04/02/2019
Monday

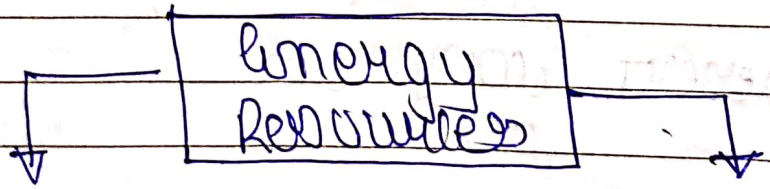
Lecture : 8

⇒ Till now we have finished two important topics:

Eco Cycles:
- Equilibrium and balance
- Channel of materials.
- Nutrient cycle
- Energy flow.

Eco Ecosystems:
- Various different
  - ↳ different conditions
  - ↳ different adaptations for organisms.

*

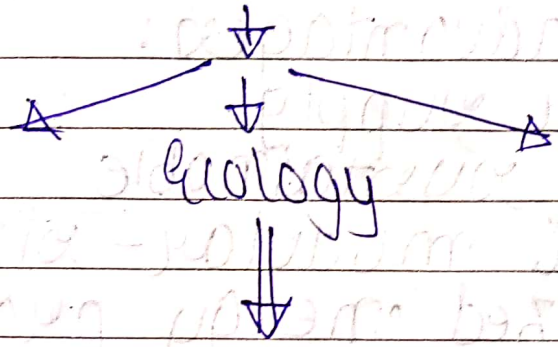


Conventional
Non-renewable
(Fossil, Nuclear, Hydro)
33% Petrol & Diesel
27% Coal
5% Nuclear Fuel

Non-conventional
Renewable
(Solar, Wind, Biomass, Geothermal, Tidal)

⇒ Even while sleeping, we require energy in the form of carbs.

Why non-conventional?
⇒ Because conventional are exhaustible and not sustainable



Conventional → pollute the env.
↳ may get exhausted in the upcoming century.

⇒ There are many problems regarding production & distribution of non-conventional.

⇒ USA & Canada - 5% of popu.
25% available resources

⇒ USA & Canada
avg person consumes 300GJ/year

⇒ Person in a developed country consumes as much energy in a single day as a person consumes in a whole year in poorer countries.

⇒ USA : Use and throw has became the norm

Renewable advantages:
- Unlimited supply
- Fits into sustainable
- Reliable & modular-sized devices
- Decentralized energy production

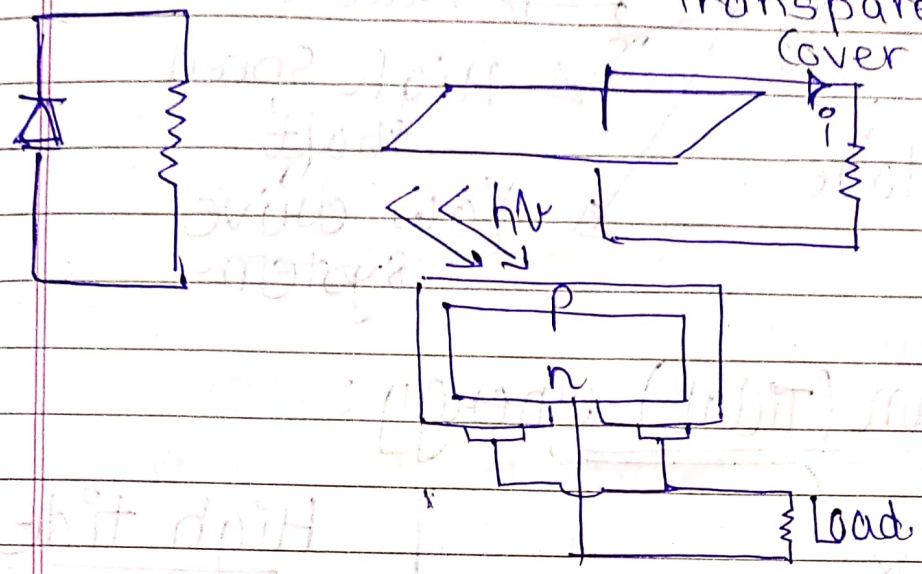
⇒ India is blessed. Why?
- Tropical
- Large amt. of sunlight across the year
  - 2000 kWh/m^2.
  - 5-7 kWh/m^2, daily.

⇒ Problem
- Cost of production
- Solar energy is diffused

⇒ - Not focused at a point
- diffcult to harness.
- omni-directional

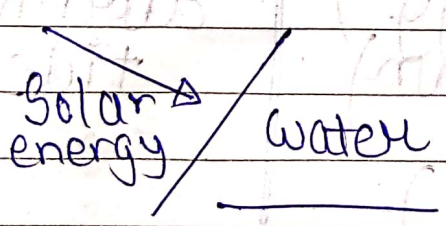
⇒ 1 week solar energy = coal reserve of the world.

* Photovoltaic cells :- Antireflection coating
Transparent adhesive
Cover glass



⇒ Conversion rate is less because of dispersed solar energy and cost of production is too high.

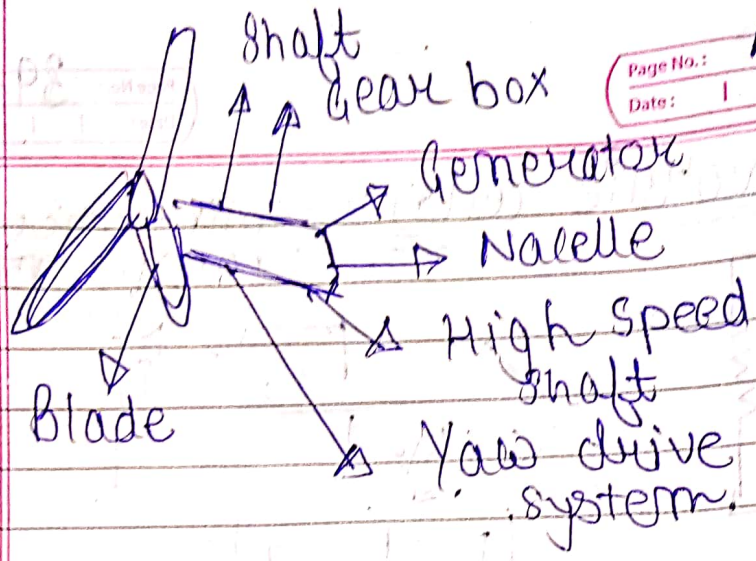
⇒ Another means of solar energy collection - SOLAR HEAT



* Wind energy :-

⇒ India is blessed
└ long coastline

⇒ When $v_{wind} > 6.5$ m/s, we can capture its energy.



* Ocean (Tidal) energy:

I). Tides
(Gravitational force of moon)
(Daily phenomenon)
(1 m wave 90kW energy.)
(25-70kW ocean shore)
(Storm 5-MW)

High tide
- Water flows into the reservoir through the turbine
- Comes out during low tide.

* Geothermal energy:-

⇒ ↑ temp (earth) by 20-75°C per km
high temp steam fields - springs

⇒ Heat, Mechanical } → Electrical

* Biomass energy:-

- ↳ >14% global energy supply
- ↳ organic matter - plants or animals
- ↳ heating, cooling & industrial
- ↳ 32% of total consumed
- ↳ caters 40% of pop.
- ↳ widely available, ren. & carbon neutral

- ↳ CH_4, CO_2, H_2S — mixture
- ↳ 65% of CH_4 as a major constituent
- ↳ Obtained by the anaerobic fermentation of animal dung or plant wastes in presence of water.

($C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO$).

⇒ Dead wood is used
- ↳ generates CO_2
- ↳ But carbon neutral. why?

⇒ Ethanol → Sugarcane
(∵ Biofuels not to study).

06/02/2019 Wednesday * Lecture: 9. *

"Coal formation"

Conventional sources: generally used

⇒ Jhoom cultivation - sustainable

⇒ Wood is considered as carbon neutral fuel. It is a renewable source of energy provided intelligent management takes place.

⇒ 10-15 years must be allowed for sufficient logging & delogging

⇒ Hydroelectricity is a clean form of energy. (NO harmful substance are released).

⇒ But the other face of the coin is, it takes up a lot of area under submergence which

includes a large portion of the forest cover.

⇒ Coal forming plants grew in swampy areas.

⇒ Under anaerobic water, high pressure and heat induced sedimentation, coal is formed.

⇒ Wood → (60%) Coal → (70%) Lignite → Bituminous → Anthracite

Carbon content 80% 90%

⇒ Total 4×10^{12} metric tons which is equivalent to 5×10^{22} calories

⇒ India → Reservoir of coal
→ Jharkhand
→ low calorific value (50-60%)
→ Dirty Fuel → (S which produces SO_2 = acid rain)
→ Solvent ~~Dissolution~~ Refining process to improve quality
→ Ash is also a big concern.
→ { remove S, remove ash, ↑ calorific value } } pulverize using solvent.

∴ Thermal energy → steam

⇒ 5% of world coal is in India

* Methanol :-

$CO + 2H_2 \xrightarrow[Cu]{\substack{50\ atm \\ 460^\circ C}} CH_3OH$

mixed with gasoline and petrol in 15% proportion which improves calorific value.

11/02/2019. Monday

* Lecture : 10 *

"Oil-formation.mp4"

Dead plankton → Sapropel (1-1.2 kms) → Kerogen (3-5 kms) → Oil.

(source of nutrients)

burial ↳ depth ↓

phytoplankton, Zooplankton → sun

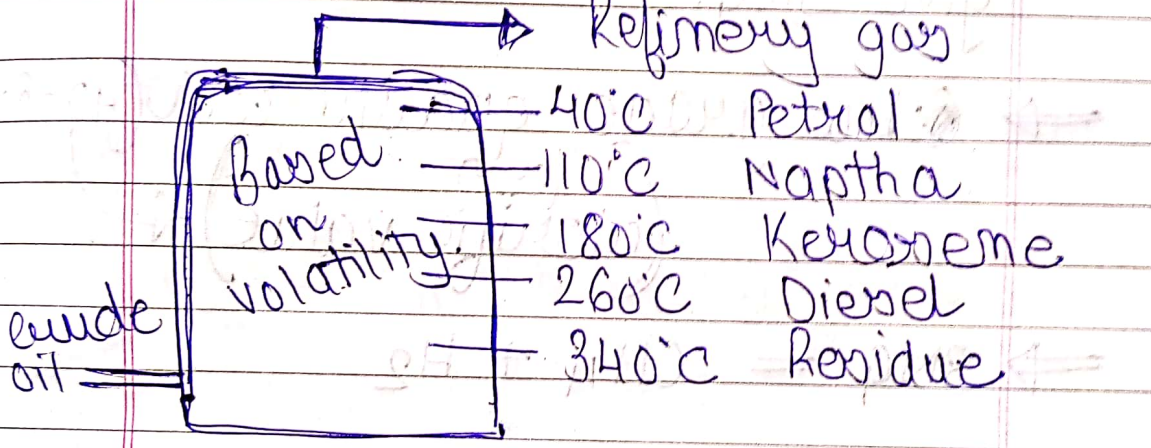
⇒ Oil = C/H/S/O/N.

⇒ World reserve ⇒ 800 billion barrels (last 100 years)

⇒ OPAC → 13 - 14 countries → producers and exporters of oil

⇒ Separation by fractional distillation of oil.

⇒ Almost 25% of reserve in Saudi Arabia ⇒ establishing their hegemony.



* LPG: → Butane (C_4H_{10})
→ Also Propane & ethane
→ odourless
→ methyl mercaptane added for smell → safety purpose

* Natural gas:

→ Methane (95%)
→ cleanest fossil fuel
→ without any smoke
→ 50 kJ/g High calorific value
→ CNG → petrol/diesel alternative
→ SNG → $CO + H_2$

from coal gasification

⇒ The above gas is called Producer gas which undergoes cleaning up process which gives synthetic gas which further undergoes methanification to give SNG.

⇒ Low grade quality coal (40-50) (less calorific value)

⇒ SNG = $CH_4 + H_2$

* Nuclear energy :-

- clean energy
- Radioactive emission
- 1 - kg $_{92}U-235$ complete fission by slow neutrons release energy = 1.4×10^{13} cal.
- 1 lb. ⇒ 5 million cal.

⇒ Thorium used in India
- Nuclear stations in India - Tarapur / Rajasthan / Kakrapara

⇒ France (>85%) from nuclear
⇒ Australia gives us raw elements.

⇒ Many European countries have smaller carbon footprints.

⇒ Nuclear
- Fission
- Fusion

⇒ Isotopes (same A.N., diff mass)
(H_1^1, H_1^2, H_1^3) $(C_6^{12}, C_6^{13}, C_6^{14})$

⇒ Fission: $U_{92}^{235} + 1n \rightarrow Kr_{36}^{92} + Ba_{56}^{141} + 3n + \Delta$

⇒ Fusion: at 1 billion°C (> fission) ⟶ energy obtained

$H_1^2 + H_1^2 \longrightarrow 1n + He_2^3 + \Delta.$

- Flip riders:
  - ↳ Radioactive emission
  - ↳ Expensive technology
  - ↳ Disposal
    - ↳ international protocol

* put into containers and put deep under the ocean.

* Land Resources :-

- Existence of civilization
- Top soil
- Renewable (400 million)
- Mixture: Inorganic and Organic (Dead organisms) → Rocks/minerals
- Formation (Weathering)
  - (i) Physical
  - (ii) Chemical
  - (iii) Physico-chemical
- Becomes non-renewable for use.

⇒ Degradation :- loss of fertility/nutrients
- loss of productivity
- availability of moisture
- microbial activity
- nutrients, etc.

(generic)

⇒ Desertification: (Reversible) (eg. Israel)
- arid/semi-arid + land degrad. → higher level → desert-ification

(↑) 2.1 - 2.2

⇒ Causes
- Popula
- Urbaniz
- Fertilizer

Carrying capacity of people in a given a given

Tillage
- Dama
- Water
- erosi

⇒ Causes
- detac

⇒ Water:
- Sheet
- Rill
- Gully
- Stream

(Ravines) high order

medi

→ (↑) 2.1 – 2.2%.

⇒ Causes of degrad. :-
- Population
- Urbanization
- Fertilizers / Pesticides

} Anthropogenic

▦ Carrying capacity is the number of people which can sustain on a given piece of land under a given env.

▦ Tillage
- Damage of top soil
- Waterlogging (not submergence)
- erosion
  - ↳ air space choked up with water.

⇒ Causes of erosion:
↳ detachment and movement.

→ Water:
- Sheet
- Rill
- Gully
- Stream bank

→ Wind
- Saltation
- Suspension
- Surface creep

(Ravines) (high order)

→ (Plains) (: Top sheet removed) (2D)

(Undulating) (Heavy rainfall)

medium order

(lower order)

Streambank : North Gujarat Assam
- higher order stream
- high velocity
- porous soil at the banks.

13/02/2019 Wednesday *Lecture: 11*

⇒ Soil gets eroded and displaced in the form of sediments.

⇒ Streambank is a different form of erosion.

Sheet < Rill < Gully < Ravines.

⇒ Moisture and organic material (humus) are important binding components.

⇒ Arid and semi-arid regions lack in both - moisture (dry) and organic (high temperatures → high microbial activity → fast decomposition of organic matter

⇒ Extent of erosion by wind depends on the size

⇒ Suspension is prominently observed in Gujarat because of pressure gradients.

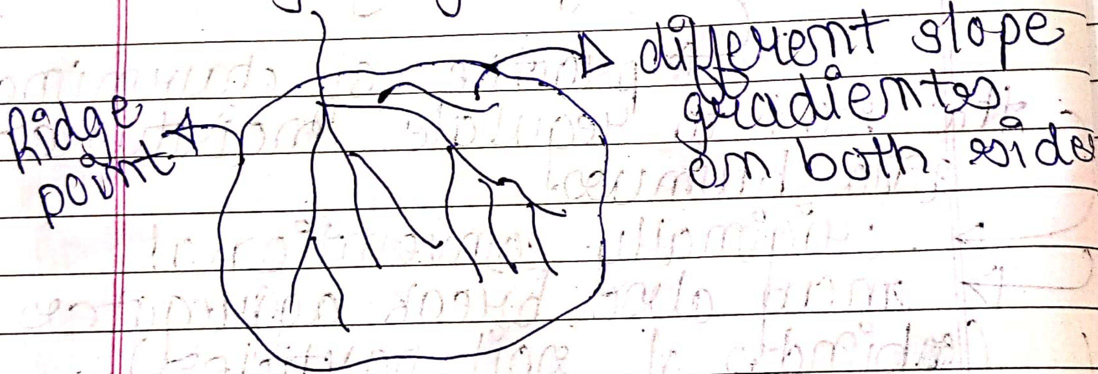
⇒ Saltation is the formation of dunes.

⇒ Control of soil erosion:
- Conservational till farming or no-till farming.
  ↳ practice of churning the soil to regulate moisture and humus.
  ↳ originally conventional
  ↳ may also break aggregates (bonds of soil particles)
  ↳ using furrows is advisable and now it is avoided.
- Contour farming
  ↳ land having same attitude w.r.t. mean sea level (originally was used) (now even GPS works)
- Terracing.
  Decreases speed of wind and water.

⇒ Not contour since it is practised at a much higher altitude

→ Alley cropping / Agro forestry :- (mixed cropping)
eg. Paddy and groundnut.

* Watershed management
→ hydrological boundary



⇒ Very effective soil and water management :-
- control over water distribution and dynamics.

Complications :
1.) Human intervention :
- Non scientific
- Human greed
→ { · Land management · Stop pollution · Waste manag · Reduce Fertili

2.) Surface & ground water quality and quantity
- equitable distribution among

stakeholders.
- change in cropping pattern
- agri. water manage.
- rainwater harvesting
- stopping point
- nonpoint sources of pollution

Principles:
- Utilize land
- maintain adequate vegetative cover.
- Conserve max possible rainfall
- Contour farming
- Drain out excess water with a safe velocity (waterlogging).

* WATER RESOURCES

100%
- Ocean 97.6%
- Fresh 2.4% — 87.2% Ice & Snow; 12% Groundwater; 0.8% Fresh surface water.

→ less usable.
- → Salty water – desalting is a capital-intensive process.
- Israel conducts it – nuclear power
- reverse osmosis.

⇒ North Gujarat – dark zone – poor groundwater conditions.

⇒ Groundwater can exist in two ways -

1) Confined aquifer - very less permeable layers at the top and bottom

2) Unconfined aquifer - clearly closer to surface

⇒ Groundwater dynamics are difficult to understand

⇒ Water Pollution: Any physical, chemical or biological change in the quality of water.

⇒ Symptoms:
- Bad taste
- Offensive smell
- Unchecked growth of weeds

→ Better management

Two types :-

⇒ Point-Source Pollution
- easy to manage
- factories, power plants.
- sewage treatment plants
- underground coal mines
- oil wells
- drainpipes, ditches or sewer outfalls.
- sources are discrete and identifiable

⇒ Non-point sources :
- Tracer technique using isotope
- Discharge into a water body
- particularly difficult to identify

⇒ Major categories :
(i) O_2 - demanding wastes
- Manure Residues

(ii) Plant nutrients
- NO_3^-, PO_4^{3-}, NH_4^+

(iii) Sediment
- Soil, Salt

(iv) Thermal changes
- Heat

Lead to Algal bloom → Depletion of O_2

Lead to certain org.

Biological Oxygen demand:-

Upstream (high)

Clean zone → Decomp zone → Septic zone 0-2ppm → Recovery zone 2-5ppm → clean zone 5-10ppm

→ Natural process to improve BOD in water bodies.

⇒ Bioaccumulation and Biomagnification: complex nutrients and heavy metal → non degradable → deposit and accumulate at trophic levels.

40 ppm — Humans
↓
20 ppm — Large fish
↓
2 ppm — Fish
↓
1 ppm — Shrimp
↓
0.01 ppm — Plankton

Oxygen sag $\propto \frac{1}{BOD} \propto$ Depth

18/02/2019. Monday

* Lecture : 12 *

⇒ Groundwater is less likely to get polluted as compared to surface water.

↳ It is confined

↳ Filtration happens through the layers of soil.

↳ Certain cations will get adsorbed on the soil particles which possess negative ions because of hydrolysis of certain oxides and hydroxides

- Cation exchange capacity (CEC)
- Heavy metales

↳ Microbes larger than the pore size of soil get filtered.

ppt → Reasons and sources of groundwater pollution.

⇒ Arsenic is a major concern

which makes bones brittle

When the sediments are eroded during the higher order, Arsenic accumulates which settles down in groundwater

Fes containing impurity of As. Air follows water as it percolates down the land and oxidation separates As.

DA has both → solid & liquid

⇒ Waste water treatment
(Primary treatment)

BOD · 200ppm, NH_4^+ 30ppm, PO_4^{3-} 25ppm

↓ Screening → Solids, grease & scum removed

↓ Sedimentation → effluent for secondary treatment

Primary sludge

↓

Air ← Activated sludge → CO_2

↓

Sedimentation

⇒ Chlorination helps kill germs and absorbs cations to form salts.

* ⇒ Non-hazardous waste management:

eg: Landfill eg: Incineration

↳ Avoiding leaching is important.

* Marine Pollution :-

⇒ Main sources:-
1) Drainage basins → rivers
2) Oil drilling and shipment
3) Industries & agriculture

20/01/2019. Wednesday

* Lecture: 13 *

* Air Resources :-

- Major: Nitrogen 78%
  Oxygen 20%
  H_2O 0.1%
- minor Ar, CO_2
- Trace Ne, He, CH_4

⇒ Air is not a homogenous mixture across depth

Structure:- { Ionosphere (Aurora)
Mesosphere
Stratosphere
Troposphere

⇒ Temperature and its gradient also varies across the layers

↳ High variability of air bet polar and tropical regions } less temp.

dominated by ozone
blocks UV ray
greenhouse gas.

⊖ Negative lapse
⊕ Positive lapse

IMST
⊕ ⊖ ⊕ ⊖

can absorb heat

Upto 1200°C

higher temp

Meteorologist

Nitric oxide and oxygen get ionized

Turbulence
↳ No breeze.

LG → winter night.

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Date: / /

* Air Pollution:

↳ Smoke, Haze, Dust, Odors, Corrosive gases, Noise and toxic compounds.

- SO_2 → irritate lungs & eyes.
- Fine ppm → enter lungs.
- Airborne metals – enter blood

↳ dangerous beyond a threshold

⟹ Came to light in 1952 after London smog.

↳ December 5
↳ Less temp.
↳ Normally sun heats earth, warm air goes up and cold air comes down
↳ Breeze generally stabilizes.
↳ However Inversion occured.
↳ Cold air got trapped
↳ { Moisture + Smoke } ⟹ Smog.
↳ 4000 people in 3–4 days.
↳ 8000 people died in the next one month.

* ASIAN Brown cloud :

↳ Source: forest fires, industrial exhausts.
↳ Nov - July.
↳ Cleared during monsoon
↳ Above South-East Asian countries
↳ Cuts the incoming solar energy by approx 15%
↳ 3km — size
↳ Monsoonal rain
↳ 16 parameters
⇒ vapor pressure
⇒ el nino
⇒ wind
⇒ temperature

↳ natural	anthropogenic
• volcanic eruptions • forest fires	

* Major responsible substances

CO_2 Complete oxid. of C
CH_4 Anaerobix oxidation
CO Incomplete oxide of C

NOx
SOx
SPM

⇒ SO_2, ↑
pneum
-unds)
m
↳ co
⇒ mon
pollut
⇒ Fugi
⇒ Prim
pollutants
direct
he
CO
NOx
HC
SOx
Partic

NOx
SOx
SPM
→ Suspended Particulate Matter → categorised by size

⇒ SO_2, NOx, CO, O_3 (and its precursor volatile organic compo-unds), lead and particulate matter.
↳ conventional/ criteria pollutants.

⇒ many pollutants come from → smokestack.

⇒ Fugitive do not go to smokestack.

⇒ Primary pollutants ~~sources~~
↓
directly damage health
CO
NOx
HC
SOx
Particulates
} 40-45% eg. Transportation

Secondary pollutants
↓
react and become dangerous eg. photochemical oxidants.

* CO :- Colourless, Odourless, Tasteless. Injurious to health.

- $2C + O_2 \rightarrow 2CO$
- $CO_2 + C \xrightarrow{\Delta} 2CO$
- $2CO_2 \xrightarrow[High]{\Delta} 2CO + O_2$

⇒ Sink available ⇒ Soil micro-organisms

28 kg removes ⇒ 120 ppm CO ⇒ 3 hours

⇒ Part of CO lost in upper atmosphere.

* Control of CO, HC, NOx :

↳ Catalytic converter ⇒ IC engine of automobiles.

I Reduction

Auto Exhaust

$Pt - H + NO \xrightarrow{R} Pt O + N_2 + NH_3$

II Oxidation

$Pt - O +$

* Particul

↳ Small

↳ 0.00

↳ Natu mos

eg. Soot

Adso

eg

Adso

Be

Remova

Electros

Precip

II Oxidation:

$$Pt-O + \begin{matrix}HC\\CO\end{matrix}\Big\} \rightarrow Pt-H + \begin{matrix}CO_2\\H_2O\end{matrix}\Big\}$$

O_2

* Particulate :-

↳ small solid and liquid particles droplets.

↳ 0.00002 to 500 μ. size

↳ Natural
man-made

eg. Soot 0.1 – 20μ
Adsorbed organics
eg Benzo-α-pyrene
Adsorbed toxic metals
Be, Cd, Cr
} huge surface area

London Smog

Removal/Control:

Electrostatic Precipitator ⟹ Aerosol acquires charge

↳ Charged particles are grounded.

25/02/2019.
Monday *Lecture : 14*

* NOx:
  - (NO + NO2)
    - ↳ inside automobile engine

$N_2 + O_2 \rightleftharpoons 2NO$

$2NO + O_2 \rightleftharpoons 2NO_2$

  - Exhaust is converted to HNO_3 also known as acid rain

$NO_2 + O_3 \rightleftharpoons NO_3 + O_2$

$NO_3 + NO_2 \rightleftharpoons N_2O_5$

$N_2O_5 + H_2O \rightleftharpoons 2HNO_3$

⇒ Very prevalent in Europe

* HC:

⇒ Primarily CH_4 is produced by anaerobic

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

⇒ A side another to give a peroxy stron
  - ↳ Ph
  - ↳ cl to A
  - ↳ Tr

* SOx
  - ↳
  - ↳

⇒ SO_2

Soot
↓
Adsorbs

⇒ SO

- Com

- $2NaCO_3$

⇒ A side reaction also followed by another route through aldehyde to give an injurious product, peroxy acyl nitrate which is a strong eye irritant

↳ Photochemical smog
↳ closer to surface as compared to ABC
↳ In the presence of sunlight

* SO_x :-

↳ Pyrites
↳ SO_2 & SO_3

Auto
↓
- NO_x contributor in pollution
- does not produce SO_x

⇒ $SO_2 + O_3 \rightarrow SO_3 + O_2 + H_2SO_4$
($SO_3 + H_2O \rightarrow H_2SO_4$)

Soot
↓
Adsorbs organic materials

↓
$(H_2SO_4)_n$ Aerosol Droplet

⇒ $SO_2 + 1/2\,O_2 \rightarrow SO_3 \rightarrow H_2SO_4$

- Control: chemical scrubbing

- $2CaCO_3 + 2SO_2 + O_2 \rightarrow CaSO_4 + CO_2$

⇒ Generally sulphates and chlorides are completely soluble

⇒ But $CaSO_4$ is partially soluble.
↳ comes with a problem of disposal.

◎ CO_2 not discussed as a pollutant?
↳ We have discussed primary and secondary pollutants.
↳ H_2CO_3 is present in ocean
↳ CO_2 is a secondary pollutant.
↳ CO_2 is a greenhouse gas which is able to trap the heat.
↳ 8000 – 25000 nm wavelength is basically heat which is not allowed to escape back.
↳ CH_4 and H_2O are other major greenhouse gases.
↳ 280 ppm ⟶ 350 ppm
(pre-industrial) (present)

⇒ Fossil fuel ⇒ major source
⇒ 1–2 % (↑) / year
⇒ Earth's surface temp may increase by 2°C in the next 100 years.
⇒ Ocean and plants are imp.

sinkes.
⇒ USA opt

• Effects of

⇒ Wheat
– Influen
temp
– Only
obtain

⇒ Biolo
ocean.
– Fixatio
atmos
phyt
– Phytop
temper

⇒ Sea l
years
– Net
– R

Expans
of wat
with tem

sinkes.

⇒ USA opts out of Paris Agreement

- Effects of GHG :-

⇒ Wheat production will suffer.
- Inflorescence of wheat is very temp-sensitive
- Only after flowering can we obtain grains.

⇒ "Biological productivity" of the ocean will fail due to warming
- Fixation and sequestration of atmospheric carbon by phyto plankton.
- Phytoplankton are sensitive to temperature

⇒ Sea level rise (↑) 15cm by 100 years.
- Netherlands is below sea level
- Reason { schools of thought

Expansion of water with temp rise

Melting of glaciers

• El Nino → Spanish (small boy)

"La Nina" (small girl)

⇒ Atmosphere & ocean coupling

⇒ Eastern pacific is colder than western Pacific
- ↳ Temp gradient
- ↳ Tradewinds
  - ↳ Winds of Troposphere
  - ↳ East to west
- ↳ Cold water moves along
  - ↳ Rich in nutrients.
- ↳ Thermocline → Upwelling.

⇒ El Nino occurs when reverse current blows.

⇒ We measure temp anomalies from long term temp averages.

El Nino occurs (↑ (4°C))

→ monsoon pattern changes (Drought) → wind vector and vapour pressure changes.

⇒ La Nina
Unusual

⇒ These
atmosph
tradewin

Nutrient rich "co

• Ozone

⇒ Im
breaks
which
chair

⇒ CFC

⇒ CFC
st

⇒ 19

⇒ Ku

⊙ SAF

→ La Nina ⟶ ↓ (4°C)
Unseasonally heavy rainfall

⇒ These two are known as atmospheric ocean coupling process:

tradewinds ↓ — Upwelling.

Nutrient rich "cold water" ⟶ moving towards surface

- Ozone hole :- (check out reactions)

⇒ In presence of UV (200 nm), CFC breaks up into chlorine free radical which consumes ozone by chain reaction

⇒ 1 CFC ⟶ (cons.) 100000 O_3.

⇒ CFC slowly troposphere ⟶ stratosphere

⇒ 1979 (obser.) ozone hole (30% ↓ Ozone) Antarctica

⇒ Kyoto Treaty 1999.

⊙ SAFAR
↳ website
↳ IITROPMET developed it

↳ captures air quality data from Ahmedabad, Pune, Mumbai, Delhi
↳ displays AQI and also predicts for next day.
↳ Updation cycle: 4-5 hours

27/02/2019
Wednesday

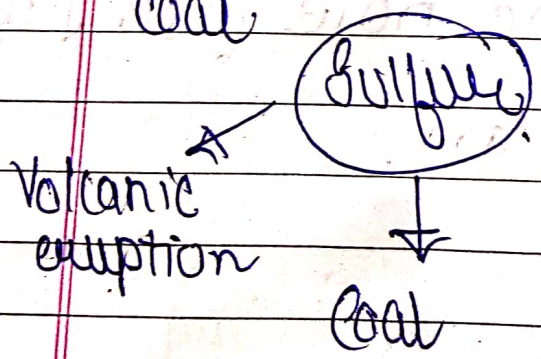
* Lecture: 15 *

* Air Pollution Control :-

⇒ Dilution: → Does not work now
↳ allowing to stabilize in some layer of air
↳ Best Strategy is to reduce consumption and loss.

↳ Filtering particulate matter eg precipitators (electrostatic).

↳ Switching from coal with high sulfur content to low sulfur coal



↳ NO_x can be reduced in both IC engines and industrial boilers by approx 50%.

CO → Automobiles major source
incomplete combustion is the problem
used Pt to solve

* Clean Air legislation :-

Breathing air and using water ← Cost of pollution → Growing crops

Cost of pollution → Diseases.

⇒ Air (Prevention and Control of Pollution) Act in 1981

⇒ Implementing laws
- US Research
- investment of order : 50 billion $
- Return of order : 1300 billion $.
- Ratio 1:25.

⇒ CPCB & SPCB
Central Pol. control board — State

→ Env. Protection Act ↔ 1986

* Trading pollution credits :
  - Cap and trade system
  - EPA sets max pollution level
  - Buy and sell emission credits
  - Very successful strategy for sulfur dioxide

* Problems :

1) Developing
   - Lead level among children in Mexico is quite high
   - 80,000 polluting countries
   - weak governance in South American countries
   - deformed children.

2) Shenyang - world's worst continuing particulate matter - China

3) Brazil - Valley of Death.

4) Rakhiyal - Ahmedabad
   Red colored groundwater.

* Improvements :-

1.) Biggest problem of Delhi - vehicle emissions.

* Laws and Acts :-

Act
Amendment
Rule.

Not been approved by statutory bodies.

1.) Indian Forest Act, 1927 :
└ Considered forest as a source of revenue back then
└ today perceived as sink.

2.) Atomic Energy Act, 1962
└ double edged sword
Peaceful → But only 5% usage

3.) Wildlife Protection Act, 1972 → Stop poaching
└ Amended in 2003
└ Separate chapter to create NTCA (National Tiger Conservation Authority).

4.) Water Act, 1974.
↳ (Min 80%) (forest area)

5.) Forest Conservation Act, 1980, amended in 2005.

6.) Env. Protection Act, 1986. amended in 1991.

↳ 13,00,000 tribes must be evicted.

↳ must prove usage to sustain ownership of land (patta).

↳ (National Green Tribunal) Central govt. NGT. Authoritarian body

7.) Ozone depleting substance rules, 2000

8.) Biological diversity Act, 2002

9.) Disaster Management, 2005

↳ Successful globally. stratospheric ozone.

↳ 3R { Reuse, Relief, Rehabilitation }

Next page

10.) CRZ not

11.) National

12.) Solid W 20

(ix) No
↳ N
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⇒ No
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(xi) Solo

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10.) CRZ Notification, 2011

11.) National Renewable energy act, 2015

12.) Solid Waste management rules, 2016

(ix) No co-ordination before act
↳ Now consolidated and under authority of home minister

(x) coastal pollution.
↳ confluence rivers
↳ illegal construction
⇒ No construction till 500m - 1km - regulation
↳ protect backwaters and estuaries.

(xi) Solar, Tidal, Wind, etc

* International :-

1.) Convention on Int. Trade in Endangered Species (CITES, 1973)
↳ wildlife

2.) Montreal Protocol (1987).

↳ Ozone
↳ CFC

3.) Basel Convention (1992)
↳ Oil Balast → produce pollutant and dispose at other Oceans
↳ Marine pollution
↳ 172 signatories

4.) UN Framework of climate change (UNFCCC) (1994).
↳ Started at Germany, 1995
↳ Every Year
↳ Kyoto Protocol (1997)
⇒ Reduction in GHG emission
↳ Conference of Parties (COP)
↳ Paris Agreement (2015)
↳ Us dopts out.
↳ stopped financing UNFCCC

set up locale-specific advisories

06/03/2019
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06/03/2019
Wednesday

* Lecture: 16 *

⇒ 3 very imp factors for vegetation growth
- ↳ temperature
- ↳ sunlight
- ↳ water

color represented limitation.

⇒ 20% Biomass → 9% C

⇒ Carbon sinks
- (i) Biomass
- (ii) Ocean
- (iii) Photosynthesis
- (iv) Fossil Fuels

⇒ LAI (Leaf Area Index)
- ↳ Active Photosynthesis
- ↳ Transpiration

⇒ NDVI
- ↳ $\frac{NIR - Red}{NIR + Red}$ → Near Infrared
  - ↳ green → healthy
  - ↳ red → stressed

⇒ FAPAR

25/03/19 Monday

⇒ Higher rainfall ⇒ More vegetation ⇒ More carbon sequestrated.

⇒ High Drought ⇒ Less vegetation ⇒ More carbon release

⇒ Insolation → sunlight falls ⊥ to the surface of earth
→ 9:30 – 10:30 a.m.

⇒ NPP = GPP – respiration

Allometric – in situ
Flux tower – costly
Extrapolation
Light use efficiency – most used

⇒ Spatial & Temporal resolution

⇒ NPP = 0.5 * GPP

25/03/19 Monday

* Lecture : 17 *

* Biodiversity

Biological - Diversity.

- various life forms of Earth
- evolved over 3.5 billion years
- estimated ~~7~~ - 30 billion life forms since the dawn of life
- many life-forms are now extinct
- species : can produce offspring and survive in Earth system

methods → sexual, asexual

all ecosystems

footprint - DNA.

- Different forms of biodiversity

(i) genetic (ii) species (iii) Ecological

(ii)	(iii)
same species different footprints → (iii) different ecosystems.	different species in "similar" ecosystem → (eg. Western and Eastern Ghats)

- α-diversity = |A| → set of species in system A
- β-diversity =
- γ-diversity = |A ∪ B ∪ C ∪ ...|

* Values of biodiversity :-

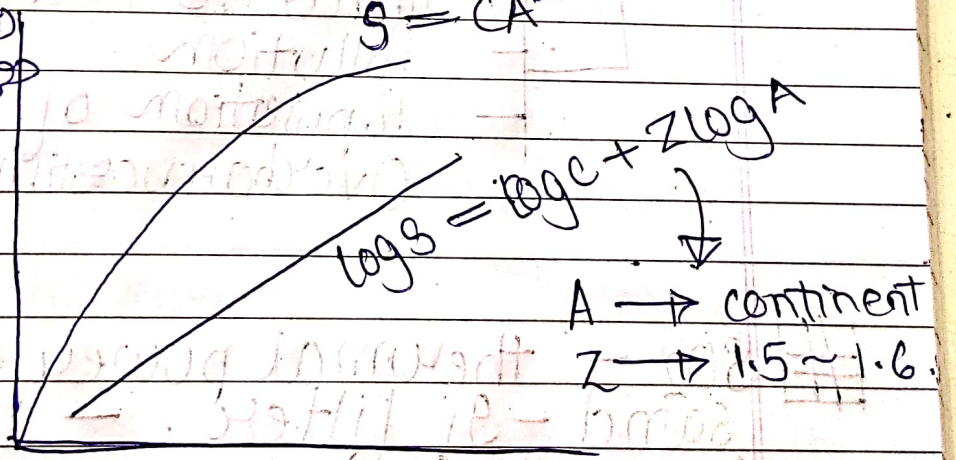
(i) Food : 80000 edible plants & 90% food crops from wild
(ii) Drugs : 75% from wild

Alcoloids : cure of cancer, especially in infants - periwinkle plant → only in Madagascar - vinblastine, vincristine - exploitation of Madagascar (endemic)
→ similar with farmers growing high-quality Basmati rice in Dehradun.

(iii) Stability : 95% control of pests and pathogens.

eg. Paddy and wheat which are quite vulnerable are protected because of biodiversity.

* Patterns of BD :-
  - No equal distribution
  - Latitudinal gradients.
    - Tropical (23°N - 23°S) high diversity areas (Columbia - 1400 bird species)
    - Polar (less diversity areas)



* Hotspots of diversity :-
  - endemic eg Asiatic lion in Gir"
  - Biodiversity quite high
Cambodia, Vietnam, Laos, Thailand, Myanmar, Bhutan

⇒ Hotspots must be conserved and maintained

* Threats :-

- extinction 1 species / decade is normal
- 1000+ species extinct in last 100 years

* 6th stage of extinction :-

└ Anthropogenic
  - Habitat destruction
  - Invasive species
  - Pollution
  - Population of humans
  - Overharvesting

SO2 — thermal power station
sand - si filter — DA
2000 - 25000
transportation
earth worm
paddy fields
particulate matter
soil organism
both

ocean water is heated up
True
False
False
False
True

Wednesday

⇒ Fragm
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⇒ Biodive
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Wednesday

Lecture : 18.

24/03/2019

⇒ Fragmentation of ecosystem (+) IPO hinders symbiosis between organisms thus threatening biodiversity, at the cost of development.

⇒ Biodiversity is estimated to be worth $6120 (US) per hectare of a tropical forest. (₹4.28 lakh)

⇒ Trees moreover form the sink for CO_2 released because of automobiles.

⇒ Biodiversity

- Richness
  - Qualitative: Variety of species
  - Quantitative: Margalef's diversity index $D_{mg} = (S-1)/\ln N$
- Evenness: less dominance of a given species.

* Shannon index or entropy

$\Rightarrow H^+ = -\sum_{i=1}^{R} p_i \ln p_i$

↳ depends on proportion of species
↳ associated with uncertainty

* Simpson's index

↳ probability

↳ $D = \sum \left(\frac{n}{N}\right)^2$

two given samples ~~species~~ are of same species

$\frac{79}{225} = \frac{5}{45}$

Monday *

Climate

- Rise in
- Rainfall
- Rise in
- Frequen

"explaining Climate

Sun

Regul

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Monday * Lecture: 19 * 1/4/2019

Climate change

- Rise in temperature
- Rainfall pattern
- Rise in sea level → Miami $40 million
- Frequency of storms.

"explainingclimatechange.com"

Climate Science

Sun → Source
- → warmes land, oceanes, atmosphere
- → Eabsorbed = Ereflected
  - → stability
- → Tilt of earth's axis regulates distribution.

- Water (75%) → earth's surface
  - Absorption is maximum
- clouds, glaciers, polar ice
  - → reflection

- 1 million years → 100,000 year cycles → ice ages and warmer periods.

- Weather $\xrightarrow[\text{time}]{\text{longer}}$ climate
- Solar radiation has no correlation with "occuring rise" in temp.
- Paris agreement $\xrightarrow{\text{prevent}}$ 1.5°C
- Earth's albedo : (Ratio of reflected to transmitted energy)

⇒ Evaporation of water D_2O and H_2O^{18} get less vaporized because of mass.

↳ ice core samples are checked for relative amt of isotopes

Wednesday

Lecture : 20

3/04/2019

Monsoon ← trade winds — Pacific Ocean

⇒ Distribution of energy and rainfall is quite uneven because of a variety of factors

⇒ 3 cell of Hadley Cell, Ferrel Cell, Polar Cell

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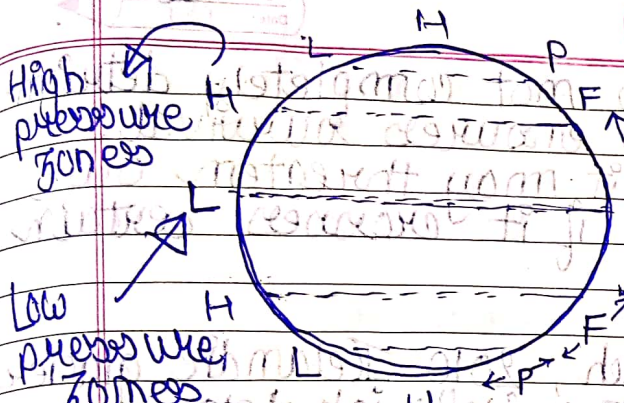

⇒ Polar molecules result in absorption.

⇒ High frequency waves
γ-, X-, UV-, rays
↳ ionization.

⇒ Infrared & Microwave
↓ ↓
Increased oscillation → E(↑) ← Increased rotation.
↓
Heat (↑)
↓
Temp (↑)

Tropospheric Lapse Rate

→ Heating is not completely detrimental, it ensures survival. However, it may threaten our existence if it crosses certain limits.

⇒ 20th March, 2010 Icelandic glacier volcano Eyjafjallajokul erupted.

→ large amount of ash was spread into the atmosphere

aerosol of a certain dimension

⇒ Two definitions

Per-Capita
- USA, Australia (highest CO_2 emitters)

Total
- India, China (highest CO_2 emitters)

Monday

Recap: Rad

filtered by O_3

UV Vis.

Emission of therm radiation

↓

mostly infrared

(concept of black radiat

⇒ Gre

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rest

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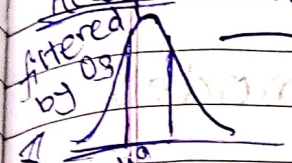
Monday

Lecture : 21

08/04/2019

Recap: Radiation balance



Incoming radiation

Primarily in visible region

Emission of thermal radiation

Mostly infrared

(Concept of blackbody radiation)

Reflection (30%)

By
1) Clouds
2) Ice
3) Snow
4) Sand
5) Vegetation
6) Water bodies

Effectiveness varies.

Greenhouse effect.

⇒ Greenhouse accumulation because of anthropogenic activities results in imbalance

Climate model

- IPCC – Intergovernmental panel for climate change
- General circulation model

Economy
Population
Technology
Energy / Env

A1F1 — A1B — A1T

A1F1 → Fossils (Non-renewable)

A1B → between

A1T → Technology (Renewable)

⇒ Polar affected more ⟹ less buffer

(↳ simulation
↳ 55 million years ago
↳ Paleocene Eocene Thermal Maximum
↳ temp. anomaly (5 – 6 °C)

⇒ Difference from today
- anthropogenic
- not ~~the~~ transportation

methane clathrate hydrate trapped below water and ice released because of tectonic movements
- → high temp
- → low pressure

2) Coral reefs.

symbiotic
- zooxanthellae algae
  - colours
  - provides nutrients.
  - gains shelter and protection

→ Just like rhizobium and leguminous plants

Coral bleaching.

4) Extreme weather

5) Biodiversity

Frogs — cold blooded
— yet thermoconformers
↳ many migrating away from equator

Monday * Lecture: 22 * 15/04/2019

Cycle → Numerous processes where the concerned substance returns to its original state

↳ Hydrological cycle
↳ Carbon cycle
↳ Oxygen cycle.

Certain resilience possessed against changes.

Feedback loops

Positive feedback loop
(eg. money deposited in a bank)

Negative feedback loop
(eg radioactivity)

⊕
I/P → O/P
⊖

we have been in the +ve feedback loop for about 50 years.

Another example
Population growth

Detour: 2%
China has established great control. Italy county.

↳ By the this centu will reach CA CAPACITY.

eg. Therm

∴ "Feedback" is c

∴ called

⇒ CO_2 s

short term

⇒ lot of atmosph

⇒ Phyt

Short - for stor

• Water
• Ocea
in ta

↳ By the end of this century we will reach CARRYING CAPACITY. → stabilisation around (8–9 billion).

eg: Thermostat (+, −) Heater } Artificial process.

∴ "Feedback" is defined as intrinsic to a system.

∴ ~~FORCEDING~~ Climate change is affected by external factors which is called external forcing.

⇒ CO_2 sequestration

- short term
- long term
  - ocean
    - dissolved in water
    - corals → CO_3^{2-}

⇒ Lot of CO_2 is emitted into the atmosphere due to volcanic eruptions
↳ positive forcing.

⇒ Phytoplankton use CO_2 for photosynthesis

short term reserves for storage of CO_2.

⇒ $Q = mC\Delta T$

- Water has high heat capacity.
- Ocean and atmosphere are always in tandem with each other.

- "Great conveyor belts" ↔ why does it move
  - "Eddies"
    1) Temperature gradient
    2) Salinity gradient
  - Thermo - haline belt → lifeline of ocean
    - Cool water : Polar → Tropical (Nutrient rich) (food for marine animals).

EL NINO

- ocean and atmosphere in perfect sync.
- rise in sea-surface temperature rises.
  - anomalous rise will disturb the pressure difference as well as the locomotion of water vapour which might result in droughts or floods in the terrestrial regions because of extreme conditions concerning rainfall.

- Rise in Sea level
  - Thermal expansion.

- Salinity variation
  - Change in pH
  - disturbance of carbonate structures.