

GREENHOUSE GAS AND WARMING

- Water Vapour- **Largest** amt among GHGs by Volume and by Weight (Humans are NOT directly responsible for it)
- Contributors: 1. China= 26% 2. USA= 14.75% 3. EU= 9.33 + 7.45
India=6.43%

CARBON DIOXIDE

Sources

- Natural-
 1. Ocean-atm exchange
 2. Plant and animal respiration
 3. Soil respiration and decomposition
 4. Volcanic eruptions
- Highest emitting industry- 1. Electricity and energy
- Top emitters: 1. China 2. USA 4. India (5 times less than china)
- Emission per capita: china= 7.5 india= 1.7

METHANE

Natural

- Wetlands
- Termites, ocean, sediments, volcanoes and wildfires

Human

- Agriculture: CATTLE (Agri- primary source of CH₄ emission)
- Landfills
- Crude oil and gas production

NITROUS OXIDE

Natural

- Bacteria in soils and oceans

Human

- Agriculture- synthetic fertilizers + livestock urine and manure
- Transportation
- Industry: 1. Byproduct in prod of commercial fertilizer 2. Byproduct in prod of adipic acid (prodn of fibres like nylon)

FLURINATED GASES- HFC, PFC, SF6

- Very high GWP
- Most potent and longest lasting GHGs
- Removed only when destroyed by sunlight in far upper atmosphere

HFC- refrigerants, aerosol propellents, solvents, fire retardants

PFC- Aluminum production, Manf of semiconductors

SF6- Used in: Magnesium processing, semiconductor manf., tracer gas (leak detection), electrical transmission equipment

GHGs & Lifetime of GHGs

SR NO	GAS	GWP	LIFETIME
1	Carbon Dioxide	1	100
2	Methane	21	12
3	Nitrous Oxide	310	120
4	HFCs	140-11,700	1-270
5	PFCs	6,500-9,200	800-50,000
6	SF6	23,900	3,200

CARBON

Carbon type	What is it	Source	Effect on atm	Lifetime
BLACK CARBON aka SOOT	Solid particle or aerosol	1. Biomass burning 2. Cooking with solid fuels 3. diesel exhaust	1. strongest absorber of sunlight 2. reduce albedo 3. disrupts cloudiness and monsoon rainfall 4. PM	Only days or weeks (Short lived Climate Pollutant SLCP)
BROWN CARBON	Light absorbing organic matter	1. organic Biomass burning 2. Agri fires	GHG	
BLUE CARBON	Coastal, organic or marine carbon sinks			

NOTE- Project Surya for Reduction of black carbon in atm

CLIMATE CHANGE AND OCEAN ACIDIFICATION

- Saturation horizons- levels below which calcium carbonate minerals undergo dissolution

- Ocean acidification causes SH to rise vertically
pH of ocean falls>>>shallowing of SH>>>more shells dissolves>>>buffers ocean acidification
- **Lysocline**- depth at which dissolution **strongly increases**
- Carbonate Compensation Depth (**CCD**)- depth @ which **ALL** carbonate **dissolves**
- Upwelling>>>cold water with more CO₂ and nutrients>>undersaturated in calcium carbonate>>>harms corals

OZONE DEPLETION

- Major Ozone depleting Substances-
 1. CFC
 2. N₂O
 3. Carbon tetrachloride
 4. HCFC
 5. Methyl chloroform
 6. Bromine
- NOTE- HFC= **NOT** ozone depleting, but GHG

CHLOROFLUOROCARBON (CFC)

- Uses- refrigerants, propellants in aerosol sprays, foaming agents in plastic manufacturing, fire extinguishers, solvents for cleaning electronics and metallic components, food freezing
- $\text{CFC} + \text{UV light} = \text{Cl}$, $\text{Cl} + \text{O}_3 = \text{ClO} + \text{O}_2$, $\text{ClO} + \text{O} = \text{Cl} + \text{O}_2$
- NOTE- **NOT** destroyed by Photodissociation, but reacts with Nitrogen or Hydrogen compounds which return it to its reservoirs

NITROUS OXIDE

- Thermonuclear weapons, industrial emissions, agricultural fertilisers
- Photolytically destroyed in stratosphere to form **Nitric oxide** which destroys Ozone

OZONE DEPLETION MECHANISM

- Ozone Hole- in **lower stratosphere**
- Background- Cl is present in **inactive form** in reservoirs such as HCl and ClONO₂ (Chlorine nitrate).
- Polar Stratospheric Clouds (PSC)- forms during Antarctic Winter (March- Oct) due to fall of temperature due to **polar vortex**
 - PSCs fastens the reaction of HCl and ClONO₂ and releases **free Chlorines**
 - However, **Lack of sunlight** prohibit ozone depletion process until Polar Spring

- Polar Vortex- Strong Westerly winds formed in Polar winter contains polar cool winds near Antarctic Zone
- Polar Spring- **Sunlight** returns to centre of polar vortex and drives photochemical reaction which causes **ozone depletion**
 - Further warming of Polar region around December causes disintegration of PSCs and warm, ozone rich air flows from lower latitudes. This shuts down ozone depleting process

Why Depletion more in Arctic than Antarctic

1. **Air Exchange with mid latitudes**- greater in Arctic than Antarctic, thus prevents temp to reach much lower (-65°C) which forms PSCs
2. **Polar Vortex**- Remains throughout the winter over Antarctic, but disintegrates by polar spring in Arctic (March- April)
3. **Temperature**- Daily temp in winters are much less in Antarctic than Arctic

MITIGATION STRATEGIES

CARBON SEQUESTRATION

- Carbon sequestration = Carbon capture + Carbon Storage

Carbon Sinks

- Natural- Ocean, Forest, Soil
- Artificial- Depleted oil reserves, unmineable mines
- Ocean systems are very efficient at sequestering and storing carbon (At higher rates than Tropical Forest)

Types of Sequestration

1. Ocean Sequestration- storage in ocean through Direct injection and Fertilization
2. Geologic Sequestration- Natural pore spaces
3. Terrestrial Sequestration- Natural sinks like soils and vegetation

CARBON CREDIT

- Under **KYOTO protocol**, 1997
- Tradeable certificate or permit representing right to emit one tonne of carbon or tCO_2e
- How it is obtained? >>>Org which produces One tonne less Carbon, then obtains 1 Carbon credit>>>can sell to company emitting more than its limit>>thus org can get finance + limit breacher can achieve target
- Traded in stock exchanges
- **Multi Commodity Exchange (MCX)**- first in **Asia** to allow carbon credit trading

CARBON OFFSETTING

- Credits for REDUCTION in GHG made at ANOTHER location
- Carbon offsets are quantified and sold
- Not only reduces carbon footprint, but also gives added benefits

Diff between carbon credit & carbon offset

- Offset- permit to emit only when actual realization of result at another place (i.e. actual reduction in GHG)
- Credit- Transfers techno or finance and earns credit (irrespective of benefits/ reduction realized)

LULUCF (Land Use, Land-Use Change, Forestry)

- Category within UNFCCC accounting framework for **GHGs**
- Aka Forest and Other Land Use (**FOLU**)
- It's a **net carbon sink**- includes carbon pool of living organism, dead organic matter, organic soil carbon

CARBON TAX

- Based on **amount of carbon contained** in fuel
- India against carbon tax by developed countries
- Border Carbon Adjustment by US , EU and other dev countries

INDIA'S NATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

- **PM's Council on Climate Change**- responsibility of overall Implementation
- Council will periodically review progress on each underlined missions
- Council: MoEFCC, MEA, FinMin, MoWR, MoAgri, MoUD, MoS&T, MoSoPower, Principal secre to PM, Cabinet secre, Foreign secre

1. National Solar Mission

- Target: **100 GW** by **2022**- 40 GW rooftop + 60 GW thr Large and Medium Scale Grid Connected Solar Power projects (Earlier target: **20 GW** by 2022)
- NOTE- India- **5th** highest solar installed capacity in world

2. National Mission for Enhanced Energy Efficiency (NMEEE)

A. PAT B.MTEE C.EEFP (Energy Efficiency Financing Platform) D.FEEED

3. National Mission on Sustainable Habitat

4. National Water Mission- promotion of water neutral and water positive tech

5. National Mission for Sustainable Himalayan Ecosystem
6. National Mission for Green India- A. Increase forest cover over 5 million hect and improve quality of forest cover of another 5 million hect
7. National Mission on Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change (NMSKCC)

NATIONALLY DETERMINED CONTRIBUTIONS

- 19th COP@ Warsaw- initiate domestic preparations for INDC and communicate them in 21st COP@Paris
- NOTE- INDC= what post-2020 actions they intend to take under new international agreement

India's INDC @ COP 21

1. reduce emission intensity of GDP by 33-35 % by 2030 from 2005 levels
2. 40% electric power installed capacity from Non-fossil fuel by 2030
3. Additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent by 2030

INDIAN NETWORK ON CLIMATE CHANGE ASSESSMENT (INCCA)

- By MoEFCC to promote domestic research on climate change
- Independent body of Indian Scientist to prepare scientific reports on impact of CC
 - Reports form part of India's Nat Com to UNFCCC
- 2nd assessment: 4X4 : 4 regions, 4 sectors
 - W.Ghats, Himalaya, Coastal, N.E. Agri, Water, Forest, Human Health

NATIONAL COMMUNICATION (NATCOM)

- **Funded** by Global Environment Facility (GEF)
- Implementing and executive agency- MoEFCC

GRIHA (Global Rating for Integrated Habitat Assessment)

- TERI + MNRE
- It is green building rating system

NICRA (National Initiative on Climate Resilient Agri)

- By ICAR

NAPA (National Adaption Programs of Action)

- Plans submitted by LDC to UNFCCC to describe country's perception of it's most urgent and immediate needs to adapt CC

CLIMATE CHANGE SUMMITS

YEAR	COP	PLACE	MAIN POINTS
1997	3 rd	Kyoto	1. Kyoto protocol- operationalizes UNFCCC 2. set binding targets on 37 industrial nations- CBDR 3. *See below 4. Penalties for non compliance
2001	7 th	Marakkash	Creation of Adaption Fund
2007	13 th	Bali	1. to decide on 2 nd phase of Kyoto after 2012 2. Bali Roadmap- to finalize binding agreement in 2009 3. Launch of Adaption Fund
2009	15 th	Copenhagen	1. Copenhagen Accord - BASIC+ US – non binding (includes “goal” for \$100billion/year by 2020) 2. Mention of ‘Copenhagen GCF’
2010	16 th	Cancun	1. All parties agreed to report their voluntary mitigation goals- developed countries to report their inventories annually , developing country report every two years 2. Technology mechanism - Tech dev and transfer 3. GREEN CLIMATE FUND - to support projects in developing countries (WB as interim trustee)- Formally estd 4. Adaption fund - to finance concrete adaption projects in developing countries that are vulnerable to CC- Managed by Adaption Fund Board (AFB) 5. Climate Tech Centre Network (CTCN) 6. Subsidiary Body of Implementation (SBI) on loss and damage 7. Official entry of REDD
2011	17 th	Durban	Adaption of governing instrument of GCF (though empty)
2012	18 th	Doha	1. 2 nd phase of Kyoto protocol- targets to developed and some developing countries 2. GCF>>S. Korea 3. Climate Technology Centre
2013	19 th	Warsaw	1. Cancellation of CER under Kyoto 2. Warsaw framework for ‘REDD+’ 3. Warsaw International mechanism on Loss and Damage
2014	20 th	Lima	1. Capitalization of GCF 2. initiation of ‘Multilateral Assessment’ 3. National Adaption Plans to curb and cut GHG emission

			4. UNFCCC secretariat's 'Momentum for Change'
2015	21 st	Paris	1. Nationally Determined Contributions 2. Global Stocktake- 5 yearly review of impact of country's climate change action Paris agreement entered in force in 2016, CMA started from Marrakech 3. agreement requires developed countries to provide BINNIAL reports on financial support provided thr 'Public intervention'
			NOTE- USA is ONLY country that rejected Paris agreement
2016	22 nd 1 st CMA	Marrakech	1. initiation of process to structure global stocktake 2. "Orphan" issues 3. Adaption fund- decision to continue AF estd under Kyoto inspite of having GCF 4. Mid-century strategy- new initiative " 2050 Pathway Platform " 5. first review of Warsaw Loss and damage mechanism 6. Marakkesh Partnership on Global Climate Action – to mobilise benefits of climate actions quickly 7. Marakkash Accords : regulatory framework for implementation of Kyoto protocol
2017	23 rd	Bonn (prez: Fiji), germany	1. ' Fiji Momentum for implementation '- steps needed to taken in 2018 to make paris agreement operational 2. Talanoa Dialogue (aka Faciliatative dialogue)- process to help countries to implement their NDCs by 2020- precursor of global stocktake that will take place from 2020 every 5 yrs 3. Suva Expert Dialogue on Loss and Damage
2018	24 th	Katowice (Poland)	1. 'Facilitative dialogue' – early stocktake in 2018 2. Paris rulebook - to implement Paris agreement from 2020

Kyoto mechanism-

1. Emission Reduction Commitments- binding

2. Flexible Market Mechanism- trade of emission permits

1. Joint Implementation- Annex B country earning Emission Reduction Units (ERU) from emission reduction projection in another Annex B counry (thus JOINT implementation)

2. CDM- Annex B country to implement emission reduction project in developing countr (But APPROVAL of Annex B countries is required)

3. Carbon Trading- exchange of emission permits(aka Carbon credit)
(WITHIN or OUTSIDE economy + CO₂ or any other gas)
- A. Emission Trading/ Cap-and-trade - limiting amount on emission of country
- B. Offset Trading/ Carbon project/ baseline-and-credit: earn Carbon credit by investing some amount in carbon projects

NOTE- India's Multi Commodity Exchange= Asia's First commodity exchange to allow carbon trading

Green Climate Fund (GCF)

- Within framework of UNFCCC (NOT Kyoto Protocol)
- Base: Incheon, South Korea
- Governed by: BoD with 24 members
- Funding: by Member countries (Note- EU- Does not provide direct funding>> but member countries individually contribute>> aggregate contribution is Highest)
- MoEFCC- Nationally Designated Agency for GCF>.recommends funding proposal to GCF board
- NABARD- National Implemented Agency for GCF in India
- Accredited entites: NABARD and SIDBI

UN-REDD : FUU

- Multilateral body to partner with developing countries to support them to meet REDD+ targets
- Created in 2008 in response to UNFCCC decision on Bali Action Plan and REDD at COP13
- Collaborative programme of : FAO + UNDP + UNEP
- India: NOT a part of UN REDD

REDD+

- Voluntary Climate change mitigation approach developed by parties to UNFCCC
- Aim- incentivize developing countries to reduce emissions from deforestation and forest degradation, conserve forest carbon stocks, sustainably manage forest and enhance forest carbon stocks
- REDD+ - created by Coalition of Rainforest Nations (India member) and put forth to UNFCCC

COP 11, 2005 at Montreal	Coalition of 9 rainforest nations sought attention to growing threat of deforestation and introduced concept of Reducing Emission from Deforestation (RED)
COP 12, 2006 at Nairobi	' Compensated Conservation ' policy introduced by India intended to compensate countries for maintaining and increasing carbon pools of their forests.
COP 13, 2007 at Bali	' Compensated Conservation ' policy approach finally recognized
COP 16, 2010 at Cancun	Official entry of REDD as a UNFCCC-enabled mitigation mechanism
COP 19, 2013 at Warsaw	It agreed on Warsaw REDD+ framework

- 2018: India released National REDD+ Strategy
 - Prepared by Indian Council for Forestry Research and Education (**ICFRE**)
 - One of tools to supplement commitments under paris agreement, 2015
 - **Green Skill Dev Programme** will be launced for imparting forestry related specialized skills
 - Will communicate to UNFCCC
 - Imp points:
 1. Covers all trees **within and outside** the forest area
 2. Sub-national REDD+ approach: country divided in **14** physiographic zones by **Forest Survey of India**
 3. Funding: thr Finance Commision + GCF + CAMPA
- **Forest Carbon Partnership Facility (FCPF)-**
 1. global partnership of govts, business, CSO, Indigenous peoples **focused on targets of REDD+**
 2. Estd in 2008, Complements UNFCCC negotiations on REDD+
 3. funding mechanism- A. Readiness Fund B. Carbon Fund
 4. does NOT participate in direct aids to Insti, individuals, etc, but funds to countries
 5. India- **not** a member
 6. Secreatariat- **World Bank**

GLOBAL ENVIRONMENT FACILITY (GEF)- **WUU**

- Estd @ Rio summit, 1992
- Estd as Pilot project in **World Bank**, (But @ rio summit>>>moved out of WB and made SEPRATE INSTITUTE)
- Implementing partners- **WB + UNDP + UNEP**
- **Trustee**- WB
- GEF **assembly**- **184** countries- meet **every 4 years**
- GEF **council**- **34** members
- Areas of work- BD, CC, Int Waters, LD&desertifi, Ozone deplet, POP
- Serves as financial mechanism for

1. CBD
2. UNFCCC
3. UNCCD
4. Stockholm convention on POP
5. **Minamata Convention** on Mercury

Also supports impl. of Montreal Protocol in countries with economic transition

- Other Implementing partners (total 18): ADB, AfDB, EBRD, FAO, IUCN, UNDP, UNEP, WB
- India: Founding Member, **1st GEF assembly took place in India**
- **MoEFCC**- GEF **Operational Focal Point** (OFP) for India- responsible for all country coordination
- **DoRevenue, MoFinance**- GEF **Political Focal Point** (PFP)
- **GEF/UNDP Small grants Program**- launched @ Rio, 1992>> financial and technical support to **Civil Society Org** for projects of envi conservn (Indian nodal agency: **Centre for envi Edu** (CEE))

IPCC

- By **UNGA** on proposal of **UNEP + WMO** in **1988** (thus estd by UNEP + WMO)
- Thus IPCC- org of govts that are members of Un or WMO
- **Secretariat- @ WMO HQ**
- Does **NOT** conduct any research, Does **NOT** monitor any climate related data
- Work of org- policy neutral or policy relevant, **NEVER** policy prescriptive
- Special report- on specific topics
- Assesment report- at regular intervals for understanding of human induced CC, potential impacts of CC, options for mitigation and adaption- Published in several volumes as **synthesis reports**- written in NON-technical language
- Estd National GHG Inventory Program (**NGGIP**)- to provide methods for estimating national inventories of GHG emissions

World Meterological Organisation

1. Intergovernmental + **Specialised Agency of UN** for meterology, hydrology
2. Origin: International Meterological Org, 1873>> **World Meterological convention, 1947**
3. **HQ- Geneva**, Switzerland

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY (TEEB)

- By **Germany** and **European Commission** in 2007
- Initiative to draw attention to global economic benefits of biodiversity
- MoEFCC launced TEEB-India initiative

ECOLOGICAL FOOTPRINT

- Human demand on Earth's ecosystem
- Earth overshoot day or Ecological Debt day- By Global Footprint Network (GFN)

CARBON FOOTPRINT

- Amount of carbon emitted by activity or Organisation
- Carbon component of ecological footprint converts amount of CO₂ being released into amount of Land and sea required to **sequester** it>> thus tells demand on earth that results from burning fossil fuel

CLIMATE INVESTMENT FUNDS (CIF)

- Devolped by countries and implemented by Multilateral Developement Banks (MDB) to bridge financing and learning gap between now and next international CC agreement
- Additional to Official Dev Assistance (ODA)
- Two types- 1. Stratergic Climate Fund 2. Clean Tech Fund

Strategic Climate Fund (SCF)- administered by **WB**

Forest Investment Programme	World Bank	1. to developing countries on REDD and sustainable forest management
Pilot Programme for Climate Resilience	World Bank	1. integrate CC and resilience into core dev planning and implementation
Scaling-Up Renewable Energy Program for Low Income Countries	World Bank	1. demonstrate Socio-envi viability of low carbon dev pathways

Clean Technology Fund

- World Bank
- Financing transfer of low carbon technologies

Other funds:

Forest Carbon Partnership Facility	World Bank	To assist developing countries on REDD +
Partnership for Market Readiness	World Bank	Support mitigation efforts of middle income countries
Adaption Fund	Adaption Fund Board	1.Financial instrument under UNFCCC and Kyoto 2.Financed with shares of proceeds from CDM projects
Special Climate Change Fund(SCCF)	Global Envi Facility (GEF)	1. adaption of developing countries vulnerable to to CC
Global Climate Change Alliance (GCCA)	European Commission	Build new alliance on CC between EU and Poor developing countries
Global Energy Efficiency and Renewable Energy Fund (GEEREF)	European Commission	1. PPP designed to maximise private finance leveraged thr public funds (thus Fund of Funds) 2. managed by European Investment Bank (EIB)
Adaption for Smallholder Agri Program (ASAP)	Int Fund for Agri Dev (IFAD)	Finance to small farmers