ENVIRONMENT STUDIES

Since 1951

JAMAL MOHAMED COLLEGE (Autonomous)
College with Potential for Excellence
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(Affiliated to Bharathidasan University)
TIRUCHIRAPPALLI-620 020

Semester II

Ability Enhancement Course – II

Paper Title : Environmental Studies

Hours : 2 **Code: 20UCN3AE2**

Credits : 2 **Max. Marks : 100**

Course Outcomes:

At the end of the course, students will be able to

1. Realize the multidisciplinary nature of environment.
2. Justify the need to preserve and conserve biological diversity.
3. Analyze various natural resources available for sustaining human life.
4. Create opportunities for alternative ways of energy harvesting.
5. Produce wealth from waste by employing the concept of natural recycling.

Unit I: The multidisciplinary nature of environmental studies Definition, scope, importance, awareness and its consequences on the planet.

Unit II: Biodiversity -Introduction and conservation values. Biodiversity levels, Hot spots, common flora and fauna in India, endangered and threatened species of India. *In situ* and *Ex situ* conservation of biological resources.

Unit III: Natural resources - Forest, water, marine, minerals, food, land and energy resources. Alternative energy – Bio energy, composting energy biomass characteristics, biomass and their uses.

Unit IV: Energy and Environment - Basics principles, applications, non-renewable and renewable and renewable energy resources significance of wind, solar, hydal, tidal, waves, ocean thermal energy and geothermal energy.

Unit V: Waste to wealth - Energy from waste, value added products from waste, fly ash utilization and disposal of garbage, solid waste management in urban and rural areas, Swachh Bharat Abhiyan, recent advances in solid waste management, modern techniques in rain water harvesting and utilization.

Text books:

1. Asthana DK and Meera A, Environmental studies, 2ndEdition, Chand and Company Pvt Ltd, New Delhi, India, 2012.
2. Arumugam N and Kumaresan V, Environmental studies, 4thEdition, Saras Publication, Nagercoil, Tamil Nadu, India, 2014.

Activity I

- ❖ Assignments – Titles on Environmental awareness to be identified by teachers from the following (scripts not less than 20 pages)
- ❖ Elocution – (Speech on "Environment beauty is the fundamental duty" of citizen of the country for 3 to 5 minutes)
- ❖ Environment issues – TV, Newspaper, Radio and Medias messages – Discussion
- ❖ Case Studies/Field Visit/Highlighting day today environmental issues seen or heard
- ❖ Debating/Report Submission – Regarding environment issues in the study period

Activity II

- Environmental awareness through charts, displays, models and video documentation. Celebrating Nationally Important Environmental Days
- National Science Day – 28th February
- World wild life day – 3rd March
- International forest day – 21st March
- World Water Day – 22nd March
- World Meteorological Day – 23rd March
- World Health Day – 7th April
- World Heritage Day – 18th April
- Earth / Planet day – 22nd April
- Plants day – 26th May
- Environment day – 5th June

Activity III

Discipline specific activities

EVALUATION COMPONENT:

Component I: (25 Marks)

Document (or) Poster presentation or Elocution

Component II: (25 Marks)

Album making (or) case study on a topic (or) field visit

Component III: (25 Marks)

Essay writing (or) Assignment submission

Component IV: (25 Marks)

Quiz (or) multiple choice question test

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Unit I: The multidisciplinary nature of environmental studies Definition, scope, importance, awareness and its consequences on the planet.

Environmental Science

Word environment is derived from the French word '*environner'* which means to 'encircle or surround'. Environment is 'a word which describes, "the Social, Cultural and Physical conditions that surround, affect and influence the survival, growth and development of people, animals and plants".

This broad definition includes *the natural world and the technological environment as well as the cultural and social contexts that shape human lives*.

It includes both living and nonliving that affect an individual organism or population at any point in the life cycle.

Multidisciplinary Nature of Environmental Studies

Environmental studies is a multi-disciplinary programme created to promote the study of our natural surroundings. Since it includes all disciplinary such as agriculture, chemical, physical and life and earth science, commerce, climatology, economics, humanities laws, politics, policy studies, mathematics, meteorology, sociology, laws, engineering and Mathematics.

- Life sciences including botany, zoology, microbiology, genetics, biochemistry, biotechnology help in understanding the biotic components and their interactions.
- The physical and chemical structure of the biotic components and energy transfer and flow are understood with the help of basic concept of physics, chemistry, atmospheric science and oceanography.
- Mathematics, statics and computer science serve as effective tools in environmental modelling and management.

Scope of environment

It consists of four segments as under:

1. **Atmosphere:** The atmosphere implies the protective blanket of gases composed of nitrogen and oxygen. Besides, argon, carbon dioxide and trace gases surrounding the earth.
2. **Hydrosphere:** Various water bodies present on the earth.
3. **Lithosphere**: Contains various types of soils and rocks on the earth.
4. **Biosphere:** Composed of all living organisms and their interactions with the environment.

Scope of the environmental studies is broad based and it encompasses a large number of areas and aspects broadly listed below.

a. Natural resources–their conservation and management
b. Ecology and biodiversity
c. Environmental pollution and control
d. Social issues in relation to development and environment
e. Human population and environment

These scope focused on

- Studying the **interrelationships among biotic and abiotic components** for sustainable human ecosystem.
- Managing and maintaining of forests and wild life under **natural resources conservation**
- It deals with the study of **flow of energy and materials** in the environment.
- Carrying out impact **analysis and environmental auditing** for the further catastrophic activities.
- Developing methods to curb **the pollution** urban and industrial pollution and **manage waste** effectively.
- **Protection of environment** from the potentially deleterious effects of human activity and improving the environmental quality for the health and well beings of humans.
- **Stopping the use of biological and nuclear weapons** for destruction of human race.
- Development of policies and plans for **management of natural disasters and mitigate climate change events.**

Importance of Environmental Studies

1. Understand the influence of Environmental factors on activities of all organisms.
2. It aims to protect bio diversity and utilize them sustainably.
3. It enlighten us on the importance of protection and conservation of our natural resources, indiscriminate release of pollution into the environment.
4. It help to achieve sustainable development and understand the relationship between development and the environment.

5. It is a subject that is actually global in nature.
6. Deals with the analysis of the processes in water, air, land, soil, and organism which leads to pollution (or) environment degradation.
7. Environmental studies helps maintain ecological balance by providing a basic operating knowledge of environmental system and processes.
8. The concepts can be applied to the study of agriculture and the design of sustainable production system.
9. It also provide knowledge about the development and utilization of energy resources and the role of public policy.
10. It examines the scientific basic for environmental and social concerns about our present energy needs, global climate changes, toxic emission and waste disposal.
11. Deals with the most important issues like safe and clean drinking water, hygienic living conditions, clean and fresh air, and healthy food for man and for development.

Awareness

Public awareness is very essential to help, understand pros and cons of environmental problems.

i. **Growing Population:** It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth.
ii. **Poverty alleviation:** The poverty and environmental degradation are mixed with one another. The vast majority of people are directly dependent on the nature resources for their basic needs of food, fuel shelter and fodder.
iii. **Environment degradation** has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge of environment degradation are two facets of the same challenge.
iv. **Agricultural Growth:** Massive rainfall or drought due to climate change activities, monoculture cropping system stable agriculture productivity is retarded.
v. **Need to increase Ground water:** Both surface and Ground water have polluted due to agrochemicals and industrial effluents. Hence strategies for conservation of water, provision of safe drinking water and keeping water bodies clean should be developed.

vi. **Development of forest and restoration of degraded land:** Monitoring and management of forest both animal and plants and restoration of degraded lands with native plants and implement afforestation programs for increasing the forest cover.

vii. **Air and water Pollution:** Reduce the pollutants from urban residents, automobile and industry and converting waste to wealth.

viii. **Production of Plastic Goods-** Currently our society creates a great deal of waste and much of that waste consists of plastic. According to the Environmental Protection Agency (EPA) in 2010 alone 31 million tons of plastic waste was created. This waste ends up all over the globe in both land and water. So utilization of plastic goods should be reduced.

ix. **Environmental Laws:** Understand some important laws related to environmental protection and wildlife a) The Environment (Protection) Act, 1986; b) The Forest (Conservation) Act, 1980; c)The Wildlife Protection Act, 1972; d) Water (Prevention and Control of Pollution) Act, 1974; e) Air (Prevention and Control of Pollution) Act, 1981 and f) The Indian Forest Act, 1927.

Involve yourself and Creating Public Awareness

- Create awareness among the above said topics, this can only be made possible through mass public awareness, Mass media such as newspapers, radio, television, strongly influence public opinion
- Follow the environmental ethical principles no harm to the environment and utilize the resource in sustainable manner.
- Practice and promote good civic sense such as no spitting or tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.
- Practice and promote issues such as saving paper, saving water, reducing use of plastics, **practicing the 5Rs Principle of Refuse, Reduce, Reuse, Recycle and Recover.**
- Take part in events organised on World Environment Day, Wildlife Week, etc.
- Enjoy beauty of nature encompasses every aspect of the living and non-living part of our earth.
- Develop visual arts and post poets to create awareness that vitalize the lives in the earth.

Unit II: ***Biodiversity Introduction and conservation values. Biodiversity levels, Hot spots, common flora and fauna in India, endangered and threatened species of India. In situ and Ex situ conservation of biological resources.***

Biological diversity' means that the *variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems*.

Biodiversity plays an integral role in the way ecosystems work and in the benefits they provide. Some of the benefits of biodiversity include:

- Forests are the backbone for Biodiversity.
- Forest are considered as lungs of the country or world.
- Regulating elements such as climate, water quality, disease, and pollination
- Provisioning resources such as food, clean water, industrial raw materials, and genetic resources
- Cultural promotion such as recreational, aesthetics, spiritual benefits

Major values of biodiversity are as follows

1. **Environmental value:** includes different types ecosystem process and identifying its services
2. **Social value:** includes aesthetic, recreational, cultural and spiritual values.
3. **Ecosystem Services value:** Nutrient recycling, pollination, maintenance of habitats of all organisms.
4. **Economic value:** Economic potential in terms of food, fodder, medicinal use.
5. **Consumptive use value:** Natural products, fodder, timber and fuel wood.
6. **Productive use value:** Crop varieties and its products that are commercially harvested and marketed
7. **Ethical and Moral value:** It is based on the importance of protecting all forms of life
8. **Aesthetic value**: Beauty of a landscape and for recreation value.

Levels of Biodiversity

i. **Genetic level:** It is the amount of variation at genetic level within a species or population.
ii. **Species level:** It is the number and abundance of different species that occupy a location

iii. **Ecological or Ecosystem level:** It includes the variation in both terrestrial and aquatic ecosystems.

A healthy biodiversity offers many valuable services as follows.

- Forests regulate the amount of carbon dioxide in the air by releasing oxygen as a by-product during photosynthesis control rainfall and soil erosion.
- Protects water resources from being depleted, contaminated or polluted.
- Helps in nutrient storage and recycling.
- Helps check pollution and contributes climate stability.
- Helps an ecosystem in recovery from unpredictable events.
- Provides biological resources such as food, medicinal resources, and pharmaceutical drugs, wood products, ornamental plants, breeding stocks, etc.
- Provides recreation and tourism facilities.
- Helps in research, education, and monitoring.

What is Biodiversity Hotspots?

A biodiversity hotspot is a biogeographic region with significant levels of biodiversity that is threatened by human habitation.

Biodiversity hotspot, a region must meet following two strict criteria:

- Contain at least 1,500 species of vascular plants found nowhere else on Earth (known as "endemic" species).
- Have lost at least 70 percent of its primary native vegetation.

There are currently 36 recognized biodiversity hotspots on earth among them four biodiversity hotspots are present in Indian region which includes

a. **The Western Ghats:** These hills are present along the western edge of peninsular India.
b. **The Himalayas:** This region comprises of Bhutan, Northeast India, and Southern, Central and Eastern Nepal.
c. **Indo-Burma Region :**This region consists of numerous countries including North-Eastern India (to the south of the Brahmaputra River), Myanmar, and China's Yunnan provinces southern part, Lao People's Democratic Republic, Vietnam, Cambodia, and Thailand

d. **Sundaland:** This region lies in South-East Asia and includes Thailand, Singapore, Indonesia, Brunei, and Malaysia. The Nicobar Islands represent India.

Flora and Fauna of India

The flora and fauna in India are diverse with a variety of plants and animal varieties. Indian flora that includes the Alpines, temperate forests, deciduous forests, evergreen forests, oaks, rhododendrons, pine, spruce, deodar, laurels, maples, bamboos and tall grasses. Botanical Survey of India is an organization collect, classify and describe flora of India.

The popular fauna of India includes 500 different varieties of mammals, 2000 species of birds, 30.000 types of insects and several varieties of fish, amphibians and reptiles. Elephants, Royal Bengal Tiger, rhinos, bison, lions are some common fauna found in the country. Zoological Survey of India is an organization collect, classify and describe the fauna of India.

Other than Government agencies several academic institutes and NGOs are also involving for collection of flora and fauna

Endangered and Threatened species

An endangered or threatened species is a native species that faces a significant risk of extinction in the near future throughout all or a significant portion of its range.

Such species may be declining in number due to threats such as **habitat destruction, climate change, or pressure from invasive plants and animal species.**

Plants (Botanical Name)	Animals (Species name in bracket)
Agasthiyamalaia pauciflora	Nilgiri tahr (*Nilgiritragus hylocrius*)
Aglaia malabarica	Asiatic lion (*Panthera leo persica*)
Berberis nilghiriensis	Bengal tiger (*Panthera tigris tigris*)
Garcinia travancorica	Red panda (*Ailurus fulgens*)
Mangifera austro-indica	Lion-tailed macaque (*Macaca silenus*)
Memecylon subramanii	Indian rhinoceros (*Rhinoceros unicornis*)
Myristica andamanica	Snow leopard (*Uncia uncia*)
Myristica malabarica	Sloth Bear (*Melursus ursinus*)
Syzygium andamanicum	Steppe eagle (Aquila nipalensis)
Syzygium courtallense	Bengal florican (*Houbaropsis bengalensis*)
Syzygium travancoricum	Himalayan quail (*Ophrysia superciliosa*)
Tribulus rajasthanensis	Jerdon's courser (*Rhinoptilus bitorquatus*)

Conservation of Bioresources

It the care and protection of these resources so that they can persist for future generations. It includes maintaining diversity of species, genes, and ecosystems, as well as functions of the environment, such as nutrient cycling.

There are two methods of conservation

i) ***In situ*** **Conservation** (Inside the Native region such as Forest)

ii) ***Ex situ*** **Conservation** (Outside the Native region such as gardens, zoos, laboratory condition)

In situ **Conservation** is one of the methods of the conservation of genetic resources in natural populations of plant or animal species. It means the conservation of biodiversity in their natural habitats itself. By implementing this establish a Protected Area networks (PAs), with appropriate management practices, corridors to link fragments restore degraded habitats within and outside.

In India following types of natural habitats are being maintained

i) **National parks :** Gir National Park (Gujarat), Nanda Devi National Park (Uttarkand); Kaziranga National Park (Assam); Silent Valley National Park; Sundarbans National Park (West Bengal).

ii) **Biosphere reserves:** Great Nicobar (Andaman and Nicobar Islands) Gulf of Mannar Biosphere Reserve; Nilgiri Biosphere Reserve.

iii) **Sanctuaries** : Mudumalai Wildlife Sanctuary (Tamil Nadu), Mount Abu Wildlife Sanctuary (Rajesthan) ; Anamalai Wildlife Sanctuary (Indira Gandhi Wildlife Sanctuary and National Park) (Tamil Nadu).

India has over 600 protected area which includes over 90 national parks, over 500 animals sanctuaries and 15 biosphere Reserves.

Advantages of in-situ conservation

1. The flora and fauna live in natural habitats without human interference.
2. The life cycles of the organisms and their evolution progresses in a natural way.
3. *In situ* conservation provides the required green cover and its associated benefits to our environment.

4. It is less expensive and easy to manage.
5. The interests of the indigenous people are also protected.

Ex-situ conservation is the relocation of endangered or rare species from their natural habitats to protected areas equipped for their protection and preservation. It means the conservation of biological diversity outside their natural areas Established botanical and zoological gardens, conservation stands; banks of germplasm, pollen, seed, seedling, tissue culture, gene, and DNA, etc.

i) **Seed gene bank:** Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.
ii) **Gene bank:** Genetic variability also is preserved by gene bank under normal growing conditions.
iii) **Cryopreservation**: Preservation of biological specimens at very low temperature (-196°C) in liquid nitrogen
iv) **Tissue culture bank:** Cryopreservation of disease free meristems and culture of excised roots and shoots are maintained.
v) **Long term captive breeding:** capture, maintenance and captive breeding on long term basis of individuals of an endangered species.
vi) **Botanical gardens:** A botanical garden is a place where both native and exotic plants are grown for educational and research purposes.
vii) **Animal Translocation:** Release of animals in a new locality which come from anywhere

Unit III: Natural resources - Forest, water, marine, minerals, food, land and energy resources. Alternative energy – Bio energy, composting energy biomass characteristics, biomass and their uses.

Natural resources can be defined as the resources that exist (on the planet) independent of human actions. Common examples of natural resources include air, sunlight, water, soil, rocks, plants, animals and fossil fuels.

There are two types of resources

i) **Inexhaustible Resources:** The resources which cannot be exhausted by human consumption are called inexhaustible resources. These include energy sources like solar radiation, wind hydro and tidal power and substances like sand, clay, air, water in oceans, etc.

ii) **Exhaustible Resources:** which are available in limited quantities and are going to be exhausted as a result of continuous use. These are called exhaustible resources. For example, the stock of coal in the earth is limited

Most Important Natural Resources are:

1. **Air:** Clean air is important for all the plants, animals, humans to survive on this planet. So, it is necessary to take measures to reduce air pollution.
2. **Water:** 70% of the Earth is covered in water and only 2 % of that is freshwater. Initiative to educate and regulate the use of water should be taken.
3. **Soil:** Soil is composed of various particles and nutrients. It helps plants to grow.
4. **Iron:** It is made from silica and is used to build strong weapons, transportation and buildings
5. **Forests:** As the population increases, the demand for housing and construction projects also increases. Forests provide clean air and preserve the ecology of the world.

Based on the availability are two types of natural resources**:**

1. **Renewable:** resources that are available in infinite quantity and can be used repeatedly are called renewable resources. Example: Forest, wind, water, etc.
2. **Non-Renewable:** resources that are limited in abundance due to their non-renewable nature and whose availability may run out in the future are called non-renewable resources. Examples include fossil fuels, minerals, etc.

Importance for Conservation of Natural Resources

- ❖ Maintain ecological balance for supporting life.
- ❖ Preserve different kinds of species (biodiversity).

- ❖ Make the resources available for present and future generations.
- ❖ Ensure survival of human race.

Soil is a very important natural resource and an abiotic component of the environment. Soil is the uppermost layer of earth's crust, which supports growth of plants.

Water is essential for survival of all living organisms. It is the most important component of all life forms and necessary for sustaining life. Water also regulates climate, generates electricity and is also useful in agriculture and industries

Biodiversity is essential for maintenance of ecosystem. It maintains gaseous composition of atmosphere, controls climate, helps in natural pest control, pollination of plants by insects and birds, soil formation and conservation, water purification and Health

Alternative energy

It refers to energy sources other than fossil fuels (such as coal, petroleum, and diesel) and includes all renewable and nuclear energy sources.

Bioenergy

- ❖ **It** is one of many diverse resources available to help meet our demand for energy.
- ❖ It is a form of renewable energy that is derived from plant- and algae-based materials known as biomass, which can be used to produce transportation fuels.
- ❖ Fuel developed from natural and organic materials or wastes, which are a renewable and sustainable source of energy is known as Biomass.

Few types of fuels used to generate biomass are

a) Scrap Wood

b) Forest debris (Wood waste, sawmill waste, green waste from landfills and other vegetative)

c) Certain agricultural crops and wastes

d) Manure

e) Animal waste

f) Ethanol waste

g) Municipal Solid Waste (sewage sludge or other landfill organics)

h) Landfill gas

i) Other industrial waste (i.e. paper sludge from paper recycling processes)

Characteristics of Biomass Energy:

a. Biomass fuels consists of three main parts i.e., wood, waste and alcohol fuels.
b. Wood is the common method of biomass. Earlier, wood is burned because of cooking. Generally wood is used to generate electricity.
c. Trash which comes from plants turns waste into a source of energy. Waste energy comes from garbage which is used to produce electricity and also from collection of methane gas from landfills
d. Alcolol fuels refer to ethanol which is used in transportation sector.

Some of the advantages of biomass energy are:

a. Biomass is always and widely available as a renewable source of energy.
b. It is carbon neutral.
c. It reduces the overreliance of fossil fuels.
d. Is less expensive than fossil fuels.
e. Biomass production adds a revenue source for manufacturers.
f. Less garbage in landfills.

Unit IV: Energy and Environment - *Basics principles, applications, non-renewable and renewable and renewable energy resources significance of wind, solar, hydal, tidal, waves, ocean thermal energy and geothermal energy.*

Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation. The sun is the primary energy source in our lives. Besides, water, fossil fuels such as coal, petroleum products, water, nuclear power plants are sources of energy.

Principles of Energy

1. Energy is a physical quantity that follows precise natural laws.
2. Physical processes on Earth are the result of energy flow through the Earth system.
3. Biological processes depend on energy flow through the Earth system.
4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.
5. Energy decisions are influenced by economic, political, environmental, and social factors.
6. The amount of energy used by human society depends on many factors.
7. The quality of life of individuals and societies is affected by energy choices.

Renewable Energy Resources

Renewable energy systems use resources that are constantly replaced and are usually less polluting. E.g., hydropower, solar, wind, tidal and geothermal (energy from the heat inside the earth), burning of biomass.

i) Wind Energy: The moving air or wind has huge amounts of kinetic energy, and it can be transferred into electrical energy using wind turbines.

Significance of wind energy

1. Wind Energy is virtually a limitless natural physical resource
2. Energy is generated without polluting environment.
3. Has potential to generate energy on large scale.
4. Wind Energy can be used directly as mechanical energy.
5. In remote areas, wind turbines can be used as great resource to generate energy.

6. In combination with Solar Energy they can be used to provide reliable as well as steady supply of electricity.
7. Land around wind turbines can be used for other uses, e.g. Farming.

ii) Solar Energy: Solar energy is the light and heat procured from the sun.

Significance of Solar Energy

1. Solar power is pollution free and causes no greenhouse gases
2. Reduced dependence on foreign oil and fossil fuels
3. Renewable clean power that is available every day of the year, even cloudy days produce some power
4. Return on investment unlike paying for utility bills
5. Virtually no maintenance as solar panels last over 30 years
6. Excess power can be sold back to the power company if grid intertied
7. Can be installed virtually anywhere; in a field to on a building
8. Use batteries to store extra power for use at night
9. Solar can be used to heat water, power homes and building, even power cars
10. Safer than traditional electric current

iii) Biomass Energy: When a log is burned we are using biomass energy. Agricultural waste, sugarcane wastes, and other farm byproducts are also used to produce energy.

Significance of Biomass energy

1. Biomass is always and widely available as a renewable source of energy.
2. It is carbon neutral.
3. It reduces the overreliance of fossil fuels.
4. Is less expensive than fossil fuels.
5. Biomass production adds a revenue source for manufacturers.
6. Less garbage in landfills.

iv) Hydropower Energy produced from water is called hydropower

Significance of Hydropower

1. Hydropower is fueled by water, so it's a clean fuel source.
2. It is pollution free and causes no greenhouse gases

3. The energy generated through hydropower relies on the water cycle
4. Hydropower creates reservoirs that offer a variety of recreational opportunities, notably fishing, swimming, and boating.
5. In addition to a sustainable fuel source, hydropower efforts produce a number of benefits, such as flood control, irrigation, and water supply.

v) Tidal and Wave Power: The earth's surface is 70% water. By warming the water, the sun creates ocean currents and the wind that produces waves.

Significance of Tidal energy

1. Tidal power is an environmentally friendly source of energy
2. It does not produce any harmful gas
3. It utilizes a very little space for energy production
4. It is possible to generate electric power at very low speed.

vi) Ocean Thermal Energy Conversion (OTEC) is a process that can produce electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters.

Significance of OTEC

1. Power generated from OTEC is pollution free
2. The output generated from OTEC shows very little seasonal or daily variation.
3. Electric power generated can also be used to produce hydrogen.
4. The cold water pumped in the OTEC plant can be used for other things such as air-conditioning and refrigeration.

viii) Geothermal energy: It does this using high-temperature (300°F to 700°F) heat – known as geothermal energy – from the Earth, accessed by drilling hot water or dry steam wells in a process similar to drilling for oil.

Significance of Geothermal energy

1. Comparatively ecologically clean.
2. Geothermal power stations have great capacity.
3. Pollution free and cost effective technology
4. Occupies less space and produce less noise.
5. Provides energy security. .

Non-renewable Resources

Those natural resources, on the other hand, that cannot be replaced after their depletion is called non-renewable resources.

- ❖ Fossil fuels include coal, petroleum, natural gas, oil-sand, and oil-shale and natural gas are considered nonrenewable resources.
- ❖ Metals have a wide range of useful physical and chemical properties. They can be used as pure elemental substances, as alloys (mixtures) of various metals, and as compounds that also contain non-metals.

Significance of Nonrenewable resources

1. The main advantages of non-renewable energies is that they are abundant and affordable. For example, oil and diesel are still good choices for powering vehicles.
2. Non-renewable energy is cost effective and easier to product and use.

Disadvantages

1. They can't be replaced or revitalized.
2. Causes damage to the environment. Produce greenhouse gases.

Unit V: Waste to wealth - Energy from waste, value added products from waste, fly ash utilization and disposal of garbage, solid waste management in urban and rural areas, Swachh Bharat Abhiyan, recent advances in solid waste management, modern techniques in rain water harvesting and utilization.

Waste is viewed as unwanted or unusable material that has been disposed or discarded after primary use.

Waste Management

1. Generation of less waste, reuse of consumables, recycling of waste and recovery of valuable resources from waste are considered as good practices.
2. Conserve valuable natural resources and energy
3. Lower environmental damage caused by socio-economic development. Thus waste management is strongly linked with the idea of sustainable development.
4. Generate energy in the form of electricity or heat from waste

Benefits of Waste-to-Energy

1. Waste-to-Energy (or energy-from-waste) facilities provide a safe, technologically advanced
2. It reduces greenhouse gases, generates clean energy and recycles metal.
3. It can help mitigate climate change

Utilization of Fly ash

a. Fly ash, a principal byproduct of coal burning power plants, is an industrial waste.
b. It contains large amounts of silica, alumina and small amount of unburned carbon, which pollutes environment.
c. This fly ash has real disposal problems, and should hence be utilized effectively for various purposes.
d. Both ceramic as well as pozollanic properties and therefore can be **replace of the Portland cement** and utilized in a unique way for manufacturing bricks.

Some of the resulting benefits are:

- Higher Ultimate Strength
- Increased Durability,
- Improved Workability

- Reduced Bleeding
- Increased Resistance to Sulfate Attack
- Reduced Shrinkage
- Bricks are smooth and uniform size.

e. Fly ash for Road : Fly ash can be used for **construction of road** and embankment.

f. Fly ash is also used as a **nutrient manure.**

With an ever increasing population and rapid pace of urbanization, the country is facing a huge challenge of Municipal Solid waste Management. The volume of waste is projected to rise from the present 62 million tons to about 150 million tons by 2030. This necessitates the importance of scientific solid waste management in today's context.

Disposal of Garbage (Solid Waste)

Garbage is arising from human or animal activities, that is abandoned as unwanted and useless is referred as solid waste.

- ❖ It is generated from industrial, residential and commercial activities in a given area
- ❖ It categorized based on materials such as paper, plastic, glass, metal and organic waste.
- ❖ Solid waste disposal management is usually referred to the process of collecting and treating solid wastes.

Methods of Solid Waste Disposal and Management:

Following methods are generate pollution in air, land and water. So it should be avoided.

- Burning of Solid Waste in Open areas
- Dumping of waste in Ocean
- Disposal by hog feeding **(**Garbage disposal into sewers including BOD and TSS increases by 20-30 %.)
- Damping on the land

Ecofriendly disposal Methods

a) **Solid wastes sanitary landfills:** Solid wastes sanitary landfills process is simple, clean and effective.

b) **Incineration method:** Incineration method is suitable for combustible refuse. It can be used to reduce the volume of solid wastes for land filling.

c) **Composting process:** The biodegradable wastes processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. Two methods have been used in this process:

   a) Open Window Composting

   b) Mechanical Composting

d) **Electricity generation:** Utilizing plasma arc gasification process is an option for eco-friendly solid waste management in which large volume reduction of waste up to 95% is possible. This use for generation of electricity.

e) **Salvaging procedure:** Materials such as metal, paper, glass, rags, certain types of plastic and so on can be salvaged, recycled, and reused.

f) **Fermentation/biological digestion:** Biodegradable wastes are converted to compost and recycling can be done whenever possible. Hazardous wastes can be disposed using suitable methods.

Rain water harvesting

- Rain is the first form of water in the hydrological cycle.
- It is a primary source of water for us.
- The rainwater collected can be stored for direct use or can be recharged into the groundwater.
- Collection and efficient storage of rainwater from different basement areas like rooftops of residential buildings, ground surface, rock catchments
- These methods are mostly used for water conservation.

Swachh Bharat Abhiyan

Swachh Bharat Mission (SBM), Swachh Bharat Abhiyan, or Clean India Mission is a country-wide campaign initiated by the Government of India in 2014 to eliminate open defecation and improve solid waste management .Swachh Bharat Mission was launched throughout length

and breadth of the country as a national movement. The campaign aims to achieve the vision of a 'Clean India' by 2nd October 2019, the 150th anniversary of the birth of Mahatma Gandhi.

Objectives Swachh Bharat Mission

- The first phase of the mission also included eradication of manual scavenging, generating awareness and bringing about a behavior change regarding sanitation practices, and augmentation of capacity at the local level.
- The second phase of the mission aims to sustain the open defecation free status and improve the management of solid and liquid waste

Importance of rainwater harvesting

Rainwater is the primary source of new fresh water. Therefore, harvesting rainwater at the point of supply itself has many advantages as below:

1. Harvesting the rainwater are simple, economical and eco-friendly
2. Rainwater is bacteriologically pure, free from organic matter and soft in nature.
3. It help in reducing the flood hazard.
4. It improves the quality of existing ground water through dilution.
5. The recharged aquifer also serves as a distribution system.
6. Rainwater may be harnessed at place of need and may be utilized at time of need.

Methods of rainwater harvesting

There are two basic ways of rainwater harvesting

a) Surface runoff harvesting: rainwater flowing along the surface is collected in an underground tank.
b) Rooftop rainwater harvesting: Rainwater is collected from roof catchment and stored in a tank

- Rainwater is the purest type of water source. As a result, it can be consumed directly.
- If water is collected from a dirty surface, it can be made usable by utilizing a proper filtering system.
- Following that, it can be used for drinking, cooking, bathing, laundry, toiletry purposes, watering gardens, composting, birdbaths, recharging ponds and pools, washing vehicles, and fire extinguishing.

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