



## UNIT III

### Natural Resources

Natural resources refer to the things that exist freely in nature for human use and don't necessarily need the action of mankind for their generation or production. The key aspect of natural resources is that they dictate the survival of humans and other life forms on earth. These resources include land, rocks, forests (vegetation), water (ocean, lakes, streams, seas, and rivers), fossil fuel, animals (fish, wild life, and domesticated animals), minerals, sunlight and air.

#### Types of Natural Resources

##### 1. Renewable and Non-renewable Natural Resources

##### a. Renewable natural resources

- Renewable resources are the ones that are consistently available regardless of their use.
- They can be fairly recovered or replaced after utilization. Examples include vegetation, water, and air.
- Animals can also be categorized as renewable resources because they can be reared and bred to reproduce offspring to substitute the older animals.

##### b. Non-renewable natural resources

- Non-renewable resources are the ones that cannot simply be substituted or recovered once they have been utilized or destroyed.
- Examples of such natural resources include fossil fuels and minerals. Minerals are categorized as non-renewable because, even though they take shape naturally through the rock cycle, their formation periods take thousands of years.
- Some animals mostly the endangered species are similarly regarded as non-renewable because they are at the verge of extinction.

#### Land Resource and land Use Pattern

- Land is a limited resource and yet an indispensable resource for meeting the social, economic and environmental demands and targets.
- The growing development associated by the growing population and the associated urbanization and industrialization is increasing pressure on land resource.
- Due to unplanned and haphazard use of land resources, land gets increasingly affected by the conflicting land uses and competition of mutually exclusive uses, besides posing serious concerns and negative impacts due to over exploitation of natural resources, pollution, climate change, disaster risks, erosion and desertification, and social concerns particularly due to diversion of agricultural lands.

The land in India was broadly classified into five categories:

- (i) Area under forests,
- (ii) Area not available for cultivation,
- (iii) Uncultivated lands excluding current fallow,
- (iv) Area under current fallow, and

(v) Net area sown.

### **Changes in Land Use Patterns:**

- Significant spatial and temporal changes have been noted in the land use pattern in India.
- Though radical changes have occurred in all parts of India, the changes in agricultural land use are substantial in areas where the green revolution has been successful. In 1951-52, the net area sown was 119.4 million hectares; in 2006-07, it was more than 141 million hectares.
- However, there is a slight decline from the 1990s. Forest cover had increased from about 14 per cent of land cover in 1951-52 to more than 23.5 per cent in 2006-07.
- This increase in forest cover just means an increase within the demarcated area for forests. There has been a rise in the area that is double-cropped and multiple-cropped.
- Agricultural land use has recorded substantial changes; the area under wheat and rice has increased while that under pulses, millets and fodder has reduced.

### **DEFORESTATION**

- Forest is a broad area that is fully covered with trees that improves the entire biological potential of the environment.
- Trees have a greater role in maintaining the environmental equilibrium than any other component of nature.
- They play the role of a mute but living guardian in the enrichment of the useful elements for nourishment of life.
- Trees and plants protect us against global warming by absorbing extra and harmful carbon dioxide from the atmosphere.
- In a year, trees spread over one acre absorb as much carbon as a car produces covering a distance of 26000 miles, on an average.
- Deforestation occurs when forests are converted to non-forest areas without making adequate forestry for urbanization, agriculture and other reasons.
- It implies permanent destruction of forests and woodlands for domestic, industrial and mechanical needs. At one time the vast majority of the earth was covered with forests, but today its size is diminishing day by day.
- Forests are known as Earth's lungs. They absorb carbon dioxide ( $CO_2$ ), which is a greenhouse gas. Deforestation slows down this rate of absorption, speeding up the rate of global warming in return.
- As massive deforestation goes on, the forest area of the world is declining, which is very worrisome from the environment point of view. Rampant cutting of trees has given rise to unbalanced weather cycle, which has also affected human life.

### **CAUSES/REASONS OF DEFORESTATION**

- Since the beginning of agriculture, there has been a reduction of 40% in the forests worldwide. The three-fourths of the loss occurred in the past two centuries, because the land was cleaned to meet the demands of agriculture and wood.
- Besides, the cutting of trees has been going on for years for the purpose of development work, residential needs, industries and mineral exploitation.
- Trees are cut for domestic fuel, wood, coal business, furniture and other physical resources.
- Despite various laws and regulations, deforestation continues due to unscientific and lopsided development, population explosion and growing materialistic culture.
- Sadly, the prevailing model of development is dependent on indiscriminate exploitation of resources.

- According to environmental experts, the activities of human beings have accelerated the deterioration of nature and it has seen unusual rise in the last 50 years.
- To meet the immediate needs of physical prosperity of man, indiscriminate cutting of trees began and its far-reaching consequences were ignored.

## **IMPACTS/EFFECTS OF DEFORESTATION**

- Deforestation has caused great damage to the environment. The entire ecological cycle has become disturbed, which is visible everywhere in the form of various types of destruction.
- Untimely changes in weather, excessive rainfall, drought, etc are the ill effects of destruction of trees, which are integral to maintenance of natural balance.
- There are new additions in the series of nature disasters: landslides and soil erosion.
- A large part of the fertile land is being lost every year.
- Along with that, innumerable people are losing their lives every year.
- Cutting of forests is increasing carbon dioxide in the environment. Destruction of forests is proving to be poisonous to the environment with two billion tonnes of extra carbon dioxide dissolved in the atmosphere every year.
- Increasing carbon dioxide in the atmosphere, deforestation and global burning of fossil fuels can cause large-scale climate change. If the level of carbon above the natural protection level goes on increasing per year due to human activities, then it will almost be doubled in 40 years.
- Deforestation and degradation in their area have contributed about 20 percent of global greenhouse gas emissions (GHG), although forests absorb them, if properly managed.
- Global warming has increased due to ruthless deforestation, and the balance of nature is deteriorating.
- Many creatures are facing extinction.
- As per an estimate, seven million hectares of forest area is being destroyed worldwide in the name of development every year. It is harming the ozone layer considered to be the protector of life.
- According to 'Nature Geoscience', the loss of the ozone layer has increased the number of certain types of very short-lived substances (VSLs) which is extremely dangerous to the existence of wildlife and human beings.
- Scientists say that these special types of VSLs are ninety percent responsible for damaging ozone.
- Due to environmental pollution as a fall-out of deforestation, there has been an increase in human diseases.
- As a result of the increase in global temperature, there is a decline of 20 to 25 percent in crop production. The Earth's fertility is decreasing.
- One of the major utilities of forests is that they absorb water in large quantities during flooding quickly. But due to deforestation on a large scale there are no trees to absorb water as a result of which there is a loss of many lives in this way.
- The roots of the trees bind it to the soil and make it underlying bedrock. That's how the trees are getting off the soil from getting clogged or by natural agents like water. When the trees are uprooted, there will be nothing to hold the soil together to increase the risk of landslides which can seriously threaten people's safety and damage their properties.

## **SOLUTIONS TO PREVENT DEFORESTATION**

- The main cause of the growing crisis is the rise in atmospheric temperature, increasing levels of pollution, extensive erosion of forests and land, etc. Therefore, we should take steps for the prevention of haphazard deforestation.
- Apart from this, the forest area should not be reduced for agricultural expansion.
- The 'transfer of cultivation' should be controlled and if possible, it should be eliminated.

- Deforestation for the development of the cities should be stopped.
- Procedures such as preventing the burning of fossil fuels and converting some land for crops into forests can bring about improvement in the circumstances, but for this we will have to initiate a sort of social revolution.
- Continuous efforts are being made about environmental protection for decades.
- In the wake of global problems such as climate change, natural disasters, floods, storms, landslides etc, from time to time, the United Nations has continuously tried to focus on climate by providing protection to forests through its various agencies.
- Massive efforts have been taking place to prevent the environmental imbalance, but there has been little change in the situation.
- Now there is a need to create and implement such laws, which can prevent forest area imbalance due to deforestation.
- On the other hand, the level of public awareness should be so high that people treat tree-plantation as the goal of their life.
- Forest planning should be implemented just like family planning. Under this, the ban on cutting should be tightened and complete implementation should be started on developing new forest areas.
- People should imbibe the kind of attachment that the Bishnoi society of Rajasthan has towards animals, birds and forests.
- The public should take inspiration from the previously run movements and campaigns to save the environment.
- Indigenous communities of forest dwellers have inborn attachment to the forest, land and water. They should be made as protector of the forest wealth.
- In 1973, Chandi Prasad Bhatt in Uttarakhand organized Chipko Movement to protect the forests from traders; the movement derived its name from the act of hugging the trees by villagers to prevent the contractors' from felling them.
- The women of the hills, under the leadership of Bhatt, used to go into the forest and form a circle around the trees preventing the men from cutting them down.
- Taking a cue from the past, panchayats should be put in charge of forest protection.
- Plantation should be done in the premises of every educational institution, and every government office.
- A meaningful campaign of 'one family, one tree' should be run.
- If the trees are properly planted in cities today, the problem of pollution and excessive heat due to nuclear power plants can be solved.
- Every city should become a green city. As long as there is forest, there is life.
- **Dam building on Environment**
- The construction of large dams completely change the relationship of water and land, destroying the existing ecosystem balance which, in many cases, has taken thousands of years to create. Currently there are around 40,000 large dams which obstruct the world's rivers, completing changing their circulation systems: this is not going to occur without dire environmental impacts.

Throughout the past few years, the negative impacts of dams have become so well known that most countries have stopped building them altogether and are now forced to invest their money into fixing the problems created by existing dams.

### **Soil Erosion**

One of the first problems with dams is the erosion of land. Dams hold back the sediment load normally found in a river flow, depriving the downstream of this. In order to make up for the sediments,

the downstream water erodes its channels and banks. This lowering of the riverbed threatens vegetation and river wildlife.

One of the reasons dams are built is to prevent flooding. However, most ecosystems which experience flooding are adapted to this and many animal species depend on the floods for various lifecycle stages, such as reproduction and hatching. Annual floods also deposit nutrients and replenish wetlands.

### **Species Extinction**

As fisheries become an increasingly important source of food supply, more attention is being paid to the harmful effects of dams on many fish and marine mammal population. The vast majority of large dams do not include proper bypass systems for these animals, interfering with their lifecycles and sometimes even forcing species to extinction.

### **Spread of Disease**

Dam reservoirs in tropical areas, due to their slow-movement, are literally breeding grounds for mosquitoes, snails, and flies.

### **Biodiversity and Tribal Population**

- Biodiversity, a contraction of "biological diversity," generally refers to the variety and variability of life on Earth.
- One of the most widely used definitions defines it in terms of the variability within species, between species, and between ecosystems.
- It is a measure of the variety of organisms present in different ecosystems.
- This can refer to genetic variation, ecosystem variation, or species variation (number of species) within an area, biome, or planet.
- Terrestrial biodiversity tends to be greater near the equator, which seems to be the result of the warm climate and high primary productivity.
- Biodiversity is not distributed evenly on Earth. It is richest in the tropics. It is an essential component of nature and it ensures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind.
- The richness of biodiversity depends on the climatic conditions and area of the region. All species of plants taken together are known as flora and animals known as fauna.
- Tribal people not only in India but also in other parts of the world have been known for their unique cultural identities since time immemorial.
- They are very close to nature and natural objects like trees and plants which have not only economic importance for them but also have cultural importance.
- Various trees and plants have religious as well as health importance among the whole tribal India. So far the preservation of these is concerned, tribal people are keener to save biological resources than anything else as their survival and life activities directly depend on them.

### **Water – Uses and Over exploitation of surface and ground water**

- WATER RESOURCES:  
Water is the most abundant, inexhaustible renewable resource. It covers 70% of the globe in the form of oceans, rivers, lakes, etc. Of this 70%, only 3% is available as freshwater. From this 3%, roughly 2% is frozen in polar icecaps and only a fraction of the remaining 1% is used as drinking water (potable). 90% of the water is utilized for agricultural purposes in India.

- **USE OF SURFACE AND GROUND WATER**

**Consumptive use:** In such uses, water is completely utilized and cannot be reused.

Ex: Domestic, industrial and irrigation

**Non-consumptive use:** In such uses, water is not completely utilized and is reused

Ex: Hydropower plant

**Other uses:**

1. Water is used for domestic purposes like drinking, bathing, cooking, washing. etc.
2. Water is used in commercial establishments like hotels, theaters, educational institutions, offices, etc.
3. Almost 60-70% of fresh water is used for irrigation
4. 20-30% of water is used for industrial operations by refineries, iron & steel industries, paper & pulp industries, etc.
5. Water plays a key role in sculpting the earth's surface, moderating climate and diluting pollutants.

**Over-utilization of surface & ground water**

The rapid increase in population and industrial growth led to severe demand on water resources. After using all available surface water resources to the maximum, human beings began using groundwater to meet their needs.

1. The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level. The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.
2. Building construction activities seal permeable soil zone and reduce the area for percolation of rainwater thereby increasing surface runoff.
3. If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get compacted resulting in sinking of overlying land surface. This is called land subsidence which leads to structural damage in buildings, fracture in pipes and reverses the flow of canals leading to tidal flooding.
4. Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers coupled with changes in speed and direction of water flow.
5. Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.
6. Over-utilization of groundwater leads to decrease in water level thereby causing earthquake, landslides and famine.
7. Over-utilization of groundwater leads to drying-up of dug wells as well as bore wells.
8. Due to excess use of groundwater near agricultural fields, agricultural water that contains nitrogen as a fertilizer percolates rapidly and pollutes the groundwater thereby rendering the water unfit for potable use by infants. (Nitrate concentration exceeding 45 mg/L).

**Floods**

- Floods are natural occurrences where an area or land that is normally dry abruptly becomes submerged in water. In simple terms, flood can be defined as an overflow of large quantities of water onto a normally dry land. Flooding happens in many ways due to overflow of streams, rivers, lakes or oceans or as a result of excessive rain.

**Causes**

- There are several causes of floods and they differ from region to region. The causes may vary from a rural area to an urban area. Some of the major causes of floods in India are given below.

- **Heavy rainfall:** It is the primary cause for floods in India. Especially, rainfall in a short span of time is of much concern as they are leading to flash floods.
- **Siltation of the Rivers:** Heavy siltation of the river bed reduces the water carrying capacity of the rivers and streams leading to flooding.
- **Blockage in the Drains:** Blocked drains are the primary cause for the floods in urban areas, especially in metros.
- **Landslides:** They are the major reason behind floods in hilly areas of the north and northeast. Apart from the above reasons, natural hazards like cyclones and earthquakes and encroachments of river banks and water bodies cause flooding.

- **Impact of recurrent floods**

The most important consequence of floods is the loss of life and property. Structures like houses, bridges and roads get damaged by the gushing water.

Some of the negative impacts of recurrent floods are given below –

- **Impact on Agriculture:** Recurrent floods impact the agriculture sector adversely. Due to recurrent floods, fields get submerged and lead to the loss of harvest increasing the vulnerability of farmers to indebtedness. The loss is not only for the farming community but also the common man is hit hard due to persistent inflation. Moreover, floods may also affect the soil characteristics. The land may be rendered infertile due to erosion of top-layer.
- **Damage to infrastructure:** Recurrent floods cause severe damage to economic infrastructure like transportation networks, electricity generation and distribution equipment, etc. Outbreak of diseases: Lack of proper drinking water facilities, contamination of water (well, ground water, piped water supply) leads to outbreak of epidemics like diarrhoea, viral infection, malaria and many other infectious diseases. The probability of outbreak of diseases in highly densed areas of India is high.

Besides the above, strain on the administration, cost of rescue and rehabilitation of the flood affected population are other causes of concern.

- **Solution – Mitigation & Rehabilitation**

The solution to the problem of recurrent floods lies in mitigation and rehabilitation measures. Some of the important measures are given below.

- I. Mapping of the flood prone areas is a primary step involved in reducing the risk of the region. Historical records give the indication of the flood inundation areas and the period of occurrence and the extent of the coverage.
- II. Land use control will reduce danger of life and property when waters inundate the flood plains and the coastal areas.
- III. The number of casualties is related to the population in the area at risk. Hence, in areas where people already have built their settlements, measures should be taken to relocate to better sites so as to reduce vulnerability.
- IV. No major development should be permitted in the areas which are subjected to high flooding. Important facilities like hospitals, schools should be built in safe areas. In urban areas, water holding areas can be created like ponds, lakes or low-lying areas.
- V. The buildings should be constructed on an elevated area. If necessary build on stilts or platform.
- VI. The amount of runoff can be decreased with the help of reforestation, protection of vegetation, clearing of debris from streams and other water holding areas, conservation of ponds and lakes etc.

- VII. Flood diversion measures like construction of levees, embankments and dams should be undertaken.

## **Droughts**

- Drought is a deficiency in rainfall/precipitation over an extended period of time, usually a season or more.
- Drought is caused at times due to direct or indirect human involvement. Basically, it is the shortage of water availability due to insufficient precipitation, over-usage of water from the sources, high rate of evaporation etc.

### **Droughts can be of three kinds**

- **Meteorological drought:** This happens when the actual rainfall in an area is significantly less than the climatological mean of that area. The country as a whole may have a normal monsoon, but different meteorological districts and sub-divisions can have below normal rainfall.
- **Hydrological drought:** A marked depletion of surface water causing very low stream flow and drying of lakes, rivers and reservoirs
- **Agricultural drought:** Inadequate soil moisture resulting in acute crop stress and fall in agricultural productivity

### **Environmental Impact of Drought**

The environment is directly impacted by drought. Drought can affect water sources, land, fish and wildlife and plant communities.

- I. Drought can result in lower water levels in reservoirs, lakes and ponds, as well as reduced stream flow in rivers. This decrease in available water can also lead to a reduction of some wetlands, groundwater depletion and even impact water quality (e.g. salt concentration can increase).
- II. Inadequate water supply can result in reduced ability for soils to support crops, an increased amount of dust due to dryness, erosion, and a greater chance of wildfires due to the dry landscape.
- III. A lack of water and reduced ability for soil to support crops can affect fish, animals and plant life. Wildlife habitat may become degraded because poor soil quality and inadequate water may affect plant growth, and there may not be enough drinking water for animals. There may also be stress placed on endangered species and a loss of biodiversity in the affected area.

## **Conflicts over Water**

- Ever since the beginning of civilization on the banks of the Indus, rivers have been a crucial aspect of life in India as they gave rise to thriving communities and travel routes across the country. For this, they have also been worshiped and protected for centuries.
- Sadly, while major rivers of India like Ganga and Yamuna are bearing the brunt of rising industrialization and pollution, they have become instruments for political agendas.
- In several cases, they have divided people, with standoffs between states over sharing water from rivers.

### **Inter State conflict over water**

#### ➤ **Cauvery river dispute**

- The Cauvery river water dispute is one of the most talked about and old river disputes in India, dating back all the way to the 19th century.



- It is a dispute between Tamil Nadu and Karnataka. Karnataka, which has always contended that it doesn't receive a fair share of the water and an agreement from 1924 favoured Madras Presidency, has demanded a renegotiated settlement.
- Tamil Nadu says that change in the current water sharing deal will affect millions of farmers in the state. A tribunal constituted in 1990 gave a verdict in 2007. The issue remains unresolved due to a review petition, and controversies including Jayalalitha sitting on a fast in protest and farmers from Karnataka & Tamil Nadu committing suicide.

## **International conflict over water**

### **China-India: The Brahmaputra River**

- The Brahmaputra River is a 2,900 km river that originates in Tibet and flows through India's Arunachal Pradesh state before merging with the Ganges and draining into the Bay of Bengal in Bangladesh.
- It is considered an important resource in all three countries that it flows through: for energy-hungry China, it provides hydroelectricity; and for India and Bangladesh, a key agricultural lifeline in otherwise overpopulated and arid region.
- The Brahmaputra River is particularly important to the agricultural industry in India's Assam plains, and worries have arisen recently regarding a series of hydroelectric plants that China is in various stages of construction on its Tibetan plateau.
- Some experts believe that these projects will reduce the flow of the Brahmaputra in India, compounding an already tenuous water situation in the affected areas.
- While there is no comprehensive bilateral treaty in place for the sustainable management of the Brahmaputra River, some steps have been taken recently by the Modi and Xi Jinping governments, mainly in the form of an information sharing agreement for hydrological data.
- But until cooperation becomes more entrenched, the Brahmaputra River remains a potential source of friction between two of the world's prominent rising powers.

### **Heating of earth and circulation of air**

- The air circulation, climate and weather system depend on the distribution of temperature over the surface of the earth. Atmospheric circulation is the large-scale movement of air by which heat is distributed on the surface of the Earth. It varies due to the variations in the atmospheric pressure.

### **Air mass formation and Precipitation**

- An air mass is a large body of air that exhibits uniform temperature and moisture characteristics and helps to determine the weather within an area.
- Warm air masses tend to form over oceans in warm-temperature regions of the tropics and sub-tropics, while cold air masses tend to form over land in cold-weather regions nearer the poles.
- The cold air masses that form at the poles move toward the equator, while the warm air masses that form at the equator move toward the poles.
- These air masses can undergo gradual, but significant, changes as they pass over warmer or colder land surfaces encountering different types of air. These boundary lines are called **fronts**.
- Cold fronts occur when a cold air mass moves into warmer air. Since cold air is heavier than warm air, the incoming colder air forms a wedge that displaces the warm, and often moist, air at the surface.
- As the warm moist air rises, towering clouds often form releasing energy in the form of brief, intense rain storms with high winds and lightning.
- On the other hand, warm fronts will ride up and over cold air near the surface. These fronts can also cause clouds and rain, but they tend to be less violent and longer lasting.

## Sources of energy, classification

- Energy plays a very important role in our lives, providing comfort, increasing productivity and allowing us to live the way we want to.
- Since the beginning of mankind, we have made use of wood, water, and fossil fuels as a means of heating and making machines work. Almost for all types of activities, we rely on one or another form of energy.

## Sources of Energy

- In simple terms we can say that anything out of which usable energy can be extracted is a source of energy.
- There is a variety of sources that provide us energy for different purposes. You must be familiar with coal, petrol, diesel kerosene and natural gas.
- Similarly you must have also heard about hydroelectric power, wind mills, solar panels, biomass etc.

## Fossil Fuels – Conventional Source of Energy

- A fossil fuel is a fuel formed by natural processes, such as anaerobic decomposition of buried dead organisms, containing energy originating in ancient photosynthesis.
- Millions of years ago the remains of dead plants and animals were buried under the ground. Over the years by the action of heat from the Earth's core and pressure from rock and soil, these buried and decomposed organic materials have been converted into fossil fuels.
- Fossil fuels contain high percentages of carbon and include petroleum, coal, and natural gas. Coal, crude oil and natural gas are common examples of fossil fuels.
- They are used to run the vehicles, cooking, lighting, washing, to generate electricity, for making plastics and paints etc.

## Advantages

- Provide a large amount of thermal energy per unit of mass
- Easy to get and easy to transport
- Can be used to generate electrical energy and make products, such as Plastic, paints etc.

## Disadvantages

- Nonrenewable
- Burning produces smog
- Burning coal releases substances that can cause acid precipitation
- Risk of oil spills
- High cost

## Energy from the Atom – Nuclear Energy

- Nuclear power is the use of nuclear reactions that release nuclear energy to generate heat, which most frequently is then used in steam turbines to produce electricity in a nuclear power plant.
- Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion. The atoms of a few elements such as radium and uranium act as natural source of energy.
- In fact atoms of these elements spontaneously undergo changes in which the nucleus of the atom disintegrates.
- The energy stored in the nuclei of atoms can be released by breaking a heavy nucleus such as uranium into two lighter nuclei.

- The splitting of the nucleus of an atom into fragments that are roughly equal in mass with the release of energy is called nuclear fission.
- When a free neutron strikes a Uranium (235) nucleus at a correct speed, it gets absorbed. A Uranium (235) nucleus on absorbing a neutron becomes highly unstable and splits into nuclei of smaller atoms releasing huge amount of energy in the process.
- During this process, a few neutrons are also released. These neutrons split other nuclei of the Uranium (235).
- The reaction continues rapidly and is known as the chain reaction. In this process a large amount of energy is released. This energy is used for boiling water till it becomes steam. Steam so generated is used to drive a turbine which helps in generating electrical energy.

#### **Advantages**

- Very concentrated form of energy
- Power plants do not produce smog

#### **Disadvantages**

- Produces radioactive waste
- Radioactive elements are nonrenewable

### **Sun - The Ultimate Source of Energy**

- Solar energy is energy derived from sun in the form of solar radiation. It is harnesses by either direct sources (like solar cooker, solar steam systems, solar dryer, solar cells, etc.), or indirect sources (biomass production, wind, tidal, etc.).
- The output of the sun is  $2.8 \times 10^{23}$  Kw/y . The energy reaching the earth is  $1.5 \times 10^8$  Kw-y<sup>-1</sup> . It is used for drying, cooking, heating, generating power etc.

#### **Advantages**

- Almost limitless source of energy
- Does not produce air pollution

#### **Disadvantages**

- Expensive to use for large scale energy production
- Only practical in sunny areas
- It is intermittent in nature

### **Wind Energy**

- Wind power is another alternative energy source that could be used without producing by-products that are harmful to nature.
- Like solar power, harnessing the wind is highly dependent on weather and location. However, it is one of the oldest and cleanest forms of energy and the most developed of the renewable energy sources. There is the potential for a large amount of energy to be produced from windmill.

#### **Advantages**

- Renewable
- Does not produce air pollution

#### **Disadvantages**

- Relatively inexpensive to generate
- Only practical in windy areas

- Produces less energy
- Wind mill is big, bulky and inconvenient to use as compared to other forms of energy

## **Biomass Energy**

- Organic material made from plants and animals (microorganisms). Biomass has an existing capacity of over 7,000 MW.
- Biomass as a fuel consists of organic matter such as industrial waste, agricultural waste, wood, and bark. Biomass can also be used indirectly, since it produces methane gas as it decays or through a modern process called gasification.
- Methane can produce power by burning in a boiler to create steam to drive steam turbines or through internal combustion in gas turbines and reciprocating engines.

### **Advantages**

- Renewable
- Cleaner burning than oil
- Abundant

### **Disadvantages**

- Produces smoke
- It has low energy density
- It is dispersed and land intensive source

## **Geothermal Energy**

- Geothermal energy is energy derived by tapping the heat of the earth itself like volcano, geysers, hot springs etc. These volcanic features are called geothermal hotspots.
- Basically a hotspot is an area of reduced thickness in the mantle which exports excess internal heat from the interior of the earth to the outer crust.
- The heat from these geothermal hotspots is altered in the form of steam which is used to run a steam turbine that can generate electricity.

### **Advantages**

- Reliable
- Sustainable
- Environmentally friendly
- Abundant Supply

### **Disadvantages**

- Emission of greenhouse gases during extraction of heat from ground
- High cost of investment

## **Ocean Tidal and Wave energy**

Tidal power or tidal energy is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity.

- **Wave energy**, also known as ocean energy is defined as energy harnessed from oceanic waves. As the wind blows across the surface of the ocean, it creates waves and thus they can also be referred to as energy moving across the surface of the water
- **Tides** are defined as the rise and fall of sea level caused by the gravitational pull of the moon and the sun on the Earth. They are not only limited to the oceans, but can also occur in other systems whenever a gravitational field exists.

- **Ocean thermal energy (OTE)** is the temperature differences (thermal gradients) between ocean surface waters and that of ocean depths. Energy from the sun heats the surface water of the ocean. In tropical regions, surface water can be much warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water **Advantages**
- Running cost is negligible
- Continuous power supply

#### **Disadvantages**

- Low efficiency
- High installation cost

### **Classification of energy sources**

#### **Based on usability**

- **Primary resources** :- Primary sources can be used directly, as they appear in the natural environment: coal, oil, natural gas and wood, nuclear fuels (uranium), the sun, the wind, tides, mountain lakes, the rivers (from which hydroelectric energy can be obtained) and the Earth heat that supplies geothermal energy.
- **Secondary resources**: - They are derived from the transformation of primary energy sources: for example petrol that derives from the treatment of crude oil and electric energy obtained from the conversion of mechanical energy (hydroelectric plants, Aeolian plants), chemical plants (thermoelectric), or nuclear (nuclear plants). Electric energy is produced by electric plants, i.e. suitable installations that can transform primary energy (nontransformed) into electric energy.

#### **Based on transaction**

- **Commercial Energy**:- The energy sources that are available in the market for a definite price are known as commercial energy. By far the most important forms of commercial energy are electricity, coal and refined petroleum products.
- **Non Commercial Energy**:- The energy sources that are not available in the commercial market for a price are classified as non-commercial energy. Non-commercial energy sources include fuels such as firewood, cattle dung and agricultural wastes, which are traditionally gathered, and not bought at a price and used especially in rural households. These are also called traditional fuels. Non-commercial energy is often ignored in energy accounting.

#### **Based on energy storage or cycling time involved**

- **Renewable energy (inexhaustible)** are mostly biomass based and are available in unlimited amount in nature. Since these can be renewed over a relatively short period of time, energy sources that are replenished more rapidly are termed as renewable. These include firewood or fuel wood from forest, petro plants, plant biomass i.e. agricultural waste like animal dung, solar energy, wind energy, water energy in the form of hydroelectricity and tidal energy and geothermal energy etc.
- **Non-renewable energy (exhaustible)** are available in limited amount and develop over a longer period of time. As a result of unlimited use, they are likely to be exhausted one day. These include coal, mineral, natural gas and nuclear power. Coal, petroleum and natural gases are common sources of energy being organic (biotic) in this origin. They are also called fossil fuels.

### **Based on traditional use**

- Conventional energy sources:- The sources of energy which have been in use for a long time, e.g., coal, petroleum, natural gas and water power. They are exhaustible except water and cause pollution when used, as they emit smoke and ash.
- Non-conventional energy sources:- The resources which are yet in the process of development over the past few years. It includes solar, wind, tidal, biogas, and biomass, geothermal. They are inexhaustible, pollution free, easy to maintain and less expensive due to local use.

### **Growing Energy Needs**

- With a population of 1.4 billion and one of the world's fastest-growing major economies, India will be vital for the future of the global energy markets.
- The Government of India has made impressive progress in recent years in increasing citizens' access to electricity and clean cooking.
- It has also successfully implemented a range of energy market reforms and carried out a huge amount of renewable electricity deployment, notably in solar energy.
- Looking ahead, the government has laid out an ambitious vision to bring secure, affordable and sustainable energy to all its citizens.

### **CASE STUDY**

- In 1981 a plane called "The Solar Challenger" flew from Paris to England in 5 hours 20 minutes. Its wings and tail were glued with 16000 solar cells.
- Thus this plane could complete its flight with the help of solar power. In 1987 in Australia solar operated vehicles covered 3000 Kms.
- The world's first solar powered hospital is in Moli in Africa situated at the edge of Sahara desert. Due to desert area it gets plenty of sunlight.
- Panels of solar cells supply the power needed to run hospital equipment. Japanese farmers are using photovoltaic operated insect killer in place of chemical pesticides.
- Energy department of DAVV, Indore has building constructed in such a way that it gets maximum light from sun and also has photovoltaic devices to produce electricity to meet out the needs of the department.
- There are more than 3000 buildings integrated photovoltaic systems in Germany. Japan has programme to build 70000 buildings with integrated photovoltaic devices.

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