Environmental Studies

(**A**BILITY **E**NHANCEMENT **C**OMPULSORY **C**OURSE)

Edited by

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Jamal Mohamed College (Autonomous)
Accredited with 'A++' Grade by NAAC (4th Cycle) with CGPA 3.69 out of 4.0
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Tiruchirappalli -620020

FOREWORD

Environmental Studies acts as an interdisciplinary approach for understanding the complex relationships between human and natural systems, and addressing the various environmental challenges such as climate change, desertification, water scarcity, agricultural problems, loss of biodiversity and extinction of species.

The contents of this book are based on the recommendations of UGC and TANSCHE syllabus for common Environmental Studies for all UG subject disciplines. The content is edited for inculcating knowledge on Environmental Sciences and involves the students for disseminating and implementing to protect our environment for sustainable future. The students also develop environment ethical values by learning this subject.

I acknowledge with gratitude the admirable work undertaken and accomplished by Dr. I. Joseph A. Jerald, Co-ordinator, Centre for Human Excellence and Associate Professor and Head i/c Department of Zoology, Dr. H. Syed Jahangir, Associate Professor and Head, Department of Botany, Dr. B. Balaguru, Assistant Professor Department of Botany.

I congratulate the Professors handling Environmental Studies classes focusing on activity based learning pertaining to conservation of nature in the current climate change scenario.

June 2024

Tiruchirappalli 620 020

Dr. D.I. George Amalarethinam

Principal

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UCN3AE2	AECC - II	2	2	-	-	100
Course Title	**Environmental Studies**						

Unit	Contents	Hours
I	The multidisciplinary nature of environmental studies Definition, scope, importance, awareness and its consequences on the planet.	6
II	**Ecosystems:** Definition, structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	6
III	**Natural Resources:** Renewable and Non-renewable Resources: Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Heating of earth and circulation of air; air mass formation and precipitation. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. renewable energy resources significance of wind, solar, hydal, tidal, waves, ocean thermal energy and geothermal energy.	6
IV	**Biodiversity and Conservation:** Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns biodiversity hot spots. mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: *In situ* and *Ex situ* conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.	6
V	**Environmental Pollution & Conservation:** Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution 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.	6

Text books:

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

Activity – I:

1. Assignments – Titles on Environmental awareness to be identified by teachers from the following (scripts not less than 20 pages)
2. Elocution – (Speech on "Environment beauty is the fundamental duty" of citizen of the country for 3 to 5 minutes)
3. Environment issues – TV, Newspaper, Radio and Medias messages – Discussion ϖ Case Studies/Field Visit/Highlighting Day today environmental issues seen or heard
4. Debating/Report Submission – Regarding environment issues in the study period Activity II
5. Environmental awareness through charts, displays, models and video documentation.
6.

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

Course Outcomes		
Course Outcomes: Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-level)**
CO1	To understand the multi-disciplinary nature of environmental studies and its importance	K1
CO2	To obtain knowledge on different types of ecosystem	K2
CO3	To acquire knowledge on Renewable and non-renewable resources, energy conservation	K3
CO4	To understand biodiversity conservation	K4
CO5	To analysis impact of pollution and conversion waste to products	K5

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	02	02	02	02	02	03	03	03	03	03	2.5
CO2	02	03	03	02	03	03	03	03	03	03	2.8
CO3	02	03	03	03	03	03	03	03	03	03	2.9
CO4	02	02	03	03	03	03	03	03	03	03	2.8
CO5	02	03	03	03	03	03	03	02	03	03	2.8
										Mean Overall Score	2.7
										Correlation	High

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

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

Environmental Science

The 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, commerce, climatology, earth science and economics, engineering, humanities, life science, laws, mathematics, meteorology, physical sciences, politics, policy studies and sociology.

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 environmental studies

It consists of four segments which are follows

1. Atmosphere: The atmosphere implies the protective blanket of gases composed of nitrogen and oxygen. Also 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

(Image source : https://www.dreamstime.com/illustration/hydrosphere-lithosphere.html)

Scope of the environmental studies are based on

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

This scope of environmental studies 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 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 all the living beings.
2. The major goal is to protect the biodiversity and utilize them for sustainable development
3. It helps to achieve sustainable development and understand the relationship between development and the environment.

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

i. Public awareness is very essential to help, understand pros and cons of environmental problems.
ii. 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.
iii. Poverty alleviation: The poverty and environmental degradation are mixed with one another.
iv. The vast majority of people are directly dependent on the nature resources for their basic needs of food, fuel shelter and fodder.
v. 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.
vi. Agricultural Growth: Massive rainfall or drought due to climate change activities, monoculture cropping system stable agriculture productivity is retarded.
vii. 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 and maintained.
viii. 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.
ix. Air and water Pollution: Reduce the pollutants from urban residents, automobile and industry and converting waste to wealth.

x. 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.

xi. **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, which explain not to harm to the environment and utilize the source 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 conservation 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.

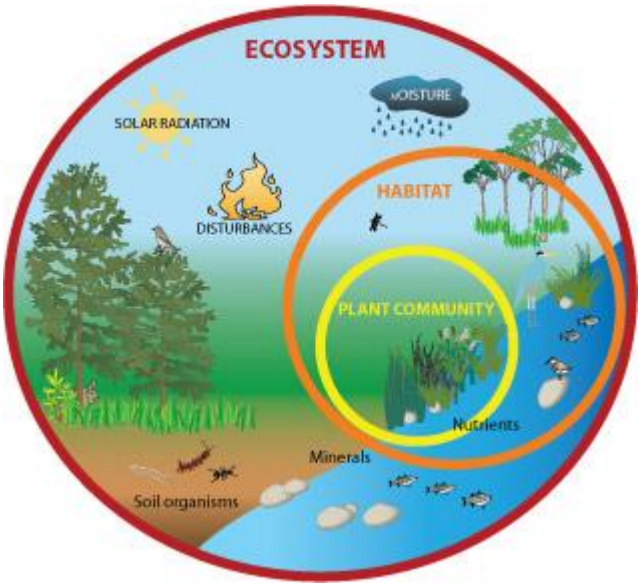
Unit 2: Ecosystems: Definition, structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

1. What is Ecosystem?

A complex relationship between all the living and non-living things (plants, animals, organisms, sun, water, climate etc) interact with each other is known as 'An Ecosystem'. Ecosystems are the foundation of 'Biosphere' and maintain the natural balance of the earth.

For example, let's take the relationship between sheep and lion in the ecosystem; for its survival, the lion eats the sheep. And each relationship like this has an effect on other creatures and plants living in the same area.

Each organism in the ecosystem plays an important role, so anytime a 'foreign' factor is put in the ecosystem, it poses a major threat to the ecosystem. This happens because the foreign factor can deform the natural balance of the ecosystem and harm it potentially.



(Image Source: https://socratic.org/questions/can-you-define-ecosystem)

2.Components of the Ecosystem

The components of an ecosystem are divided into abiotic components that include all non-living components such as minerals, climate, soil, water & sunlight. Biotic components that includes all the living components. These components together make up for the flow of energy and the nutrient cycle in the ecosystem.

The gleaming energy from the sun is the basic source of energy in all the ecosystems. The autotrophs (self-sustaining organisms) absorb this energy and produce photosynthesis where they can use this energy to convert CO2 and H2O into simple carbohydrates. The autotrophs store energy in these carbohydrates, which they then use to produce more complex and organic products like lipids, proteins, and starches that help the organism to survive.

These autotrophs are the producers of the ecosystem Organic compounds produced by autotrophs help in the survival of the heterotrophic organisms.
Heterotrophs are the consumers of the ecosystem since they're incapable of making their own food. Example bacteria, fungi and animals.

Food Chain

A food chain is a linear sequence of organisms where each organism is eaten by the next one in the chain. It illustrates a straightforward path of energy flow in an ecosystem, from producers to top predators.

Example of a Simple Food Chain

1. **Producers (Autotrophs):**
    - Plants or algae that produce their own food through photosynthesis.
    - Example: Grass.
2. **Primary Consumers (Herbivores):**
    - Organisms that eat producers.
    - Example: Grasshopper.
3. **Secondary Consumers (Carnivores):**
    - Organisms that eat primary consumers.
    - Example: Frog.
4. **Tertiary Consumers (Top Carnivores):**
    - Organisms that eat secondary consumers.
    - Example: Snake.
5. **Quaternary Consumers (Apex Predators):**
    - Organisms at the top of the food chain with no natural predators.
    - Example: Hawk.

Characteristics of a Food Chain

- **Simplicity:** It involves a direct and singular path of energy flow.
- **Linear Structure:** Each organism occupies a specific level known as a trophic level.
- **Limitations:** It does not account for organisms that occupy multiple trophic levels or those with varied diets.\

Food Web

A food web is a more complex and interconnected network of food chains within an ecosystem. It shows how different food chains overlap and interlink, representing a more comprehensive picture of feeding relationships.

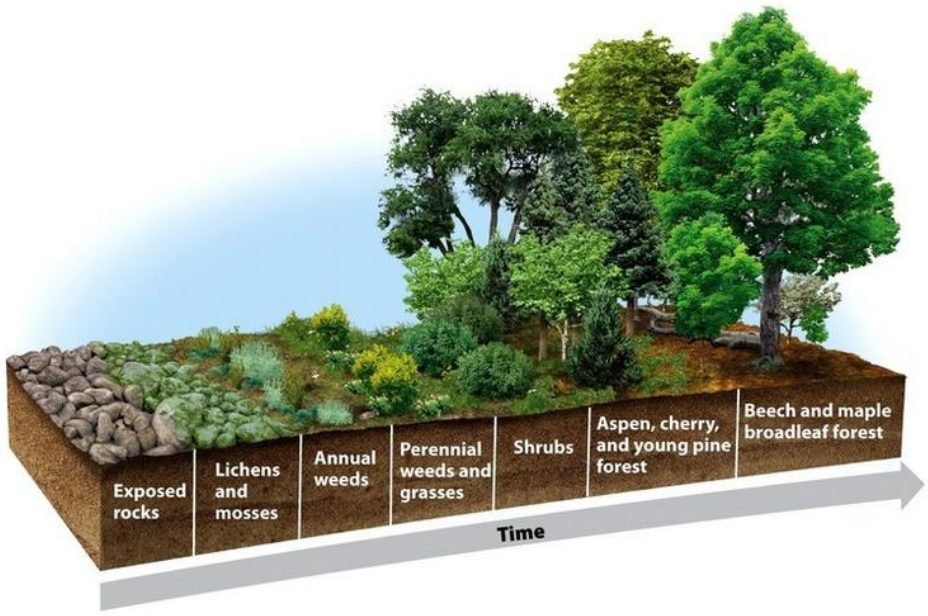
Example

- **Producers:** Grass, shrubs, and phytoplankton.
- **Primary Consumers:** Herbivores like deer, rabbits, and zooplankton.
- **Secondary Consumers:** Carnivores like foxes, small fish, and birds that eat insects.
- **Tertiary Consumers:** Larger predators like wolves, large fish, and eagles.
- **Decomposers:** Organisms like bacteria, fungi, and earthworms that break down dead organic matter.

Characteristics of a Food Web

- **Complexity:** Shows multiple interconnected food chains.
- **Interconnected Structure:** Organisms can occupy multiple trophic levels.
- **Realistic Representation:** Reflects the diverse diet and feeding relationships in an ecosystem.

*i*Ecological succession is the process of change in the species structure of an ecological community over time.



Ecological succession image source : https://livingnatureweb.wordpress.com/ecological-succession/

- Pioneer species are the first species that invade and establish in a bare area for example Lichens are the pioneer species on bare roc (xerarch) and Phytoplantons are the pioneer species in hydrach.
- Various states of species colonise in the succession are known as seral stages.
- Climax community is the final community seen in an area of succession which is in equilibrium with the environment.
- Succession are of hydrarch and xerarch types
- Hydrarch succession takes place in water medium and it gradually processes to mesis conditions. From Phytoplanktons, submerged, submerged free floating, reed-swamp, marsh, meadow, scrub, forest (climax).

  Image source : https://www.geeksforgeeks.org/hydrarch-succession/

- Xerarch succession starts on bare rocks and sand dunes etc.

Causes of Succession:

The main causes of succession are as follows:

(1) Climatic causes,

(2) Topographic causes, and

(3) Biotic causes.

Succession and climax concept

- Plant succession is an orderly change of vegetation. which involves gradual and successive replacement of one plant population by the other.
- The first plants which appear on the bare habitat are called **pioneer plants**.

- Plant succession is not a series of steps of stages but is continuous and very slowly changing complex. **It is dynamic process.**
- After several such changes, a stage may come when the habitat becomes occupied by **most tolerant species** that can reproduce and perpetuate well. Thus the process leads to establishment of climax community, a mature, dominant, self-maintaining and slow changing plant community.
- If temporary change of the climate which decline the development of vegetation before it has reached the expected climax, it forms **pre-climax.** sometimes the environment changes in such a way the vegetation progresses beyond the expected **climax stage**. The new climax, thus formed is termed **post-climax**..

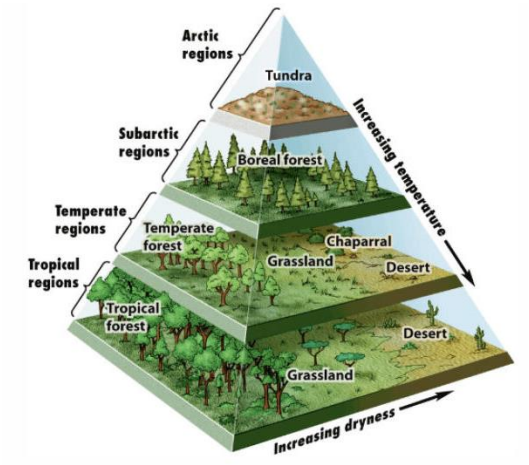
Understanding the various types of ecosystems is crucial for studying biodiversity, ecological interactions, and environmental conservation. There are examples of food webs in four major types of ecosystems i.e forest, grassland, desert, and aquatic.

a) Forest Ecosystem

A forest ecosystem is characterized by a high density of trees and a complex structure that includes various layers, such as the canopy, understory, and forest floor.

Characteristics

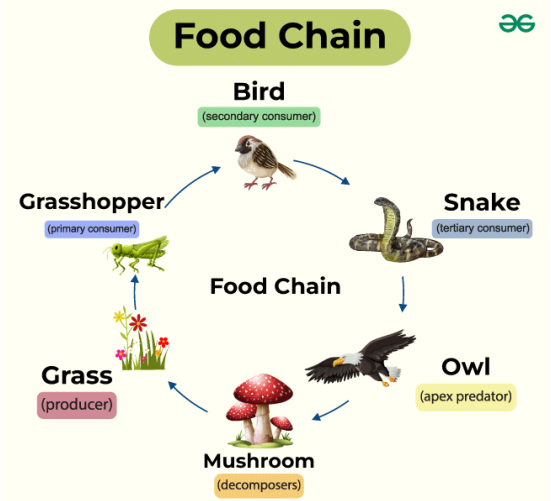
- **High biodiversity:** Includes a wide range of plant and animal species.
- **Multiple layers:** Different organisms inhabit different layers of the forest.
- **Rich soil:** Often enriched with organic matter from decomposing plant material.



(Image source : https://www.geeksforgeeks.org/overview-of-food-chain/)

Example Interaction

- Oak tree → Caterpillar → Woodpecker → Hawk

(Image source 

https://www.adda247.com/school/types-of-ecosystems/)

b) Grassland Ecosystem

Grassland ecosystems are dominated by grasses rather than large shrubs or trees. They are typically found in regions where rainfall is insufficient to support a forest but more abundant than in deserts.

Characteristics

- **Dominated by grasses:** Few trees or large shrubs.
- **Seasonal variation:** Often have distinct wet and dry seasons.
- **Rich soil:** Usually fertile and ideal for agriculture.

Example Interaction

- Grass → Grasshopper → Mouse → Snake → Hawk

c) Desert Ecosystem

Desert ecosystems are characterized by low precipitation, extreme temperatures, and sparse vegetation.

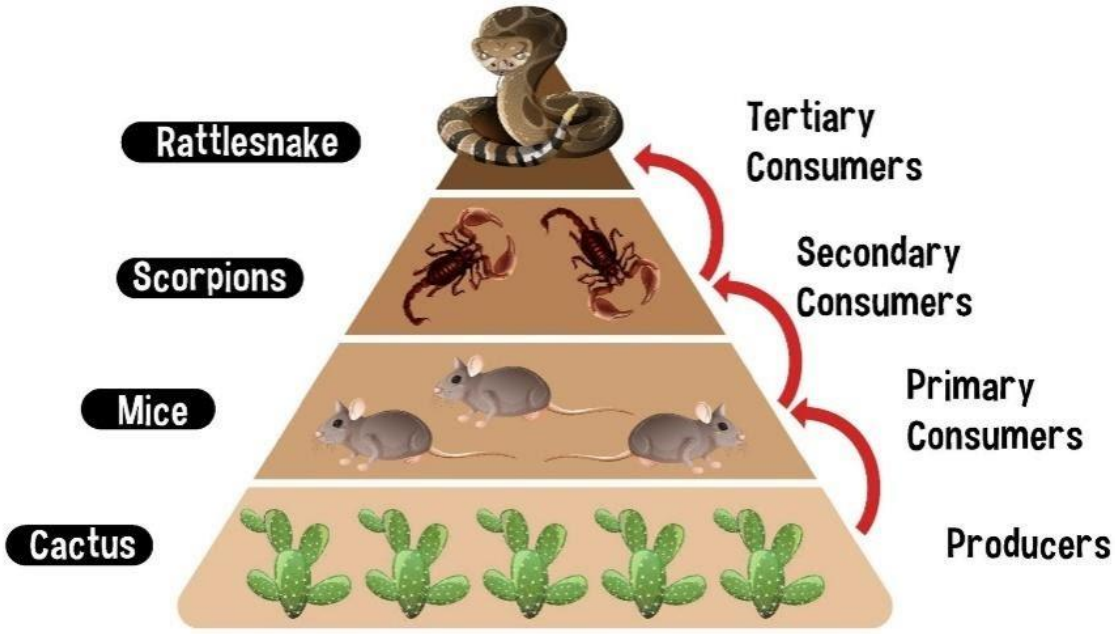
Characteristics

- **Low rainfall:** Less than 25 cm (10 inches) per year.

- **Extreme temperatures:** Hot during the day and cold at night.
- **Sparse vegetation:** Plants like cacti and succulents adapted to conserve water.

Example Interaction

- Cactus → Beetle → Lizard → Snake → Hawk



(Image source : https://www.vedantu.com/question-answer/the-food-chain-of-the-desert-ecosyste-class-10-biology-cbse-6148cc781637dc792e13e42a**)**

d) Aquatic Ecosystems

Aquatic ecosystems include ponds, streams, lakes, rivers, oceans, and estuaries, each with distinct characteristics and diverse forms of life.

Characteristics

- **Water-based:** Can be freshwater or saltwater.
- **High biodiversity:** Especially in coral reefs and estuaries.

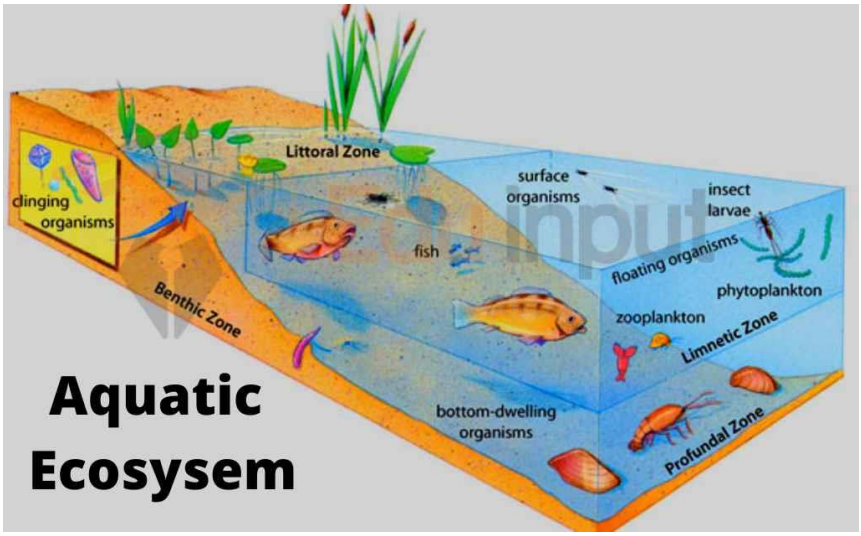
- **Varied environments:** Includes still waters (lakes, ponds) and flowing waters (rivers, streams).

Example Interaction (Pond)

- Algae → Zooplankton → Small Fish → Large Fish → Heron

Example Interaction (Ocean)

- Phytoplankton → Zooplankton → Small Fish → Tuna → Shark



(Image source : https://eduinput.com/what-is-an-aquatic-ecosystem/)

Unit 3: Natural Resources: Renewable and Non-renewable Resources: Land Resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Heating of earth and circulation of air; air mass formation and precipitation. **Energy resources:** Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. renewable energy resources significance of wind, solar, hydal, tidal, waves, ocean thermal energy and geothermal energy.

Renewable Resources

Renewable resources are those that can be replenished naturally over short periods of time. They are often sustainable, provided they are managed properly.

Examples of Renewable Resources

1. Solar Energy:
2. Wind Energy:
3. Hydropower:
4. Biomass:
5. Geothermal Energy:
6. Tidal and Wave Energy:

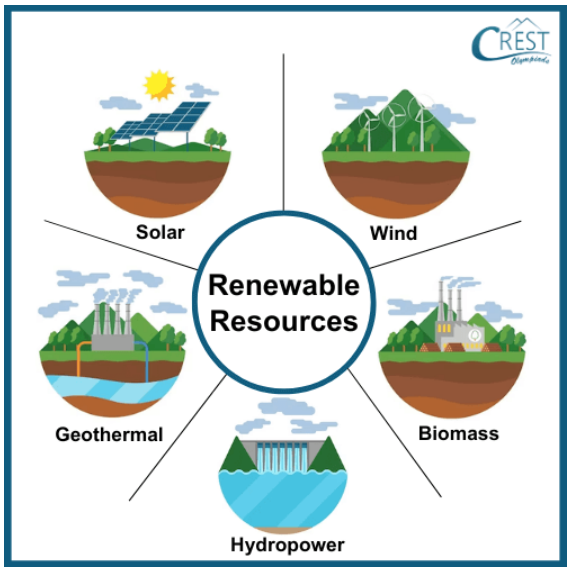


Image source https://www.crestolympiads.com/topic/class-5-natural-resources-and-source-of-energy

Non-renewable Resources

Non-renewable resources are those that do not replenish at a sufficient rate for sustainable economic extraction. They are finite and will eventually deplete.

Examples of Non-renewable Resources

1. Fossil Fuels
2. Nuclear Energy
3. Minerals and Metals
4. Petroleum Products

Land resources refer to the natural features of the Earth's surface, including soil, minerals, water, flora, and fauna, that are utilized for various human activities. Land use change involves alterations in the way land is utilized, typically driven by human activities such as agriculture, urbanization, deforestation, and industrialization.

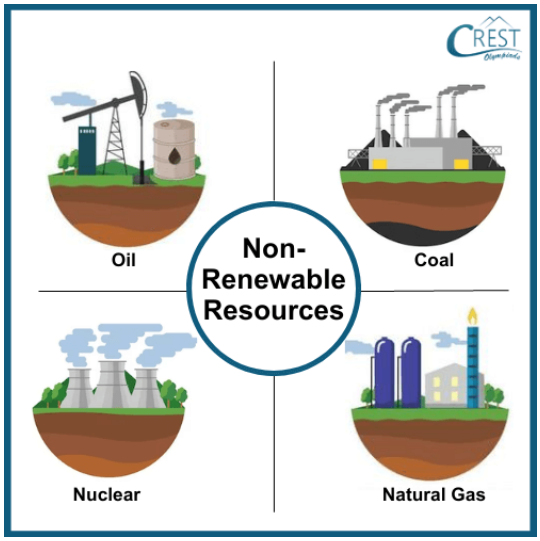


Image source https://www.crestolympiads.com/topic/class-5-natural-resources-and-source-of-energy

Land Resources

Types of Land Resources

1. **Agricultural Land**
2. **Forests**

3. **Water Bodies**
4. **Urban Land**
5. **Mineral Resources**
6. **Grasslands**

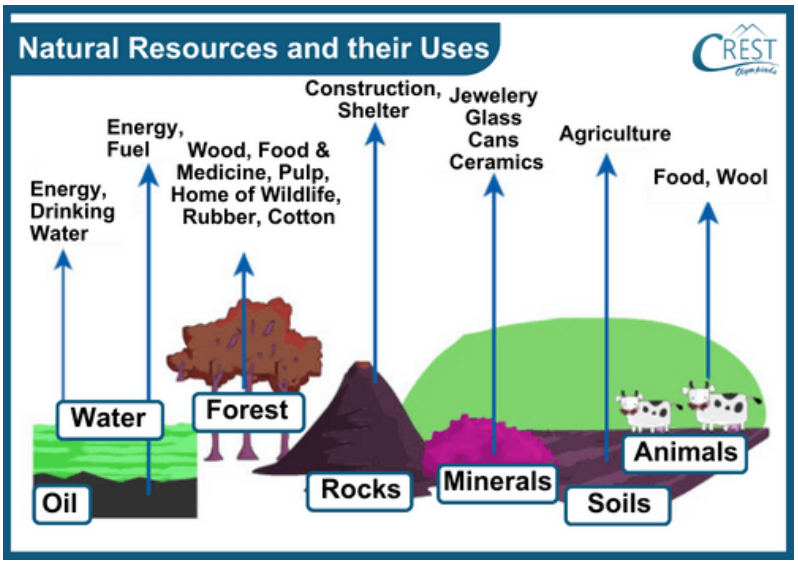


Image source https://www.crestolympiads.com/topic/class-5-natural-resources-and-source-of-energy

Land Use Change

Land use change refers to the transformation of land from its natural state to human-dominated landscapes. It is driven by various socio-economic factors and has significant environmental and ecological impacts.

Types of Land Use Change

Urbanization: Conversion of rural or natural land into urban areas.

Impacts: Loss of natural habitats, increased pollution, higher demand for infrastructure.

Deforestation: Clearing forests for agriculture, logging, or urban development.

Impacts: Loss of biodiversity, soil erosion, disruption of water cycles, increased greenhouse gas emissions.

Agricultural Expansion: Conversion of natural landscapes into agricultural fields.

Impacts: Habitat loss, soil degradation, pesticide and fertilizer runoff, changes in local climate.

Industrialization:: Development of land for industrial purposes.

Impacts: Pollution, land

Land Degradation, Soil Erosion, and Desertification

Land Degradation

Land degradation refers to the decline in land quality and productivity due to various natural and human activities. It encompasses a range of processes that result in the deterioration of the physical, chemical, and biological properties of the land.

Causes of Land Degradation

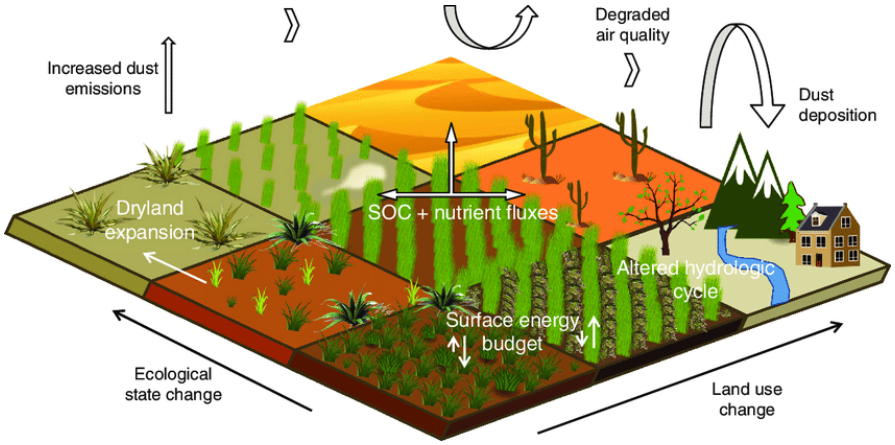
Deforestation: Removal of trees reduces soil stability, leading to erosion and loss of nutrients.

Agricultural Practices: Overgrazing, improper irrigation, and excessive use of chemicals degrade soil quality.

Urbanization: Expansion of urban areas leads to the conversion of fertile land into non-productive surfaces.

Industrial Activities: Pollution and waste from industries contaminate the soil.

Climate Change: Changes in temperature and precipitation patterns can exacerbate land degradation.



(Image source : www.researchgate.net/publication/323129310_Quantifying_Anthropogenic_Dust_Emissions)

Impacts of Land Degradation : Reduce agriculture productivity, loss of biodiversity, water scarcity, economic loss, increased vulnerability to natural disasters

Soil Erosion

Soil erosion is the process by which the topsoil is worn away by natural forces such as water, wind, or human activities. It is a significant contributor to land degradation.

Causes of Soil Erosion: Water and wind erosion, human activities, : Caused by rainfall and surface runoff, leading to the removal of soil particles.

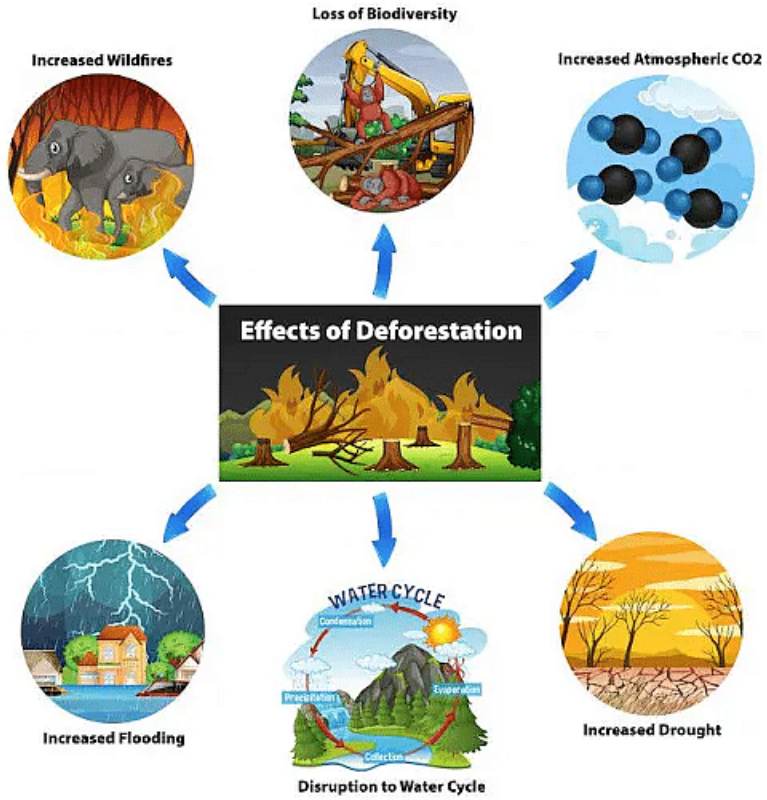
Impacts of Soil Erosion : Loss of top soil, sedimentation, increased flood risk, infrastructure damage, desertification.

Desertification

Desertification is a specific type of land degradation that occurs in arid, semi-arid, and dry sub-humid areas, resulting in the persistent degradation of dryland ecosystems.

Causes of Desertification : Climate change, Unsustainable agricultural practices, deforestation, urbanization ,water management practices

Impacts of Desertification : Loss of arable land, decline in water quality, biodiversity, socioeconomic consequences increased dust and sandstorm



(image source : https://prepp.in/news/e-492-impacts-of-deforestation-environment-notes)

Water: Use and Over-Exploitation, Floods, Droughts, and Conflicts

Use and Over-Exploitation of Surface and Ground Water

Water is an essential resource for life, agriculture, industry, and ecosystems. However, its over-exploitation leads to significant environmental and socio-economic challenges.

Uses of Water : Agricultural,Industrial, Domestic and Environmental

.**Overuse of Water Resources:** Unsustainable water extraction reducing available supplies.

Impacts of Droughts : Water scarcity, agriculture losses, economic impact, environmental degradation, health issues for humans and animal.

Conflicts Over Water

Water conflicts arise when the demand for water exceeds supply or when water is unevenly distributed.

l Water Conflicts : Trans boundary rivers, eg : **Cauvery River Dispute (India), Colorado River Dispute (USA):**

Drivers of Water Conflicts : Population growth, economic development, climate change and poor water management.

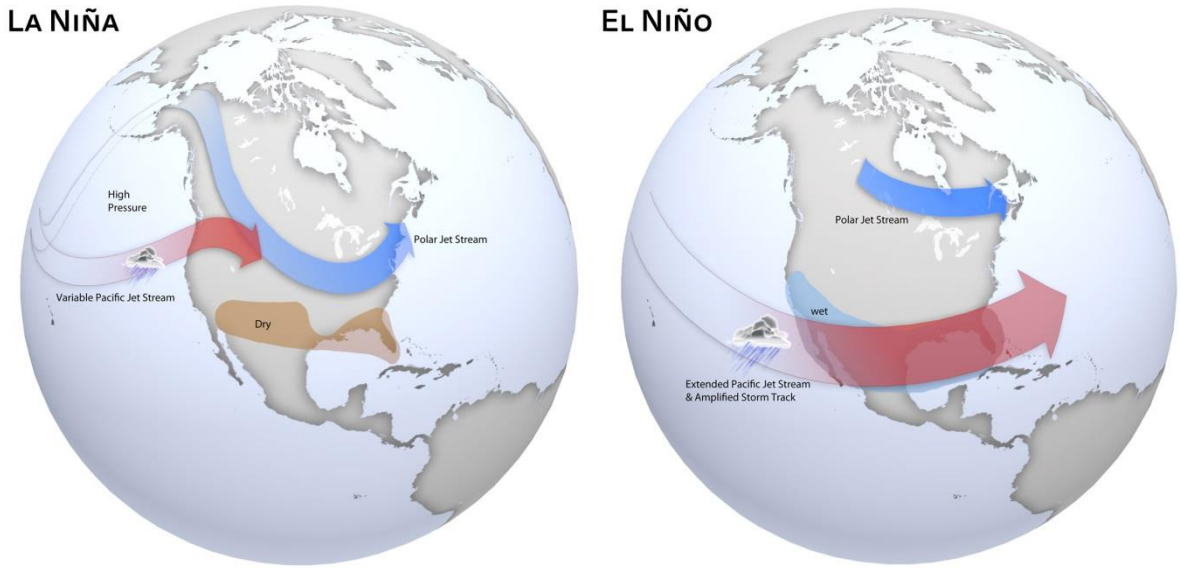
Heating of the Earth and Circulation of Air

Heating of the Earth

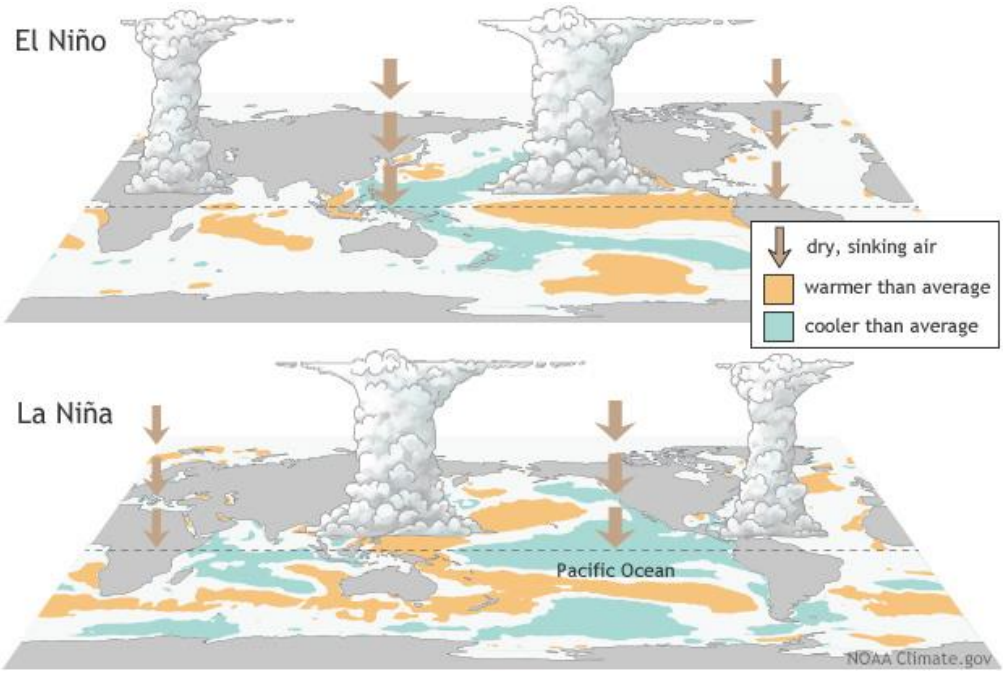
The Earth's surface is heated by solar radiation. This heating process is not uniform due to the tilt of the Earth's axis, its rotation, and the varying nature of surfaces (land, water, ice).

Circulation of Air

The differential heating of the Earth's surface leads to the movement of air in the atmosphere, creating wind patterns and weather systems eg: Jet streams, convection currents. .



(Image source: https://www.neefusa.org/story/climate-change/el-nino-and-la-nina-whats-difference)



(Image Source L https://www.civilsdaily.com/news/what-is-el-nino-and-impacts-monsoon/

Air Mass Formation

Air masses are large bodies of air with relatively uniform temperature and humidity characteristics. They form over large surfaces with consistent climatic conditions, such as oceans and large landmasses.

Precipitation

Precipitation is any form of water - liquid or solid - falling from the atmosphere to the Earth's surface. It is a key component of the water cycle and is influenced by various factors such as a) formation mechanisms, b) types of precipitation such as rain , snow, drizzles, c) Precipitation process d) Weather fronts such as cold and warm.

Use of Alternate Energy Sources and Growing Energy Needs

Growing Energy Needs

The global demand for energy continues to rise due to population growth, urbanization, industrialization, and increased standard of living. This growing energy demand has significant implications for sustainability, economic development, and environmental impact.

Factors Driving Energy Demand : Population growth, urbanization, economic development, technological advancements and rising living standards

Use of Alternate Energy Sources

Alternate energy sources, also known as renewable energy sources, offer a sustainable way to meet growing energy needs while reducing environmental impacts. The main types of alternate energy sources include solar, wind, hydro, geothermal, and biomass.

- Solar Energy
- Wind Energy
- Hydro Energy
- Geothermal Energy
- Biomass Energy

Significance of Renewable Energy Resources

1. Wind Energy: Abundance, Low environmental impact, economic benefits.

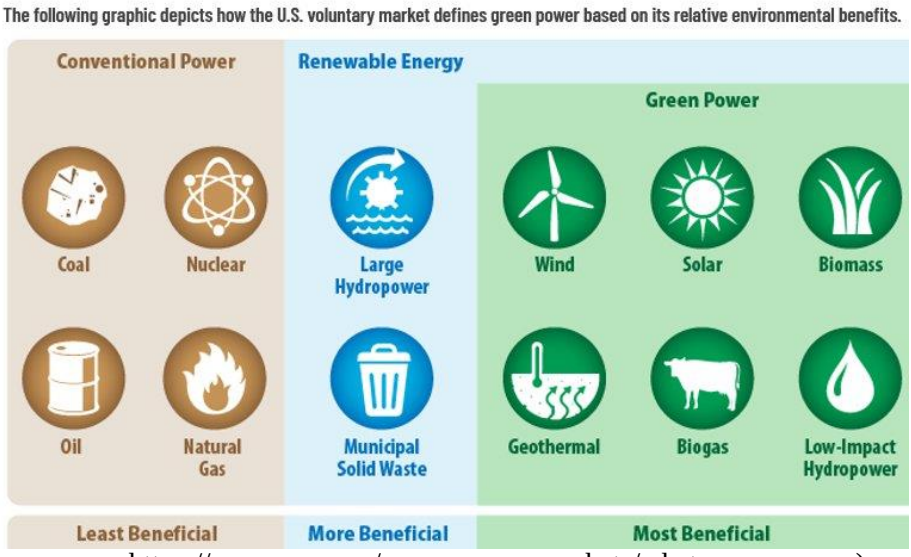
3. Hydro Energy: Reliability, renewability, water management. Low carbon emission

4. Tidal Energy: Predictability, high energy density, low environmental impact, long lifespan

5. Wave Energy: Abundance , consistency, complementary to other renewables, minimal land use.

6. Ocean Thermal Energy: stable energy source, renewability, potential of desalination, environmental consideration.

7. Geothermal Energy: Stability, low emission, versality, long life span



: (Image source https://www.epa.gov/green-power-markets/what-green-power)

Unit 4: Biodiversity and Conservation:

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns biodiversity hot spots. mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: *In situ* and *Ex situ* conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational value.

Biological diversity' means that the variability among living organisms from all sources including, interalia, 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 and 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 and 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 byproduct 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.

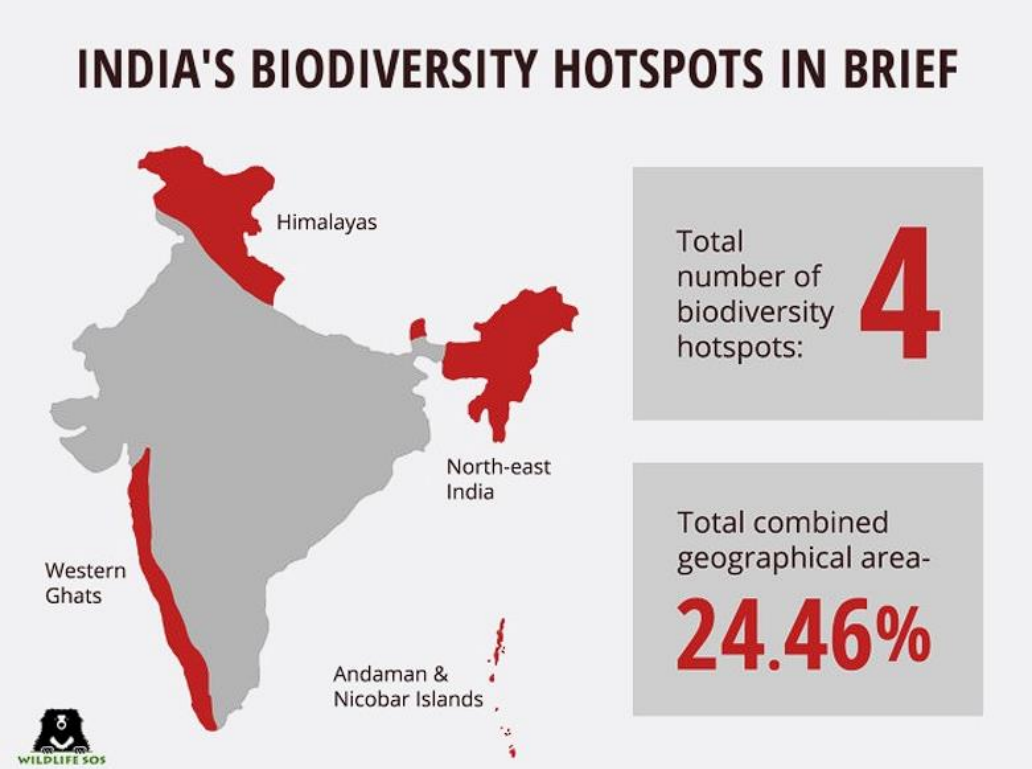
There are currently 36 recognized biodiversity hotspots on earth among them four biodiversity hotspots are present in Indian region which includes

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.

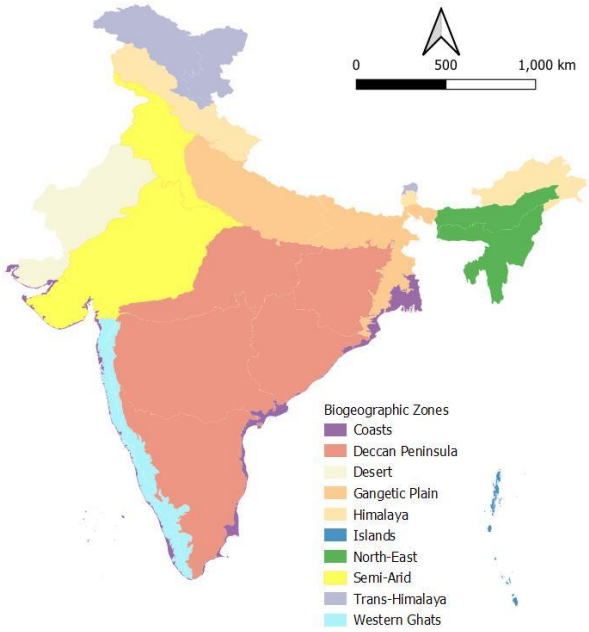


(Image Source: https://dhiacademy.in/blog/biodiversity-hotspots-of-india/)

India's biogeography zones are diverse and reflect its wide range of climates, topographies, and ecosystems. These zones are essential for understanding the distribution of species, conservation planning, and ecological studies. Here are the major biogeography zones of India:

1. Trans-Himalayan Region
2. Himalayan Zone
3. Indian Desert (Thar Desert)
4. Semi-Arid Zone
5. Western Ghats
6. Deccan Plateau
7. Gangetic Plain
8. North-East India
9. Coastal Zones
10. Islands

These biogeographical zones are crucial for conservation efforts and understanding the ecological dynamics of the region. Each zone supports unique ecosystems and species, highlighting the ecological richness of India.



(Image Source L https://indiaflora-ces.iisc.ac.in/bio_zones.php)

Global Biodiversity Patterns

1. **Latitudinal Gradient**:
    - **Description**: Biodiversity generally increases as one moves from the poles towards the equator. Examples: Tropical regions, such as the Amazon Rainforest and Southeast Asian rainforests, have the highest biodiversity, while polar regions have the lowest.
2. **Altitudinal Gradient**:
    - **Description**: Biodiversity varies with altitude, often decreasing as altitude increases. Examples**:** Lower altitudes (e.g., tropical rainforests) have more species than higher altitudes (e.g., alpine regions).
3. **Island Biogeography**:
    - **Description**: Islands often have unique species due to isolation and exhibit a balance between immigration and extinction rates. Examples: The Galápagos islands and Hawaii.

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

Biological invasions refer to the introduction and spread of species into regions where they are not native. These invasive species can have significant ecological, economic, and social impacts. Here is an overview of biological invasions, their causes, effects, and management strategies:

Causes of Biological Invasions

1. **Human Activities**:
2. **Environmental Changes**:

Effects of Biological Invasions

- **Ecological Impacts**: Biodiversity loss**, e**cosystem changes and Genetic effects
- **Economic Impacts**: Agriculture and forestry**, f**isheries**, m**anagement costs
- **Social and Health Impacts**: Human health, livelihoods**, c**ultural effects**:**

Conservation of Bioresources

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

a) **National parks :** Gir National Park (Gujarat), Nanda Devi National Park (Uttarkand); Kaziranga National Park (Assam); Silent Valley National Park, Sundarbans National Park (West Bengal).
b) **Biosphere reserves:** Great Nicobar (Andaman and Nicobar Islands) Gulf of Mannar Biosphere Reserve and Nilgiri Biosphere Reserve.
c) **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

Biodiversity holds immense value across various dimensions, encompassing ecological, economic, social, ethical, aesthetic, and informational aspects. Understanding these values highlights the importance of conserving biodiversity for the well-being of the planet and human society.

1. Ecological value: Ecosystem services, resilience stability and interconnectedness.
2. Economic value: Direct economic benefits, tourism and recreation and ecosystem services valuation.
3. Social value: Cultural heritage, livelihood and subsistence.
4. Ethical value: Intrinsic worth & moral responsibility
5. Aesthetic value: Natural beauty & recreational spaces
6. Informational value: Scientific research, educational awareness, innovation and biotechnology

Integration of Biodiversity Values in Conservation

To effectively conserve biodiversity, it is essential to recognize and integrate these diverse values into policies and practices:

- **Policy Development**, **Community Involvement**: **Economic Incentives and Ethical and Educational Campaigns**: Raising awareness about the ethical and aesthetic values of biodiversity can foster a culture of respect and care for the natural world.

Unit V: Environmental Pollution & Conservation:

Environmental Pollution and Conservation: Environmental pollution: Types, causes, effects and controls; Air, water, soil, chemical and noise pollution 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.

Environmental pollution can be classified into various types based on the environmental medium affected and the nature of the pollutants. The primary types of pollution include air, water, soil, chemical, and noise pollution.

1. Air Pollution

Causes:

- **Industrial Emissions:** Factories and power plants release pollutants like sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter (PM).
- **Vehicle Emissions:** Cars, trucks, and buses emit CO, NO, hydrocarbons, and PM.
- **Burning of Fossil Fuels:** Coal, oil, and gas combustion in power generation, heating, and cooking.
- **Agricultural Activities:** Use of pesticides and fertilizers releasing ammonia and methane.
- **Natural Sources:** Volcanic eruptions, wildfires, and dust storms.

Effects: Respiratory diseases (asthma, bronchitis), cardiovascular problems, and cancer. **Environmental:** Acid rain, smog formation, and global warming. **Ecosystems:** Damage to vegetation, aquatic life, and soil quality.

Controls: Regulation and Legislation, Technological Improvements,Public Transport, and Afforestation programmes

2. Water Pollution

Causes:

- **Industrial Discharges:** Factories releasing chemicals, heavy metals, and waste into water bodies.
- **Sewage and Wastewater:** Untreated or inadequately treated sewage entering rivers and oceans.

- **Agricultural Runoff:** Pesticides, fertilizers, and animal waste washing into water sources.
- **Oil Spills:** Accidental releases of oil during drilling, transportation, and storage.
- **Plastic Waste:** Non-biodegradable plastic accumulating in oceans and waterways.

Effects: Human Health: Waterborne diseases (cholera, dysentery), poisoning from heavy metals. **Aquatic Life:** Death of fish and other organisms, disruption of food chains. **Ecosystems:** Eutrophication leading to oxygen depletion and loss of biodiversity. **Economic:** Loss of tourism, fishing industries, and increased water treatment costs.

Controls: Waste Treatment, Sustainable Farming Practices, Pollution Prevention and Legislation

3. Soil Pollution

Causes: Industrial Activities: Disposal of industrial waste, mining operations, **Agricultural Practices:** Excessive use of fertilizers, pesticides, and herbicide, **Waste Disposal:** Improper disposal of household and hazardous waste, **Oil Spills:** Contamination from oil and petroleum products, **Urbanization:** Construction and development activities leading to soil degradation.

Effects: Human Health: Exposure to toxic chemicals causing cancers, reproductive problems, and neurological disorders. **Agricultural Productivity:** Reduced soil fertility, affecting crop yields and quality. **Ecosystems:** Loss of soil biodiversity, disruption of natural processes. **Water Quality:** Leaching of pollutants into groundwater affecting drinking water supplies.

Controls: Soil remediation, sustainable agriculture, waste management and legislation

4. Chemical Pollution

Causes: Industrial Processes: Manufacturing and processing activities releasing chemicals, **Agricultural Chemicals:** Pesticides, herbicides, and fertilizers. **Household Products:** Cleaning agents, paints, solvents, and personal care products.

- **Accidental Releases:** Chemical spills and leaks during transport or storage.

Effects: Human Health: Acute and chronic poisoning, endocrine disruption, and cancer, **Environment:** Contamination of air, water, and soil, affecting ecosystems., **Wildlife:** Bioaccumulation and biomagnification leading to health issues in animals, **Economic:** Costs associated with health care, environmental clean-up, and loss of biodiversity.

Controls: Regulations, alternative products, spill response and public awareness

5. Noise Pollution

Causes: Transportation: Noise from vehicles, trains, airplanes. **Industrial Activities:** Machinery, construction work, and manufacturing processes. **Urbanization:** High population density areas with traffic, recreational activities, and household noise. **Social Events:** Concerts, parties, and public gatherings.

Effects: Human Health: Hearing loss, stress, sleep disturbances, and cardiovascular issues. **Wildlife:** Disruption of communication, breeding, and navigation in animals.**Quality of Life:** Reduced productivity, annoyance, and mental health problems.**Economic:** Costs related to health care, productivity loss, and soundproofing measures.

Controls: Urban planning, regulation, technology and public awareness

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 by product 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 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.

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: The 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

Eco-friendly 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:

- Open Window Composting
- Mechanical Composting

d) **Electricity generation:** Utilizing plasma are 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

a) Rain is the first form of water in the hydrological cycle. ϖ It is a primary source of water for us.
b) The rainwater collected can be stored for direct use or can be recharged into the groundwater.
c) 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

a) The first phase of the mission also included eradication of manual scavenging, generating awareness and bringing about a behaviour change regarding sanitation practices, and augmentation of capacity at the local level.
b) 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 helps 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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SAVE NATURE FOR OUR SUSTAINABLE FUTURE

ADDIIONAL INFORMATION

Awareness Component

Climate Change and Mitigation

Climate change is a pressing global issue, and colleges and universities play a critical role in addressing it through education, research, and community engagement. Here are several ways colleges can contribute to combating climate change:

1. Education and Awareness : Curriculum Integration**,** Workshops and Seminars and Sustainability Programs

2. Research and Innovation

3. Campus Sustainability Initiatives: Energy efficiency, renewable energy, waste management and sustainable transportation

4. Community Engagement: Outreach programmes, service learning and policy advocacy

5. Student Leadership and Participation: Green student organization and climate ambassadors

6. Sustainable Campus Operations: Green building standards, sustainable food systems and water conservation

7. Carbon Neutrality Goals: Carbon footprint assessment, carbon offset programs and long term strategies.

8. Partnerships and Networks

9. Publications and Dissemination

Calculating your carbon footprint involves assessing the greenhouse gas emissions associated with our activities, including energy use, transportation, diet, and waste. Here's a step-by-step guide to calculating your carbon footprint at home.

Note :Co_2e (Carbon dioxide equivalent)

Step-by-Step Carbon Footprint Calculation

1. Energy Use

- **Electricity Consumption**:

- Find your total electricity usage from your utility bills (kWh per month/year).
- Multiply your total kWh by the carbon intensity of your electricity grid (kg CO_2e/kWh). This information is often provided by your utility company or can be found online.
- Formula: Total electricity use (kWh) × Carbon intensity (kg CO_2e/kWh) = CO_2 emissions from electricity.

- **Heating and Cooling**:

  - **Natural Gas**:
    - Find your natural gas usage (therms or cubic meters) from your bills.
    - Multiply by the emission factor (typically 5.3 kg CO_2e per therm or 1.89 kg CO_2e per cubic meter).
    - Formula: Total gas use (therms or cubic meters) × Emission factor (kg CO_2e/unit) = CO_2 emissions from natural gas.
  - **Oil or Propane**:

    - Find your oil or propane usage (gallons or liters) from your bills.
    - Multiply by the emission factor (typically 10.15 kg CO_2e per gallon of oil, 5.67 kg CO_2e per gallon of propane).
    - Formula: Total oil/propane use (gallons) × Emission factor (kg CO_2e/unit) = CO_2 emissions from oil/propane.

2. Transportation

- **Car Travel**:
  - Calculate the total distance driven annually (miles or kilometers).
  - Find your car's fuel efficiency (miles per gallon or liters per 100 km).
  - Determine the fuel emission factor (typically 8.89 kg CO_2e per gallon of gasoline or 2.31 kg CO_2e per liter).
  - Formula: (Total distance driven / Fuel efficiency) × Emission factor = CO_2 emissions from car travel.
- **Public Transport**:
  - Calculate the total distance traveled by bus, train, etc.
  - Multiply by the average emissions per passenger mile or kilometer (varies by transport type).
  - Formula: Total distance traveled × Emission factor per mile/kilometer = CO_2 emissions from public transport.
- **Air Travel**:
  - Calculate the total distance flown annually.
  - Use emission factors (short haul: ~0.15 kg CO_2e per mile, long haul: ~0.10 kg CO_2e per mile).
  - Formula: Total distance flown × Emission factor per mile/kilometer = CO_2 emissions from air travel.

3. Diet

- **Food Consumption**:
  - Estimate your diet's carbon footprint based on dietary patterns.

- General estimates (annual):
  - High meat diet: ~3,000 kg CO_2e.
  - Average meat diet: ~2,500 kg CO_2e.
  - Low meat diet: ~1,800 kg CO_2e.
  - Vegetarian: ~1,500 kg CO_2e.
  - Vegan: ~1,000 kg CO_2e.

4. Waste

- **Waste Generation**:
  - Estimate your household waste generation (kg per week/year).
  - Multiply by the emission factor for waste (typically ~0.2 kg CO_2e. per kg of waste).
  - Formula: Total waste generated (kg) × Emission factor = CO_2 emissions from waste.

Example Calculation

Let's calculate a simplified annual carbon footprint for a household:

1. **Energy Use**:
   - Electricity: 4,000 kWh/year × 0.5 kg CO_2e. CO_2e./kWh = 2,000 kg CO_2e..
   - Natural Gas: 500 therms/year × 5.3 kg CO_2e./therm = 2,650 kg CO_2e..
2. **Transportation**:
   - Car: 12,000 miles/year, 25 mpg, gasoline.
   - Fuel consumption: 12,000 miles / 25 mpg = 480 gallons.
   - CO2 emissions: 480 gallons × 8.89 kg CO_2e./gallon = 4,267.2 kg CO_2e..
   - Air Travel: 3,000 miles/year × 0.15 kg CO_2e.e/mile = 450 kg CO_2e.
3. **Diet**:
   - Average meat diet: ~2,500 kg CO_2e..
4. **Waste**:
   - Waste: 500 kg/year × 0.2 kg CO2e/kg = 100 kg CO_2e.

Total Annual Carbon Footprint

- Energy: 2,000 kg (electricity) + 2,650 kg (natural gas) = 4,650 kg CO_2e.
- Transportation: 4,267.2 kg (car) + 450 kg (air) = 4,717.2 kg CO_2e.
- Diet: 2,500 kg CO_2e.
- Waste: 100 kg CO_2e.
- **Total**: 4,650 + 4,717.2 + 2,500 + 100 = **11,967.2 kg** CO_2e./**year**.

Carbon Footprint of Social Media

1. Data Centers

- **Energy Consumption**: Data centers store and process vast amounts of data, consuming significant amounts of electricity for servers, cooling, and other infrastructure.
- **Emissions**: The carbon footprint of data centers depends on the energy sources used. For instance, fossil-fuel-based energy sources have higher emissions compared to renewable energy sources.

- **Estimates**: Major social media platforms like Facebook and YouTube have massive data centers, each potentially consuming hundreds of megawatts of power annually.

2. Transmission Networks

- **Internet Infrastructure**: Data travels through a global network of cables, satellites, and wireless systems and each consuming energy.
- **Network Equipment**: Routers, switches, and other networking equipment require electricity, contributing to carbon emissions.
- **Energy Intensity**: The energy required for data transmission can vary, but estimates suggest it can be about 0.02 kWh per GB transmitted.

3. End-User Devices

- **Device Energy Use**: Smartphones, tablets, and computers consume energy when accessing social media. Regular usage, especially video streaming, significantly increases this consumption.
- **Charging**: Regularly charging these devices also adds to the carbon footprint, depending on the energy mix used for electricity.

Carbon Emissions Breakdown

Here's how the carbon emissions can be broken down for a typical activity like streaming a one-hour video on social media:

1. **Data Centers**:
    - Assume energy consumption of 0.1 kWh per hour of video streaming.
    - If the electricity emission factor is 0.5 kg CO_2e./kWh:
        - Emissions = 0.1 kWh × 0.5 kg CO_2e./kWh = 0.05 kg CO_2e.
2. **Transmission Networks**:
    - Assume energy consumption of 0.02 kWh per GB of data transmitted.
    - If one hour of video is approximately 1 GB:
        - Emissions = 0.02 kWh × 0.5 kg CO_2e./kWh = 0.01 kg CO_2e.
3. **End-User Devices**:
    - Assume energy consumption of 0.01 kWh per hour of video streaming.
    - If the electricity emission factor is 0.5 kg CO_2e./kWh:
        - Emissions = 0.01 kWh × 0.5 kg CO_2e./kWh = 0.005 kg CO_2e.

Total Emissions for One Hour of Video Streaming

- **Data Centers**: 0.05 kg CO_2e.
- **Transmission Networks**: 0.01 kg C CO_2e.
- **End-User Devices**: 0.005 kg CO_2e.
- **Total**: 0.05 + 0.01 + 0.005 = **0.065 kg CO2e**

Mitigation Strategies

For Social Media Companies

1. **Renewable Energy**: Transition data centers to renewable energy sources like solar, wind, or hydroelectric power.
2. **Efficiency Improvements**: Invest in energy-efficient technologies, such as advanced cooling systems and server optimization.
3. **Sustainable Data Centers**: Build data centers in cooler climates to reduce cooling energy needs and in regions with abundant renewable energy.

For Users

1. **Reduce Data Usage**: Limit time spent on high-data activities such as streaming high-definition videos.
2. **Optimize Settings**: Use lower video resolutions and settings to reduce data consumption.
3. **Energy-Efficient Devices**: Use devices with higher energy efficiency ratings and ensure they are charged using renewable energy where possible.
4. **Conscious Usage**: Be mindful of social media usage patterns and reduce unnecessary online activities.

For Internet Service Providers

1. **Infrastructure Upgrades**: Invest in energy-efficient network infrastructure.
2. **Renewable Energy**: Source electricity from renewable energy providers to power network operations.
3. **Optimization**: Implement technologies that reduce the energy intensity of data transmission.

Total Emissions for One Hour of Internet Browsing

- **Data Centers**: 0.025 kg CO_2e
- **Transmission Networks**: 0.01 kg CO_2e
- **End-User Devices**: 0.03 kg CO_2e
- **Total**: 0.025 + 0.01 + 0.03 = **0.065 kg CO_2e**

Total Emissions for Sending a 1 MB Image

- **Data Centers**: 0.00025 kg CO_2e
- **Transmission Networks**: 0.00001 kg CO_2e
- **End-User Devices**: 0.00000014 kg CO_2e
- **Total**: 0.00025 + 0.00001 + 0.00000014 = **0.00026014 kg CO_2e** (or 0.26 grams of CO2e).

Total Emissions for Loading One Facebook Page

- **Data Centers**: 0.025 kg CO_2e
- **Transmission Networks**: 0.005 kg CO_2e
- **End-User Devices**: 0.02 kg CO_2e
- **Total**: 0.025 + 0.005 + 0.02 = **0.05 kg CO_2e**

Total Emissions for Loading One Tweet

- **Data Centers**: 0.015 kg CO_2e
- **Transmission Networks**: 0.004 kg CO_2e.
- **End-User Devices**: 0.015 kg CO2e
- **Total**: 0.015 + 0.004 + 0.015 = **0.034 kg CO_2e**

Note: The compilation of the content have taken from various web content. It is for education and environmental awareness purpose only. Also the editor thanks all web content providers.

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