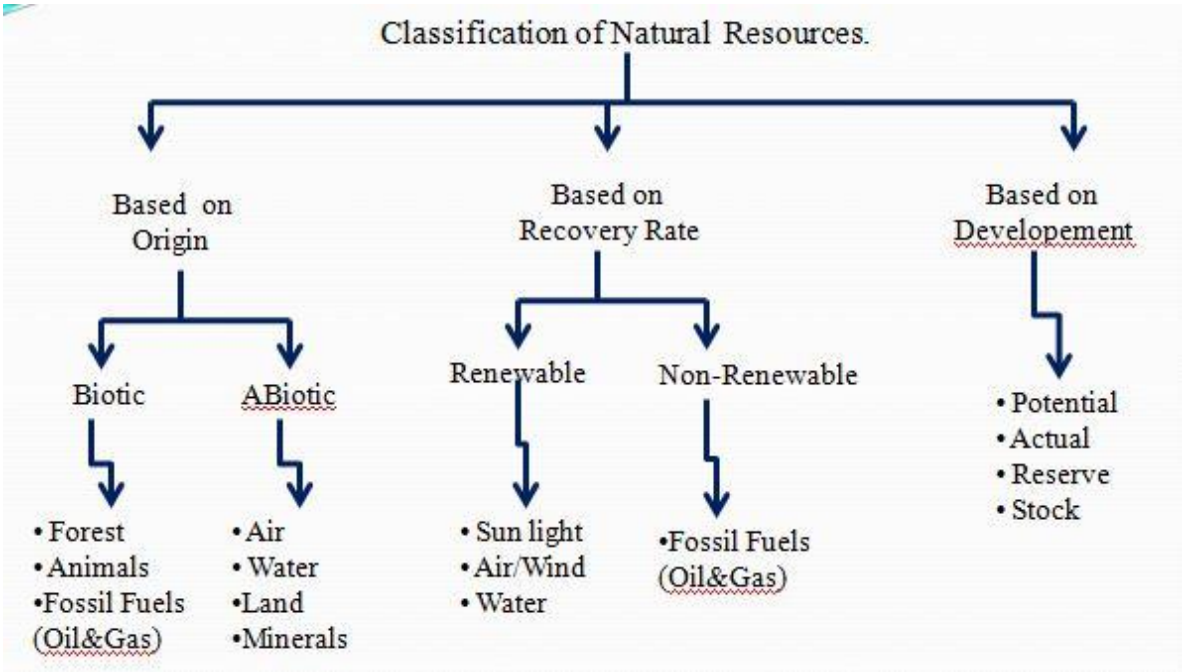
UNIT-II
NATURAL RESOURCES

Life on this planet earth depends upon a large number of things and services provided by the nature, which are known as Natural resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources.

(i) A resource is a stock or supply of things or materials and other assets that can be drawn on by a person or organization in order to function effectively.
(ii) A resource is a source or supply from which a benefit is produced and that has some utility.

Natural resources are resources that exist without any activity of human.

- On Earth, it includes sunlight, atmosphere, water, land (includes all minerals) along with all vegetation, crops, and animal life .
- All valued characteristics of the Earth such as gravitational, electrical and magnetic properties and forces etc. are also included in natural resources.



On the basis of continuity, the resources are classified as

- Renewable Resources
- Non-renewable Resources.

1. Renewable Resources: Renewable resources which are inexhaustive and can be regenerated within a given span of time. e.g. forests, wildlife, wind energy, biomass energy, tidal energy, hydro power etc. Solar energy is also a renewable form of energy as it is an inexhaustible source of energy.

2. Non-renewable Resources: Non-renewable resources which cannot be regenerated e.g. Fossil fuels like coal, petroleum, minerals etc. Once we exhaust these reserves, the same cannot be replenished.

Even our renewable resources can become non-renewable if we exploit them to such extent that their rate of consumption exceeds their rate of regeneration.

It is very important to protect and conserve our natural resources and use them in a judicious manner so that we don't exhaust them. It does not mean that we should stop using most of the natural resources. Rather, we should use the resources in such a way that we always save enough of them for our future generations.

In this unit we shall discuss the major natural resources:

- ✓ Forest resources
- ✓ Water resources
- ✓ Energy resources
- ✓ Land resources

FOREST RESOURCES

Forest: Forest is a biotic community, predominantly of trees, shrubs or any other woody vegetation with a closed canopy. Meadows and pastures vary in density are also part in the forest.

Depending upon the density of trees, soil found in the forests, species developed with the age of forests, forests are classified in the following main types and they are different from one another.

1) Equatorial moist evergreen or rainforest
2) Tropical and sub tropical deciduous (254 cm)
3) Temperate forests (Between 20-50 latitude and average annual rainfall (76 cm to 152 cm)
4) Temperate broad- leaved deciduous mixed forest
5) Boreal (This can be easily found on latitude 50 to 60).
6) Monsoon forest
7) Plantations (Plantations are actually a large farm, piece of land or estate that is used for cultivation.) etc.

Forests are one of the most important natural resources on this earth. Covering the earth like a green blanket these forests not only produce innumerable material goods, but also provide several environmental services which are essential for life.

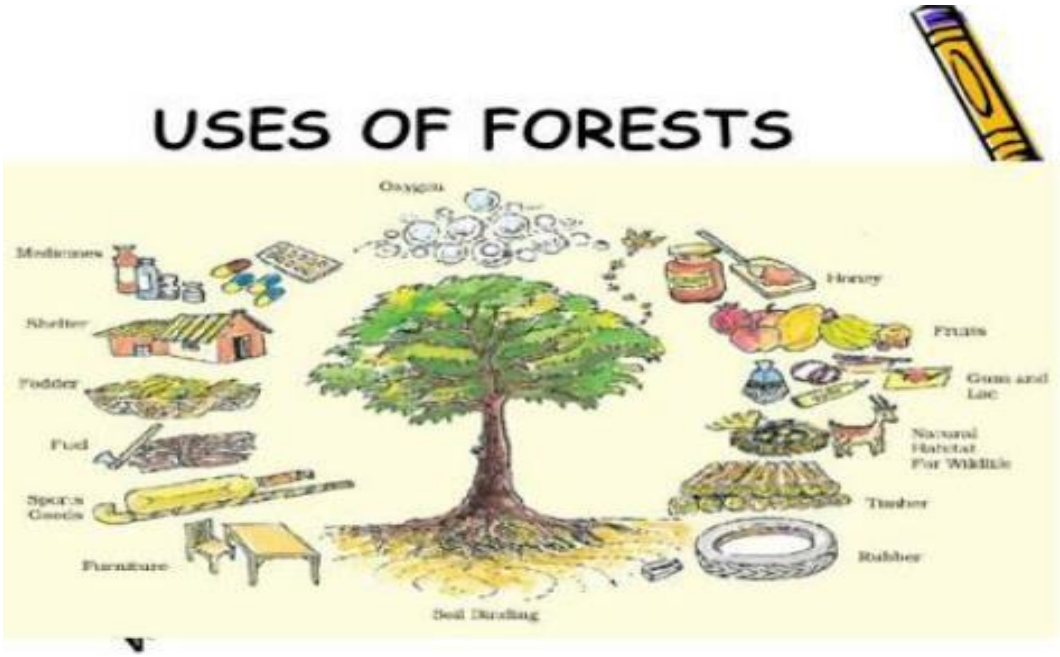
About 1/3rd of the world's land area is forested which includes closed as well as open forests. Former USSR accounts for about a 5th of the world's forests, Brazil for about a 7th and Canada and USA each for 6-7%. But it is a matter of concern that almost everywhere the

cover of the natural forests has declined over the years. The greatest loss occurred in tropical Asia where one third of the forest resources have been destroyed.

USES OF FORESTS:

Forests are of immense value to the life and prosperity of human being and of nations. They provide rich variety of goods to industrial and rural society.

1) Consumptive /Domestic use (fruits, roots, tubers, leaves of plants and meat from animals, Fuel Wood etc)
2) Productive/Commercial/Economical use (Timber)
3) Environmental/Eological use (Furifies air, regulate Stream flow, wind wrosion and conserve the soil)
4) Aesthetic use etc.



1. Consumptive uses: Fruits,roots,t\tubers,honey, meat etc are provided by forest as consumptive use to human beings and other life on the earth.

2.Commercial/ Productive uses: Forests provide us a large number of commercial goods which include timber, firewood, pulpwood, food items, gum, resins, non-edible oils, rubber, fibers, lac, bamboo canes, fodder, medicine, drugs and many more items, the total worth of which is estimated to be more than $ 300 billion per year.

Half of the timber cut each year is used as fuel for heating and cooking. One third of the wood harvest is used for building materials as lumber, plywood and hardwood, particle board and chipboard. One sixth of the wood harvest is converted into pulp and used for paper industry. Many forest lands are used for mining, agriculture, grazing, and recreation and for development of dams.

3. Environmental/Ecological uses:

- *Production of oxygen*: The trees produce oxygen by photo-synthesis which is so vital for life on this earth. They are rightly called as earth's lungs.
- *Reducing global warming*: The main greenhouse gas car-bon dioxide (CO_2) is absorbed by the forests as a raw material for photosynthesis. Thus forest canopy acts as a sink for CO_2 thereby reducing the problem of global warming caused by greenhouse gas CO_2.
- *Wild life habitat*: Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.
- *Regulation of hydrological cycle*: Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff and slowly releasing the water for recharge of springs. About 50-80 %of the moisture in the air above tropical forests comes from their transpiration which helps in bringing rains.
- *Soil Conservation*: Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as wind-breaks.
- *Pollution moderators*: Forests can absorb many toxic gases and can help in keeping the air pure. They have also been reported to absorb noise and thus help in preventing air and noise pollution.

4. Aesthetic use etc.

The concept of aesthetics is itself hard to define. It is an attempt to judge what is beautiful or what carries emotional or sentimental values.

All of us who are drawn to forests find delight in the simple beauty they possess. It is difficult to describe just what it is about them that resonates within us as beauty. It may be seeing a forested hillside aflame with fall color, a majestic oak branching toward the sky, or a sunlit spider web glistening with dew. Such scenes inspire us to pause and reflect on the natural beauty that surrounds us.

By incorporating visual concerns into woodland management activities, you can increase your opportunities to enjoy natural beauty and minimize activities that may detract from your land's scenic value. As you work to enhance the scenic qualities of your land, you may grow to more fully appreciate the splendor and completeness of nature's everchanging artistry.

OVER EXPLOITATION OF FORESTS:

The process of excessive use of forest involved in the reduction of those resources is termed as over exploitation of forest.

Since time immemorial, humans have depended heavily on forests for food, medicine, shelter, wood and fuel. With growing civilization the demands for raw material like timber, pulp, minerals, fuel wood etc. shooted up resulting in large scale logging, mining, road-building and clearing of forests.

Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to over-exploitation of our forests leading to their rapid degradation.

Extent of overexploitation is of

1. Local overexploitation
2. Global overexploitation

Causes of Overexploitation of forest

- Deforestation
- Expansion of Shifting Cultivation
- Overgrazing
- Excess fuel wood gathering
- Excess commercial logging
- For mining, quarrying
- River valley or development projects
- Uneconomic land use

DEFORESTATION: Deforestation is the process of felling trees indiscriminately resulting in nude or semi-nude surface of the hill hitherto covered by thick forests.

Major Causes of Deforestation:

(i) *Shifting cultivation*: There are an estimated 300 million people living as shifting cultivators who practice slash and burn agriculture and are supposed to clear more than 5 lakh ha of forests for shifting cultivation annually.

(ii) *Fuel requirements*: Increasing demands for fuel wood by the growing population in India alone has shooted up to 300-500 million tons in 2001 as compared to just 65 million tons during independence, thereby increasing the pressure on forests.

(iii) *Raw materials for industrial use*: Wood for making boxes, furniture, railway-sleepers, plywood, match-boxes, pulp for paper industry etc. have exerted tremendous pressure on forests. Plywood is in great demand for packing tea for Tea industry of Assam while fir tree wood is exploited greatly for packing apples in J&K.

(iv) *Development projects*: Massive destruction of forests occur for various development projects like hydroelectric projects, big dams, road construction, mining etc.

(v) *Growing food needs*: In developing countries this is the main reason for deforestation. To meet the demands of rapidly growing population, agricultural lands and settlements are created permanently by clearing forests.

(vi) *Overgrazing*: The poor in the tropics mainly rely on wood as a source of fuel leading to loss of tree cover and the cleared lands are turned into the grazing lands. Overgrazing by the cattle leads to further degradation of these lands.

Effects of Overexploitation of forest

- Loss of flora (forest area) and also fauna

- Loss of bio-diversity
- Loss of medicinal plants
- Climate change
- Soil erosion
- Loss of fertile land
- Desertification
- Decrease in rainfall
- Uneconomic land use
- Shortage of fuel wood

Major Activities in Forests:

- **Timber Extraction**:

  Logging for valuable timber, such as teak and Mahogany not only involves a few large trees per hectare but about a dozen more trees since they are strongly interlocked with each other by vines etc. Also road construction for making approach to the trees causes further damage to the forests.

- **Mining:**

  Mining operations for extracting minerals and fossil fuels like coal often involves vast forest areas. Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. More than 80,000 ha of land of the country is presently under the stress of mining activities. Mining and its associated activities require removal of vegetation along with underlying soil mantle and overlying rock masses. This results in defacing the topography and destruction of the landscape in the area.

  Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminate mining of various minerals over a length of about 40 Km. The forested area has declined at an average rate of 33% and the increase in non-forest area due to mining activities has resulted in relatively unstable zones leading to landslides.

  Indiscriminate mining in forests of Goa since 1961 has destroyed more than 50,000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas have caused extensive deforestation in Jharkhand. Mining of magnesite and soap- stones have destroyed 14 ha of forest in the hill slopes at Khirakot, Kosi valley, Almora. Mining of radioactive minerals in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation. The rich forests of Western Ghats are also facing the same threat due to mining projects for excavation of copper, chromite, bauxite and magnetite.

  - Mining effects
    - Loss of top soil
    - Pollution of surface and groundwater
    - Lowering of groundwater
    - Sediment production and discharge
    - Migration of tribal people from mining areas

- **Dams and their effects on forests and tribal people :**

Big dams and river valley projects have multi-purpose uses and have been referred to as “Temples of modern India”. However, these dams are also responsible for the destruction of vast areas of forests. India has more than 1550 large dams, the maximum being in the state of Maharashtra (more then 600), followed by Gujarat (more then 250) and Madhya Pradesh (130). The highest one is Tehri dam, on river Bhagirathi in Uttaranchal and the largest in terms of capacity is Bhakra dam on river Satluj in H.P. Big dams have been in sharp focus of various environmental groups all over the world which is mainly because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.

The Silent Valley hydroelectric project was one of the first such projects situated in the tropical rain forest area of Western Ghats which attracted much concern of the people. The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Sh. Sunder lal Bahuguna, the leader of Chipko movement.

For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region. Floods, droughts and landslides become more prevalent in such areas.

Dams effects

- Deforestation and loss of flora and fauna by submergence in the water.
- Increased incidence of water borne diseases
- Rehabilitation and re-settlement problems

WATER AS NATURAL RESOURCE

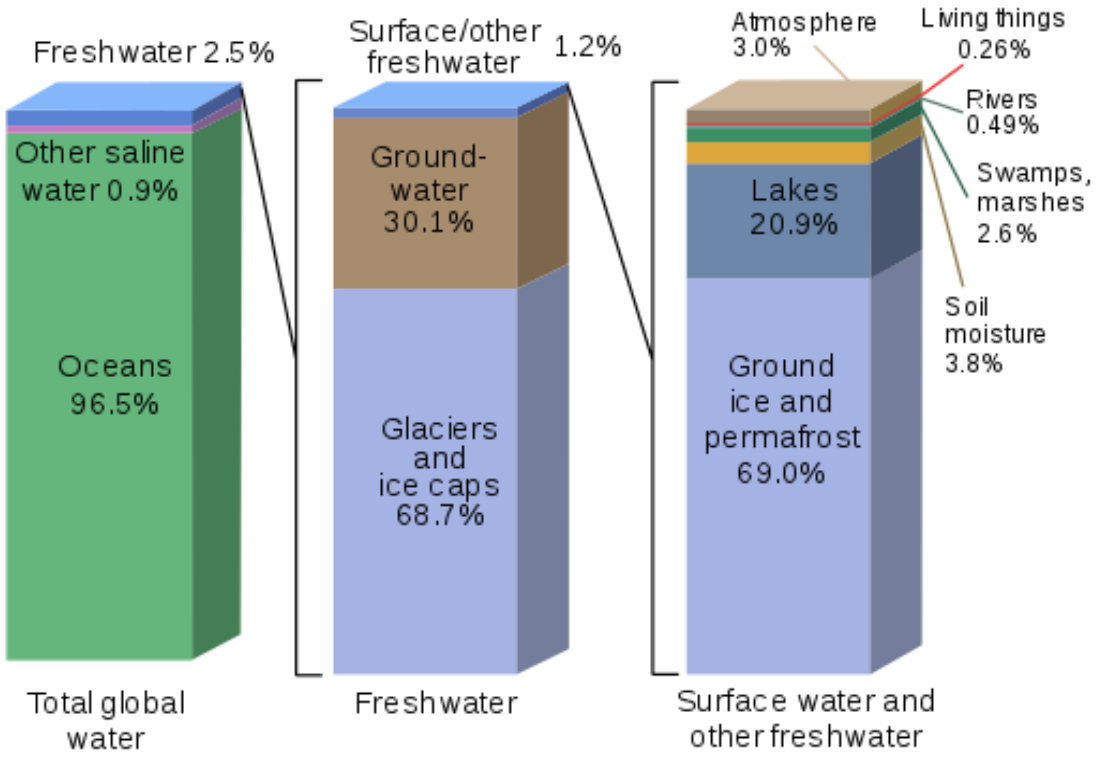
Water on the earth is potentially used by all living things. It is used in Agriculture, Industrial, Household, Recreational and environmental activities. Therefore water is a very essential precious natural resource.

Types of Water Resource:

- Oceanic water or saline water
- Fresh water
- Dieseline water(artificial)

Distribution of Water Resources on the Earth:

In the total global water, 97.5% is saline and only 2.5% is fresh. In this 2.5% of freshwater, 69% is in the state of frozen or glaciers. Groundwater is of 30%. The Earth's total freshwater percentage is only 1% including river,lakes, swamps,atmospheric water etc.



Distribution of Water Resources on the Earth

Sources of fresh water

Surface water: Surface water is naturally replenished by precipitation. Therefore the water in a river, lake or fresh water wetland normally considered as surface water.

Surface water forms naturally by various process as evaporation of oceanic water, evapotranspiration by vegetation, precipitation as rainwater on the earth surface. Part of the rain water infiltrate as ground water and remaining finally discharge again into the oceans by runoff through rivers and lakes etc.

Ground water: After rain precipitates, some amount of water infiltrate into the ground and forms aquifers. These aquifers are major sources for underground water.

Frozen (Glaciers) water: Part of rain water and snow fall freeze at high altitudes as fresh water in solid state, this water grouped as frozen water.

Desalination water: Desalination is an artificial process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis.

Use of water:
Water can be used for direct and indirect purposes as

1) Domestic/Household-Drinking,Bathing,Wshing etc.
2) Agriculture-Crop yielding, Growing of Plants etc.
3) Marine products-Fisheries, Aquaculture etc.
4) Industrial- (Mineral beneficiation, washing of coal in thermal plants, construction industry, Food processing, Tanneries, Textile and Metallurgical industries etc.)
5) Environmental- Afforestaion,watering to plants etc.
6) Recreational use
7) Aesthetic use. Etc.

Causes of over exploitation of water

- ✓ Population growth
- ✓ Population demand for water
- ✓ Expansion of agriculture and Industrial activity
- ✓ Rapid urbanization
- ✓ Climate change
- ✓ Water pollution
- ✓ Uncontrolled water usage
- ✓ Flood irrigation

Effects of over exploitation of water

- ✓ Climatic change
- ✓ Melting of glaciers and reduction of fresh water.
- ✓ Decline of surface as well as ground water
- ✓ Water stress
- ✓ Global and local water conflicts
- ✓ Depletion of aquifers by over exploitation of ground water
- ✓ Water pollution
- ✓ Conflicts on water sharing

Control of over exploitation of water

- ✓ Recharge of ground water aquifers by Recharge pit, form fonds, dug wells, Percolation tanks, Recharge trenches, Minor Check dams, Nala bund etc.)
- ✓ Use of Advanced irrigation methods like drip irrigation rather than flood irrigation.
- ✓ Afforestation
- ✓ Water policies, laws and regulations and administrative actions on over use of water.
- ✓ Depletion of aquifers by over exploitation of ground water
- ✓ Water pollution control
- ✓ Solving the conflicts on water sharing

Conflicts on water sharing
With about 4% of the water resources of the world, India should have been a water-adequate nation.However, in 2011 India turned into a water-stressed nation. India is currently ranked 120 among 122 countries on the Water Quality Index, as per a report by NITI Aayog. It uses the largest amount of groundwater - 24% of the global total, more than that of China and the US combined. UN reports estimates that by 2030, water demand in India will grow to almost 1.5 trillion cubic metres from approximately 740 billion cubic metres (2010 estimate). This situation is further aggravated by the India's water disputes with its neighbours and inter-state river water disputes in India.

India's Water Disputes with its Neighbours

Water remains a politically contested issue in much of South Asia. The region is facing water shortage. If it will continue to face increasing demands on energy and water with rapid industrialisation.

Over-extraction of groundwater is of particular concern, with an estimated 23 million pumps in use across Bangladesh, India, Nepal and Pakistan. Moreover, salinity and arsenic contamination affects over 60% of groundwater in the Indo-Gangetic plain.

Combine these factors with the impact of climate change that's reducing the amount of water in the Brahmaputra basin and changing the patterns of water flow. Under such circumstances, the increasing need for power and stable water levels could prompt reconsideration in bilateral water-sharing treaties in future.

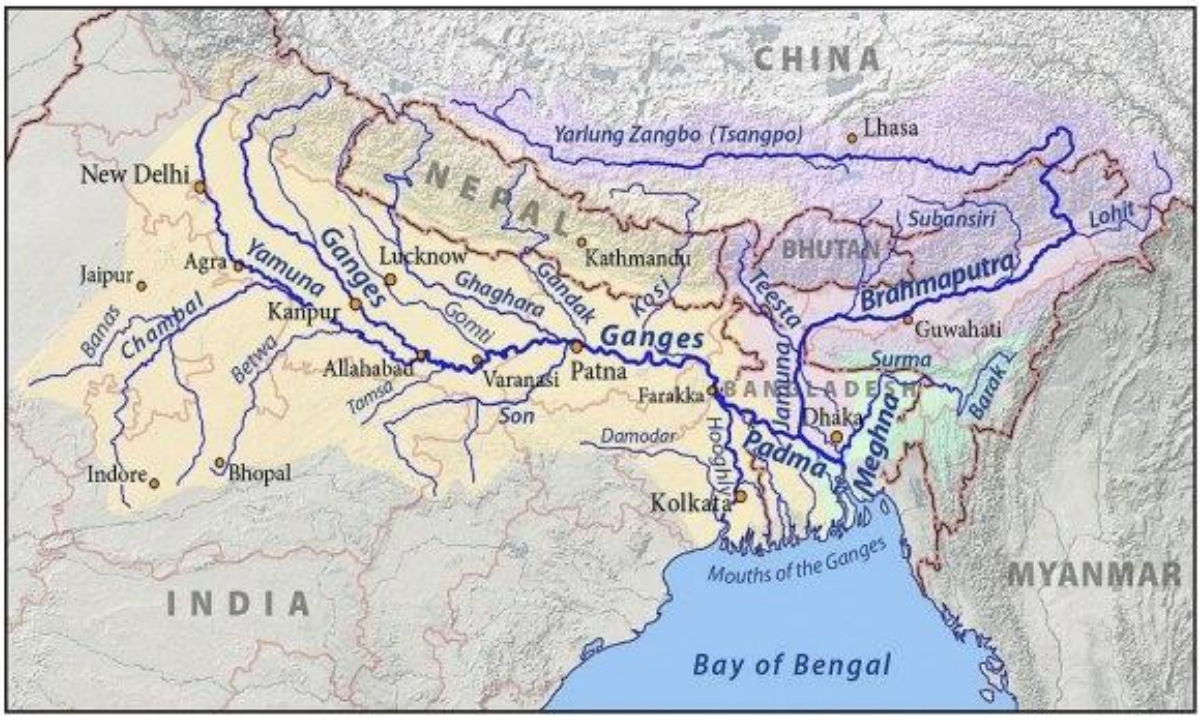
India-China Water Dispute

Both Brahmaputra and the glaciers that feed Ganga originate in China. As an upstream riparian region, China maintains an advantageous position and can build infrastructure to intentionally prevent water from flowing downstream.

Owing to previous tendencies where the Chinese have been reluctant to provide details of its hydro-power projects, there is a trust deficit between the two neighbors.

China's dam-building and water division plans along the Brahmaputra (called Yarlung Zangbo in China) is a source of tension between the two neighbors, despite the two having signed several MoUs on strengthening communication and strategic trust.

The Ganges-Brahmaputra Basin



As lower riparian countries, India and Bangladesh rely on the Brahmaputra's water for agriculture.

China has now plans to build four more dams on the Brahmaputra in Tibet.
Both India and Bangladesh worry that these dams will give Beijing the ability to divert or store water in times of political crisis.

India, for its part, has built dams on the Teesta River, a tributary of the Brahmaputra, to utilize the flow of the Teesta during the dry season.

India–Bangladesh
Sharing the waters of the Teesta river, which originates in the Himalayas and flows through Sikkim and West Bengal to merge with the Brahmaputra in Assam and (Jamuna in Bangladesh), is perhaps the most contentious issue between two friendly neighbors, India and Bangladesh.

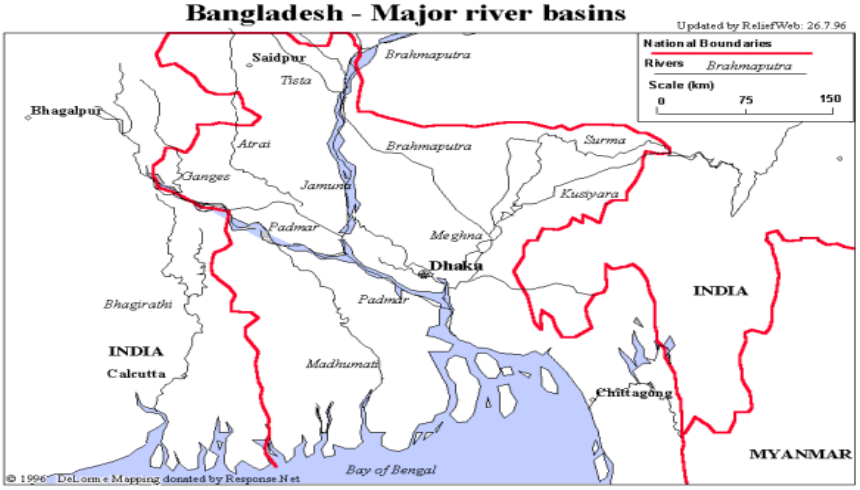
The river covers nearly the entire floodplains of Sikkim, while draining 2,800 sq km of Bangladesh, governing the lives of hundreds of thousands of people.
For West Bengal, Teesta is equally important, considered the lifeline of half-a-dozen districts in North Bengal.

Bangladesh has sought an "equitable" distribution of Teesta waters from India, on the lines of the Ganga Water Treaty of 1996 (an agreement to share surface waters at the Farakka Barrage near their mutual border), but to no avail.

In 2015, Prime Minister Narendra Modi's visit to Dhaka has generated some expectations to take forward the previous issues on fair and equitable water sharing agreement.

But Teesta remains an unfinished project, as in India individual states have significant influence over transboundary agreements.

This arrangement sometimes impedes the policymaking process. For example, one of the key stakeholders of the Teesta agreement, West Bengal is yet to endorse the deal.



India–Nepal

Water cooperation between Nepal and India have been agreements signed on major rivers like Kosi, Gandaki, Karnali or Mahakali, essentially for large hydroelectric and irrigation projects by building dams or barrages.

No project except the Kosi barrage has been completed yet. Smaller rivers have also been ignored.

Since 1954, when the Kosi Agreement was signed between India and Nepal, talks between the two governments have stalled and water rights issues have not been addressed.

There have been various disputes over this agreement fuelled by floods in the Kosi region. India and Nepal have also had disputes over the issue of compensation of the Kosi dam. Moreover, Nepal had considered India's construction as an encroachment on Nepal's territorial sovereignty.

The problem with the Kosi River is its high level of sedimentation and embankments have proven to be ineffective to tackle the sedimentation.

The only available option in this case is storage tanks and these cannot be set up without the cooperation of Nepal.

India and Nepal have traditionally disagreed over the interpretation of the Sugauli Treaty signed in 1816 between the British East India Company and Nepal, which delimited the boundary along the Maha Kali River in Nepal.

India and Nepal differ as to which stream constitutes the source of the river. The dispute between India and Nepal might seem minor but it gains strategic importance, because the disputed area lies near the Sino-Indian border.

India–Pakistan Water Dispute

Both India and Pakistan since partition have experienced friction over various water conflicts. The countries early leaders anticipated this fierce rivalry over the waters that connect their volatile border.

As a result, after numerous dialogues and through careful negotiations, both countries signed an accord called the Indus Waters Treaty in 1960, which clearly determined how the region's rivers are to be divided.

In this treaty, control over three eastern rivers of the Beas, Ravi and Sutlej was given to India, while Pakistan got the control over western rivers of the Indus, Chenab and Jhelum.

The Indus Waters Treaty has been widely hailed as a success, having survived three post-independence wars between the two hostile neighbours.

However, the situation for Pakistan has changed significantly from 1960s till the present moment, as it is now on the brink of water scarcity.

The source or flow of all of the Pakistan's rivers pass through India first, so this naturally provides India with an upper hand in controlling the outflow of these rivers.

The Indian Government has more than 40 projects that are either already completed or in the proposal stage on the western rivers. The carrying of such activities within the western rivers has irked Pakistan.

On the other hand, India keeps dismissing these accusations of Pakistan as baseless and without any scientific backing.

In 2005, Pakistan challenged India's 450 MW Baglihar dam project on the Chenab river before the World Bank, but lost the case in the end.

In 2011, both countries went head to head again at the International Court of Arbitration (ICA) over India's 330 MW project in Kishanganga project in Jammu and Kashmir.

The latest dispute is over hydroelectric projects that India is building along the Chenab River. According to Pakistan, these projects violate the treaty and will impact its water supply.

India–Bhutan

India and Bhutan hydro-electric power cooperation started more than five decades ago. Initially, the cooperation was based on the development of small-scale hydro projects such as Tala, Chukha and Kurichu.

Bhutan has the potential to generate 30,000 MW of hydro-power. In 2006, both countries inked a Power Purchase Agreement for thirty five years that would allow India to generate and import 5000 MW of hydro-power from Bhutan, the quantum of which increased to 10,000 MW in 2008.

On the other hand, the people of Bhutan raised objections to such projects on their long run effects in the country. For instance, if Bhutan ever decides to construct storage projects, issues will get intense and more problematic when it comes to dealing with India. The internal challenge in Bhutan is water accessibility.

Major Inter-State River Disputes	
River (s)	**States**
Ravi and Beas	**Punjab, Haryana, Rajasthan**
Narmada	**Madhya Pradesh, Gujarat, Maharashtra, Rajasthan**
Krishna	**Maharashtra, Andhra Pradesh, Karnataka, Telangana**
Vamsadhara	**Andhra Pradesh & Odisha**
Cauvery	**Kerala, Karnataka, Tamil Nadu and Puducherry**
Godavari	**Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Odisha**
Mahanadi	**Chhattisgarh, Odisha**
Mahadayi	**Goa, Maharashtra, Karnataka**
Periyar	**Tamil Nadu, Kerala**

Active River Water Dispute Tribunals in India

Krishna Water Disputes Tribunal II (2004) – Karnataka, Telangana, Andra Pradesh, Maharashtra.
Mahanadi Water Disputes Tribunal (2018) – Odisha & Chattisgarh.
Mahadayi Water Disputes Tribunal (2010) – Goa,Karnataka, Maharashtra.
Ravi & Beas Water Tribunal (1986) – Punjab, Haryana, Rajasthan.
Vamsadhara Water Disputes Tribunal (2010) – Andra Pradesh & Odisha.

ENERGY RESOURCES

Energy:

Generally Energy means capacity to do work. The word itself is derived from the Greek

Energeia:=En, "in"; + Ergon, "work."

On the planet earth energy available in various forms like solar heat, wind power, food etc.

Energy can either be associated with a material body, as in a coiled spring or a moving object, or it can be independent of matter, as light and other electromagnetic radiation traversing a vacuum.

These forms of energy are consumed by human beings and others by process of conversion from one form to another .

Energy consumption of a nation is usually considered as an index of its development. This is because almost all the developmental activities are directly or indirectly dependent upon energy. We find wide disparities in per capita energy use between the developed and the developing nations.

Most of the energy we use today come from fossil fuels (stored solar energy). But fossils fuels have a disadvantage in that they are non-renewable on a human time scale, and cause other potentially harmful effects on the environment. In any event, the exploitation of all energy sources (with the possible exception of direct solar energy used for heating), ultimately rely on materials on planet Earth.

GROWING ENERGY NEEDS:

Development in different sectors relies largely upon energy. Agriculture, industry, mining, transportation, lighting, cooling and heating in buildings all need energy. With the demands of growing population the world is facing further energy deficit. The fossil fuels like coal, oil and natural gas which at present are supplying 95% of the commercial energy of the world resources and are not going to last for many more years. Our life style is changing very fast and from a simple way of life we are shifting to a luxurious life style. If you just look at the number of electric gadgets in your homes and the number of private cars and scooters in your locality you will realize that in the last few years they have multiplied many folds and all of them consume energy.

Developed countries like U.S.A. and Canada constitute about 5% of the world's population but consume one fourth of global energy resources. An average person there consumes 300 GJ (Giga Joules, equal to 60 barrels of oils) per year. By contrast, an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1 GJ in a year. So a person in a rich country consumes almost as much energy in a single day as one person does in a whole year in a poor country. This clearly shows that our life-style and standard of living are closely related to energy needs.

Types of energy: There are two main types of energy.

(A) RENEWABLE ENERGY SOURCES :

Renewable Resources which can be generated continuously in nature and are inexhaustible.

e.g. wood, solar energy, wind energy, tidal energy, hydropower, biomass energy, bio-fuels, geo-thermal energy and hydrogen.

They are also known as *non-conventional sources of energy* and they can be used again and again in an endless manner.

(B) NON-RENEWABLE ENERGY SOURCES :

Non-renewable Resources which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted.

e.g. coal, petroleum, natural gas and nuclear fuels like uranium and thorium.

(a) Renewable Energy Resources

- **Solar energy**:

Sun is the ultimate source of energy, directly or indirectly for all other forms of energy. The nuclear fusion reactions occurring inside the sun release enormous quantities of energy in the form of heat and light. The solar energy received by the near earth space is approximately 1.4 kilojoules/second/m^2 known as solar constant.

Traditionally, we have been using solar energy for drying clothes and food-grains, preservation of eatables and for obtaining salt from sea-water. Now we have several techniques for harnessing solar energy. Some important solar energy harvesting devices are discussed here.

(i) Solar heat collectors: These can be passive or active in nature. Passive solar heat collectors are natural materials like stones, bricks etc. or material like glass which absorb heat during the day time and release it slowly at night. Active solar collectors pump a heat absorbing medium (air or water) through a small collector which is normally placed on the top of the building.

(ii) Solar cells: They are also known as photovoltaic cells or PV cells. Solar cells are made of thin wafers of semi conductor materials like silicon and gallium. When solar radiations fall on them, a potential difference is produced which causes flow of electrons and produces electricity. Silicon can be obtained from silica or sand, which is abundantly available and inexpensive. By using gallium arsenide, cadmium sulphide or boron, efficiency of the PV cells can be improved. The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4-0.5 volts and produces a current of 60 milli amperes. Fig. 2.5.2 (a) shows the structure of a solar cell.

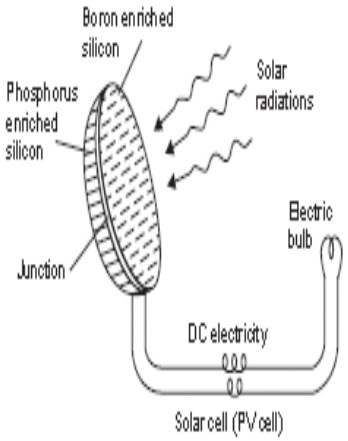


Fig. 2.5.2. (*a*) Solar cell.

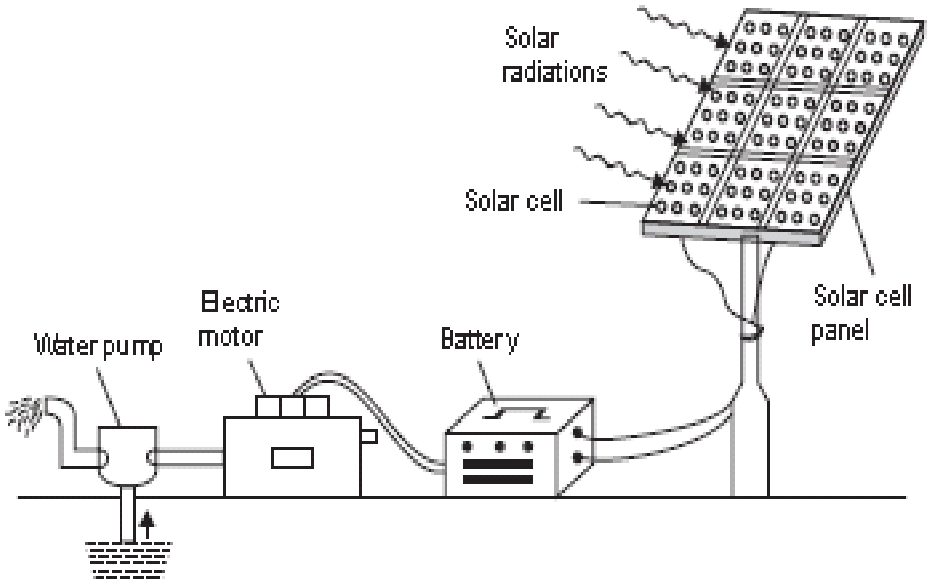


Fig. 2.5.2. (*b*) A solar pump run by electricity produced by solar cells.

A group of solar cells joined together in a definite pattern form a solarpanel which can harness a large amount of solar energy and can produce electricity enough to run street-light, irrigation water pump etc. (Fig. 2.5.2).

Solar cells are widely used in calculators, electronic watches, street lighting, traffic signals, water pumps etc. They are also used in artificial satellites for electricity generation. Solar cells are used for running radio and television also. They are more in use in remote areas where conventional electricity supply is a problem.

(iii) Solar cooker: Solar cookers make use of solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet, which covers the black insulated box within which the raw food is kept as shown in Fig. 2.5.3. A new design of solar cooker is now available which involves a spherical reflector (concave or parabolic reflector) instead of plane mirror that has more heating effect and hence greater efficiency.

The food cooked in solar cookers is more nutritious due to slow heating. However it has the limitation that it cannot be used at night or on cloudy days. Moreover, the direction of the cooker has to be adjusted according to the direction of the sun rays.

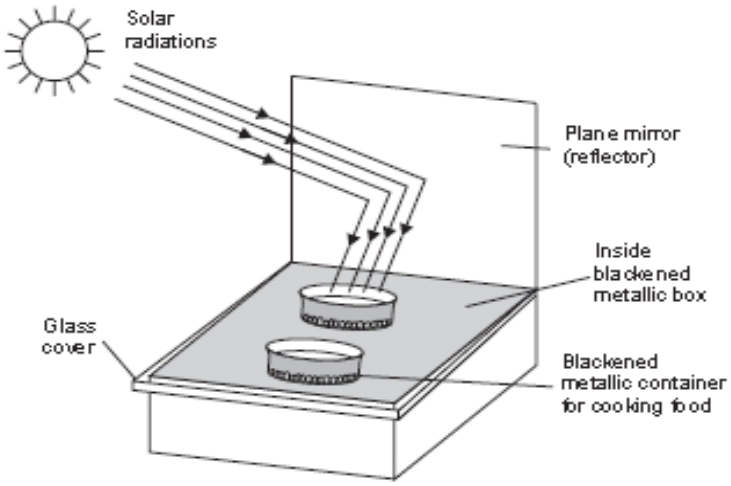


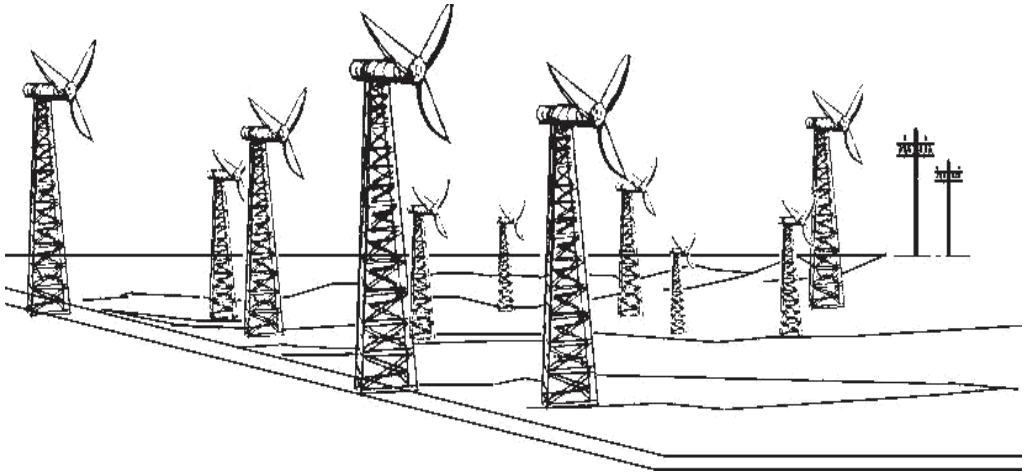
Fig. 2.5.3. Simple box-type solar cooker.

(iv) Solar water heater: It consists of an insulated box painted black from inside and having a glass lid to receive and store solar heat. Inside the box it has black painted copper coil through which cold water is made to flow in, which gets heated and flows out into a storage tank. The hot water from the storage tank fitted on roof top is then supplied through pipes into buildings like hotels and hospitals.

(v) Solar furnace: Here thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as 3000°C.

(vi) Solar power plant: Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam. The steam turbine drives a generator to produce electricity. A solar power plant (50 K Watt capacity) has been installed at Gurgaon, Haryana.

- **WIND ENERGY**



The high speed winds have a lot of energy in them as kinetic energy due to their motion. The driving force of the winds is the sun. The wind energy is harnessed by making use of wind mills. The blades of the wind mill keep on rotating continuously due to the force of the striking wind. The rotational motion of the blades drives a number of machines like water pumps, flour mills and electric generators. A large number of wind mills are installed in clusters called wind farms, which feed power to the utility grid and produce a large amount of electricity. These farms are ideally located in coastal regions, open grasslands or hilly regions, particularly mountain passes and ridges where the winds are strong and steady. The minimum wind speed required for satisfactory working of a wind generator is 15 km/hr.

The wind power potential of our country is estimated to be about 20,000 MW, while at present we are generating about 1020 MW. The largest wind farm of our country is near Kanyakumari in Tamil Nadu generating 380 MW electricity.

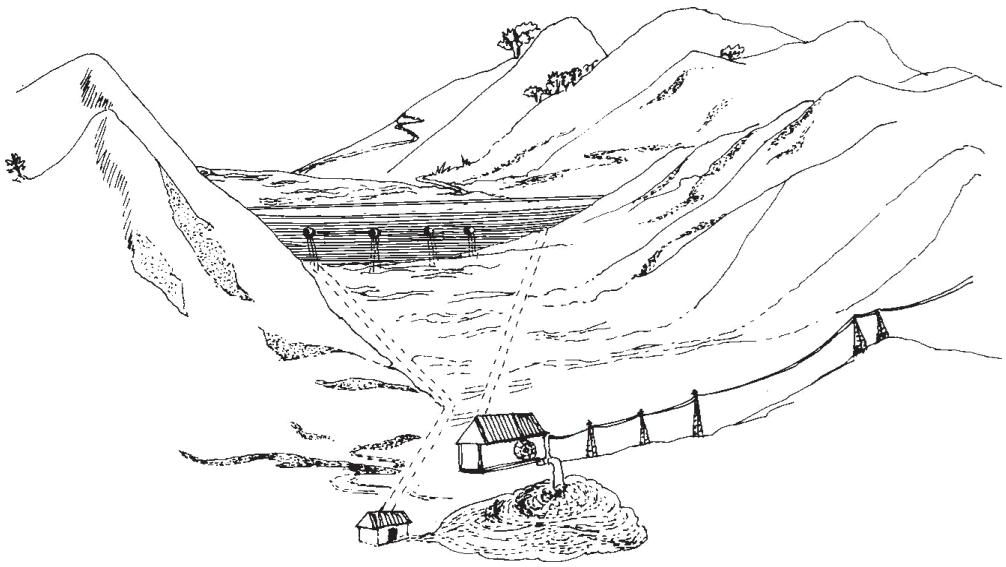
Wind energy is very useful as it does not cause any air pollution. After the initial installation cost, the wind energy is very cheap. It is believed that by the middle of the century wind power would supply more than 10% of world's electricity

HYDROPOWER ENERGY :

The water flowing in a river is collected by constructing a big dam where the water is stored and allowed to fall from a height. The blades of the turbine located at the bottom of the dam move with the fast moving water which in turn rotate the generator and produces electricity. We can also construct mini or micro hydel power plants on the rivers in hilly regions for harnessing the hydro energy on a small scale, but the minimum height of the water falls should be 10 metres.

The hydropower potential of India is estimated to be about 4×10^{11} KW-hours. Till now we have utilized only a little more than 11% of this potential.

Hydropower does not cause any pollution, it is renewable and normally the hydro power projects are multi-purpose projects helping in controlling floods, used for irrigation, navigation etc. However, big dams are often associated with a number of environmental impacts which have already been discussed in the previous section.



- **BIOMASS ENERGY**

Biomass is the organic matter produced by the plants or animals which include wood, crop residues, cattle dung, manure, sewage, agricultural wastes etc. Biomass energy is of the following types :

(a) Energy Plantations: Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. Fast growing trees like cottonwood, poplar and Leucaena, non-woody herbaceous grasses, crop plants like sugarcane, sweet sorghum and sugar beet, aquatic weeds like water hyacinth and sea-weeds and carbohydrate rich potato, cereal etc. are some of the important energy plantations. They may produce energy either by burning directly or by getting converted into burnable gas or may be converted into fuels by fermentation.

(b) Agricultural and Urban Waste biomass: Crop residues, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks etc. are some of the common agricultural wastes which produce energy by burning. Animal dung, fishery and poultry waste and even human refuse are examples of biomass energy. In Brazil 30 % of electricity is obtained from burning bagasse. In rural India, animal dung cakes are burnt to produce heat. About 80 % of rural heat energy requirements are met by burning agricultural wastes, wood and animal dung cakes.

In rural areas these forms of waste biomass are burned in open furnaces called 'Chulhas' which usually produce smoke and are not so efficient (efficiency is <8 %). Now improved Chulhas with tall chimney have been designed which have high efficiency and are smokeless.

The burning of plant residues or animal wastes cause air pollution and produce a lot of ash as waste residue. The burning of dung destroys essential nutrients like N and P. It is therefore, more useful to convert the biomass into biogas or bio fuels.

- **BIOGAS :**

Biogas is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide, the major constituent being methane. Biogas is produced by anaerobic degradation of animal wastes (sometimes plant wastes) in the presence of water. Anaerobic degradation means break down of organic matter by bacteria in the absence of oxygen.

Biogas is a non-polluting, clean and low cost fuel which is very useful for rural areas where a lot of animal waste and agricultural waste are available. India has the largest cattle population in the world (240 million) and has tremendous potential for biogas production. From cattle dung alone, we can produce biogas of a magnitude of 22,500 Mm^3 annually. A sixty cubic feet gobar gas plant can serve the needs of one average family.

Biogas advantages :

1. It is clean, non-polluting and cheap.
2. There is direct supply of gas from the plant and there is no storage problem.
3. The sludge left over is a rich fertilizer containing bacterial biomass with most of the nutrients preserved as such.
4. Air-tight digestion/degradation of the animal wastes is safe as it eliminates health hazards which normally occur in case of direct use of dung due to direct exposure to faecal pathogens and parasites

- **BIOFUELS :**

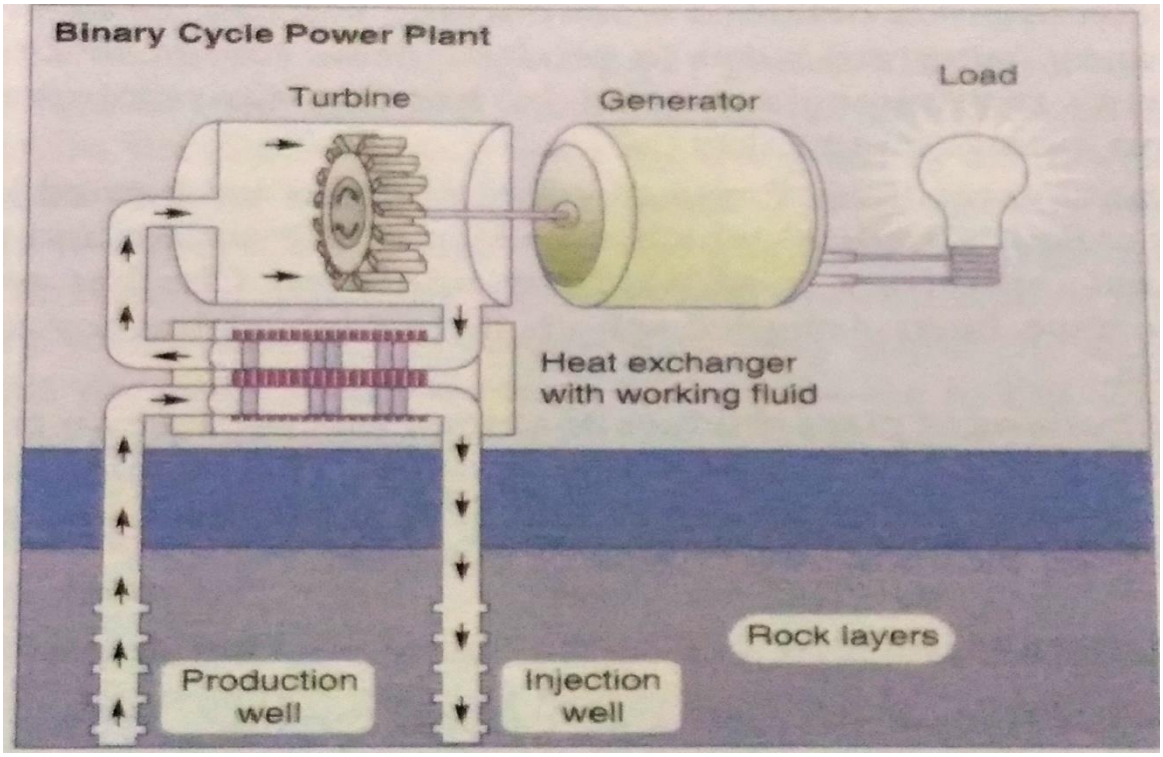
Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels. Ethanol can be easily produced from carbohydrate rich substances like sugarcane. It burns clean and is non-polluting. However, as compared to petrol its calorific value is less and therefore, produces much less heat than petrol.

Gasohol is a common fuel used in Brazil and Zimbabwe for running cars and buses. In India too gasohol is planned to be used on trial basis in some parts of the country, to start with in Kanpur. Gasohol is a mixture of ethanol and gasoline.

Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Thus the bulky radiator may be substituted by sleek designs in our cars. Methanol too is a clean, non-polluting fuel.

Methanol can be easily obtained from woody plants and ethanol from grain-based or sugar-containing plants.

- **GEOTHERMAL ENERGY**



The energy harnessed from the hot rocks present inside the earth is called geothermal energy. High temperature, high pressure steam fields exist below the earth's surface in many places. This heat comes from the fission of radioactive material naturally present in the rocks. In some places, the steam or the hot water comes out of the ground naturally through cracks in the form of natural geysers as in Manikaran, Kullu and Sohana, Haryana. Sometimes the steam or boiling water underneath the earth do not find any place to come out. We can artificially drill a hole up to the hot rocks and by putting a pipe in it make the steam or hot water gush out through the pipe at high pressure which turns the turbine of a generator to produce electricty. In USA and New Zealand, there are several geothermal plants working successfully.

(a) Non-Renewable Energy Sources :

These are the fossil fuels like coal, petroleum, natural gas and nuclear fuels. These were formed by the decomposition of the remains of plants and animals buried under the earth millions of years ago.

The fuels are very precious because they have taken such a long time to be formed and if we exhaust their reserves at such a fast rate as we have been doing, ever since we discovered them, then very soon we will lose these resources forever.

1. **Coal :** It is the non-renewable, commercial or conventional source of energy. Coal is the first fossil fuel to be exploited on a large scale, so individual revolution enabled coal to be mined at even greater depths.

About 6 lakh billion tones of coal lies under the earth and now over to 200 billion tones have been used.

If coal is used at this rate it may lost in one or two decades.

Types of coal :

- **Peat coal :**

(i) It contains 5% carbon,5% volatile matter,and 90% moisture.
(ii) It is having low calorific value.
(iii) It is generally in dry condition.

- **Lignite coal :**

(i) It is lowest form of coal.
(ii) It is brown in colour hence it is called brown coal.
(iii)It has 38% carbon, 19% volatile matter and 43% moisture.

- **Bituminous coal :**

(i) It is called as soft coal.
(ii) It contains 3% of water, 65% carbon, 32% volatile matter.
(iii)It is highly inflammable.

- **Anthracite coal:**

(i) It is hard and dense coal.
(ii) It contains 96% carbon,1% volatile matter,3% moisture.
(iii)It is called as hard or metamorphic coal.
(iv)It is used for space heating and generating electricity.

2. Oil / Petrolium :

Oil provides 45%of world energy consumption.
Petroleum is an inflammable liquid composed of hydrocarbons majority and remainder is organic compounds like O_2, N_2, S and traces of organic metallic compounds.

Occurrence : The fossil fuel was formed by the decomposition of dead animals and plants, that were buried under lake and ocean at high temperature and pressure for million of years.

It is pumped to the earth's surface as crude oil and refined to get the desired products like petrol, diesel, lubricants, gasoline, furnace oil…..

3. Petroleum gas :

It is a mixture of three hydrocarbons such as butane, propane and ethane. The main constituent is being butane. The above gases are in gaseous state in ordinary pressure but they can be liquefied under high pressure. So it is called LPG(Liquified Petrolium Gas).

A domestic cylinder contains 14 kgs of LPG. A strong smelting substance called Ethyl mercaptane is added to LPG gas cylinder to help in the detection of gas leakage.

4. Natural gas :

It consist of methane with small quantities of ethane and propane. It is available in deep undercrust of the earth, either alone or along with oil above the petroleum deposits.

Natural gas is a by product to petroleum mining. Natural gas is formed under the earth by decomposition of materials by anaerobic organisms in the absence of oxygen.

- **NUCLEAR ENERGY**

Nuclear energy is known for its high destructive power as evidenced from nuclear weapons. The nuclear energy can also be harnessed for providing commercial energy. Nuclear energy can be generated by two types of reactions:

(i) Nuclear Fission: It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a chain reaction as shown in Fig. 2.5.7 (a).

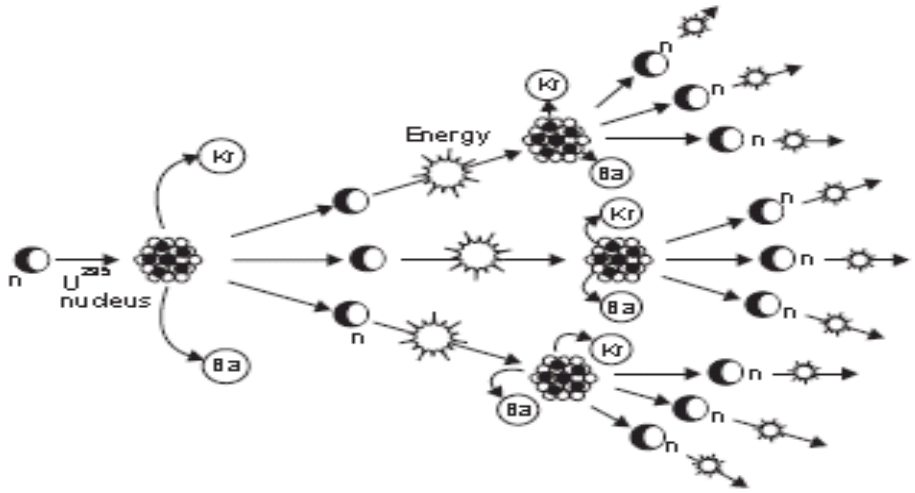


Fig. 2.5.7. (*a*) Nuclear fission—a chain reaction initiated by one neutron that bombards a Uranium (U^{235}) nucleus, releasing a huge quantity of energy, two smaller nuclei (Ba, Kr) and 3 neutrons.

$$_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\,{}_{0}n^{1} + \text{Energy}$$

Nuclear Reactors make use of nuclear chain reaction. In order to control the rate of fission, only 1 neutron released is allowed to strike for splitting another nucleus. Uranium-235 nuclei are most commonly used in nuclear reactors.

(ii) Nuclear fusion: Here two isotopes of a light element are forced together at extremely high temperatures (1 billion °C) until they fuse to form a heavier nucleus releasing enormous energy in the process. It is difficult to initiate the process but it releases more energy than nuclear fission. (Fig. 2.5.7 (b))

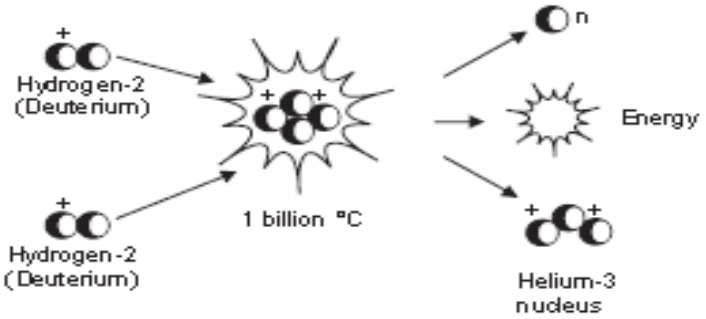


Fig. 2.5.7. (*b*) Nuclear fusion reaction between two hydrogen-2 nuclei, which take place at a very high temperature of 1 billion °C; one neutron and one fusion nucleus of helium-3 is formed along with a huge amount of energy.

$$_1H^2 + {}_1H^2 \longrightarrow {}_3He^2 + {}_0n^1 + \text{Energy}$$

Two hydrogen-2 (Deuterium) atoms may fuse to form the nu-cleus of Helium at 1 billion °C and release a huge amount of energy. Nuclear fusion reaction can also take place between one Hydrogen-2 (Deuterium) and one Hydrogen-3 (Tritium) nucleus at 100 million °C forming Helium-4 nucleus, one neutron and a huge amount of energy.

Nuclear energy has tremendous potential but any leakage from the reactor may cause devastating nuclear pollution. Disposal of the nuclear waste is also a big problem.

Impact of Energy Use on Environment

- Decline of conventional energy resource
- Various kinds of pollution due to increase in industrial use of energy
- Radio-active elements impact
- Effect on flora or vegetation or Deforestation

LAND AS A RESOURCE :

Land is a finite and valuable resource upon which we depend for our food, fibre and fuel wood, the basic amenities of life. Soil, especially the top soil, is classified as a renewable resource because it is continuously regenerated by natural process though at a very slow rate. About 200-1000 years are needed for the formation of one inch or 2.5 cm soil, depending upon the climate and the soil type. But, when rate of erosion is faster than rate of renewal, then the soil becomes a non-renewable resource.

LAND DEGRADATION

With increasing population growth the demands for arable land for producing food, fibre and fuel wood is also increasing. Hence there is more and more pressure on the limited land resources which are getting degraded due to over-exploitation. Soil degradation is a real cause of alarm because soil formation is an extremely slow process as discussed above and the average annual erosion rate is 20-100 times more than the renewal rate.

Soil erosion, water-logging, salinization and contamination of the soil with industrial wastes like fly-ash, press-mud or heavy metals all cause degradation of land.

SOIL EROSION

The literal meaning of 'soil erosion' is wearing away of soil. Soil ero-sion is defined as the movement of soil components, especially surface-litter and top soil from one place to another. Soil erosion results in the loss of fertility because it is the top soil layer which is fertile. If we look at the world situation, we find that one third of the world's cropland is getting eroded. Two thirds of the seriously degraded lands lie in Asia and Africa.

Protect the soil

- While constructing your house, don't uproot the trees as far as possible. Plant the disturbed areas with a fast growing native ground cover.
- Grow different types of ornamental plants, herbs and trees in your garden. Grow grass in the open areas which will bind the soil and prevent its erosion.
- Make compost from your kitchen waste and use it for your kitchen-garden or flower-pots.
- Do not irrigate the plants using a strong flow of water, as it would wash off the soil.
- Better use sprinkling irrigation.
- Use green manure and mulch in the garden and kitchen-garden which will protect the soil.
- If you own agricultural fields, do not over-irrigate your fields without proper drainage to prevent water logging and salinisation.

Use mixed cropping so that some specific soil nutrients do not get depleted

Soil Conservation Practices :

In order to prevent soil erosion and conserve the soil the following conservation practices are employed:

(i) Conservational till farming: In traditional method the land is ploughed and the soil is broken up and smoothed to make a planting surface. However, this disturbs the soil and makes it susceptible to ero-sion when fallow (i.e. without crop cover). Conservational till farm-ing, popularly known as no-till-farming causes minimum disturbance to the top soil. Here special tillers break up and loosen the subsurface soil without turning over the topsoil. The tilling machines make slits in the unploughed soil and inject seeds, fertilizers, herbicides and a little water in the slit, so that the seed germinates and the crop grows suc-cessfully without competition with weeds.

(ii) Strip cropping: Here strips of crops are alternated with strips of soil saving covercrops like grasses or grass-legume mixture. Whatever run-off comes from the cropped soil is retained by the strip of cover-crop and this reduces soil erosion. Nitrogen fixing legumes also help in restoring soil fertility (Plate I, b).

Plate I(a) Terrace farming

Plate I(b) Strip cropping

(iii) **Terracing:** It is used on still steeper slopes are converted into a series of broad terraces which run across the contour. Terracing retains water for crops at all levels and cuts down soil erosion by controlling run off. In high rainfall areas, ditches are also provided behind the terrace to permit adequate drainage (Plate I, a).

(iv) Contour farming: On gentle slopes, crops are grown in rows across, rather than up and down, a practice known as contour farming. Each row planted horizontally along the slope of the land acts as a small dam to help hold soil and slow down loss of soil through run-off water.

Water Logging :

In order to provide congenial moisture to the growing crops, farmers usually apply heavy irrigation to their farmland. Also, in order to leach down the salts deeper into the soil, the farmer provides more irrigation water. However, due to inadequate drainage and poor quality irrigation water there is accumulation of water underground and gradually it forms a continuous column with the water table. We call these soils as waterlogged soils which affect crop growth due to inhibition of exchange of gases. The pore-spaces between the soil particles get fully drenched with water through the roots.

Water logging is most often associated with salinity because the water used for irrigation contains salts and the soils get badly degraded due to erroneous irrigation practices.