018

Natural Resources

- water, land, Energy sources (fossil fuels), forests
- must be conserved

→ conventional & Non-conventional

mostly non-renewable (except maybe hydroelectric)	Renewable.

└ coal & petrol - mostly widely used.

Consumption pattern:

33% petrol, diesel; 27% coal, 5% nuclear.

- US, Canada → 5% of world population - 25% of energy.

→ renewable sources

Solar, wind, biomass, hydroelectric (small), waste to energy

→ Sunshine 5-7 kW/m² - diffused energy → distributed

photovoltaic cells - silicon, Ge - 760%

light → heat energy. (copper, water heater etc)

→ Turbines, Wind → Mechanical

→ Ocean & tidal energy.

1m high wave on falling → 90 kW energy

operations along shores.

→ geothermal energy - temp & pressure increases as we dig deeper - 75-880°C

→ biomass energy

* Oil & coal formation videos.

* fractional distillation order. natural gas petrol

→ Land Resources

- provide food, fibre, wood, fuels, biological materials.
- Soil - mixture of inorganic mat. (rocks & minerals) & organic mat. (dead plants & animals)
- Top soil → renewable resource.
  ↳ growing vegetation - fertile

- land degradation - loss of fertility. → long term effects are not good.
  - population, urbanisation, fertilizers & pesticides, damage of top soil, water logging, soil erosion
  + if uncontrolled, then becomes irreversible - desertification
  → exhausted, less aeration

→ causes of erosion - water (sometimes wind)

stages → (water) + sheet erosion, Rill erosion, Gully erosion, Stream bank erosion

Rill erosion - channels formed.

Gully erosion - ravines

Splash erosion - early stage

Alluvial - sediments

(wind) + Saltation - suspension - surface creep.

How to control erosion?

- Conservational (or) till farming (or) no-till-farming
  tilling → causes erosion
- Contour farming - across slope, not along slope.
- Terracing
- Alley cropping (or) Agro forestry. (mix crops)
- Wind breaks.

Water resources

* pie charts.
- groundwater storage.
  96% marine - very little is freshwater
  most is blocked as ice
  0.8% only available

less rainfall in catchment area
x command area.

aquifers - confined by impervious layers.

- watershed management.
  - find where water can be stopped to maintain velocity
- complications, principles — land utilisation, adequate veg.
  conserve rainwater, contour farm
  drain out excess water - properly,
  prevent erosion,
  increase groundwater
  human influence
  issues - quantity, quality. remedies
- conserve water
  - drip irrigation / sprinkling - efficient irrigation & reduce evaporation.
  - install system to capture rain water
    reuse water for irrigation.
  - build rain water harvesting system.

Q. why should Forests be preserved?

① * CO_2 sink - absorbs - long term storage.
② Helps in condensation of atmospheric moisture.
③ Acts as a sponge for holding water - prevents se
   recharging aquifer
④ source of timber, diversity etc.

Forest: any area with more than 10% wooded area
pasturelands -
(see pie chart & graph).

- very dense forests - wooded area > 30% → only 3%

Carbon stock in Indian Forests.
- enormous amt - in five pools.
(1) Above ground biomass (AGB)
(2) Below ground biomass (BGB)
living portion of biomass carbon.
(3) dead wood } dead organic matter.
(4) litter
(5) soil organic matter (SOM) (Maximum)
on burning crops C:N ratio increases.
* report in lecture folder.

Must be conserved, managed - intelligently planned.
'sustainable harvest'
- forest regeneration - ~~Thoom~~ cultivation (slipping) on hillsides after few yrs allowing to regenerate.
14% of forest area under conservation. Indonesia diversity
- Reserved - protected forests.
- Reducing carbon emission - global agreement 5%

- Tribes in Amazon - to monitor changes
→ Draft criteria for Forest conservation.
- Conservation of biodiversity → variety in species
- Maintenance of productive capacity of forest ecosystem
- " of forest eco. health and vitality
- " of soil & water resources.
- " of forest contribution to global carbon cycle
- " enhancement of long term socioeconomic benefits to meet needs of legal, institutional & economic framework for forest conservation & sustainable dev.

Forest Rights Act - allows ppl to own land in forest for cultivation

Ecosystem Management.

- Manage across whole landscape, watersheds, regions over ecological time scales.
- Depend on scientifically sound, ecologically credible data for decision making.
- human needs.
- Biodiversity maintenance
- cooperative institutions.
- stakeholders.

Q. Release of carbon by deforestation & degradation.

- Burning of trees. (wood & leaves)
- Fallen vegetation decays & releases C
- Accumulation of C in soil litter declines, exposed soil dries, C oxidises to CO_2
- Forest eco. is no longer available to store C.

✗ – Coal → combustion - sulphuric oxide.

✗ – Fission Rx → Uranium.

✗ – across slope

✗ – CO_2, H_2S,

✓ – p type → p-n junction → n type.

MCQ 1. b ✓ 2. a ✓ 3. c ✗ 4. c ✓ 5. a. ✓

Lapropel

T/F 1. T ✓ 2. F ✓ 3. F ✓ 4. T ✓ 5. T ✓

↳ solar power is diffused.

3 groups - 3 levels.

3/3/18

BIODIVERSITY

- Variety & differences among living organisms from all sources - terrestrial, marine, aquatic ecosystems & ecological complexes of which they are a part.
- 'Life on Earth'
- 'totality of genes, species & ecosystems of a region'
- 3.5 billion years of evolution → biodiversity.

Biodiversity

(1) genetic diversity - same genes within one species — variety of versions
(2) species diver — no. of diff kinds of organisms within individual communities & ecosystem.
(3) Ecological diversity. α β γ.

Q. Why do we study biodiversity?
→ Food: 80k edible plants, 90% present day food crops domesticated from wild. wild crossed with domestic ↳ must be maintained.
* Analgesic? eg. Morphine
Periwinkle, child leukemia → Madagascar

→ Drug & Meds: 75% population depends on plant extracts.
* Basmati rice - grown primarily in Dehradun — US grown in India since long. claim they breeded
→ Adds ecosystem stability - estimated that 95% pest, disease carrying organisms are controlled by natural predators & competitors. 'Pest control'
* 1 species per decade - extinct decayed. Normal. But last CE, 1k species became extinct
→ Fuel: forests - fuel wood, fossil fuels are also products of biodiversity.

→ Social value - plants tulsi, lotus, peepal etc. considered holy & sacred.

Penicillin, developed from Fungus.
Some Natural Medicinal Products Table 5.2.

HOT SPOTS of Biodiversity.
Biogeographic region with a significant reservoir of biodiversity that is threatened with destruction.
- endemic (species only available here)
eg. Bastards - bird only in Kutch.
- 0.5% of plant species - designated as hotspot.
- only 25 such hotspots globally. 2 in India
Himalaya, Western Ghats
- cover less than 2% land, 50% biodiversity.

Ex
→ Cambodia, Vietnam, Laos
Thailand, Myanmar, Bhutan
Nepal, far eastern India, extreme Southern China.
- lost by mining, dams
Pristine - Indonesia.

- extinction due to human impact

- Possible causes - Glaciation, Climate change / possible meteorites,

HIPPO - sixth mass extinction.
Habitat destruction, Invasive species, Pollution, Population of humans, Overharvesting.
- habit destruction - forest, grasslands → farmlands.

resource extraction, mining, dams, fishing.
→ Fragmentation - reduces habitat to small isolated areas, reduces biodiversity - some species require large areas to sustain - bears, cats.

Q. What is biodiversity worth?
2. conservation necessarily contradictory to good economic sense? Yes.

loss per hectare of pristine forest VS $ 6K.

Q Can we afford to restor biodiversity?
cost of restoration Vs destruction.
↳ revenue friendly. save more lose less.

→ Protection
- enough habitats for native species
regulated zones - interaction less. created restricted area to be maintained.
- Manage at regional scales large enough to accomodate natural disturbances (fire, wind, climate change etc.)
Development should not be of permanent nature that damages biodiversity.

→ How is Biodiversity measured. (stars diagram)
① richness - more no. of species
② one type of species occupy more - evenness
- more spread.
must coexist.

* Shannon Index OR Shannon Entropy.
quantifies ~~taxa~~ uncertainty (entropy or degree of surprise) associated with mis prediction.

$$H' = -\sum_{i=1}^{R} pi \ln pi$$

p_i → proportion of individuals belonging to the i^{th} species in the dataset of interest.

* Simpson's diversity index (D)
- probability that 2 individuals randomly selected will belong to same species.

$$D = \sum (n/N)^2 \qquad D = \sum \frac{n(n-1)}{N(N-1)}$$

less D, more diversity
when D=1 → no diversity - occupied only by 1 species.

→ Index of diversity 1-D.
→ Reciprocal 1/D.

	(n)
W	2
H	8
B	1
Y	1
S	3
	15

eg.

~~D = 4/.~~

$$\left(\frac{2}{15}\right)^2 + \left(\frac{8}{15}\right)^2 + \left(\frac{1}{15}\right)^2 + \left(\frac{1}{15}\right)^2 + \left(\frac{3}{15}\right)^2$$

$$\frac{4+64+1+1+9}{(15)^2} = \frac{79}{225}$$

→ London Fog → in winter Dec 5, 1952
· 4000 dead in 3 days; 10k people health problems.
· high use of coal SO_2, SO_3 on burning coal
Sulphuric acid in air (soot particles)
+ fog due to winter
No wind, trapped → = Smog
Temperature inversion
— Similarly in Delhi but NO, no fog. only smoke
less trapped.

Air Resources

Nitrogen (78.09) } Major.
Oxygen (20.95) }
Water vapours (0.1) }
Argon (0.9) } Minor
CO_2 (0.032) }
Neon (0.0018) } Trace comp.
Helium (0.0005) }
Methane (0.0002) }

Temp. profile.
- Troposphere
- Mesosphere
- Stratosphere
- Ionosphere
- Earth.

- Stratosphere — Ozone — ↓. for living organi Temp. & pressure distribution.
  CFCs
- Troposphere - most active Rods UV radiation.
  most reactions takes place here - controlling layer.
- Mesosphere — coolest -
- Thermosphere — Temp. rises very fast here.

(Pollution) — affects health or any other process.

→ Air pol. — smoke, haze, dust, odors, corrosive gases, noise, toxic comp

- Sulphur dioxide — eyes & lungs
- fine particulates penetrate ↑
- airborne metals in blood stream.
- Sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, lead, — conventional / criteria pollutants.
- point source → smokestack; fugitive or non-point source - emissions don't go through smokestack.
- Primary pollutants — substance harmful when released
  Secondary — harmful after they react with other gas, substances in air eg. photochemical oxidants &

eg. factory can be controlled / single point can't be identified, distributed

- Studies - South Asia - 3km thick cloud of ash, acids, aerosols, dust, smog over India almost all year.
- forest fires, burning agri wastes, increase in use of fossil fuels, → solar energy is cut-off by 15%.
- disrupts monsoon patterns, cuts rainfall by 40%.
- 'Brian Brown Cloud' — Indian Ocean drifts.

Pak, Afghan, China west, Arabian

∫ → Volcanic activity, vegetation decay
Man made (90%)

Primary - CO, NO_x, HC, SO_x, particulates : 1

→ Particulate matter
- small solid particles (0.0002 - 500 μ) or liquid droplets - 500-2000 million tons discharge by natural
200-2000 " man-made.

∫ - Soot particle p/c

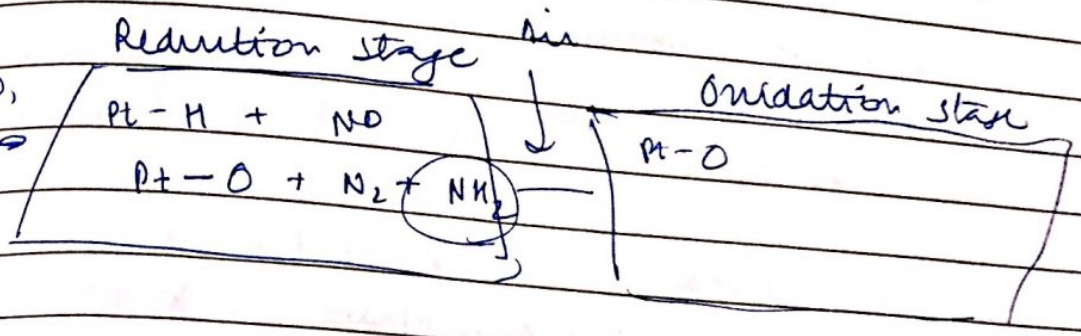
→ Carbon Monoxide (CO)
colourless, odorless, tasteless, injurious to health.
Diesel & petroleum engines - 70% emission

- Incomplete combustion of C.
$$2C + O_2 \rightarrow 2CO.$$
- Elevated temp. in industries - blast furnaces.
$$CO_2 + C \rightarrow 2CO$$
- High temp.
$$CO_2 \xrightarrow{\text{dissociation}} CO + O$$

Sinks.
- lost in upper atmosphere
- soil microorganism (2 kg can remove 120 ppm CO from ambient air in 3 hrs)

Control of CO, HC, NO_x pollution

- catalytic conversion in combustion engines of automobiles.



→ Nitrogen oxides (NO, NO_2)

$$N_2 + O_2 \rightleftharpoons 2NO$$
$$2NO + O_2 \rightleftharpoons 2NO_2$$

} inside automobile engines.

$$NO_2 + O_3 \longrightarrow NO_3 + O_2$$
$$NO_3 + NO_2 \longrightarrow N_2O_5$$
$$N_2O_5 + H_2O \longrightarrow 2HNO_3$$

} exhaust

└ acid rain.

→ Sulphur dioxide SO_2

- Volcanic eruption.
- Coal fired power stations.

$$S + O_2 \rightleftharpoons SO_2$$
$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

Soot particles, containing metal oxides, catalyze the oxidation

$$SO_2 + O_2 \rightarrow SO_3 + O_2 \xrightarrow{H_2O,\ \text{hydrolysis}} H_2SO_4 \longrightarrow (H_2SO_4)$$

$$SO_2 + \tfrac{1}{2}O_2 \xrightarrow{\text{(Soot)}} SO_2 \longrightarrow H_2SO_4 \longrightarrow (H_2SO_4)$$

Chemical scrubbing.

$$2CaCO_3 + 2SO_2 + O_2 \longrightarrow 2CaSO_4 + CO_2$$

↳ means to control SO_x pollution.

→ Hydrocarbons & photochemical smog.

- produced by bacteria - anaerobic decomposition of organic matter.
- Domestic animals
- Automobils

$2(CH_2O) \xrightarrow{\text{bacteria}} CO_2\uparrow + CH_4\uparrow$

- chain reaction - NO_2, aldehydes, RCHO (benzyl) PAN) - peroxy acyl nitrate. ✗
- photochem smog - brown hazy fumes.

→ Greenhouse effect - global warming.

absorb energy - temp. rise.

CO_2 280 ppm → 350 ppm (pre industrial - now)

Fossil fuel combustion 1-2% increase.

Earth surface temp. rise 2°C

→ wheat production badly suffers.

→ Biological productivity - in oceans will fail

→

→ Ozone hole

$O_3 + NO \longrightarrow O_2 + NO_2$

$O_3 + NO_2 \longrightarrow O_2 + NO_3$

CFC

$CFCl_3 \longrightarrow CFCl_2 + Cl^-$

$Cl^- + O_3 \longrightarrow ClO^- + O_2$

$ClO + O \longrightarrow Cl^- + O_2$

Kyoto Treaty

18.

Air Pollution Control

'Dilution is the solution to pollution'

- Reduce, Recycle, Reuse
- Reduce electricity, insulating home & offices, better public transport, alternative energy.
- Particulate removal → filtering air emissions
  Electrostatic precipitators.
- switch from to low sulfur coal (high sulfur-dirty)
- NO_x - combustion engines & boilers - carefully controlling reduce by 30%.
- Catalytic converter - car - pt-pd, rhodium
  remove NO_x, HC, CO
- HC - complete combustion - evaporation control.

Clean air legislation - controversial but successful.

- costs of pollution have been absorbed by public,
  - Putting greater emphasis on pollution prevention rather than control.
  - Reducing use of fossil fules.
  - Improving quality of vehicular fuel
  - Increasing use of renewable energy

* Odd/Even in Delhi.

Trading pollution credits.

cap-and-trade

EPA sets max. emission levels - permitted allotments.
Install pollution control equipment or buy someone else's credits → buy emission 'credits'

Air pollution status in India.

- Hotspots - Delhi, Ahmedabad.
→ SAFDR — 4th most polluted in the World.
- continuous monitoring of pollutants.
- Ahm - most noxious air, Kanpur, Solapur, Dhanbad.
- small particulate levels (PM10) 3-4 times the standards of 10 mg per year

- Ambient air quality standards in India. (Table)

- The ongoing challenge
  - Pollution persists in developing areas.
  - Improvement in some places
    - Brazil - Valley of Death — 20 yrs ago.

WATER RESOURCES.

- 71% earth covered in water
- 97% of this water in oceans.
- 2.997% of 3% is locked in ice caps.
- only 0.003% of earth's total vol. is available.

→ Water Pollution

Any physical, biological, chemical change in water quality that adversely affects living organisms or makes water unavailable for desired uses can be considered pollution.

→ Symptoms.

- Bad taste
- Offensive smells from lakes, rivers, bays
- Marked growth of aquatic weeds
- Dead fish floating on surface.
- Oil & grease "

drainage.

→ water pollutants.
- organic, inorganic → from factories, agri...
materials, Thermal pollutants.
→ Rise in temp.
less dissolved O_2

Water Pollution.
Point & Non-point source (for management point - easier)

Major components of water pollutants (Table) T 11.3
(PIC) BOL (Biological Oxygen level) ∝

++ ppm	human	
25	Large fish	dyficult for ecosystem to survive if remove any level.
2-3	Fish	
1	Shrimp	
0.3	zooplankton.	

→ Groundwater Pollution (Pic).
· Arsenic pollution near West Bengal.
Two theories:
→ Himalayan headwaters (Deltas) - downstream for years - brought down as sediments.
→ Pyrite oxidation hypothesis - lowering water table - arseno-pyrite oxidized in zone of aquifer releases - adsorbed into iron hydroxide - recharge releases arsenic into ground water

· Sewage treatment plants - lowering level of power in D
· Solid waste management - dry leaves - Vermicompost
fertilizers

Means of conventional sewage treatment

· 2018

→ 26/3/18 Class missed

· 3E's → → consc-govn.

✓ · EIA · Environment Impact Assessment. → Project level intervention

✗ · Strategic Env. Asm. - SEA

· Checkdam - beneficiary - downstream - wells recharge

· Evolution of EIA - categorisation

FAO - group A, B, C categories for field projects.

· Stages in EIA process.

· EIA cycle

·04.18 Climate change.

explainingclimatechange.ca

· Difference b/w weather & climate — long term average of variable)
short term variable — thousands of years.

· How is this climate change recorded? Where & how is this studied?

ICE CORE - samples in glaciers - have remained undisturbed for long, formed over the years.

Which are the most important variables, critical for understanding climate change? → CO_2

→ Temperature

gaseous remains trapped in glaciers - bubbles.

(separate out CO_2 from other gases
'Gas chromatography'

calculate conc. by volume - 'Mass spectroscopy'

'Isotopic temperature' Isotopes. O_{16} O_{18}

H_2O

↳ mass will change if isotope changes.

↳ Hydrogen - Deuterium.
↳ may replace at diff. temp.

↳ vapour pressure also changes when decreases - hard to change state → liquid → gas

find conc. of atoms of different mass - less in atm ✗
than in the ocean.

Isotopic ration $O_{18} : O_{16}$

↳ condensation (when falls as rain as snow) can be related to change in temperature. → non-linear relationship

* Graph: Temp vs years.
-ve side anomaly indicating rise in temp.
CO_2 and Temp - similar behaviour.?

CO_2 conc. increased after 1800s - industrial era
human induced process.

e⁻ vity - affinity to attract -ve ions.
- affects distribution of charges in molecule

perm. dipole H_2O → will absorb infared radiation in atm and then vibrates/rotates - due to e⁻ vity of O.

N_2 → no uneven charge distri

temp. dipole O_3 → bent configuration

- EM Spectrum, ~~wave~~ λ increased, E decreased.

* Molecular interaction with radiation.
CFCs will break up when energy applied.
absorbs - vibrates in Infared.
Rotates - in Microwave.
breaks into - in UV

→ CO_2, N_2O, H_2O → greenhouse gases O_2, N_2 ✗
absorb radiation

4.18

· Even though majority of gas on Earth constitutes of N_2, O_2 which are not greenhouse, then why is the effect of small amount of greenhouse gases so much?

→ 'collisional Heating'
graph wavelength vs energy absorption for different gases. temp. bulb. atm.
· transfer of energy - losses - temp. increases.

→ Lapse Rate & Earth's Radiative Energy Balance'
highest at the bottom.
form of height

· all ghg are not the same (3) pts.
· Residence time - how long remains in atm
· Concentration
· Region of IR where it absorbs.

· Earth's emission spectrum Vs gas emission
when both are high → high temp.
CFC has higher potential of making atm. warm

(4) climate : A balancing act
'volcano' ... 'Radiation Balance'
- Outgoing vs incoming - albedo.
avg. Earth temp. = 15°

(5)

Impacts of climate change
1. Polar Regions.
eg. PETM caused extreme warming - growth of lush green in the arctic.
methane clathrate by drakes → destabilized.
released gas

4/18

- IPCC simulation means.
- Arctic ice caps melting - water level rise
  albedo. increase
- Coral reefs - $CaCO_3$
  coloured algae - symbiotic - corals
  Coral bleaching - fungus unable to survive invertebrates
  due to temp. change, rejected by coral
- El nino & La nina. phenomena - temp. change. | drops down - white
- Surface temp. rise
- Sea level rise - corals in shallow water only -
- Extreme weather - Hurricane Katrina
- Biodiversity - prog population decrease
  → thermoconformers

7) L-6 skipped!

- Climate feedback loops.
- Robust cycles cannot withstand forcing changes.
  +ve, -ve looping eg water feedback
  (solid, liq, gas.
  resisting equations - balance