STUDY MATERIAL FOR COMPULSORY COURSE ON ENVIRONMENTAL STUDIES

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- **B.A.(H) Pol. SC. I Year Semester-II**
- **B.A.(H) Economics I Year Semester-II**
- **B.A.(H) English I Year Semester-II**
- **B.A. Program I Year Semester-II**

Topic covered:

- Unit-3

Natural Resources

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Unit 3

Natural Resources

- Land resources: Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods; Land cover, land use change, land degradation, soil erosion, and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities
- Water resources: Natural and man-made sources; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international &inter- state conflicts over water
- Energy resources: Renewable and non-renewable energy sources; Use of alternate energy sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and bio gas; Agro-residues as a biomass energy source
- Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g., National Solar Mission, Cauvery river water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc)

Reference books were considered for preparing the study materials:

1. *Gadgil, M. and Guha, R. (1993) .This Fissured Land: An Ecological History of India. University of California Press, Berkeley, USA.*
2. *Mc Cully, P. (1996). Rivers no more: the environmental effects of dams, in: Silenced Rivers: the Ecology and Politics of Large Dams, Zed Books, New York, USA.*
3. *Raven,P.H,Hassenzahl,D.M.,Hager,M.C,Gift,N.Y.andBerg,L.R.(2015).Environment, 9th Edition. WileyPublishing, USA.*
4. *Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.*
5. *Kaushik, Anubha and Kaushik, C.P. (2018)Perspectives in Environmental Studies*
6. *Bharucha, Erach Textbook of Environmental Studies for Undergraduate Courses(2018)*
7. *Sharma, P.D. Fundamentals Of Ecology*
8. *Biology Book 12th NCERT*
9. *https://en.wikipedia.org/wiki/Reference*

NOTE: ***The prepared study materials are indicative only. For complete coverage, please refer to the mentioned textbooks or the basic books like "Textbook for Environmental Studies" by Erach Bharucha"***

NATURAL RESOURCS

"Natural resources can be defined as the resources that exist (on the planet) independent of human actions."

These are the resources that are found in the environment and are developed without the intervention of humans. Common examples of natural resources include air, sunlight, water, soil, stone, plants, animals, and fossil fuels.

The natural resources are naturally occurring materials that are useful to man or could be useful under conceivable technological, economic or social circumstances or supplies drawn from the earth supplies such as food, building and clothing materials, fertilizers, metals, water, and geothermal power. For a long time, natural resources were the domain of the natural sciences.

Based on the availability are two types of natural resources:

Renewable:

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.

As much as these resources are renewable, it may take tens to hundreds of years to replace them. The renewable raw materials that come from living things namely animals and trees are termed as organic renewable resources while those that come from non-living things such as sun, water and wind are termed as inorganic renewable resources.

Non-Renewable:

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.

It brings about the many reasons the endangered species have to be protected by all means. The non-renewable materials that come from living things such as fossil fuels are known as organic non-renewable resources while those that come from non-living things such as rocks and soil are referred to as inorganic non-renewable resources.

Renewable resource	Non-renewable resource
It can be renewed as it is available in infinite quantity	Once completely consumed, it cannot be renewed due to limited stock
Sustainable in nature	Exhaustible in nature
Low cost and environment-friendly	High cost and less environment-friendly
Replenish quickly	Replenish slowly or do not replenish naturally at all

TYPES OF NATURAL RESOURCES

1. Land Resources

1.Forest Resources

2. Water Resources

4. Energy Resources

(I) LAND RESOURCES:

(a) Land as a resource: Landforms such as hills, valleys, plains, river basins andwetlands includedifferent resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. Eg. Inthe 'sacred groves' of the Western Ghats, requests to the spirit of the Grove for permissionto cut a tree, or extract a resource, were accompanied by simple rituals. The outcome of achance fall on one side or the other of a stone balanced on a rock gave or withheld permission. The request could not be repeated for a specified period.

If land is utilized carefullyit can be considered arenewable resource.The roots of trees andgrasses bind the soil. Ifforests are depleted, orgrasslands overgrazed,the land becomes unproductive and wasteland is formed. Intensiveirrigation leads to water logging and salination,on which crops cannot grow. Land is also converted into a non-renewable resource whenhighly toxic industrial and nuclear wastes aredumped on it.

Land on earth is as finite as any of our othernatural resources. While mankind has learnt toadapt his lifestyle to various ecosystems worldover, he cannot live comfortably for instance onpolar ice caps, on under the sea, or in space inthe foreseeable future.

Man needs land for building homes, cultivatingfood, maintaining pastures for domestic animals,developing industries to provide goods, and supporting the industry by creating

towns and cities. Equally importantly, man needs to protectwilderness area in forests, grasslands, wetlands,mountains, coasts, etc. to protect our vitallyvaluable biodiversity.

Thus a rational use of land needs careful planning. One can develop most of these differenttypes of land uses almost anywhere, but Protected Areas (National Park's and Wildlife Sanctuaries) can only be situated where some of thenatural ecosystems are still undisturbed. TheseProtected Areas are important aspects of goodlanduse planning.

(b) Landuse change: The most damaging change in landuse is demonstrated by the rapidity with which forests havevanished during recent times, both in India andin the rest of the world. Forests provide us witha variety of services. These include processessuch as maintaining oxygen levels in the atmosphere, removal of carbon dioxide, control overwater regimes, and slowing down erosion andalso produce products such as food, fuel, timber, fodder, medicinal plants, etc. In the longterm, the loss of these is far greater than theshort-term gains produced by converting forested lands to other uses.

(c) Land degradation: It is a process of deterioration of soil or loss of fertility.Due to increasing population, 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. Nearly 56% of total geographical area of the country is suffering due to land resource degradation. Out of 17-million-hectare canal irrigated area, 3.4 million hectares is suffering from water logging and salinity.

Effects of land degradation:

1. Soil texture and soil structure are destructed.

2. Loss of soil fertility.

3. Loss of valuable nutrients.

4. increase in water logging, salinity, alkalinity and acidity problem.

5. Loss of economic social and biodiversity.

Causes of land degradation:

1. Population: More land is needed for producing food, fibre and fuel wood. So land is degraded due to over exploitation.

2. Urbanisation: Urbanisation reduces the agricultural land. Urbanisation leads to deforestation, which inturn affects millions of plants and animals.

3. Fertilizers and pesticides: It affects fertility of the soil and causes land pollution.

4. Damage of top soil: Increase in food production generally leads to damage of top soil through nutrient depletion.

5. Water logging, soil erosion, salination and contamination of the soil with industrial wastes and cause land degradation.

(d) Soil erosion: The process of loss or removal of superficial layer of soil due to the action of wind, water and human factors. In other words, it can be defined as the movement of soil components, especially surface-litter and top soil from one place to another. It has been estimated that more than 5000 million tonnes topsoil is being eroded annually and 30% of total eroded mass is getting loosed to the sea.

Types of soil erosion:

1. Geological erosion:

It is caused by gradual removal of top soil by the natural process. The rate of erosion is less.

2. Accelerated erosion:

It is caused by man-made activities. The erosion is much faster than the rate formation of soil.

Causes of soil erosion:

1.water:water causes soil erosion in the form of rain, run off, rapid flow and wave action.

2.wind: It is an important climatic agent, which carry away the fine particles of soil creates soilerosion.

3.Biotic agent:Over grazing, mining and deforestation are the major biotic agent cause soil erosion.35% of soil erosion is due to over grazing and 30% is due to deforestation.

4. Land slide: It causes soil erosion.

5. Construction:Construction of dams, buildings, roads remove protective vegetal cover and leads tosoil erosion.

Control of soil erosion (or) Soil conservation practices:

The art of soil conservation is based on following basic principles

1. To slow down the water for concentrating and moving down the slope in a narrow path.

2. To slow down the water movement when it flows along the slope.

3. To encourage more water to enter into the soil.

4. To increase the size of soil particles.

5. Reduction in the wind velocity near the ground by growing vegetation.

Conservational tillage:The process of mixing the residues from previous crops into the soil by ploughing is calledconservational tillage. It improves soil permeability and increase organic matter, which in turnimprove soil moisture and nutrients.

Organic farming: Process of increasing organic input to the soil. E.g bio fertilizer

Crop rotation:Process of growing different crops in successive year on the samew land. It prevents the loss offertility of the soil.

Contour Ploughing:It is very useful areas with low rain fall, i.e. placing some furrows to store water, which reducesrunoff and erosion.

Mulching: Soil is covered with crop residues and other form of plant litters.

Strip cropping:Planting of crops in rows to check flow of water.

Terrace farming: Conversion of steep slopes in to a series of broad terraces which run across the contour. Itreduces soil erosion by controlling run off.

Agroforestry: Planting crops in between rows of trees or shrubs, that can provide fruits and fuel wood. Afterharvesting the crops the soil will not be eroded because trees and shrubs will remain on the soil andhold the soil particles.

Wind break:Trees are planted in long rows along the boundary of cultivated lands, which block the windand reduces soil erosion.

(e) Desertification: Desertification is a process whereby the productive potential of arid or semiarid lands falls by ten percent or more. Desertification is characterized by de-vegetation and depletion of groundwater, salinization and severe soil erosion.

Causes:

1. Deforestation
2. Over grazing
3. Over utilisation of water
4. Mining and quarrying
5. Climate change
6. Excessive use of fertilizers and pesticides

Effects of desertification:

80% of productive land in the arid and semi-arid regions are converted in to desert. Around 600million people are suffered by desertification.

(II) FOREST RESOURCES

Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country.Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment.

It is estimated that about 30% of world area is covered by forest whereas 26% by pastures. Among all continents, Africa has largest forested area (33%) followed by Latin America (25%), whereas in North America forest cover is only 11%. Asia and former USSR has 14%

area under forest. European countries have only 3% area under forest cover. India's Forest Cover accounts for 20.6% of the total geographical area of the country as of 2005.

(1) *Significance of forests*

Forest can provide prosperity of human being and to the nations. Important uses of forest can be classified as under

(i)Commercial values

- Forests are main source of many commercial products such as wood, timber, pulpwood etc. About 1.5 billion people depend upon fuel wood as an energy source. Timber obtained from the forest can used to make plywood, board, doors and windows, furniture, and agriculture implements and sports goods. Timber is also a raw material for preparation of paper, rayon and film.
- Forest can provide food , fibre, edible oils and drugs.
- Forest lands are also used for agriculture and grazing.
- Forest is important source of development of dams, recreation and mining.

(ii) Life and economy of tribal

Forest provide food, medicine and other products needed for tribal people and play a vital role in the life and economy of tribes living in the forest.

(iii) Ecological uses

Forests are habitat to all wild animals, plants and support millions of species. They help in reducing global warming caused by green house gases and produces oxygen upon photosynthesis.
Forest can act as pollution purifier by absorbing toxic gases. Forest not only helps in soil conservation but also helps to regulate the hydrological cycle.

(iv) Aesthetic values

All over the world people appreciate the beauty and tranquillity of the forest because forests have a greatest aesthetic value. Forest provides opportunity for recreation and ecosystem research.

2. Over exploitation of forests

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest .At present international level we are losing forest at

the rate of 1.7 crore hectares annually. Overexploitation also occurs due to overgrazing and conversion of forest to pastures for domestic use.

3. Deforestation

Forest are burned or cut for clearing of land for agriculture ,harvesting for wood and timber , development and expansion of cities .These economic gains are short term where as long term effects of deforestation are irreversible

1. Deforestation rate is relatively low in temperate countries than in tropics If present rate of deforestation continues we may losses 90% tropical forest in coming six decades
2. For ecological balance 33% area should be under forest cover but our nation has only 20.6% forest cover.

Causes of deforestation

Forest area in some developed area has expanded. However in developing countries area under forest is showing declining trend particularly in tropical region. Main causes of deforestation are

a) Shifting cultivation or jhum cultivation

This practise is prevalent in tribal areas where forest lands are cleared to grow subsistence crops. It is estimated that principle cause of deforestation in tropics in Africa, Asia and tropical America is estimated to be 70, 50, and 35% respectively. Shifting cultivation which is a practice of slash and burn agriculture are posses to clear more than 5 lakh hectares of land annually. In India, shifting cultivation is prevalent in northeast and to limited extent in M.P, Bihar and Andhra Pradesh and is contributing significantly to deforestation.

b) Commercial logging

It is a important deforestation agent. It may not be the primary cause but definitely it acts as secondary cause, because new logging lots permits shifting cultivation and fuel wood gatherers access to new logged areas.

c) Need for fuel wood

Increased population has lead to increasing demand for fuel wood which is also acting as an important deforestation agent, particularly in dry forest.

d) Expansion for agribusiness

With the addition of cash crops such as oil palm, rubber, fruits and ornamental plants, there is stress to expand the area for agribusiness products which results in deforestation.

e) Development projects and growing need for food

The growing demand for electricity, irrigation, construction, mining, etc. has lead to destruction of forest. Increased population needs more food which has compelled for increasing area under agriculture crops compelling for deforestation.

f) Raw materials for industrial use

Forest provides raw material for industry and it has exerted tremendous pressure on forest. Increasing demand for plywood for backing has exerted pressure on cutting of other species such as fir to be used as backing material for apple in J&K and tea in northeast states.

Major effects of deforestation

Deforestation adversely and directly affects and damages the environment and living beings .Major causes of deforestation are

- Soil erosion and loss of soil fertility
- Decrease of rain fall due to affect of hydrological cycle
- Expansion of deserts
- Climate change and depletion of water table
- Loss of biodiversity ,flora and fauna
- Environmental changes and disturbance in forest ecosystems

4.Case studies

1. Jhum cultivation

Jhum Agriculture or shifting agriculture has destroyed large number of hectares of forest tracts in North-Eastern states and Orissa. Jhum agriculture is subsidence agriculture in which tract of forest land is cleared by cutting trees and it is used for cultivation. After few years, when productivity of the land decreases, cultivators abandon the land and clear next tract. As a result of this practise, combined with increasing population there is rapid deforestation as more and more cultivators clear forest to cultivate land. Also, with increase in population

there is cultivators are forced to return to previous tracts of land in relatively shorter durations, not allowing the land to regain its productivity.

2. Chipko movement

The Chipko movement or Chipko Andolan is a social-ecological movement that practised the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from being felled. The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand,with growing awareness towards rapid deforestation. The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department. Their actions inspired hundreds of such actions at the grassroots level throughout the region. By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.

3. Western himalayan region.

Over the last decade, there has been widespread destruction and degradation of forest resources in Himalayas, especially western Himalayas. This has resulted in various problems such as erosion of top soil, irregular rainfall, changing weather patterns and floods. Construction of roads on hilly slopes, have not only undermined their stability, but also damaged protective vegetation and forest cover. Tribes in these areas are increasingly facing shortage of firewood and timber, due large-scale tree cutting. Increased traffic volumes on these roads leads to increased pollution in the area.

5. Timber extraction

There has been unlimited exploitation of timber for commercial use. Due to increased industrial demand; timber extraction has significant effect on forest and tribal people.

Logging

- Poor logging results in degraded forest and may lead to soil erosion especially on slopes.
- New logging roads permit shifting cultivators and fuel wood gatherers to gain access to the logging area.
- Loss of long-term forest productivity
- Species of plants and animals may be eliminated
- Exploitation of tribal people by contractor.

6. Mining

Major effects of mining operations on forest and tribal people are:

- Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. It leads to degradation of lands and loss of top soil. It is estimated that about eighty-thousand-hectare land is under stress of mining activities in India
- Mining leads to drying up perennial sources of water sources like spring and streams in mountainous area.
- Mining and other associated activities remove vegetation along with underlying soil mantle, which results in destruction of topography and landscape in the area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminating mining.
- 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 50000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas has caused extensive deforestation in Jharkhand.
- Mining of magnetite and soapstone have destroyed 14 ha of forest in hilly slopes of Khirakot, Kosi valley and 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, chromites, bauxite and magnetite.

7. Effects of dams on forests and tribal people

Pandit Jawaharlal Nehru referred dam and valley projects as “Temples of modern India”. These big dams and rivers valley projects have multi-purpose uses. However, these dams are also responsible for the destruction of forests. They are responsible for degradation of catchment areas, loss of flora and fauna, increase of water borne diseases, disturbance in forest ecosystems, rehabilitation and resettlement of tribal peoples.

- India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 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 Himachal Pradesh. 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 Shri. Sunder Lal Bahaguna, the leader of Chipko Movement.
- The cause of Sardar Sarovar Dam related issues have been taken up by the environmental activitistMedha Patkar, joined by Arundhati Ray and Baba Amte. 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. Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying them (particularly, the tropical rain forests), we are going to lose these species even before knowing them. These species could be having marvellous economic or medicinal value and deforestation results in loss of this storehouse of species which have evolved over millions of years in a single stroke.

8. Forest conservation and management

Forest is one of the most valuable resources and thus needs to be conserved. To conserve forest, following steps should be taken.

1. Conservation of forest is a national problem;thus, it should be tackled with perfect coordination between concerned government departments.
2. People should be made aware of importance of forest and involved in forest conservation activities.
3. The cutting of trees in the forests for timber should be stopped.
4. A forestation programmes should be launched
5. Grasslands should be regenerated.
6. Forest conservation Act should be strictly implemented to check deforestation.
7. Awards should be instituted for the deserving

(III) Water Resources

Water is an indispensable resource for life on earth. Approximately 70.8 % surface of earth is covered with water in the form of oceans. Out of this, about 97% is not fit for human consumption, about 2% is locked as a glacier and only less than 1% available as fresh water that can be used for human consumption and other uses.

Water is a very important source and essential for life because it has very unique characteristic such as

1. Water exists as liquid over a wide range of temperature 0-100^{0}C with highest specific heat and latent heat of vaporization.

2. Water is excellent solvent and act as carrier of nutrient and helps to distribute them to the cells in the body, regulates the body temperature and support structure and can dissolve various pollutant and can act as carrier of large number of microorganisms
3. It is responsible for hydrological cycle which acts as resource of water to the earth. It is estimated that about 1.4 inch thick layer of water evaporates and majority of water returns to earth through hydrological cycle.

Water is renewable, but its overuse and pollution make it unfit for use. Sewage, industrial use, chemicals, etc. pollute water with nitrates, metals, and pesticides.

Use of Water Resources

Water resources are used for agricultural, industrial, domestic, recreational, andenvironmental activities. Majority of the uses require fresh water.However, about 97 percent of water found on the earth is salt water and only three percent isfresh water. A little over two-thirds of the available fresh water is frozen in glaciers and polar ice caps. The remaining freshwater is found mainly as groundwater and a negligible portion of it is present on the ground or in the air.

Following is a brief account of how water is used in different sectors.

(i)Agricultural Use: Agriculture accounts for 69 percent of all water consumption basically in agricultural economies like India. Agriculture, therefore, is the largest consumer of the Earth's available freshwater.

By 2050, the global water demand of agriculture is estimated to increase by a further 19% dueto irrigational needs. Expanding irrigation needs are likely to put undue pressure on water storage. It is still inconclusive whether further expansion of irrigation, as well as additional water withdrawals from rivers and groundwater, will be possible in future.

(ii)Industrial Use: Water is the lifeblood of the industry. It is used as a raw material coolant, a solvent, a transport agent, and as a source of energy. Manufacturing industries account for a considerable share in the total industrial water consumption. Besides, paper and allied products, chemicals and primary metals are major industrial users of water.

Worldwide, the industry accounts for 19 percent of total consumption. In industrialized countries, however, industries use more than half of the water available for human use.

(iii)Domestic Use: It includes drinking, cleaning, personal hygiene, garden care, cooking, washing of clothes, dishes, vehicles, etc. Since the end of World War II there has been a trend
of people moving out of the countryside to the ever-expanding cities. This trend has important

implications on our water resources.

Government and communities have had to start building large water-supply systems to deliver water to new populations and industries. Of all water consumption in the world, domestic use accounts for about 12 percent.

(iv)Use for Hydropower Generation: Electricity produced from water is hydropower. Hydropower is the leading renewable source of electricity in the world. It accounts for about 16 percent of total electricity generation globally. There are many opportunities for hydropower development throughout the world.

Today, the leading hydropower generating countries are China, the US, Brazil, Canada, India, and Russia.

(v)Use for Navigation and Recreation: Navigable waterways are defined as watercourses that have been or may be used for transport of interstate or foreign commerce. Agricultural and commercial goods are moved on water on a large scale in a number of regions in the world.

Water is also used for recreational purposes such as boating, swimming, and sporting activities. These uses affect the quality of water and pollute it. Highest priority should be given to public health and drinking water quality while permitting such activities in reservoirs, lakes, and rivers.

Over-Exploitation of Water

Water scarcity has become a burning global issue. The UN has held several conventions on water in recent decades. Continuous overutilization of surface and ground water has led to virtual water scarcity in the world today.

The depleting sources for high growth in human population over the centuries and increased man-induced water pollution across the world have created unforeseen water scarcity around the globe. As a result, there has been continuous overutilization of the existing water sources due to mammoth growth in world population.

(i)Surface water

Surface water mainly comes directly from rain or snow covers. The various surface sources are natural lakes and ponds, rivers and streams, artificial reservoirs. Availability of surface water decides the economy of the country. On one side surface water availability affects the productivity, but on the other side water sources may cause floods and drought. Due to unequal distribution, water may lead to national (interstate) or international disputes. Sharing

of surface water due to these disputes is affecting productivity of different agro eco-zone and creating problems for government.

(ii)Ground water

Groundwater is the major source of water in many parts of the world. However, there has been continuous depletion of this source due to its overexploitation by rising human population and the rapid rise in industrialization and urbanization in modern times.About 9.86% of the total fresh water resources are in the form of groundwater and it is about 35-50 times that of surface water supplies.

Effects of extensive and reckless groundwater usage:

1. Subsidence
2. Lowering of water table
3. Water logging

Consequences of Overutilization

Water scarcity now becomes an important topic in international diplomacy. From village to the United Nations, water scarcity is a widely-discussed topic in decision making.

Nearly three billion people in the world suffer from water scarcity. International, intrastate and regional rivalries on water are not new to world. The ongoing Jordan River conflict, Nile River conflict, and Aral Sea conflict are cases in point. The intra-state issues such as Cauvery Water dispute in South India, 2000 Cochabamba protests in Bolivia is still a simmering cauldron causing periodic tension at the national and regional levels.

According to World Health Organization (WHO) sources, a combination of rising global population, economic growth and climate change means that by 2050 five billion (52%) of the world's projected 9.7 billion people will live in areas where fresh water supply is under pressure. Researchers expect about 1 billion more people to be living in areas where water demand exceeds surface-water supply.

(i)Climate Change

Scientists, environmentalists, and biologists worldwide are now alarmed that climate change can have an impact on the drainage pattern and hydrological cycle on the earth thereby severely affecting the surface and groundwater availability.

Climate change is believed to rise the global temperature at an increasing pace. Temperature increase affects the hydrological cycle by directly increasing evaporation of available surface water and vegetation transpiration.

As a result, precipitation amount, timing and intensity rates are largely affected. It impacts the flux and storage of water in surface and subsurface reservoirs.

(ii)Floods & Draughts

Floods and droughts are two well-known natural hazards in the world. The former is due to excess in water flow and the latter is due to scarcity of water.

The amount of rainfall received by an area varies from one place to another depending on the location of the place. In some places it rains almost throughout the year whereas in other places it might rain for only few days. India records most of its rainfall in the monsoon season.

Heavy rains lead to rise in the water level of rivers, seas, and oceans. Water gets accumulated in the coastal areas, which results in floods. Floods bring in extensive damage to crops, domestic animals, property and human life. During floods, many animals get carried away by the force of water and eventually die.

On the other hand, droughts set in when a particular region goes without rain for a long period of time. In the meantime, the soil will continuously lose groundwater by the process of evaporation and transpiration. Since this water is not brought back to earth in the form of rains, the soil becomes very dry.

The level of water in the ponds and rivers goes down and in some cases water bodies get dried up completely. Ground water becomes scarce and this leads to droughts. In drought conditions, it is very difficult to get food and fodder for the survival. Life gets difficult and many animals perish in such conditions.

Frequent floods and droughts are mostly due to climate change and global warming. Various environmental organizations world over are of the view that climate change is a long-term change in weather patterns, either in average weather conditions or in the distribution of extreme weather events.

Major Water Conflicts

Some of the major water conflicts that have become thorn in relations between states and countries are

(1)Water conflict in the middle east

Countries involved are Sudan, Egypt and Turkey. It also affects countries which are water starved viz. Saudi Arabia, Kuwait, Syria, Israel and Jordan.

(2) The Indus water treaty

This Indus water treaty dispute between India and Pakistan is lingering since long.

(3) The Cauvery water dispute

It involves two major states of India viz. Tamilnadu and Karnataka.

(4)The Satluj-Yamuna link canal dispute

The dispute is between two Northern states viz. Punjab and Haryana and UP, Rajasthan as well as Delhi has also interest in it .
In traditional water management, innovative arrangements ensure equitable distribution of water, which are democratically implemented. These disputes can be solved amicably through 'Gram Panchayats", if transparency is maintained. But disputes between countries or states sometimes attain war like situation and are difficult to solve.

Dams - Benefits and Problems

Water is a precious resource and its scarcity is increasing at global level. There is a pressure to utilise surface water resources efficiently for different purposes. **Dam,** structure built across a stream, a river, or an estuary to retain water. Dams are built to provide water for human consumption, for irrigating arid and semiarid lands, or for use in industrial processes.

Major benefits of dams
The major benefits of dams are
1. Hydroelectricity generation
2. Year-round water supply to ensure higher productivity
3. Equal water distribution by transferring water from area of excess to area of deficit
4. Helps flood control and protects soil
5. Assure irrigation during dry periods
6. River valley projects provide inland water navigation, employment opportunities and can be used to develop fish hatcheries and nurseries
7. River valley projects have tremendous potential for economic upliftment and will help to raise the standard of living and can help to improve the quality of life

Disadvantages/problems
Although dams have proved very useful over the centuries but recent past big dams has created lot of human as well as environmental issues

1. Submergence of large areas may lead to loss of fertile soil and displacement of tribal people
2. Salt left behind due to evaporation increase the salinity of river water and makes it unusable when reaches down stream
3. Siltation and sedimentation of reservoirs not only makes dams use less but also is responsible for loss of valuable nutrients
4. Loss of non-forest land leads to loss of flora and fauna
5. Changes in fisheries and the spawning grounds
6. Stagnation and water logging near reservoir leads to breeding of vectors and spread of vector-borne diseases
7. Growth of aquatic weeds may lead to microclimatic changes.

(IV) ENERGY RESOURCES

Energy Scenario

Energy is a key input in the economic growth and there is a close link between the availability of energy and the future growth of a nation. Power generation and energy consumption are crucial to economic development.

In India, energy is consumed in a variety of forms such as fuel wood; animal waste and agricultural residues are the traditional sources of energy. These non-commercial fuels are gradually getting replaced by commercial fuels i.e. coal, petroleum products, natural gas and electricity.

Out of total energy, commercial fuels account for 60% where as the balance 40% is coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity,

69% is from coal (thermal power),

25% is from hydel power,

4% is from diesel and gas,

2% is from nuclear power, and

Less than 1% from non- conventional sources like solar, wind, ocean, biomass, etc.

Petroleum and its products are the other large sources of energy. In a developing country like India, in spite of enhanced energy production, there is still shortage due to increased demand of energy. In spite of the fact that there is a phenomenal increase in power generating capacity, still there is 30% deficit of about 2,000 million units.

Policy makers are in the process of formulating an energy policy with the objectives of ensuring adequate energy supply at a minimum cost, achieving self-sufficiency in energy supplies and protecting environment from adverse impact of utilizing energy resources in an injudicious manner. The main features of this policy are

- Accelerated exploitation of domestic conventional energy resources, viz., oil, coal, hydro and nuclear power;
- Intensification of exploration to achieve indigenous production of oil and gas;
- Efficient management of demand of oil and other forms of energy;
- To formulate efficient methods of energy conservation and management;
- Optimisation of utilisation of existing capacity in the country
- Development and exploitation of renewable sources of energy to meet energy requirements of rural communities;
- Organisation of training for personnel engaged at various levels in the energy sector.
- Government private partnership to exploit natural energy resources

Renewable Resources

The resources that can be replenished through rapid natural cycles are known as renewable resource.These resources are able to increase their abundance through reproduction and utilization of simple substances.

Examples of renewable resources are plants (crops and forests),and animals who are being replaced from time to time because they have the power of reproducing and maintain life cycles.
Some examples of renewable resources though they do not have life cycle but can be recycled are wood and wood-products, pulp products, natural rubber, fibres (e.g. cotton, jute, animal wool, silk and synthetic fibres) and leather.
In addition to these resources, water and soil are also classified as renewable resources. Solar energy although having a finite life, as a special case, is considered as a renewable resource in as much as solar stocks is inexhaustible on the human scale.

Non-Renewable Resources

The resources that cannot be replenished through natural processes are known as non-renewable resources.
These are available in limited amounts, which cannot be increased. These resources include fossil fuels (petrol, coal etc.), nuclear energy sources (e.g. uranium, thorium, etc). metals (iron, copper, gold, silver, lead, zinc etc.), minerals and salts (carbonates, phosphates, nitrates etc.).
Once a non-renewable resource is consumed, it is gone forever. Then we have to find a substitute for it or do without it.
Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable

(1) Recyclable resources

These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (e.g. ores of aluminium, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. phosphate sock and potassium and minerals used in their natural state (asbestos, clay, mica etc.)

(2) Non-recyclable resources

These are non-renewable resources, which cannot be recycled in any way. Examples of these are fossil fuels and nuclear energy sources (e.g. uranium, etc) which provide 90 per cent of our energy requirements.

Use of Alternate Energy Sources

There is a need to develop renewable energy sources which are available and could be utilized (solar or wind) or the sources which could be created and utilized (bio-mass). The main renewable energy sources for India are solar, wind, hydel, waste and bio-mass. Bio-mass are resources which are agriculture related like wood, bagasse, cow dung, seeds, etc.

(1) Hydel energy

India has a total hydro energy potential of about 1.5 lakh MW, of which only about 20 % is installed. Small hydro plant potential is about 15000 MW and most of it is in the northern and eastern hilly regions.

(2) Wind energy

The wind power potential of India is about 45,000 MW out of which capacity of 8748 MW has been installed in India till 2008. India is one of the leading countries in generating the power through wind energy.

Gujarat, AP, Karnataka, MP and Rajasthan are states having more than 5000 MW potential each. These potentials could be improved if the technology of putting turbines in sea is embraced. There are wind farms on sea generating as high as 160 MW of power.

(3) Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

(4) Ocean thermal energy conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still a modest 20 to 25 °C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other ocean energy options such as wave power

(5) Biomass energy

Biomass is the oldest means of energy used by humans along with solar energy. As soon as the fire was discovered, it was used widely among humans mainly for heat and light. Fire was

generated using wood or leaves, which is basically a biomass. The biomass could be used to generate steam or power or used as a fuel. Power is generated using rice husk in Andhra Pradesh, while several bagasse based plants are there. India has a potential of 3500 MW from bagasse. Other fast growing plants could be planned over a huge area, so that it provides biomass for generating power.

Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted by the anaerobic digestion or fermentation into a gaseous fuel called biogas. Biogas is a mixture of 65% methane (CH_4) and of 35% CO_2 and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. It is a renewable energy resulting from biomass. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

(6) Bio-fuels

India has more than 50 million hectare of wasteland, which could be utilized for cultivating fuel plants. Jatropha is one of the options which can be planted on arid lands and be used for production of bio fuels.

(7) Solar energy

India being a tropical country has potential to use solar energy on commercial bases. According to estimates, 35 MW of power could be generated from one sq km. With such potential, solar energy has bright future as energy source for the development of the country. Initial cost is the biggest limitation which has led to the low realization of its potential. For solar energy to become one of the front runners, it will require lot of research, cheap technology and low capital.

Problems Relate To the Use of Energy Resources

(1) Fossil fuel

• Global warming
• Acid rains
• Dangers posed by leaded fuels ,Oil spills
• Water pollution caused by poorly managed coal mines
• Air pollution.

(2) Alternate energy resources

• The initial cost of establishment of alternate energy generation is costlier than conventional resources.

• Maintenance of these structures is difficult.
• It requires more space.
• Energy supply is unpredictable during natural calamities.

Growing Energy Needs

Energy consumption of a nation is usually considered as an index of its development, because almost all the development activities are directly or indirectly dependent upon energy. Power generation and energy consumption are crucial to economic development as economy of any nation depends upon availability of energy resources. There are wide disparities in per capita energy use of developed and the developing nations. With increased speed of development in the developing nations energy needs are also increasing.

- The very original form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes.
- Wind and hydropower has also been used. Invention of steam engineers replaced the burning of wood by coal and coal was further replaced by oil.
- The oil producing has started twisting arms of the developed as well as developing countries by dictating the prices of oil and other petroleum products.
- Energy resources are primarily divided into two categories viz. renewable and non-renewable sources.
- Renewable energy resources must be preferred over the non-renewable resources.
- It is inevitable truth that now there is an urgent need of thinking in terms of alternative sources of energy, which are also termed as non-conventional energy sources which include:
  - ✓ Solar energy needs equipments such as solar heat collectors, solar cells, solar cooker, solar water heater, solar furnace and solar power plants .
  - ✓ Wind energy
  - ✓ Hydropower, Tidal energy, ocean thermal energy, geothermal energy, biomass, biogas, biofuels etc.

- The non renewable energy sources include coal, petroleum, natural gas, nuclear energy.

Case Study

Importance of the energy resources in present economy and as a base for our future can be underlined by the fact that recent confrontations between some powerful nations of the world have primarily been attributed driven by objective to secure their energy supplies. Examples of this have been the two gulf wars. It was the hunger for energy resources that drove Iraq to lead an offensive over Kuwait and also reason for second Gulf war has been attributed to energy security by defence experts. In recent times, world has witnessed a confrontation at

South China Sea between India, Vietnam and China over the issue of exploring natural gas and petroleum under the sea bed.

Cauvery – The River:

Cauvery, which is locally known as Kaveri, is a large river that flows through the southern states of Karnataka and Tamil Nadu. The river has its origin at Talakaveri, Kodagu in Karnataka and empties itself into the Bay of Bengal through Poompuhar in Tamilnadu. The river has enjoyed social, economic, political religious and even cultural importance in the life of people from both the states that are currently fighting over its water.

Cauvery Water Dispute

The Cauvery River has been a source of conflict between the states of **Karnataka** and Tamil Nadu for over 124 years. The primary quarrel, in this case, has always been about the sharing and distribution of water of Cauvery River between the two states. Over the years, repeated attempts from both the states and central governments have failed to resolve this dispute which has now transformed into regional conflict now. The Cauvery Water Dispute has become a very sensitive topic for common people of both the states who now regard treat it as a fight for regional supremacy between the two states.

• Cauvery water is vitally important for both the states as people from Karnataka depend upon it to satisfy their drinking needs, whereas farmers from Cauvery delta in Tamil Nadu depend upon it for agriculture and livelihood.

• The fight for Cauvery river water become even more important during rainfall deficient years, as the entire basin delta of the Cauvery River falls under the drought prone area. Therefore, Cauvery river water is the only source of water in this region.

• As far as water resources are concerned, around 53% of Cauvery water resources fall within the geographic boundaries of Karnataka, whereas only 30% of water resources fall within the geographical borders of Tamil Nadu.

• On the other hand, 54% of river basin area (the portion of land drained by the river) lies in the state of Tamil Nadu, whereas only 42% of Cauvery river basin area is in Karnataka.

• As per the facts provided above, Karnataka claims more rights over Cauvery water as the river originates in the state and they hold 53% of water resources fall within their state.

• Similarly, Tamil Nadu has been traditionally and historically dependent on Cauvery water to meet the irrigation needs in the northern part of the state. In addition to this, they also have larger share of river basin area and have been using more water from Cauvery historically, which has translated into demand for more water from Karnataka.

JNNSM Introduction

The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by our Prime Minister, Dr. Manmohan Singh. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 and aims at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products. It has been envisaged to achieve grid tariff parity by 2022.

The Prime Minister has emphasised the importance of the mission as:

“The importance of this Mission is not just limited to providing large-scale grid connected power. It has the potential to provide significant multipliers in our efforts for transformation of India's rural economy. Already, in its decentralized and distributed applications, solar energy is beginning to light the lives of tens of millions of India's energy-poor citizens. The rapid spread of solar lighting systems, solar water pumps and other solar power-based rural applications can change the face of India's rural economy. We intend to significantly expand such applications through this Mission. As a result, the movement for decentralized and disbursed industrialization will acquire an added momentum, a momentum which has not been seen before.”

Revision of cumulative targets under National Solar Mission from 20,000 MW by 2021-22 to 1,00,000 MW

The Union Cabinet chaired by the Prime Minister, Shri Narendra Modi, today gave its approval for stepping up of India’s solar power capacity target under the Jawaharlal Nehru National Solar Mission (JNNSM) by five times, reaching 1,00,000 MW by 2022. The target will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale

Grid Connected Solar Power Projects. With this ambitious target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries.

The total investment in setting up 100 GW will be around Rs 6,00,000 cr. In the first phase, the Government of India is providing Rs 15,050 crore as capital subsidy to promote solar capacity addition in the country. This capital subsidy will be provided for Rooftop Solar projects in various cities and towns, for Viability Gap Funding (VGF) based projects to be developed through the Solar Energy Corporation of India (SECI) and for decentralized generation through small solar projects. The Ministry of New and Renewable Energy (MNRE) intends to achieve the target of 1,00,000 MW with targets under the three schemes of 19,200 MW.

Apart from this, solar power projects with investment of about Rs 90,000 crore would be developed using Bundling mechanism with thermal power. Further investment will come from large Public Sector Undertakings and Independent Power Producers (IPPs). State Governments have also come out with State specific solar policies to promote solar capacity addition.

Scaling up of Grid Connected Solar Power Projects from 20,000 MW by the year 2021-22, to 1,00,000 MW by the year 2021-22 under National Solar Mission

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