Environmental Science

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Sustainability and climate change

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Environment, sustainability, climate change environment refers to the external surroundings and conditions that affect the existence, growth and development of living organisms including humans animals and plants.

It encompasses natural environment air, water, land and and ecosystems.

- Physical environment built infrastructures such as buildings and roads.
- The environment provides essential resources, services necessary for life including
- Clean air and water
- Food and shelter
- Climate regulation and
- Ecosystem services.

Objective

The course will provide understanding about the environment which will lead to a concern for the environment leading to develop the ability to protect the environment at individual level.

The environment is crucial for human well being, economic development and the health of ecosystems.

- Sustainability: It is about meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- It involves balancing economic, social and environmental considerations to ensure long term viability and resilience.
- Sustainability aims to create a better future for all, while preserving the planet's natural resources and ecosystems.

Key aspects

- Environmental sustainability conserving natural resources, reducing pollution and protecting ecosystems.
- Social sustainability promoting social justice human rights and community well being.
- Economic sustainability ensuring economic viability and stability while minimizing negative environmental and social impacts.

Climate

- Climate refers to long term average atmospheric conditions in a particular region or globally including:
- Temperature
- Precipitation (rainfall, snowfall etc.)
- Humidity
- Wind pattern
- Seasonal variations

Climate is different from weather which refers to short term conditions.

Climate determines the overall characteristics of a region's environment and has significant impact on ecosystem's , human activities and the planet as a whole.

Climate change : it refers to significant long term changes in the earth's climate pattern including

- Global warming rising temperatures due to increased green house gas emissions.
- Changes in precipitation, shift in rainfall and snowfall patterns.
- Increased extreme weather events. More frequent and intense heat waves, drought, and storms.

Causes :
human activates burning fossil fuels, deforestation and land use changes.

- Natural factors volcanic eruptions and changes in solar radiation,
- Impacts:
- Rising sea levels, coastal erosion and flooding.
- Ecosystem disruption loss of biodiversity and ecosystem degradation.
- Human health impacts. Heat related illnesses, respiratory problems and mental health issues.

Solutions :

Reduce green house gas emission.
Transition to renewable energy sources.
Adapt to changing climate conditions.
Implement climate resilient infrastructure and agriculture practice

Objective: after this course the student will develop a concern for the environment. He /she will be able to act at his/her level to protect the environment.

- The student should be able to understand environmental problems arising due to developmental activities.
- Identify the natural resources and suitable methods for conservation and sustainable development.
- Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
- Identify the environmental pollutants and abatement devices.

Environment awareness:

the objective of environmental education is to enlighten the public ,particularly students about the importance of protection and conservation of our environment and the need to restrain human activities which lead to indiscriminate release of pollutants into the environment.

Biogeochemical cycles

Environmental segments: the environment consists of 4 segments-

- Atmosphere
- Hydrosphere
- Lithosphere and
- Biosphere

Atmosphere: it plays a major role in maintaining the heat balance of the earth through absorption of infra-red radiation emitted by the sun and re-emitted from earth.

The major components of the atmosphere are nitrogen and oxygen while the minor components are argon, carbon-di-oxide and some trace gases.

The atmosphere is the protective blanket of gases surrounding the earth which sustains life on earth and saves it from the hostile environment of outer space.

It transmits only near ultraviolet, visible, near infrared radiation (300-2500nm)and radio waves.

Hydrosphere: it includes all type of water resources. Ocean, seas, river, lake, reservoirs, glaciers, polar ice caps and ground water.
About 97% of the earths water supply is in the ocean where the high salt content does not permit its use in human consumption. About 2% is located in in polar ice caps and glaciers while only 1% is available as fresh water for human consumption.

Lithosphere: this is the outer mantle of solid earth consisting of minerals occurring in the earth's crust and the soil. The soil comprises a complex mixture of minerals, organic matter, air and water. The soil is the most important part of lithosphere.

Biosphere : this denotes the realm of living organisms and their interaction with the environment, viz. atmosphere, hydrosphere and lithosphere.
both the biosphere and environment are influenced considerably by each other.
Thus, the oxygen and carbon di oxide levels of the atmosphere depend entirely on the plant kingdom.
Green plants alone are responsible for the accumulation of oxygen in the environment through photosynthesis

- And decay, the original atmosphere having been devoid of oxygen.
- The biological world in general is intimately related with energy fronts in the environment and water chemistry.

syllabus : natural resources
forest
water
minerals
food

- Energy resources
- Land
- Role of individual in conservation of natural resources.
- Equitable use of resources for sustainable life styles.

Ecosystems : concept of ecosystem structure and function of an ecosystem.
Energy flow in an ecosystem: food chain and food web and ecological pyramids.
Introduction, type, characteristic features, structure and function of following ecosystems:

forest ecosystem
grassland ecosystem
desert ecosystem
aquatic ecosystems (ponds, streams, lakes, rivers, ocean, estuaries).

Biodiversity and its conservation : biogeochemical cycles biodiversity at global, national and local levels.

India as a megadiversity nation.

Threats to biodiversity.

Endangered and endemic species of India.

Conservation of biodiversity.

Environmental Pollution

definition, cause, effects and control measures of:

- air pollution
- water pollution
- soil pollution
- marine pollution
- noise pollution
- thermal pollution
- nuclear hazards

Solid waste management:
causes, effects and control measures of urban and industrial wastes.
Role of individual in prevention of pollution.
Pollution case studies.
Disaster management: floods, earthquakes, cyclone and land slides.

Social issues and environment:
case studies, environmental ethics, issues and possible solutions.
Climate change, global warming, ozone layer depletion.
Waste land reclamation.
Environmental protection act,
public awareness.
Environment and human health, human rights, value education
case studies.

Remote sensing as a tool to study environmental science:

it is acquisition of information about the biosphere by non contact methods.

Its gathering information about an object or area from a distance, without physically touching it.

It involves detecting and measuring electromagnetic radiation reflected or emitted by the object or area of interest.

This data is then analyzed to understand the characteristics of the object or area.

Sensors detect and measure electromagnetic radiation (like visible light, infrared or radar) reflected or emitted by earth's surface.

Spectral signature: it is a unique pattern of electromagnetic radiation reflected or emitted by an object. This can be used to identify and classify that object.

When the amount of reflected or emitted EMR is plotted against wavelength, it forms the curve called spectral signature.
The unique curves allow remote sensing instruments to differentiate between different objects.

Sensors: detect and measure electromagnetic radiation (like visible light, infrared or microwave radar) reflected or emitted by the earths surface.

Platforms: satellite, aircraft, drone or other vehicles carrying remote sensing instruments.

Data types :

Optical imagery: visible and infrared data for land cover classification and vegetation analysis.

Thermal imagery: detecting temperature differences for applications like heat stress in crop or volcanic activity.

Radar data : uses microwave wavelength for all weather day-night imaging for applications like topography mapping and deformation mapping.

- Satellite key characteristics:
  - Spatial resolution- refers to the size of the smallest object a satellite can distinguish.
  - Spectral resolution- indicates the number of spectral bands and their widths.
  - Temporal resolution- it is the frequency at which the satellite revisits a location.

Benefits: global coverage- satellite enable monitoring of remote or inaccessible areas,
repeated observations-tracking changes over time for monitoring trends or detecting anomalies.
Multispectral data- analyzing different wavelength for various applications like vegetation health or water quality.

Nisar (NASA-ISRO Synthetic Aperture Radar) is a joint mission between NASA and ISRO that utilizes SAR technology. Launched July 26,2025

Dual frequency SAR it features L- band (24 cm wavelength) provided by NASA and S-band (10 cm wavelength) provided by ISRO for earth observation.

All-weather capability SAR can penetrate clouds and vegetation enabling data collection during all weather conditions day or night.
This will support studies on ecosystem hazards, cryosphere or more.