

ES 200

Environmental Studies: Science and Engineering

V. S. Vamsi Botlaguduru
Assistant Professor
Environmental Science & Engineering Dept.
IIT Bombay



Module

Natural Resources

Structure of the Lecture

- Part A: Basic Concepts in Natural Resources
- Part B: Sustainability and its Metrics

Objectives

- Create awareness on the concepts associated with natural resources management.
- Introduce the concept of sustainability and its metrics.

References

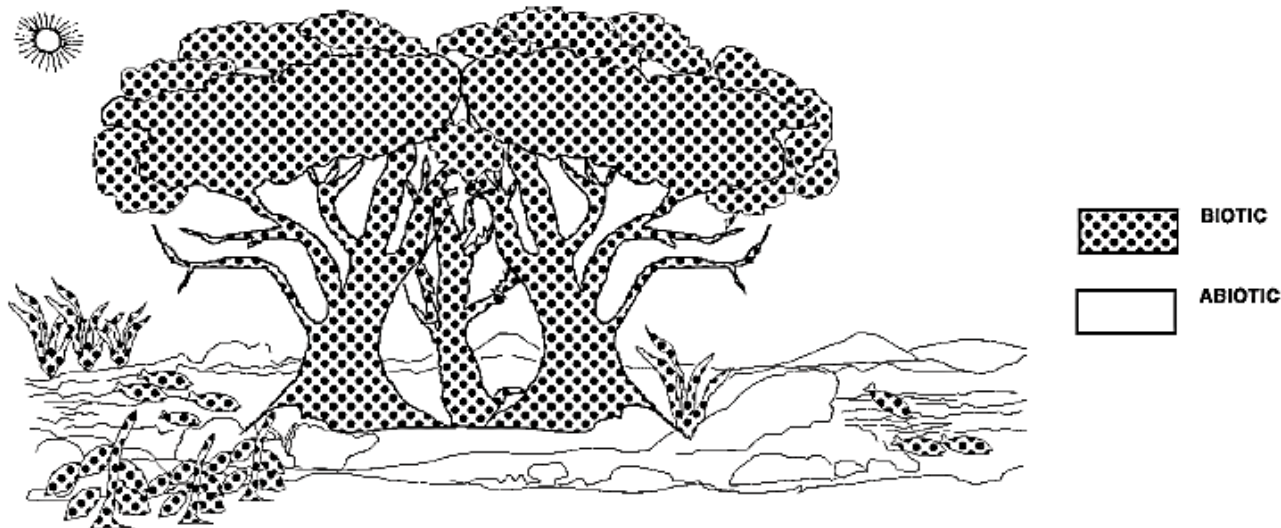
- Unit 2 of the “Textbook for Environmental Studies”, Erach Bharucha, UGC, 2004.

Web References and Data Sources

- Global Footprint Network (<https://www.footprintnetwork.org/>)
- Water Footprint Network (<https://waterfootprint.org/en/>)
- International Resource Panel (<https://www.resourcepanel.org/>)
- Pocket Book of Agricultural Statistics, 2020, Government Of India, Ministry Of Agriculture & Farmers Welfare
- Energy Statistics India – 2023, Government of India, Ministry of Statistics and Programme Implementation National Statistical Office.

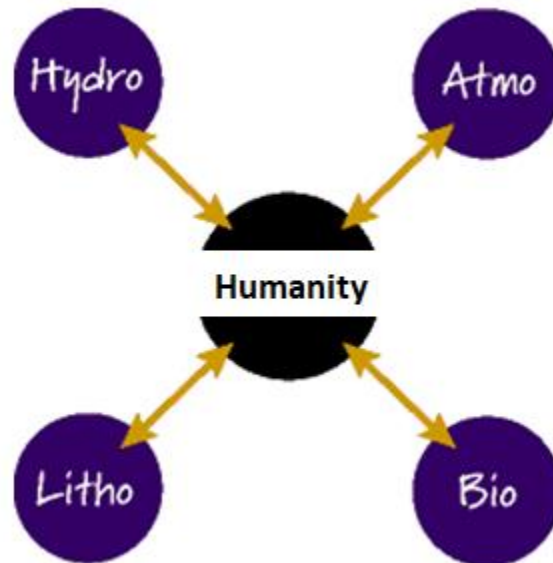
Introduction

- Our environment provides us with a variety of goods and services necessary for our day to day lives (needs and wants).
- These natural resources include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or 'abiotic' part of nature.
- The 'biotic' (living parts) of nature consists of plants and animals, including microorganisms.



Earth's Resources and Man

- The resources on which mankind is dependent are provided by various 'spheres'.



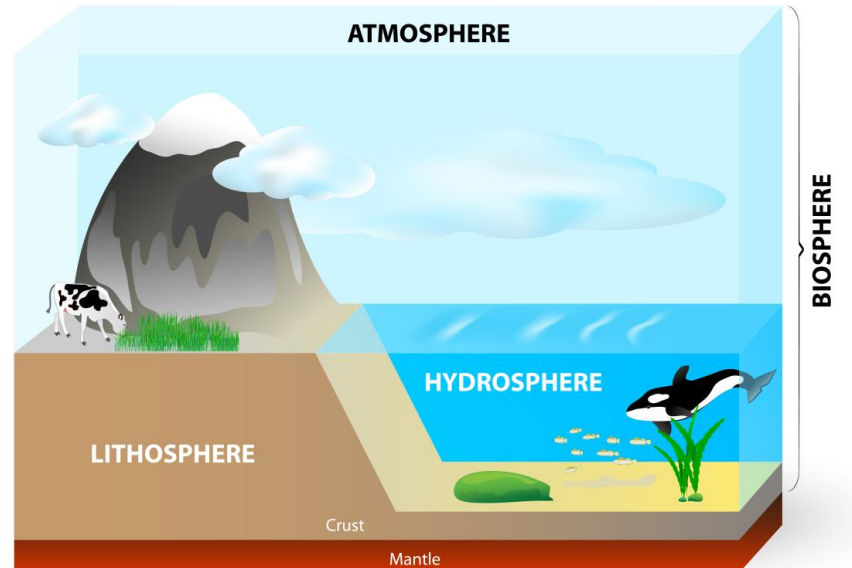
Atmosphere

- Oxygen for respiration: Humans, Wild fauna, Domestic animals
- Carbon di-oxide for photosynthesis: Plants

Earth's Resources and Man

Hydrosphere

- Clean water for drinking, washing and cooking.
- Water used in agriculture and industry.
- Food resources including fish, crustacea, sea weed, aquatic plants, etc.
- Water harnessed to generate electricity in hydroelectric projects.



Earth's Resources and Man

Lithosphere

- Soil, the basis for agriculture.
- Micronutrients in soil, essential for plant growth.
- Microscopic flora, small soil fauna and fungi in soil, which break down plant and animal wastes to provide nutrients for plants.
- Stone, sand and gravel for construction.
- Minerals on which our industries are based.
- Oil, coal and gas, extracted from underground sources.

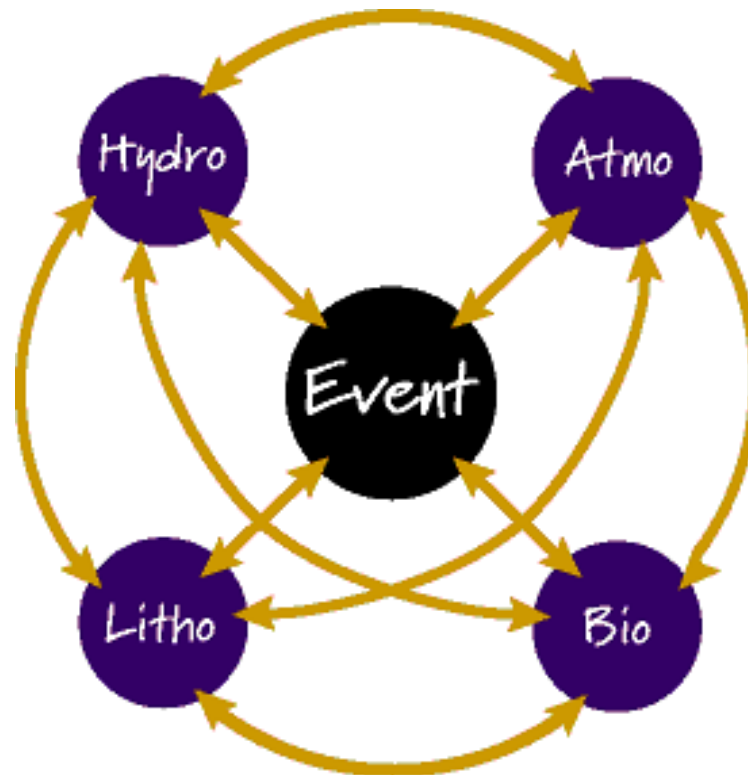
Earth's Resources and Man

Biosphere

- Food, from crops and domestic animals.
- Food, for all forms of life which live as interdependent species in a community and form food chains in nature on which man is dependent.
- Energy needs: Biomass fuel wood collected from forests and plantations, along with other forms of organic matter, used as a source of energy.
- Timber and other construction materials.

Earth's Resources and Man

- Linkages between the spheres are mainly in the form of cycles
- Hydrologic Cycle
- Carbon, Nitrogen, Oxygen Sulfur, Phosphorous Cycles



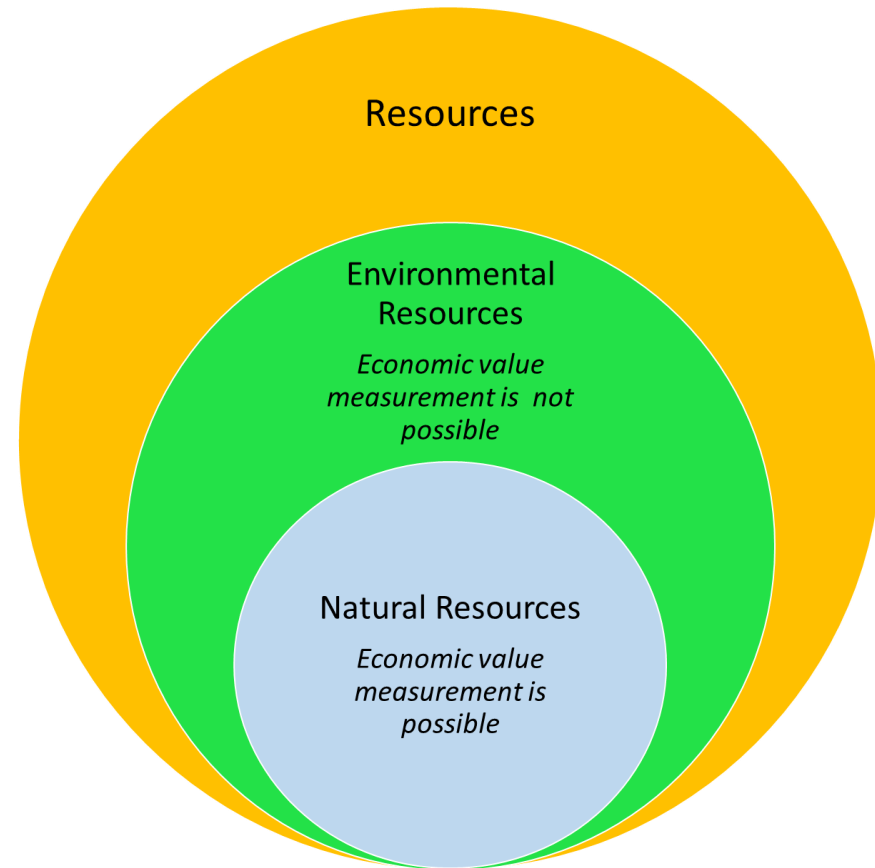
Classification of Natural Resources

Potential Resources

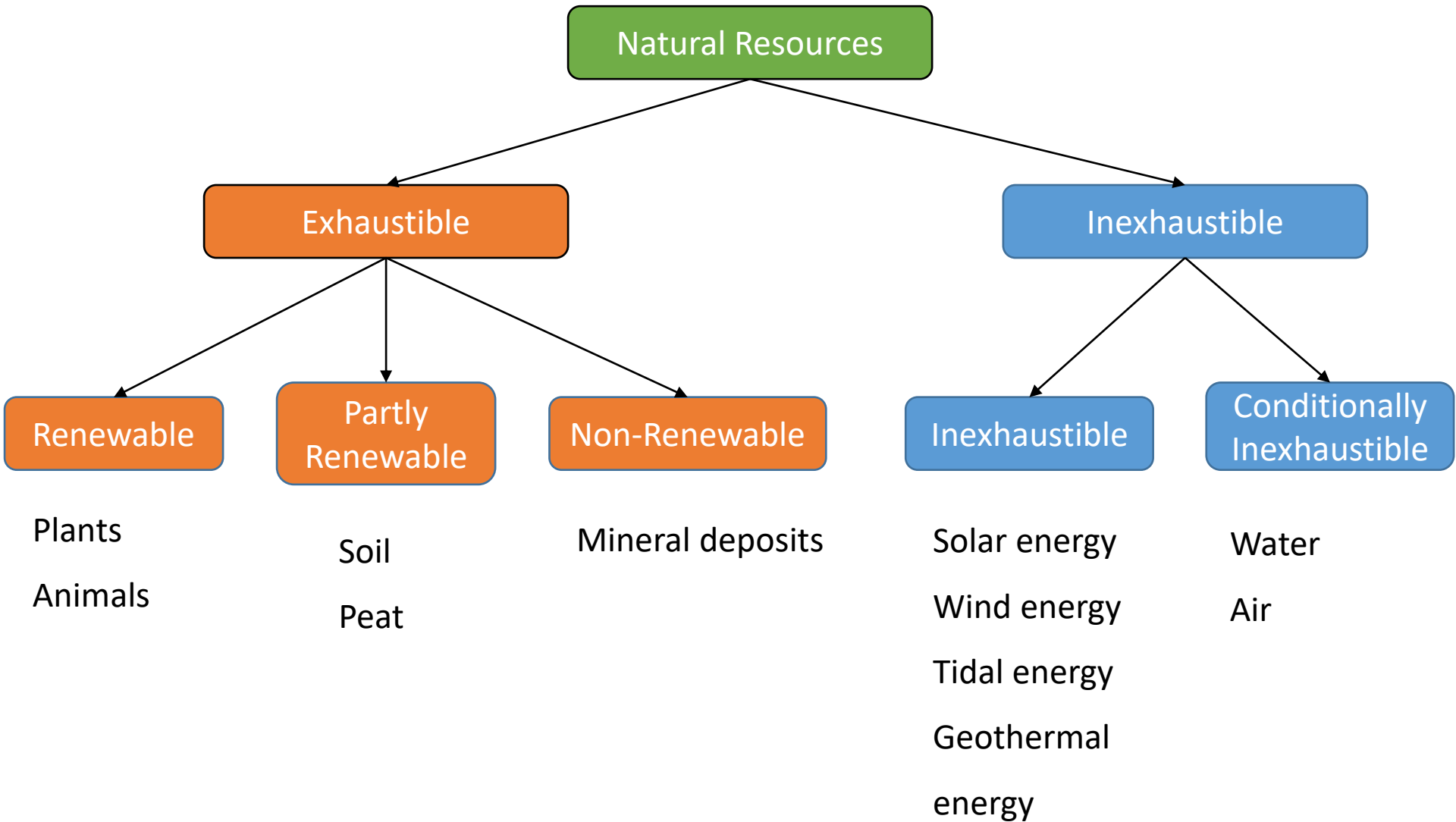
- Available in a specific region and their usage requires advanced technology
- Geothermal energy, earthquake energy, wave energy, freshwater in iceberg, etc.

Realistic Resources

- Can be accessed with existing technology
- Mineral deposits, timber, freshwater in lakes, etc.



Classification of Natural Resources



Concept of Preservation vs Conservation

Preservation	Conservation
Attempt to prevent the use of a natural resource	Attempt to use a natural resource in a way to minimize its exploitation
Aim is to keep the resources intact, 'as it is' or 'as it was'	Aim is to maintain the resource in as good condition as possible for sustained human access.
Preservationists often see nature as having an inherent value, not only when it can help us humans.	Conservationists typically support measures that reduce human use of natural resources, but only when such measures will be beneficial to humans.

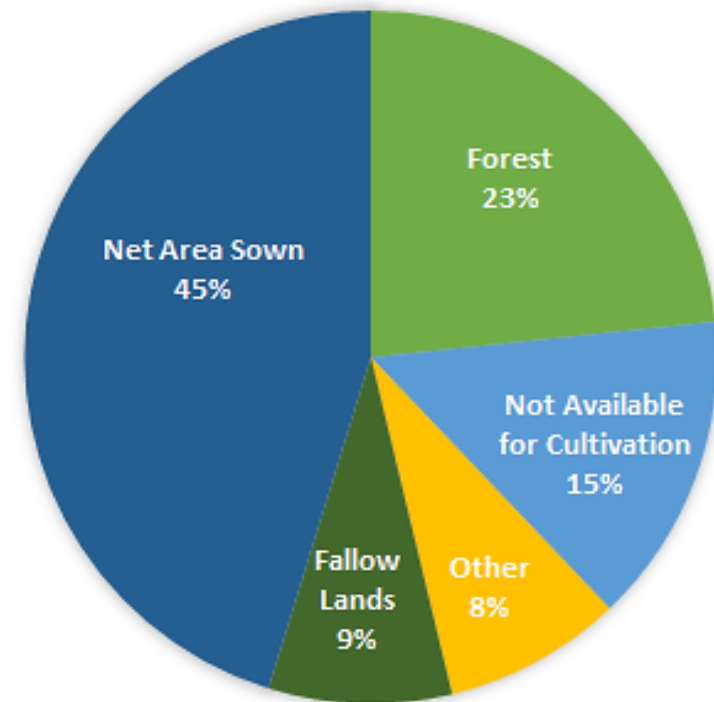
Natural Resources and Associated Problems

- 1) **Land resources** - *Degrading soil quality, land hunger*
- 2) **Forest Resources** - *Over-exploitation, deforestation*
- 3) **Water resources** - *Over-utilization of ground water, pollution, floods, drought, conflicts over dams*
- 4) **Mineral Resources** - *Exploitation, environmental effects from mining*
- 5) **Energy resources** - *Increasing energy needs, environmental effects*

Land Resources of India

- India has 2.4% (3,287,263 km²) of the world's land and is home to 18% of world's population. Percentage of cultivable land is ~ 60%.
- *Soil composition, groundwater availability, mineral availability, and local climatic condition* become the basis of the utilization and development of land resources.
- A decline in the net sown area is a recent phenomenon due to the increase in area under non-agriculture use.
- However, agricultural prosperity does not depend only on the total net sown area.

LAND BY USE IN INDIA



Forest Resources of India

- India, a tropical country should ideally have 33% of its land under forests. Currently, the land Government has identified and demarcated for forest growth is around 23%.

Types of Forests

Protected forests (53% of forest land)

- Observed by the government, but the local community is allowed to access wood/timber, grazing cattle without damaging the forests.

Reserved forests (18% of forest land)

- Under the supervision of the government and prohibited for collection of timber or grazing of cattle.

Unclassified forests

- No restrictions for tree cutting, grazing.

Forest Functions

Watershed protection

- Reduce the rate of surface run-off of water.
- Prevent flash floods and soil erosion.
- Produces prolonged gradual run-off and thus prevent effects of drought.

Atmospheric regulation

- Absorption of solar heat during evapotranspiration.
- Maintaining carbon dioxide levels for plant growth.
- Maintaining the local climatic conditions.

Land bank

- Maintenance of soil nutrients and structure.

Forest Functions

Local use - Consumptive use

- Food - gathering plants, fishing, hunting from the forest.
- Fodder - for cattle.
- Fuel wood and charcoal for cooking, heating.
- Poles - building homes especially in rural and wilderness areas.
- Timber – household articles and construction.
- Fiber - weaving of baskets, ropes, nets, string, etc.
- Sericulture – for silk.
- Apiculture - bees for honey, forest bees also pollinate crops.
- Medicinal plants - traditionally used

Market use - (Productive use)

Water Resources in India

- Total 4% of world's water resources are in India.
- India uses ~ 80-90% for agriculture, 7% for industry and 3% for domestic use.
- India experiences an average precipitation of 1,170 mm per year, or about 4,000 km³ of rains annually. However, only 6% of annual rainfall is stored.
- About 70% of surface water resources in India are polluted.
 - *The major contributing factors are wastewater from domestic sector, intensive agriculture, industrial production, infrastructure development and untreated urban runoff.*

Water Resources in India

Issues with Water Resources

- **Over-exploitation**: Groundwater provides for over two-thirds of irrigation requirements. In the last four decades, about 85% of the total addition to irrigation has come from groundwater.
- **Policy Issues**: Groundwater is used to cultivate water-intensive crops like paddy and sugarcane in rain deficit states like Punjab and Maharashtra respectively.

Water Resources in India

Issues with Water Resources

- **Poor Maintenance**: There's a large, growing gap between irrigation potential created and that actually utilized, simply due to lax maintenance.
- **Rapid Urbanization**: Reduces the ground-water replenishment.
- **Poor Water Treatment Plants and Lack of Quality Data**

Water Demands

Types of Water Demands

- 1) Domestic
- 2) Industrial
- 3) Institutional and Commercial
- 4) Demand for public uses
- 5) Fire Demand
- 6) Compensation for losses in waste and theft

Breakup of Per Capita Demand (q) for an average Indian city

Use	Demand in L/h/d
Domestic Use	200
Industrial Use	50
Commercial Use	20
Civil or Public Use	10
Waste, Thefts, etc.	55
Total	335

Mineral Resources in India

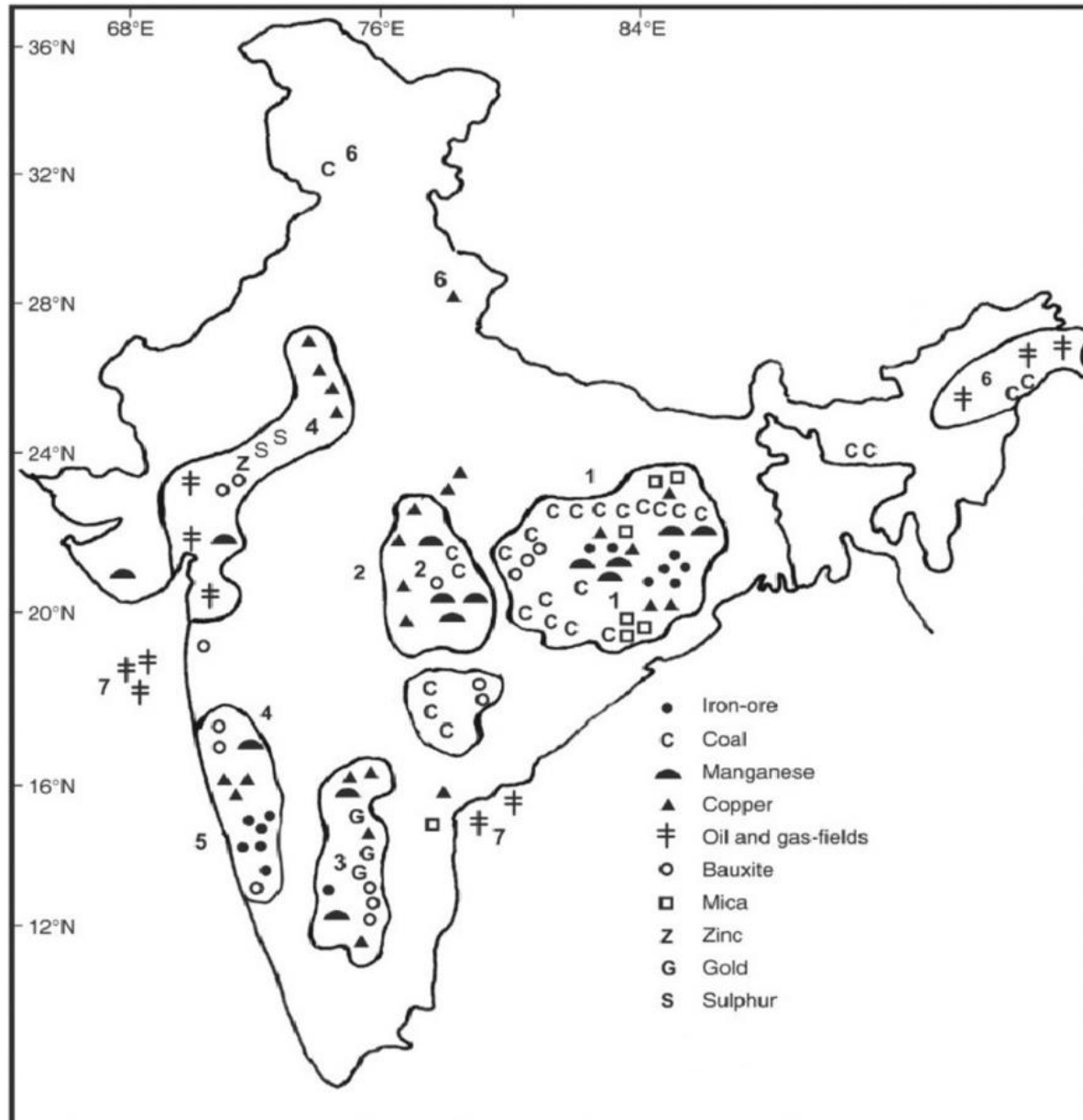
Minerals: A naturally occurring substance of definite chemical composition and identifiable physical properties.

Ore: A mineral or combination of minerals from which a useful substance, such as a metal, can be extracted and used to manufacture a useful product.

Different types of minerals

Minerals	Examples
Metallic minerals (ferrous)	Iron ore, manganese ore, chromite
Metallic minerals (non-ferrous)	Aluminum, copper, lead
Precious & semi-precious minerals	Diamond, gold, silver, ruby
Strategic minerals	Tin, nickel, cobalt, tungsten, molybdenum
Fertilizer minerals	Potassium, gypsum, phosphate
Refractory minerals	Fireclay, magnesite, graphite
Ceramic and glass minerals	Feldspar, quartz, silica sand
Others	Asbestos, fluorite, limestone, mica

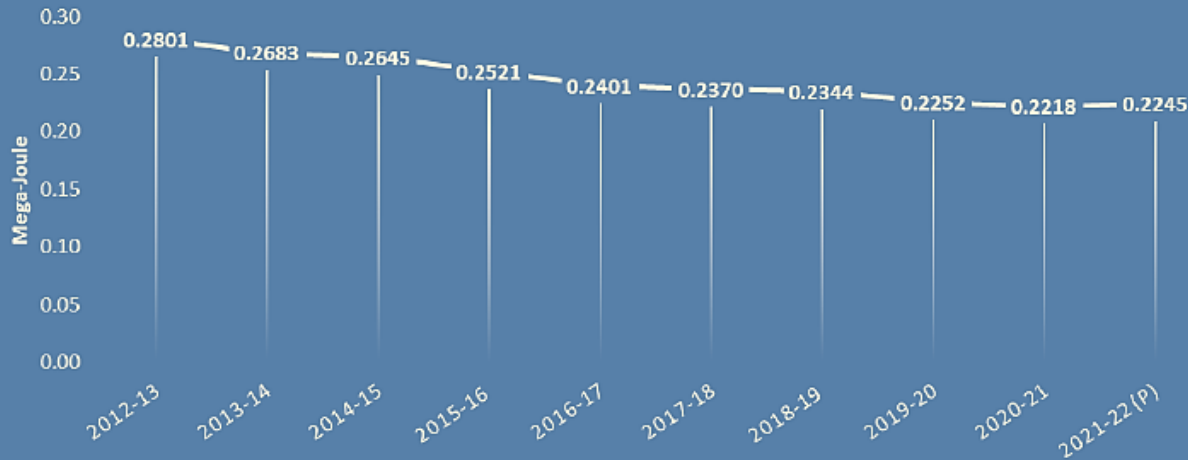
Mineral Resources in India



- North Eastern Peninsular Belt
- Central Belt
- The Southern Belt
- The South-Western Belt
- North-Western Belt

Energy Resources in India

FIG 8.1 : ENERGY INTENSITY IN MEGAJOULE PER RUPEE
FROM 2012-13 TO 2021-22(P)



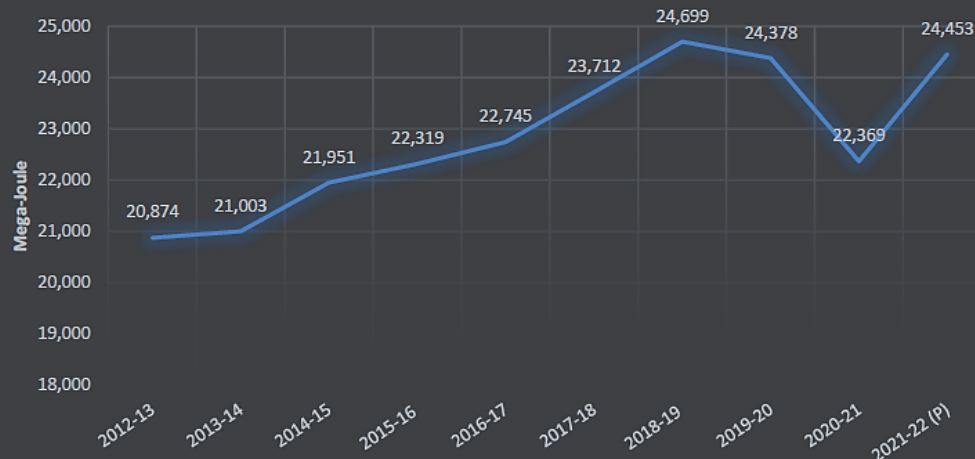
Comparative EI

China: 2.1x

USA: 1.5x

Russia: 2.3x

Fig 8.2 :Per Capita Energy Consumption in India (Megajoule/Person) from
2012-13 to 2021-22(P)



Comparative PEC

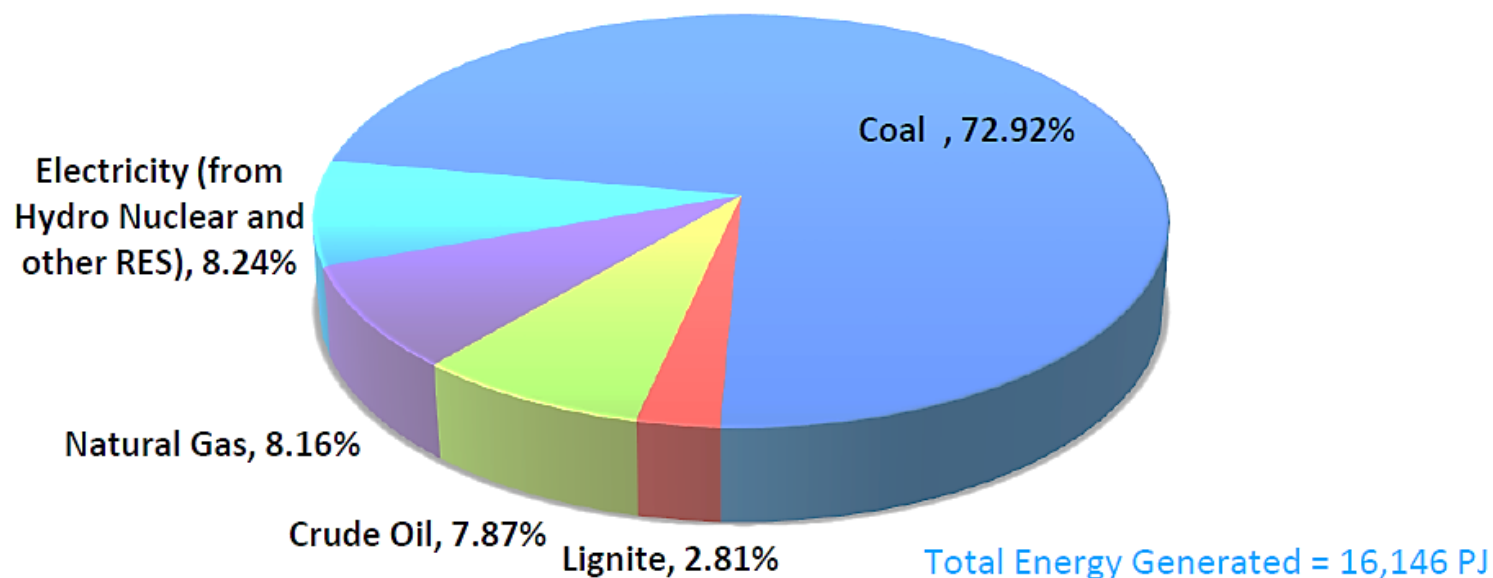
China: 1,11,784 (4.6x)

USA: 2,83,515 (11.6x)

Russia: 1,99,652 (8.2x)

Energy Resources in India

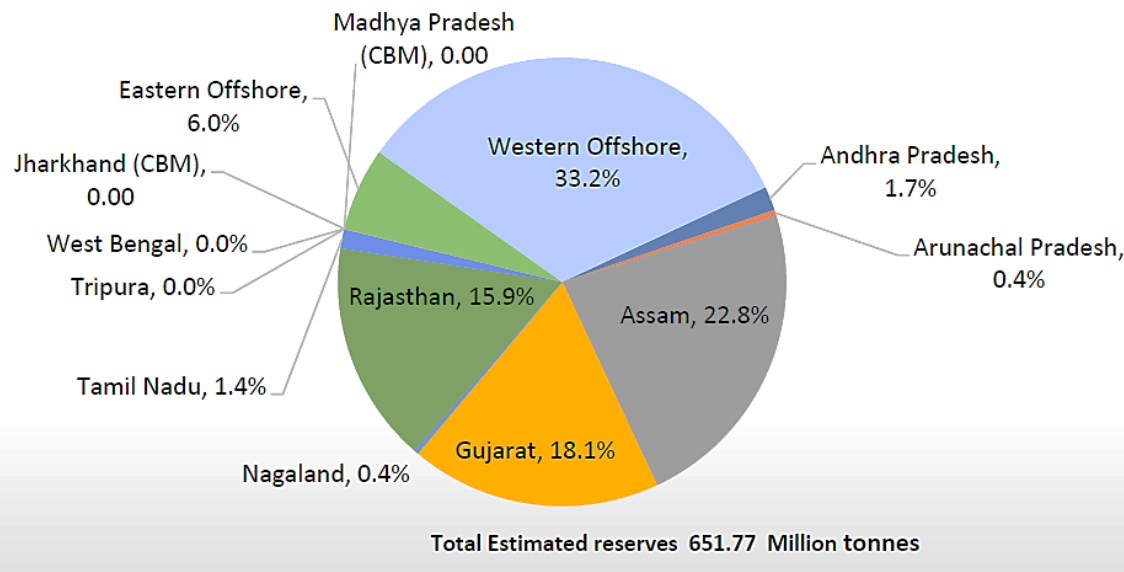
Fig 3.3: Share of Total Energy Generated (in petajoules) from different commercial sources in India during FY : 2021-22(P)



Energy Resources in India

- Total estimated reserves of coal ~ 361 billion tonnes.
- The top three states with highest coal reserves in India are *Odisha, Jharkhand, Chhattisgarh*, ~ 70% of the total coal reserves in the country.
- The estimated reserves of crude oil in India ~ 652 million tonnes.

Fig 1.3: Estimated Reserves of Crude Oil in India as on 01.04.2022



Part A:

Basic Concepts in Natural Resources

Additional Information

International Resource Panel, UNEP

(<https://www.resourcepanel.org/>)

