moisture contents whereas anthracite coal contains 96% carbon, 2% combustible substances and 1% moisture contents. It is the most important fuel.

Environmental Consequences

1. Mining of coal results in to large-scale destruction of vegetation, animal habitat and land degradation.
2. Mining activities results in water pollution in neighbouring water bodies.
3. The combustion of coal leads to the emission of carbon dioxide gas, which is a green house gas.
4. After burning it also releases carbon monoxide and sulphur dioxide like gas, which are responsible for environmental pollution. Carbon monoxide gas is very injurious to human health. Sulphur dioxide gas is gas is very injurious to human health and also responsible for acid rain.

5. The smoke emitted due to the combustion of coal causes smog especially in the cold winters is severe environmental problem.

(ii). Petroleum: Petroleum is also a fossil fuel. It provides more energy than coal. Their use is also easier and comfortable therefore its utility is increasing day by day. Overall reserves of petroleum in the world are about 356.2 billion tones. 40% of the total energy of the world is obtained from petroleum substance. The rate of consumption of petroleum oil is too high and if it is continued then it should be exhausted within 50-60 years. In India oil exploration is increasing rapidly. During 90s more than 322 lakh tones of oil has been produced on an annual basis.

Petroleum is formed inside the earth by the decomposition of the remains of marine organisms which died millions of years ago got covered with layers of sediments. Anaerobic bacterial breakdown of organic remains of animals and plants liberate nitrogen, oxygen and fatty acids. These under pressure and heat of overlapping sediments are converted in to oil droplets. Petroleum oils are extracted in the form of crude oil from its underground reserves. It is a brownish-black thick, viscous liquid with a greenish appearance, which is present deep inside the earth at a depth of about 1000meters in between the layers of impervious rocks. It is also known as crude oil. Usable petroleum oils are obtained from the distillation and refining of crude oil at deferent temperatures. The various products obtained at different temperatures are petrol, diesel, kerosene oil, fuel oil, naphtha etc. 65% of global reserves belong to Asia. 14% to North America and rest 19-21% belongs to other parts of the world. Important Indian oil producing regions are-

1. North-Eastern regions: Digboi, Nahar, Shivsagar, Lunel
2. Gujrat: Ankaleshwar, Kalol.
3. Mumbai high region: It is situated in the Arabian sea 200 km away from west from Mumbai.

(iii). Natural Gas: Natural gases are the gases found with petroleum reserves in the rocks. It is mainly composed a hydrocarbons 85% methane (CH_4), 10% ethane, propane and butane. Methane is the main component of natural gas. Many oil wells also provide natural gas as a co- product along with petroleum oil. Some wells are known only for natural gas. The coastal regions of Khambat and in the Arabian sea of Maharastrian coasts are major oil and natural gas producing regions of India. India has about 0.4% of the world's natural gas reserves. Presently some other reserves of natural gas are also discovered, which are situated in the off shores of Jaisalmer and Mumbai and in the delta of river Krishna and Godavari. The availability of petroleum and natural gas governs the energy growth and status a country.

(iv). Liquefied Petroleum Gas (LPG): LPG is a natural gas, which is a mixture of ethane, propane and butane. Butane is the chief component of LPG. It burns very easily with the release of a very high amount of energy. It is obtained from the fractional distillation of petroleum and also from natural gas. At high butane is converted into liquid state. The gas used for domestic cooking is termed as liquefied petroleum gas (LPG) because it is liquefied before filling into cylinders. When we opens the valve of cylinder then it comes out of the cylinder and get converted into gaseous state due to low pressure and flowing towards burners. It burns with blue flame. LPG is a superior quality of cooking fuel commonly used for domestic heating purposes.

Advantages of natural gas

1. It is a good fuel and can be used directly.
2. It burns without any smoke and not release any polluting gas.
3. Its burning capacity is very high; hence it is an excellent fuel.
4. The gas can be transported to the consumers with the help of pipelines.

Efforts for the Conservation of Petroleum

Petroleum products are very important for us and their reserves are just enough to last us for only about two to three decades. Hence priority will be given to conservation of petroleum products. Petroleum and Gas ministry of India have been proposed the following measures for the conservation of petroleum-

1. Development of awareness among public for the conservation of petroleum products.
2. Encouragement of misuse preventive measures of petroleum products.
3. To improve the oil utilizing efficiency of engines, instruments and vehicles.
4. Researches for the development of oil utilizing efficiency of consumers.
5. Encouragements for the use of inter fuel substitution or alternate sources of fuels, such as use of C.N.G. in road transport.

(iv). Fire wood: Firewood has been an important source of energy since the earliest times of human history. Forests are the chief source of firewood. Even today in many poor and developing countries, firewood is used for cooking and heating. In rural areas of India, firewood along with agricultural wastes provides the basic source of energy. It is estimated that the annual demand of firewood in India is increased up to 300-330 Mt. and we get only 50 Mt. firewood from our forests. The plantation of more and more trees in wastelands can fill up this gap of demand and supply of firewood.

(B) NON-CONVENTIONAL SOURCES OF ENERGY

The energy resources are alternatives that are discovered to save us from the energy crisis the world is facing due to depletion of fossil fuels are called **non-conventional sources of energy**. These are those sources of energy, which can be renewed and are being available for long time. Due to this property these sources of energy are also called as **renewable sources** of energy. E.g. biomass energy, solar energy, wind energy, ocean energy, hydel energy, geothermal energy and nuclear energy. Today we are facing energy crisis because our natural sources of petroleum, natural gas and coal are dwindling day by day. If we want to maintain our standard of life in the face of expanding population, we will have to develop new sources of energy. Approximately 80 years is the time limit for exhaustion of resources of petroleum and natural gas. So it becomes necessary to turn us to discover other sources of energy i.e. non-conventional sources of energy.

1. Biomass Energy

Biomass is the waste material of living beings. It includes wood, grasses, cattle dung, sewage, agricultural waste, and crop residue, like bagasse (remaining part of sugarcane after juice has extracted), rice husk etc. The sources of biomass can be divided into following two categories:

(i). Wastes of agricultural, forestry and town corporations,

(ii). Energy crops.

Potential

It is estimated that about 300 million tones of crop residues are produced in India every year, which theoretically can generate about 40,000 MW of electricity. The place where sufficient crop residue is not available, the only viable option would be a mix of crop residue and plantation wood. The concept of energy plantation with fast growing species of trees has come up especially for this reason. This yields about 25-30 tones of dry biomass per hectare per year in poor soils with good irrigation facilities.The technology for biomass based power plants is the same as that of a coal based plant. If power plant is fueled by 50% wood from energy plantations and 50% biomass residue, the electricity cost will be about Rs 1.45 kw/hr

for recondition plans and Rs 2.25 kw/hr for new plants. Today the power generated from these plants can be directly fed into the national grid. The following efforts have been made in India to get energy from biomass transformation-

1. A pilot project is started in Delhi (Timarpur) for the generation of electricity from the corporation waste.
2. Establishment of rice husk based heating plants with 10 MW capacity.
3. Production of fuel tablets by using corporation wastes. The production of these fuel tablets is started in Mumbai.
4. Establishment of sugar water based electricity-generating plants with 15 kw capacity.

Advantages of Biomass

1. It is a very cheap, eco-friendly and convenient conventional source of energy.
2. It generates employment to people in rural areas.
3. It fulfils the energy requirement of the villages.

Limitations : It is confined to a small area and cannot be transported to remote places.

2. Biogas

Microorganisms can easily degrade the residues of plants and animal origin in the presence of water contents. In this process the produce methane, carbon dioxide, hydrogen sulphide like gases. The mixture of these gases of biological origin is called biogas. Biogas contains about 65% methane gas, which is a best fuel. It is used for cooking of gases and lightening of houses and roads. It is also used in engines as a fuel.

Structure of Biogas plant: A biogas pant has following components-

(i). Foundation: It is made up of concrete.

(ii). Digester: It is a well like ditch on the foundation. Its wall has two holes situated opposite to each other. First hole is called inlet and second one is called outlet. Digester is used for the digestion of slurry of dung.

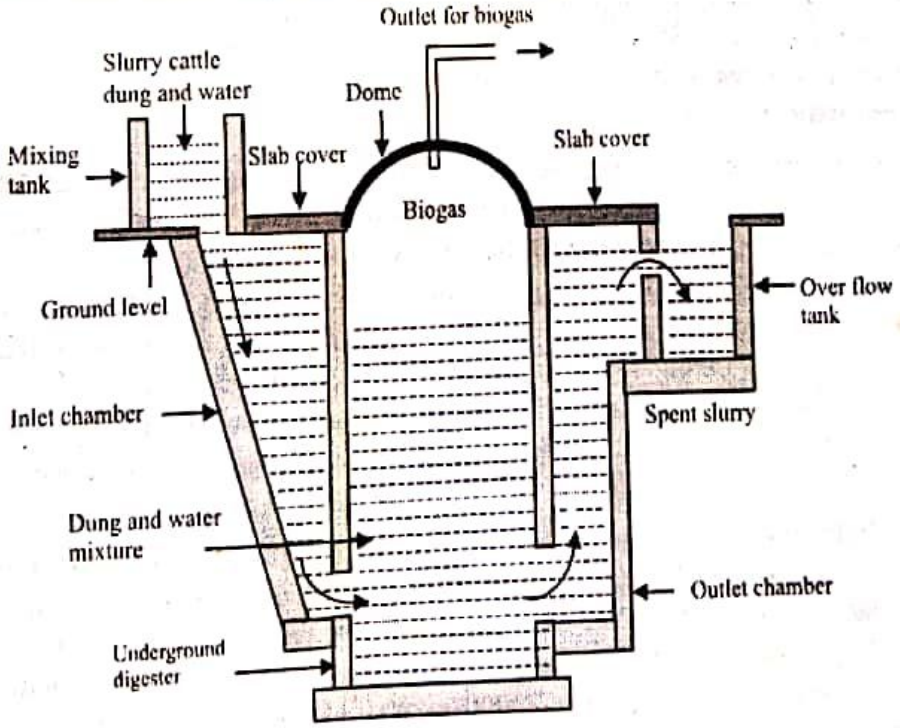

Fig- 1.2- Fixed dome type biogas plant

(iii). Dome: It is a dome shaped structure fitted over digester. It is meant for storage of biogas.

(iv). Inlet: It is a pipe like structure meant for filling the mixture of dung and water.
(v). Outlet: It is a wide mouthed structure for removal of digested slurry.
(vi). GI pipe: It is connected with the upper part of the dome. The other end is connected with gas supply pipe.

During the production of biogas a mixture of dung and water is poured in biogas plant every day. This slurry is digested in digester by anaerobic micro-organisms. During the digestion, biogas is released, which is collected within the dome or gasholder. Domestic waste and sewage is also used in large cities to biogas in large scale. It provides not only biogas but also solves the problem of water pollution.Gobar gas is a biogas. It is very, cheap, fresh and convenient fuel, which used for cooking food, lightning of houses and roads as well as a fuel foe cottage industries and small vehicles.

Advantages

1. It solves the problem of energy of the villagers and save their labour.
2. It does not cause any pollution.
3. It is safe for human health and does not cause any disease.
4. Cutting of forests for fuel wood should also be checked.
5. It also provides a good quality of organic manure for crops.

3. Solar Energy

We know that heat loss takes place from any object by the process like conduction or radiation. To prevent the loss of heat by conduction or radiation, it would be necessary that the upper surface of glass plate is covered by a black surface and then it is placed in any heat resistant box. The glass plate prevents the visible and infra radiations to go out side. The inner walls of the box are covered by black polish to absorb more and more heat and to prevent their loss. The inner surfaces of the box along the glass plate get heated when these solar heating devices are placed in light for some time. These surfaces then start to radiate infrared radiations but the glass plate prevents them to go out side. Thus the heat energy of inner box remains in side the box. This heat energy is used in solar cooker, solar water heater, solar cells etc.

3. Wind Energy

Moving air is called wind. As we all know that energy possessed due to the motion of anything is called its kinetic energy. Thus, when air moves from one place to another it possesses kinetic energy. The energy possessed by wind depends on its velocity. If air is stationary it has no kinetic energy. However, when it starts moving it generate kinetic energy. This wind energy is fast emerging as the most cost effective source of power as it combines the abundance of a natural element with modern technology. The great advantage of wind driven power stations that, it is in harmony with the environment. A wind driven power station consumes no raw materials neither does it have any waste. Being a cheap source of energy and with simple manageable technology, it is ideal for the developing countries.

In India, efforts to use the latent power in wind began in 1985, when the joint sector Gujrat Development Agency formed winds farms on its own. In the state of Tamilnadu, wind energy has harnessed. In India, the exercise to harness wind energy includes wind pumps, wind battery chargers, wind electric generators and grid connected farms. With the help of this wind energy, it is possible to generate 20000-mws of electricity. Asia's largest wind energy based power plant with a capacity of 150-mw of electricity is established in Muppandal, Tamilnadu.

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Advantages of wind energy

1. It is renewable, abundant, inexpensive and pollution free.
2. It is being used to generate electricity, to run pumps to draw water from the ground, to run flour mills to grind the grains like wheat, corns etc. at a minimum cost.
3. It can be supplied to remote areas where other sources of energy are not possible.

4. Ocean Energy

Basically, there are following six ways of generating power from the oceans water-

(i). Ocean thermal energy: There is always a temperature difference between the water at the surface and at deeper level. This difference at many places is of the order of 20° C. The energy obtained as a result of this temperature is known as ocean thermal energy. The ocean thermal energy can be converted to electric energy.

(ii). Wave energy obtained from ocean waves: Waves piled up by the wind at the surface of the oceans continuously rise up high and fall down the shorelines, this energy is known as wave energy.

(iii). Tidal energy: Tidal energy is generated by harnessing the periodic rise and fall of ocean water, which is produced by the gravitational attraction of the moon and sun. Tidal flows consist of the vertical motion of the rise and fall of the water level whereas the tidal currents are horizontal movements, which move either towards or away from the shore. Tidal power is possible along the coast where there is sufficient difference between high and low tide. Incoming and outgoing currents rotates turbine to generate electricity. At the high tide, water floes through the turbines into a bay, and during a low tide, it flows out thus running the turbine. Conversion of energy is possible only during tidal flow.

(iv). Current energy: The running water current of ocean water is passed through a series of turbines to generate electricity. The magnitude of energy generated in this way is very low and the maintenance of the movement of turbines for long time is difficult because of the irregular water currents.

(v). Ocean wind energy: The wind flowing over ocean is powerful and uninterrupted hence it should be used to generate energy.

(vi). Energy due to salinity gradient: There is difference in the concentration of salt where water from two different seas meet. This difference in salt concentration is referred to as salinity gradient. Due to this gradient water flows speedily from high concentration to low concentration, which is used to obtain energy.

5. Geothermal Energy

The energy released by the heat stored inside the earth is called geothermal energy. At most places on the earth, the magma are many miles below the ground, but at some locations, it comes close to the surface, creating hot spots. When ground water comes in contact with hot spots, the water turns to steam. This hot water or geothermal steam can be used to generate electricity. The steam can also be directly piped into buildings for heating.

In India 340 such hot water springs with an average temperature of 80-100°C have been identified in our country and researches are going on in this field. A geothermal pilot plant is established in Kullu district of Himanchal Pradesh, which generates 50kw electricity.

5. Nuclear Energy

The heat energy requirement of the human beings is increases with the progress of civilization. The energy generated by fission or fusion reactions of the nucleus of some heavy metals is called nuclear energy. Nuclear energy is basically stored in the nucleus of certain heavy metals, such as uranium and plutonium. The nuclear energy is generated by following two processes-nuclear fusion and nuclear fission.

(i). Nuclear fusion: The reaction in which two lighter nuclei at high temperature (10^7k) and high-pressure fuses to form a heavier nucleus is called nuclear fusion. E.g. two deuterium (isotope of hydrogen) nuclei fuse to form helium nuclei ($_2He^4$) with the release a huge amount of energy (about 21.6 MW).

$$_2He^4 + {}_2He^4 \longrightarrow {}_2He^4$$

The energy emitted is would be very higher then the burning of 6 x 108 kg of coal in the air. Nuclear fusion is a uncontrolled reaction which require very high temperature and pressure. The energy of the sun is also produced due to nuclear fusion.

(ii). Nuclear fission: The process of splitting of the nucleus a heavy metal in special machines called reactor is called nuclear fission. In this process a heavy metal is bombarded by moving neutrons to break into two lighter nuclei with the release of 2 or 3 neutrons and vast amount of heat energy. E.g. nuclear fission of uranium (U^{235}), it broke up into two lighter nuclei barium (Ba) and krypton (Kr) with the release of 2 or 3 neutrons and vast amount of heat energy. 0

$$_{92}U^{235} + {}^1n \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + {}^3n^1 + \text{energy}$$

When isotope of U^{235} absorbs a slow moving neutron then a reaction takes place between the neutron and nucleus. It results in the increase of electrostatic force of repulsion in comparison to nuclear attractive force due to which the nucleus becomes flattened. Further increase in the repulsion force results in the formation of a neck like shape and at last it breaks into lighter nuclei (Ba and Kr) with the release of a large amount of heat energy.

The heat energy produced by nuclear fusion and nuclear fission reactions is utilized in the production of heat from water. The steam in turn is used to rotate a turbine coupled with electric generators. Thus when blades of turbine rotate, the heat energy of the steam is converted into electric energy. Several nuclear power plants are functioning in India and they are situated at Tarapur (MS), Kalpakkam (Tamilnadu), Kota (Rajsthan) and Narora (U.P.). In India about 4% (2720 MW) electricity is generated by the use of nuclear energy. The first and largest nuclear power plant of the Asia was established in India in 1969.

Limitation of nuclear energy

1. It causes radioactive pollution.
2. It needs sophistically engineered safety features to safeguard against any accidents, which could cause a disaster.
3. Radioactive wastes endangered the environment and can affect living beings for a number of generations.
4. The waste products emits nuclear radiations which can cause diseases like cancer, leukemia etc.

NEEDS TO DEVELOP NON-CONVENTIONAL ENERGY SOURCES

Today energy would not become only a need to do work but also becomes a scale of the richness of the person and country. The consumption of energy indicates economic development of any country. Although the population of United State of America is only 5% of the total population of the world, it alone consumes about 80% of the total generate energy of the world. On the other hand, there are many poor countries in the world that are unable to cope its energy requirement. At present we are facing energy crisis because our traditional sources of energy such as petroleum, natural gas and coal are dwindling day by day. If we want to maintain our standard of life in the face of expanding population, we will have to develop new sources of energy. Approximately 80 years is the time limit for the exhaustion of natural

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ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Since the advent of industrial and technological revolutions, the ecological system has become unbalanced and natural resources has become overstrained due to greed and short sightedness of man, population explosion, environmental pollution, deforestation, habitat destruction, loss of biodiversity etc. Any development process is bound to have impact on the environment. Environmental degradation poses a direct threat to the quality of life. Thus, it became necessary to have awareness of the ecological and social cost of unrestrained technological progress and have an idea of possible impacts of any development plan. With this view, the "Earth Summit" was sponsored by United Nation Conference on Environmental and Development (UNCED), held at rio-de Janiero in 1992. The "Earth Summit" stressed on the following strategies-

1. Making development ecologically sustainable
2. Adopting environmental friendly technology
3. Effective regulatory provisions for environment protection.

Current environmental problems all over the world are related to imbalance development. Economic development can not succeed unless development planning includes environmental assessment in all economic decisions. Environmental Impact Assesment (EIA) is the study of the probable changes in socio-economic and biophysical characteristics of the environment which may result from a proposed development plan. EIA represents a means of evaluating and simultaneously controlling the quality of human environment. EIA can be considared to be a planning tool which assists planners in anticipating potential future impact of different development activities both beneficial and adverse with a view to select the 'optimal' alternative.

For efficient environmental management, EIA must be conducted for a wide range of projects and activities. The analysis must take place before the project actually produces the environmental impact. It is expected to produce and, therefore, EIA consists of the identification and the evaluation of the environmental factors that are likely to be adversly or beneficially affected by the proposed development plan. EIA is a valuable decision making tool indicating the:

1. Alternative routes of development
2. Alternate project sites
3. Alternate process technologies
4. Carrying capacity of the specific ecosystem
5. Quality of the environment before, during and after the proposed development activity

Goals of EIA

1. Resource conservation
2. Waste minimization
3. Recovery of by-product
4. Efficient equipment

- To ensure environment quality, measures must be taken before the damage occurs not after.

METHODOLOGY OF EIA

EIA consists of four phases namely

1. Organizing the job
2. Performing the assesment
3. Writing the environmental impact statement.
4. Review of the EIS

1. Organizing the job

This is the first step of EIA. In this step the project or plan is identified and an interdiscipli-

nary team is constituted to conduct the analysis. After analysis a form is prepared to document particulars concerning the project, its sponsors, the participants of the ID team, the activities that need to be complished and specify responsibilities, time frame, cost estimate etc. this form is distributed to each member of team.

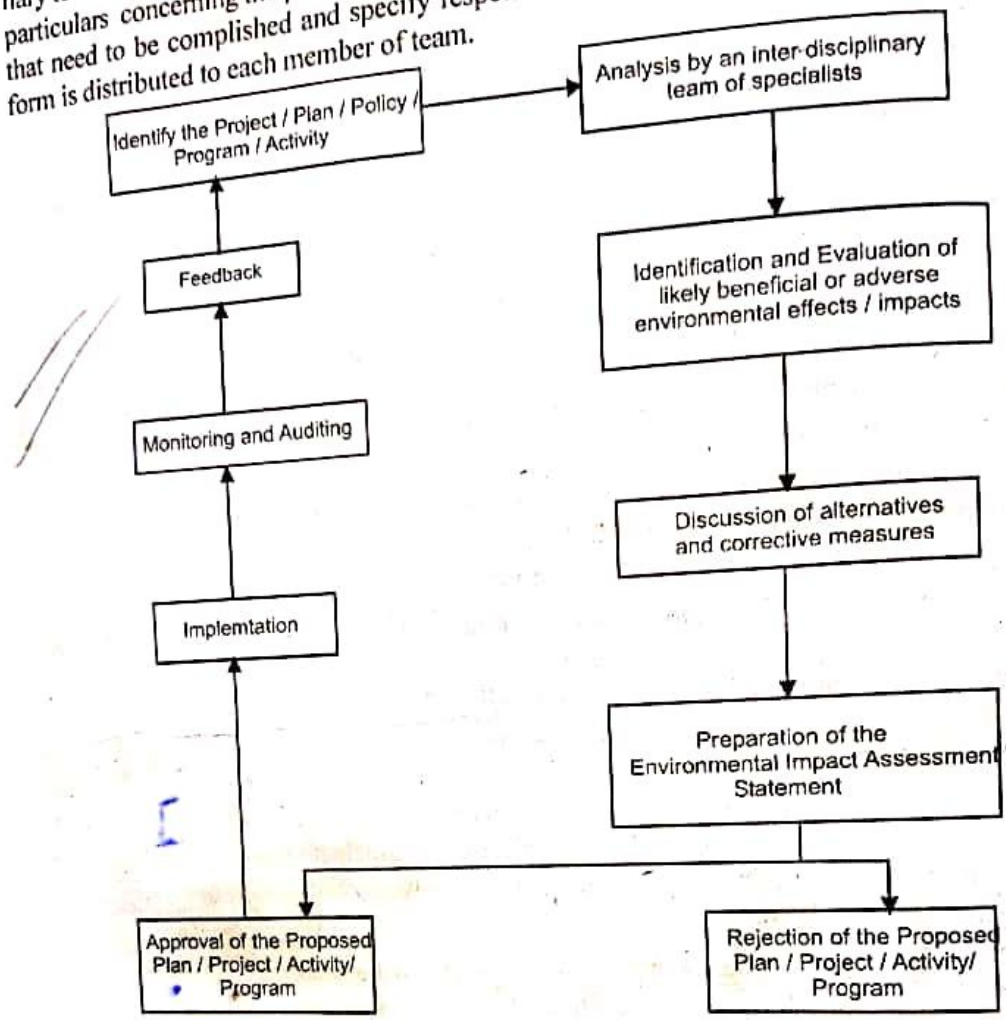

Fig. 1. 3. Methodology of EIA

2. Performing the assesment

This is the second step of EIA. It consists of the following steps-

(i). A site visit by interdisciplinary team to determine the possible environmental impact of the proposed plan or project and record the description of the environment as it exists prior to the proposed project.

(ii). Identification and evaluation of likely beneficial or adverse environmental affects of the proposed project.

(iii). Discussion of alternative and corrective measures.

(iv). Preparation of a checklist for EIA to ensure complete coverage of all possible conse quinces of the proposed activity so that it can be determined as to what administrative action be taken as a result of this activity.

3. Preparation of Environmental Impact Assesment (EIA)

EIS is the conclusion of EIA. All the conclusions or results of the assesment are reported through it. It is prepared by interdisciplinary team. The team reports the following-

(i). Description of the site where project is proposed.

(ii). Description of the proposed project, purpose of action, magnitude of the action, area,equipments, manpower and material requirement.

(iii). The environmental impact
(iv). The unavoidable adverse
(v). Alternatives of activity
(vi). Relastionship of the pro
(vii). Identifying the measures
(viii).Incorporating the modif

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4. Review of the EIA

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(iii). The environmental impact of the project (i.e. on air, water, land, ecosystem etc.)
(iv). The unavoidable adverse effects resulting from the activity.
(v). Alternatives of activity
(vi). Relastionship of the proposed activity to the existing land use plans
(vii). Identifying the measures that can be taken in order to minimize the adverse effects
(viii).Incorporating the modifications in the proposed project

Finally the EIS, written in clear and comprehension manner and is presented to the public competent authorities and independent experts.

4. Review of the EIA

The EIS written is then presented to the public participation more effective in the developmental planning processes. the proposed project is made available for public inspection by publicity through the press. This coupled with discussion session of the government opportunity for obtaining further information and comments from the public and competent authorities.

After the final review of benificial and adverse environmental impacts and cost benefit analysis etc. a discussion is ultimately taken to either to approve the most acceptable alternative in original or modified form. EIA of a project includes the following factors-

1. Air and water pollution including ground water pollution
2. Noise pollution
3. Deforestation and compensatory afforestation
4. Flora and fauna and loss of biological diversity
5. Effect on land including land degradation and subsidence
6. Recycling and reduction of waste
7. Risk analysis and disaster management
8. Socio-economic impact including human displacement, cultural loss and health aspects.

ROLE OF EIA IN SUSTAINABLE DEVELOPMENT

Ever since earth summit in Rio De Janiero in 1992, sustainable development has been emphasized for overall socio-economic development. According to United Nations World Commission of Environment and development, sustainable development must meet the needs of other generations without compromising the ability of the future generations to meet their own needs and aspirations. It is possible to have development without destroying the environment provided man ensures that any single use does not deplete the environment resources to such an extent that they are no longer capable of sustaining and other use. This requires a gradual shift from uncontrolled exploitation to efficient management of natural resources. To ensure sustainable development the depletion of renewable resources should not take place at a rate faster than their regeneration and environmental aspects should be included in the development policies and activities.

World organization have realized that economic development cannot succeed unless sufficient attention is given to the natural environment during development planning. Only those technological development with minimum environmental hazards should be adopted in order to sustain the environment for future generations.

CASE STUDY

Object : Environmental Impact Assessment of the silent valley Hydro-electricproject .

1. The proposed project: Located in the northern part of Kerla, the silent valley hydroelectric project was proposed by the Kerla state electricity board to harness the water of Kunthipuzha

for the generation of power.

2. Justification of the project: The demand for the power exceeds the annual energy generation capacity of the area. Successful completion of the project would stabilize the voltage position in the region and result in the development of this backward area. Further, the water would be utilized for irrigating about 10,000 hectares of land lower down the valley.

3. Environmental consequences likely to arise from the proposed project: Silent valley falls under southern tropical wet evergreen forest which are very valuable as the flora ad fauna provide the largest pool of genetic resources for scientific resources for human welfare. It is also highly threatened as there is a high degree of specialization and specific adaptations making the species very vulnerable to human interference. Silent valley is the habitat of many endangered species of plants and animals.

The environmental consequences likely to arise from the proposed project are:

(i) The project would destroy the habitat of the lion-tailed macaque in the silent valley. In case this happens only one more viable population will be left in the Ashambhu hills which will be constantly in danger of extinction by an epidemic.

(ii). There should be at least two population of an endangered species so that one of them suffers an epidemic it could be repopulated from the second population and thereby cover the grave risk of extinction of species.

(iii). In case of forest clearance, the top soil will be washed away in single monsoon degrading the previously productive land, making it unfit for future productive exploitation.

(iv) In the silent valley, the natural shoreline vegetation along the free flowing river provides habitat for many wildlife species.

In case of submergence of the area, the new on-shore-line vegetation may be different from natural shoreline vegetation. Further, frequent fluctuations in the re-establishment of a similar natural formation. This will disrupt the life system supported by the previous vegetation i.e. destruction of nesting sites of the various species of the birds, destruction of spawning grounds of important fish species etc. The wild animals would be forced out of the forest in to the fringes to raid the crops and cattle-lifting in the villages around the forests.

4. Recommendation on the basis of the environment impact assessment: In view of the potential environmental impacts of the proposed silent valley hydroelectric project, it was recommended that the project was neither essential nor unavoidable. According to noted environmentalist M.S. Swaminathan, "the alternate path ways available immediately for providing power, irrigation and jobs at no ecological risk will help to achieve the desired social goals more speedily and economically".

It was also recommended that no safeguards could possibly protect the ecological balance of the silent valley ecosystem. It is better to implement such projects in areas which are ecologically less valuable in order to meet the legimate demands of local people for additional labour, irrigation and electricity. The process of environmental Impact assessment has reduced the negative impacts of development by taking a futuristic view of the impacts. It has helped to achieve harmony between the needs of the present and the future generation and to achieve sustainable development without the destruction of biological wealth of inestimable value.

EXERCISE

1. Comment upon the natural components of the environment.
2. What are the major causes of environmental degradation.

3. What are the cor
4. Write short note
   (a). Abiotic cor
   (b). Division o
   (c). Atmosphe
5. What dou unde
6. What do you u
   for it.
7. What are vario
   mental pollut
   ergy.
8. What is enviro
9. Write briefly
10. Write short
11. Write infor
    (a). Pollut
    (b). Pollu
12. Name the
13. Name the
14. Describe
15. What do y
16. What are
    which the
17. Describe
    beings o

3. What are the conventional and non-conventional sources of energy.
4. Write short note on-
   (a). Abiotic components of environment
   (b). Division of physical environment
   (c). Atmosphere
5. What dou understand by Environmental Impact Assessment .
6. What do you understand by environmental degradation? State various factors responsible for it. **(R.S.U. Raipur-2003)**
7. What are various sources of energy? How are they responsible for present crisis of environmental pollution ? What are the various environmental friendly alternative sources of energy. **(Pt R,S.U. Raipur, 2003)**
8. What is environment? Enumerate and discuss the various segments of environment in brief. **(G. G.U. Bilaspur-2004)**
9. Write briefly on the components of environment on the basis of biotic and abiotic factors. **(G.G.U. Bilaspur-2004)**
10. Write short note on biotic and abiotic environments. **(G.G.U. Bilaspur-2004)**
11. Write informative note on the following-
    (a). Pollution
    (b). Pollutants
12. Name the different segments of environment and describe briefly their characteristics. **(S.V.T.U. Nov./Dec. 2006)**
13. Name the different factors, which are responsible for degradation of environment. **(S.V.T.U. Nov./Dec. 2006)**
14. Describe briefly the social causes of environmental degradation. **(S.V.T.U, May/June 2007)**
15. What do you understand by pollutants? Describe different types of pollutants. **(S.V.T.U, May/June 2007)**
16. What are the major steps of Environmental Impact Assessment ? Name the body to which the EIA application for major projects is needed to be submitted. **(S.V.T.U, Nov./Dec. 2007)**
17. Describe briefly the impact of environment upon human beings and impact of human beings on environment. **(S.V.T.U, May. 2008)**

CYCLING OF IMPORTANT NUTRIENTS

Carbon(C), hydrogen(H_2), oxygen(O_2),nitrogen(N_2),Sulphur(S) and pphosphorus (P) are the most important constituents of the body of plants and all the living beings therefore their cycles are described here.

1. Carbon Cycle

Carbon is the most significant element in organisms. It is recognised as next to water in their importance to vital phenomena. It is a cabohydrates, fats, proteins like important organic molecules of protoplasm. The source of carbon is the atmosphere and water. Carbon is present in atmosphere mainly in the form of carbon dioxide and thus it cycles in this gaseous phase. Though it is a minor constituent of the atmosphere (0.032%) as compared to oxygen (=21%) and nitrogen (=79%), yet without carbon dioxide no life could exis, for it is vital to the production of carbohydrates through photosynthesis in plants.

$$6CO_2 \xrightarrow{\text{light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The final product of photosynthesis i. e., glucose is used for synthesis of other types of carbohydrates, proteins and lipids. These compounds are stored up in plant tissues. The CO_2 dissolved in sea water is utilized by the marine animals like protozoans, corals, molluscs etc. for their life. In these animals CO_2 is converted into calcium carbonate (CaCO3) which is used for the construction of shells.

$$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow HCO_3 + H^+ \rightarrow CaCO_3 + H^+$$

Carbonic acid — Bicarbonate — Calcium carbonate

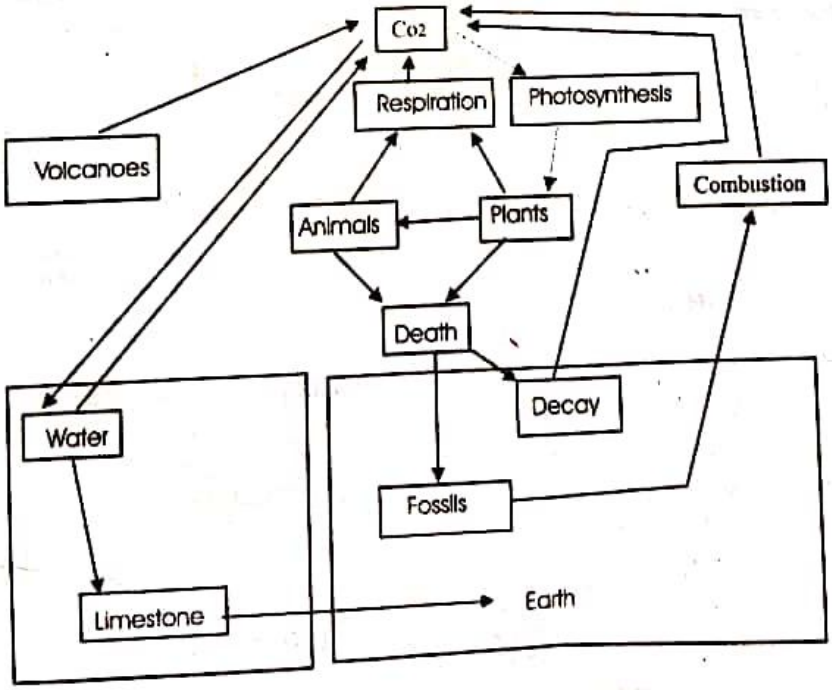


Fig 2. 6. Carbon cycle in nature

After the death of marine animals, limestone ($CaCO_3$) stored in the shells is either deposited as sedimentary rocks or dissolved in water to releaseCO_2 by the reversion of above said reactions. A certain proportion of carbon from plants is deposited as coal, carbon from coal returns to air in the form of CO_2 through combustion and weathering.

Carbon from atmospheric pool moves to green plants (producers) ,then to animals

(consumers) and finally from these to bacteria, fungi and other micro-organisms (decomposers) that return it to the atmosphere through decomposition of dead organic matter. Some of this is also returend to the atmosphere, through respiration at various levels in the food chain. It is estimated that half of the carbon fixed is subsequently returend to the soil in the form of decomposing organic matter.

2. Oxygen Cycle

If you look back at the carbon cycle, you will see that we have also described the oxygen cycle, since these atoms often are combined. Oxygen is present in the carbon dioxide, in the carbohydrates, in water, and as a molecule of two oxygen atoms. Oxygen is released to the atmosphere by autotrophs during photosynthesis and taken up by both autotrophs and heterotrophs during respiration. In fact, all of the oxygen in the atmosphere is *biogenic*; that is, it was released from water through photosynthesis by autotrophs. It took about 2 billion years for autotrophs (mostly cyanobacteria) to raise the oxygen content of the atmosphere to the 21% that it is today; this opened the door for complex organisms such as multicellular animals, which need a lot of oxygen.

2. Nitrogen Cycle

Nitrogen exist in a variety of forms in natural systems and its compounds are involved in numerous biological and abiotic processes. Nitrogen, in its gaseous form of N2, makes up almost 78.084% percent of the atmosphere and seems to have a highly complex nutrient cycle in the terrestrial and aquatic ecosystems This constitutes the major storage pool in the complex cycle of nitrogen through ecosystems. It is an important nutrient of plants as an essential constituent of chlorophyll and protiens. It lives freely in the air but plants cannot utilize it from the air. They obtain N2 from ammonium salts, nitrites and nitrates. These compounds are formed from atmospheric N2 by a process called **nitrogen fixation.**

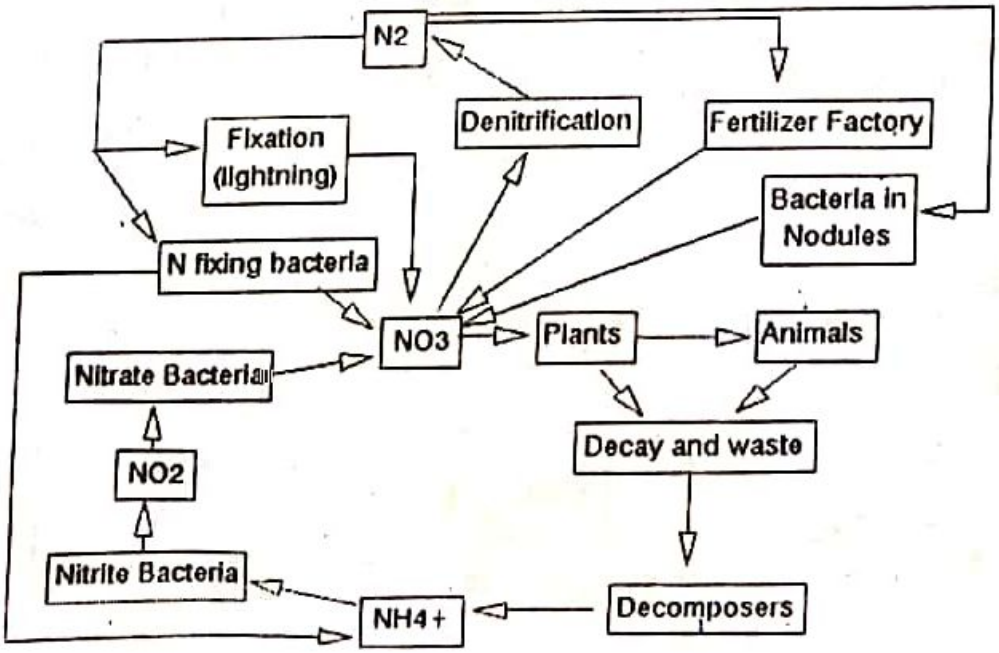


Fig 2. 7. Nitrogen cycle in nature

Nitrogen participates in protein synthesis and in the formation of protoplasm nucleic acids, purine and pyrimidine bases, chlorophyll, allkaloids and many coenzymes, in which the N2 is found in the form of organic combinations. The chief sources of nitrogen for plants are nitrates in the soil. The atmospheric nitrogen is fixed symbiotically as well as asymbiotically by a variety of micro-organisms. The chief nitrogen fixers are bacteria

belonging to the genus *Rhizobium* found in root nodules of leguminous plants. Asymbiotic nitrogen fixers are some cyanobcteria like *Anabaena, Nostoc* etc, aerobic bacteria like *Azotobacter* and anaerobic bacteria like *Clostridium*. Certain photosynthetic bacteria like *Rhodospirillum* are also nitrogen fixers. Some proportion of atmospheric nitrogen is fixed during lightning also. The fixed atmospheric nitrogen reaches the soil as nitrates, which are taken by plants of manufacture of complex nitrogenous compounds which in turn, are eaten by animals. The dead organic matter formed due to death of plants and animals is decomposed by various types of bacteria, actinomycetes and fungi occurring in the soil and water. This releases nitrogen either in free stage or as ammonia gas in the atmosphere. Ammonia(NH_3) gas may reach the soil as nitrates through the activity of nitrifying microbes, *Nitrosomonas* and *nitrobacter*. Some nitrates of soil due to activity of denitrifying microbes *Pseudomonas* may also be converted to free nitrogen gas returning to atmosphere. This inorganic nitrogen is again recycled into the organic system upon absorption by higher plants. It is presumed that the fixation of nitrogen by micro-organisms is generally in equilibrium with denitrification.

The nitrogenous excretory products like ammonia, urea and uric acid are formed in the animal body by the dissociation of amino acids which are discharged outside in the soil along with the animal urine. Insectivorous plants get N_2 by eating insects. The excretory waste products of animals and dead remains of the plants and animals body are also decomposed by decomposers and release free N_2 in the form of ammonia in the atmosphere. Some amount of nitrate is lost from the ecosystem by sedimentation. Thus, the nitrogen cycle continues in the atmosphere among green plants, animals and bacteria which are producers consumers and decomposers respectively. The denitrification is performed by the activity of *Thiobacillus denitrificans and Bacillus denitrificans* like bacteria.

SEDIMENTARY CYCLE

In sedimentary cycles, the main reservoirs are soil and rocks. The elements classified under this cycle do not have a gasous phase (Sulphur cycle is an exception). They are usually found in soil and sediments and sulphur has a gaseous phase in SO_2 and H_2S, but its resident time in this phase is very small. Plants usually take sulphur from the soil in sulphate form. Bacteria can use elemental sulphur. Some amount of sulphur always forms sediments.Hence,sulphur is included in the sedimentary cycle along with phosphorus. The elements concerned in the sedimentary cycle are earthbound and follow a basic pattern of flow through erosion, sedimentation, mountain building, volcanic activity and biological transport (e.g.,through the excreta of marine birds). Sedimentary cycles are much less perfect than gaseous in that some of the elements may get stuck in certain phase of the cycle. In sedimentary cycle, the cycling of minerals occur in two phaese:

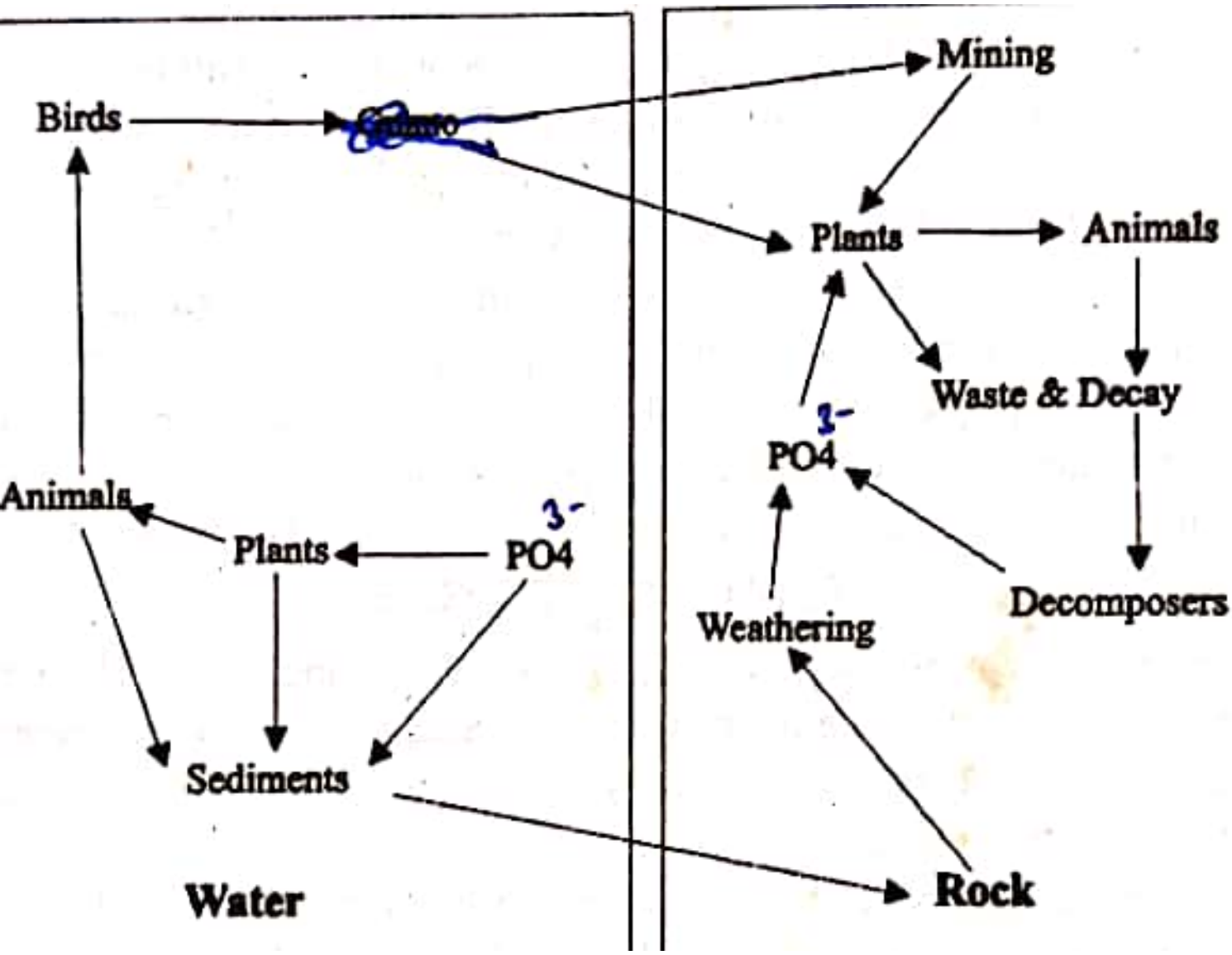
1.Rock cycle and

2.Organic cycle.

The degree of availability of a nutrient depends upon its turnover rate or release from biotic components rather than its concentration in the abiotic environment.For example, in an aquatic ecosystem, the concentration of phosphorus is very poor but the rapaid rate of growth and decay of phytoplanktons and other aquatic plants make the element available for continuous use and cycling

1. Phosphorus Cycle

Phosphorus is most important because it is vital component of DNA, RNA and ATP, NADP and in this way related with genetic and energy producing molecules of the life and therefore necessary to all living cells.The phosphorus is sedimentary rock, which is only available to basic cycle in small amounts as a result of weathering. The cycle does not have



important here as well since they can transform the organic sulfur to hydrogen sulfide gas (H_2S). In the oceans, certain phytoplankton can produce a chemical that transforms to SO_2 that resides in the atmosphere. These gases can re-enter the atmosphere, water, and soil, and continue the cycle.

In its reduced oxidation state, the nutrient sulfur plays an important part in the structure and function of proteins. In its fully oxidized state, sulfur exists as sulfate and is the major cause of acidity in both natural and polluted rainwater. This link to acidity makes sulfur important to geochemical, atmospheric, and biological processes such as the natural weathering of rocks, acid precipitation, and rates of denitrification. Sulfur is also one of the main elemental cycles most heavily perturbed by human activity. Estimates suggest that emissions of sulfur to the atmosphere from human activity are at least equal or probably larger in magnitude than those from natural processes. Like nitrogen, sulfur can exist in many forms: as gases or sulfuric acid particles. Sulfuric acid particles contribute to the polluting smog that engulfs some industrial centers and cities where many sulfur containing fuels are burned. Such particles floating in air (known as sulfate aerosols) can cause respiratory diseases or cool the climate by reflecting some extra sunlight to space.

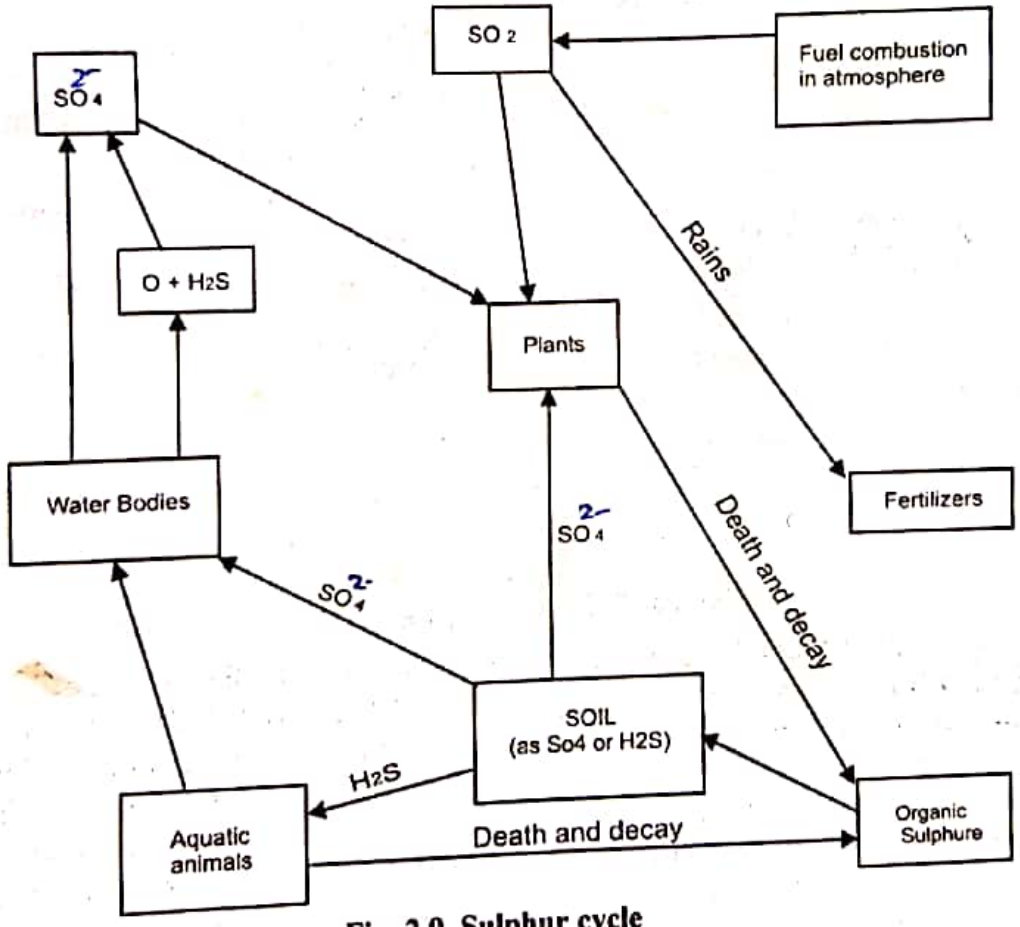


Fig. 2.9. Sulphur cycle

The lifetime of most sulfur compounds in the air is relatively short (e.g. days). Superimposed on these fast cycles of sulfur are the extremely slow sedimentary-cycle processes or erosion, sedimentation, and uplift of rocks containing sulfur. In addition, sulfur compounds from volcanoes are intermittently injected into the atmosphere, and a continual stream of these compounds is produced from industrial activities. These compounds mix with water vapor and form sulfuric acid smog. In addition to contributing to acid rain, the sulfuric acid droplets of smog form a haze layer that reflects solar radiation and can cause a cooling of the earth's surface. While many questions remain concerning

specifics, the sulfur cycle in general, and acid rain and smog issues in particular are becoming major physical, biological, and social problems.

EXERCISE

1. What is an ecosystem? What are its various characteristics. **(Pt. R.S.U., Raipur, 2003)**
2. Draw and explain the nitrogen cyle in nature. **(Pt. R. U., Raipur , 2003)**
3. "Ecosystems are not static, they are dynamic systems in time and space". Justify the statement. **(R.G.P.V., June 2004)**
4. Define the term ecology and describe any one ecosystem you have studied. **(G. G. U., Bilaspur, 2004)**
5. Explain Ecology and Ecosystem. Give a brief account of different components of an ecosystem. **(S.V.T.U., Nov/Dec 2006)**
6. Define Ecosystem. Explain the components of ecosystem. **(S.V.T.U., May/June 2007)**
7. Write short note on- Acquatic ecosystem. **(S.V. T. U., May/June, 2007)**
9. Give a classification of various ecosystems.
10. Write a short note on
    (a). Ecological balance in nature.
    (b). Energy flow in an environment. **(G. G. U., Bilaspur, 2004)**
    (c). Food chain. **(G. G. U., Bilaspur, 2004)**
    (e). Food web. **(S.V. T. U., May/June, 2007)**
    (f). Nutrient Cycling.
11. What is ecology. Explain scope and disciplines of ecology.
12. Draw and explain the carbon cycle in nature.
13. Explain sulphur cycle with the help of a neat sketch.
14. Write an informative note on the following-
    (a). Phosphorous cycle
    (b). Oxygen cycle
    (c). Trophic level.
    (d). Biosphere
    (e). Nutrient cycling.
    (f). Nutrient pools.
15. Explain the following ecosystems-
    (a). Forest ecosystem
    (b). Grassland ecosystem.

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